IDAHO HABITAT EVALUATION

FOR OFF-SITE MITIGATION RECORD

Annual Report 1988

IDAHO DEPARTMENT OF FISH AND GAME

Prepared for

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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) (1) 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 **(IDFG)** 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 **(BPA)** 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 is being developed to use actual and potential increases in smolt production as the best 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 (Scully, et al. 1990) 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. The primary objective of the intensive monitoring subproject (Kiefer and Forster 1990) is to determine the relationships between spawning escapement, parr production, and smolt production in two Idaho streams: the upper Salmon River and Crooked River. Results of the intensive monitoring will be used to estimate mitigation benefits in terms of smolt production and to interpret natural production monitoring in Idaho.

Project Benefits

Project benefits to date, estimated in terms of parr produced, averaged 122,874 chinook and 14,618 steelhead from 1986 to 1988 (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 and sediment reduction projects contributed 70, 4, 22 and 4% of the total parr benefits, respectively. A number of uncertainties exist regarding effectiveness of **instream** structures. Sediment reduction projects are still in progress, and anticipated benefits are yet to accrue.

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Summary Table 1. Total abundance of steelhead parr (ages-1+ and
                  -2+) attributed to benefits of implemented
                  projects, 1985-1988.

Project type, stream	Steelhead parr benefits				Potential parr benefits
	1985	1986	1987	1988	
Barrier Removal					
Complete					
Eldorado Cr.		7,310	5,309	1,306	14,384
Pine Cr.	(Adult passage infeasible)				0
Colt Cr.				0	8,582
Partial					
Crooked Fk. Cr.		277	85	0	54,521
Crooked R. (culvert)		1,375	1,174	1,958	10,790
Pole Cr. (screen)	210	23	32	381	1,943
Dollar Cr.			1,060	2,461	4,785
(Sub-total 1)	210	8,985	7,660	6,106	95,005
Off-Channel Development					
Crooked R.		326	3,076	1,108	912
Red R.		1	d(-not a -)		28
(Sub-total 2)		327	3,076	1,108	940
Instream Structures [a]					
Lolo Cr.	5,169	6,068	4,495	1,798	b
Upper Lochsa R.	(no measurable benefits)				
Crooked R.	-72	0	4,977	2,813	b
Red R.	704	-235	118	-1,058	b
(Sub-total 3)	5,803	5,833	9,590	3,553	
Sediment Reduction					
Bear Valley/Elk Cr.				-2,383	b
(Sub-total 4)				-2,383	
Grand Totals:	6,013	15,145	20,326	8,384	

[a] Additionally, in 1984, 1109 steelhead parr were a benefit of
the Lolo Creek instream structure project.
[b] Potential parr benefits from instream structures and sediment
reduction projects are not measurable since the differences in
carrying capacity before and after project maturity is unknown.

Summary Table 2.   Total abundance of chinook parr (age-O+)
                   attributed to benefits of implemented projects,
                   1985-1988.

Project type, stream	Chinook **parr** benefits				Potential parr benefits
	1985	1986	1987	1988	
Barrier Removal					
<u>Complete</u>					
Eldorado Cr.		30,206	13,328	5,936	110,478
Crooked Fk. Cr.		17,600	32,600	17,700	57,248
Johnson Cr.	7,206	23,711	17,700	52,086	294,750
Boulder Cr.		28,112	0	1,560	82,504
Meadow Cr.				15,000	39,036
Knapp Cr.				63	84,040
<u>Partial</u>					
Crooked R. . (culvert)	5,351	3,707	740	7,061	18,562
Pole Cr. (screen)	0	0	0	8	14,962
Dollar Cr.				38	7,255
(Sub-total 1)	12,557	103,336	64,370	99,452	708,835
Off-Channel Development					
Crooked **R.**		4,119	209	5,865	37,123
Red R.		2 1 5	(-no data-)		216
(Sub-total 2)		4,339	209	5,865	37,339
Instream Structures					
Lolo Cr.	10,788	-23,823	29,891	8,990	a
Upper Lochsa R.	(no measurable benefits)				
Crooked R.	-5,121	-886	2,092	6,852	a
Red R.	9,291	9,526	19,052	21,874	a
(Sub-total 3)	14,958	-15,183	51,035	37,716	
Sediment Reduction					
Bear Valley/Elk Cr.				17,489	a
(Sub-total 4)				17,489	
Grand Totals:	27,515	92,487	115,614	160,522	

[a] **Potential** parr benefits from **instream** structures and sediment
 reduction projects is not measurable since the difference in
 carrying capacity before and after project maturation is unknown.

Benefits of habitat improvement will depend largely on improved main stem flow and passage conditions. Under poor main stem flow conditions, many chinook populations could face extinction with or without habitat improvement. Under marginal flow conditions, improved egg-to-smolt survival from habitat improvement, such as sediment reduction, could make the difference between extinction and a viable, depressed population. Under good flow conditions, habitat projects that increase egg-to-smolt survival or carrying capacity will contribute to productivity and harvest potential of wild and natural populations.

General Monitoring

Major findings from parr density monitoring are:

I. Chinook parr densities were highest in C channel (meandered), and steelhead parr densities were highest in B channel (confined) stream sections.

2. Carrying capacity was estimated for chinook parr in excellent C channel habitat to be **108/100 m^2**, and for steelhead parr in excellent B channel habitat to be **20/100 m^2**.

3. Wild chinook parr densities and estimated **egg-to-parr** survival rates in Salmon River tributaries were significantly reduced at high sediment levels.

4. Differential supplementation levels in other streams masked sediment effects on chinook parr densities.

5. The relationship between sediment and steelhead parr densities was weak because of steelhead preference for high gradient, B channel streams which tend to flush sediments.

6. Chinook and steelhead parr densities were 13.5 and 9.3 times higher in control streams not grazed by cattle than in the heavily grazed, highly sedimented Bear Valley/Elk Creek drainage, respectively.

7. During **1985-88** chinook and steelhead parr densities averaged 15.3 and 27.2% of carrying capacity, respectively, and demonstrated no annual trend.

8. During **1985-88** the percent of carrying capacity for chinook parr averaged 11.8 in wild (indigenous) production areas and 17.4 in natural (hatchery influenced) production areas.

9. Reproduction curves for chinook parr and redd densities indicated that escapements were well below detectable density dependent effects.

I0.   During 1985-88, the percent of carrying capacity for steelhead parr in four
      classes wild A-run, wild B-run, natural A-run, and natural B-run, were:
      72.9, 11.7, 27.6, and 37.1, respectively.

11.   Chinook fry stocked into vacant habitat had **a** 20% survival rate to the parr
      stage (range **11-33%),** and generally survived better in high quality streams.

Intensive Monitoring

      Intensive studies were begun in 1987 in the upper Salmon River and Crooked
River (South Fork Clearwater River tributary) to determine the relationships
between spawning escapement, parr production, and smolt production. The studies
incorporate data from general monitoring and rely on weirs to trap adults and
scoop traps to trap juvenile migrants. PIT tags (Passive Integrated Transponder)
are being inserted into juvenile fish to determine **parr-to-smolt** survival rates.
They also provide other basic information, such as smolt migration timing,
effects of flow and passage conditions on smolt survival, upstream migrational
timing, etc.   PIT tags can provide a major key to extrapolating survival rates
between fish populations in streams with different stocks, habitat types,
instream flow regime, and sediment levels.

      This was the first year (1988) in the upper Salmon River **(USR)** that a brood
year (BY) of spring chinook was studied from spawning escapement (1986) to the
parr stage (1987) and, in part, to the smolt stage (spring 1988).   For USR **A-**
run steelhead, the first estimates for the full cycle of tributary rearing will
be made after the 1989 smolt migration.   Construction delays for the Crooked
River (CR) adult trap and weir have precluded direct counts of spawning
escapements of spring chinook and B-run steelhead.   The first estimates for CR
chinook and steelhead **parr-to-smolt** survival will be made after the 1989 and 1990
smolt migrations, respectively.

      Major findings of the intensive monitoring study are:

1.   Estimated **egg-to-parr** survival rates for USR chinook in BY 1986-87 averaged
      5.2%, lower than in similar streams due in part to low summer flows in 1987-
      88 and an apparently large, unquantified emigration of fry after emergence.

2.   USR chinook **egg-to-parr** survival varied by supplementation method with
      adult, **fry,** and eyed-egg outplants averaging **32%, 16%,** and **0.4%,**
      respectively.

3.   Egg deposition and **total** parr abundance have been estimated for USR
      steelhead, however better definition of age and size of parr is necessary
      to define **egg-to-parr** survival by brood year.

4.   Estimated **egg-to-parr** survival rate for CR chinook in BY 1987 was **19-28%,**
      depending on assumptions used to partition survival of supplemented fry from
      natural fry.

5. Lack of the adult weir and valid steelhead redd counts precluded estimation of **egg-to-parr** survival for CR steelhead through 1988.

6. The magnitude of fall outmigration was higher in the USR than in CR for chinook and steelhead. Fall 1988 outmigrants accounted for 64% and 21% of the chinook parr population and 48% and 3% of the steelhead parr population in USR and CR, respectively.

7. PIT-tagged chinook and steelhead from the USR were detected at Lower Granite Dam at rates of 4.0% and **4.1%,** respectively, in spring 1988. The first detections of PIT-tagged CR fish will occur in spring 1989.

8. Parr-to-smolt mortality for chinook and steelhead parr PIT-tagged above the S45 diversion on the USR was four and three times higher, respectively, than mortality of parr tagged below the diversion because of dewatering in late August and September when the parr emigrate from summer rearing areas.

9. Off-channel ponds connected to CR through BPA habitat improvement reared high densities of chinook **parr,** and the strategy was recommended for rehabilitation of other streams degraded by dredge mining.

10. The S45 and Alturas Lake Creek diversions blocked the majority of adult chinook from reaching the low gradient headwater streams where we have observed high **egg-to-parr** survival,

Part I

Subproject I

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INTRODUCTION

The Idaho Department of Fish and Game (IDFG) has been monitoring and evaluating proposed and existing habitat improvement projects for rainbow-steelhead trout <u>Oncorhvnchus mykiss,</u> hereafter called steelhead, and chinook salmon <u>Oncorhvnchus tshawytscha</u>, 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 to use increased smolt production at full seeding 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 crop evaluations, and estimation of survival rates between major fresh water life stages of chinook and steelhead. The latter level will be referred to as "intensive studies." Annual general monitoring of anadromous fish densities in a small number of sections for each project will be used to follow population trends and define seeding levels. For most projects, standing crop 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) will determine parr-to-smolt survival rates and provide other basic biological information that is needed for evaluation of the Fish and Wildlife Program.
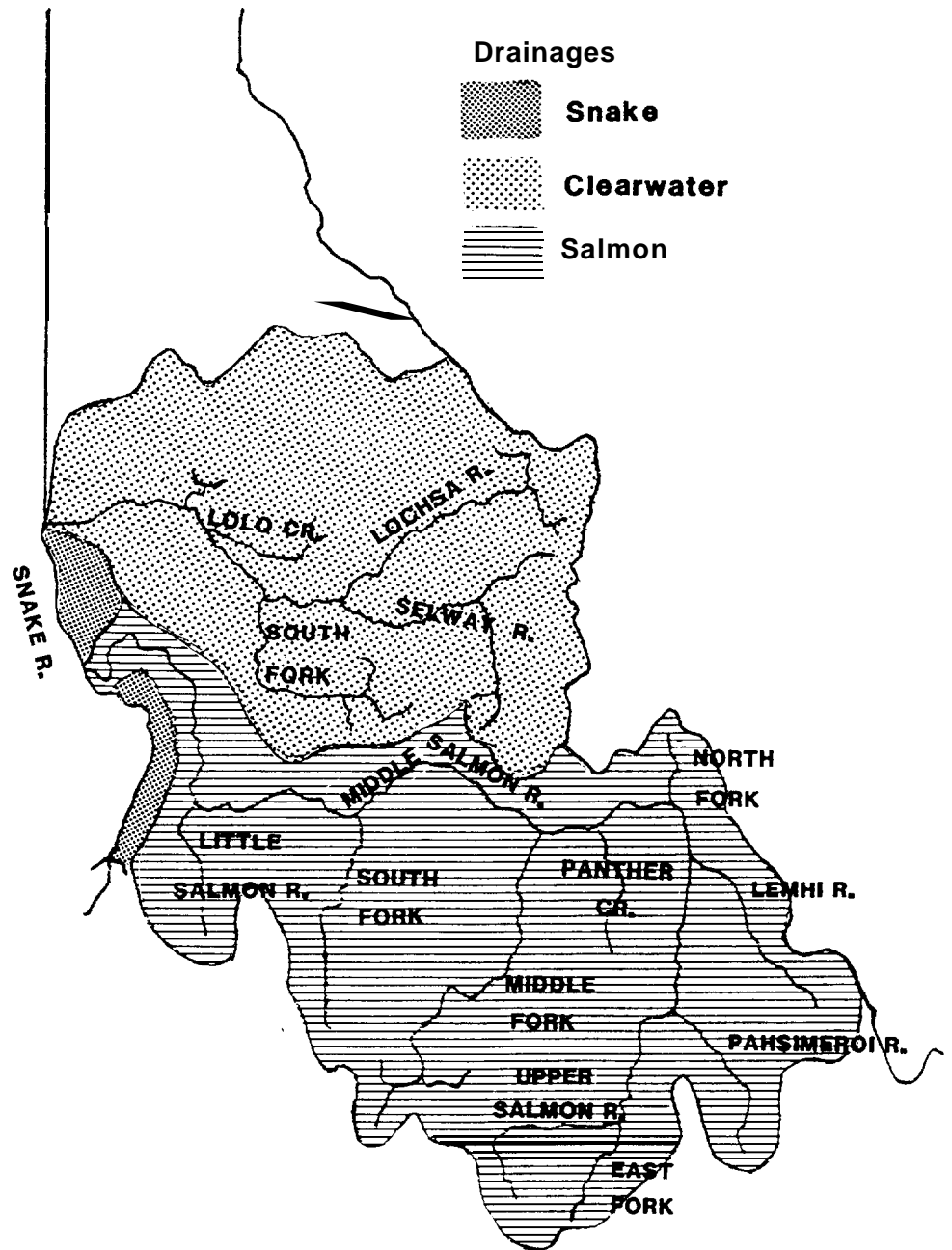
Figure 1. Idaho's anadromous fish waters showing major drainages of the Clearwater, Salmon, and Snake River subbasins.

A physical habitat and parr density data base 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 1983-1988 is presented in Table 1. A complete mitigation record will be made when three conditions are met: I) 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.

After a habitat enhancement project has been implemented and prior to the time that the aforementioned conditions have been met, IDFG will construct a partial mitigation record based on estimated increases in parr production. At a later time, the interim parr responses can be converted to estimated smolt yields. Monitoring data will be essential to establish trends and estimate partial benefits during the years that project evaluations are not conducted (Figure 2).

In 1988, the general monitoring and evaluation project focused on five areas: 1) general density monitoring; 2) anadromous fish introductions above treated passage barriers; 3) investigations into rearing potential for chinook and steelhead; 4) comparisons of percent carrying capacities of A- and B-type steelhead parr; and 5) comparisons of percent carrying capacities between wild and natural stocks of both steelhead and chinook.

METHODS

Physical Habitat

The Idaho Habitat Evaluation for Off-Site Mitigation Record project has been monitoring parr densities in stream sections within the Clearwater and Salmon River drainages since 1984. Additionally, the regional fisheries programs have been monitoring parr densities in stream sections in coordination with the former project, such that parr densities are being monitored in all major anadromous fish production areas of the State. The number of sections monitored annually since 1984 is shown in Table 2.

Monitoring sections provide an annual index of anadromous fish abundance in different habitat types and drainages. The section boundaries were defined at breaks between habitat types; most sections included at least one riffle-pool sequence, and were approximately 100 m long. Streams, project strata, and sections were cross-referenced to the Environmental Protection Agency (EPA) reach numbering system.

Physical habitat variables were standardized and measured at least one time since 1984 in each established density monitoring section and in most other sections used in habitat project evaluations. The physical habitat variables were not measured every year in each section due to time constraints (parr

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
Lolo Creek	IS	I	I,P,E	E	M	M	M
Eldorado Creek	PA		I,P	I,M	E	M	M
Upper Lochsa River	IS	I	I,E	M	M	M	M
Crooked Fork Creek	PA		I,P	I,P	E	E	E
Colt Creek	PA				I	M	M
Crooked River	PA		I,P	M	E	M	M
	IS		I,P	I,P,M	E	M	M
	BC		P	I,P	E	M	M
	OC		I,M	I,M	I,E	I,M	I,M
Red River	BC	I	I,M	M	M	M	M
	IS	I,M	I,M	I,M	E	M	M
	RR						
Meadow Creek	PA	–				I,M	M
Panther Creek	SP		P	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
	RR		M	P	M	P	P
Alturas Lake Creek	IF		P	M	M	P	P
Pole Creek	PA	I	M	M	M	E	E
	RR		M	P	M	P	M
Valley Creek	RR			P	M	M	M
	PA			P	M	M	I,M
Bear Valley Creek	SP		I,P	I,P	I,M	M	M
	RR		M	P	P	M	I,M
Elk Creek	RR		M	P	P	M	I,M
Marsh Creek	RR		M	P	M	M	M
Knapp Creek	PA		M	P	M	I,M	M
Camas Creek	RR		M	M	M	M	I,M
	BC		M	M	M	M	M
Johnson Creek	PA		I,P	I,E	I,E	E	E
South Fork Tributaries	PA			–	I,M	M	M
Boulder Creek	PA		P	I,P	E	M	E
Loon Creek	CO				M	M	M
Sulphur Creek	CO		M	M	P	M	M
South Fork Salmon	CO		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.
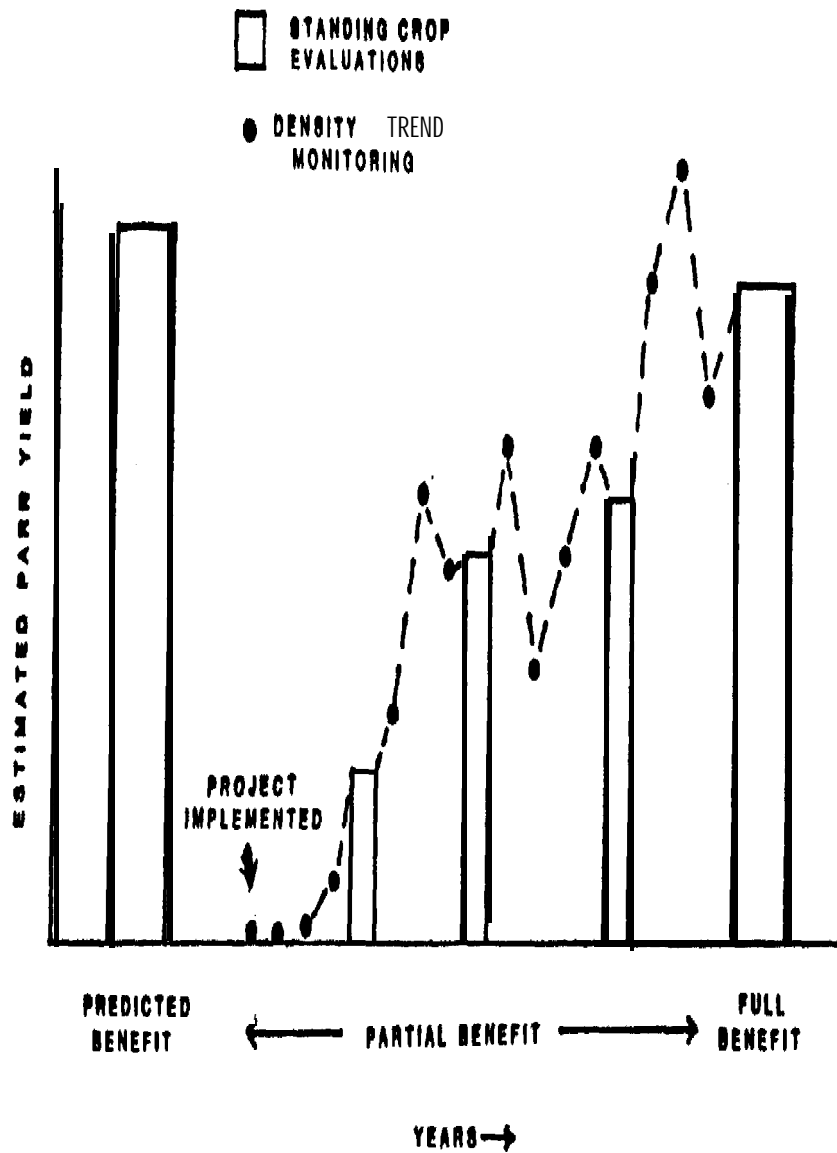
Figure 2. Hypothetical schedule for estimating partial and full benef ts of a project (in terms of parr) from monitoring and evaluation programs.

densities in all sites 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. BPA and other IDFG monitoring
sections are listed in Appendix A-l. IDFG has encouraged other agencies and
tribes to incorporate this standardized variable list into their monitoring
programs.

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 data base will be 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 will be
estimated. Actual and potential production of steelhead and chinook parr
attributable to each project will be estimated using relationships developed from
this data base.

The substrate variable, percent sand, was analyzed relative to its effects
on parr densities. Parr densities for chinook in C channels and steelhead in
B channels were examined relative to percent sand for all monitoring sections.
In addition, the effects of substrate sand on parr densities in the Middle Fork
of the Salmon River drainage were **also** analyzed separately. All major Middle
Fork Salmon River tributaries have wild spring chinook populations. Most of the
tributaries are in pristine watersheds, while others have been entered for mining
and grazing. Thus the Middle Fork Salmon River is an excellent drainage to
evaluate the effects of land use on sedimentation and chinook salmon populations.

Parr Density Monitoring

In 1984-1988, the BPA general monitoring and intensive studies 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 ages-l+ and **-2+,** with respective lengths of 3" to 5.9" and 6" to 8.9". The
steelhead length-at-age intervals are similar to those defined metrically by
Thurow (1987). Chinook parr are age-0+, with lengths less than 4". 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 data base.

Most anadromous fish production streams in Idaho are clear and have low conductivity. In these streams, snorkeling 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 **censusing** 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. Census 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. Additional sections in large main stem rivers (Appendix A-2) were snorkeled by **IDFG's** fisheries management personnel. Corridors, rather than entire widths, of these main stem sections were sampled by floating from the upper to the lower end of the section. Relative parr density was based on surface area of the corridor visible to the observer. Data from these samples were analyzed and reported separately from the general monitoring sections.

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 1985-1988. We summarized steelhead and chinook parr densities by year, production type (wild or natural), and channel type. 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 Northwest Power Planning Council (NWPPC 1986). The parr density data base was merged with the **NWPPC's** species presence/absence data base 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 IO **smolts**/100 m^2. 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, IO 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. C channels in some 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.'.

Anadromous Fish Introductions

The 1984-1988 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 1988 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.

Steelhead Rearing Potential

Inferences into steelhead rearing potential in different habitats were drawn from annual monitoring of parr densities during the five years of this project. We averaged observed densities for sections with greater than 75% of the rated carrying capacity and compared these averages to the current carrying capacity ratings for poor, fair, good, and excellent habitat. The comparison demonstrated whether or not the ratings were similar to observed densities which may approach carrying capacity. This data subset was used since wild and natural steelhead escapements are generally depressed in Idaho. As an example of present depressed conditions, wild adult steelhead past Rapid River Hatchery weir in 1983-1986 averaged only 39% of the 1968-1972 escapements (Petrosky and Holubetz 1988).

Chinook Rearing Potential

Inferences into chinook rearing potential were drawn from annual monitoring of parr densities and from fry outplants designed to test carrying capacity in different habitats.

A subset of observed densities for sections with greater than 75% of the rated carrying capacity from 1984-1988 was created and compared to parr carrying capacity ratings. We consider most of the sections in this subset underseeded and believe the average of these observed densities represent conservative estimates of rearing potential.

Chinook fry stocking in 1988 was designed to establish populations and to estimate rearing potential in portions of Johnson Creek and upper Lochsa River tributaries: Crooked Fork, Hopeful, White Sand, and Big Flat Creeks. Johnson Creek and its tributaries, Rock and Sand Creeks, were stocked on May 9 by helicopter with a total of 195,400 McCall summer chinook fry (average 439/pound). Four sites in the upper Lochsa River were stocked by helicopter on May 10 and 11, 1988, with 283,300 Rapid River spring chinook fry (average 367/pound).

The four stocking sites in the upper Lochsa River tributaries represented a range of stream size, gradient, and channel type in nondegraded habitat (Figure 3). Number of fry stocked at each site was based on its stream width.
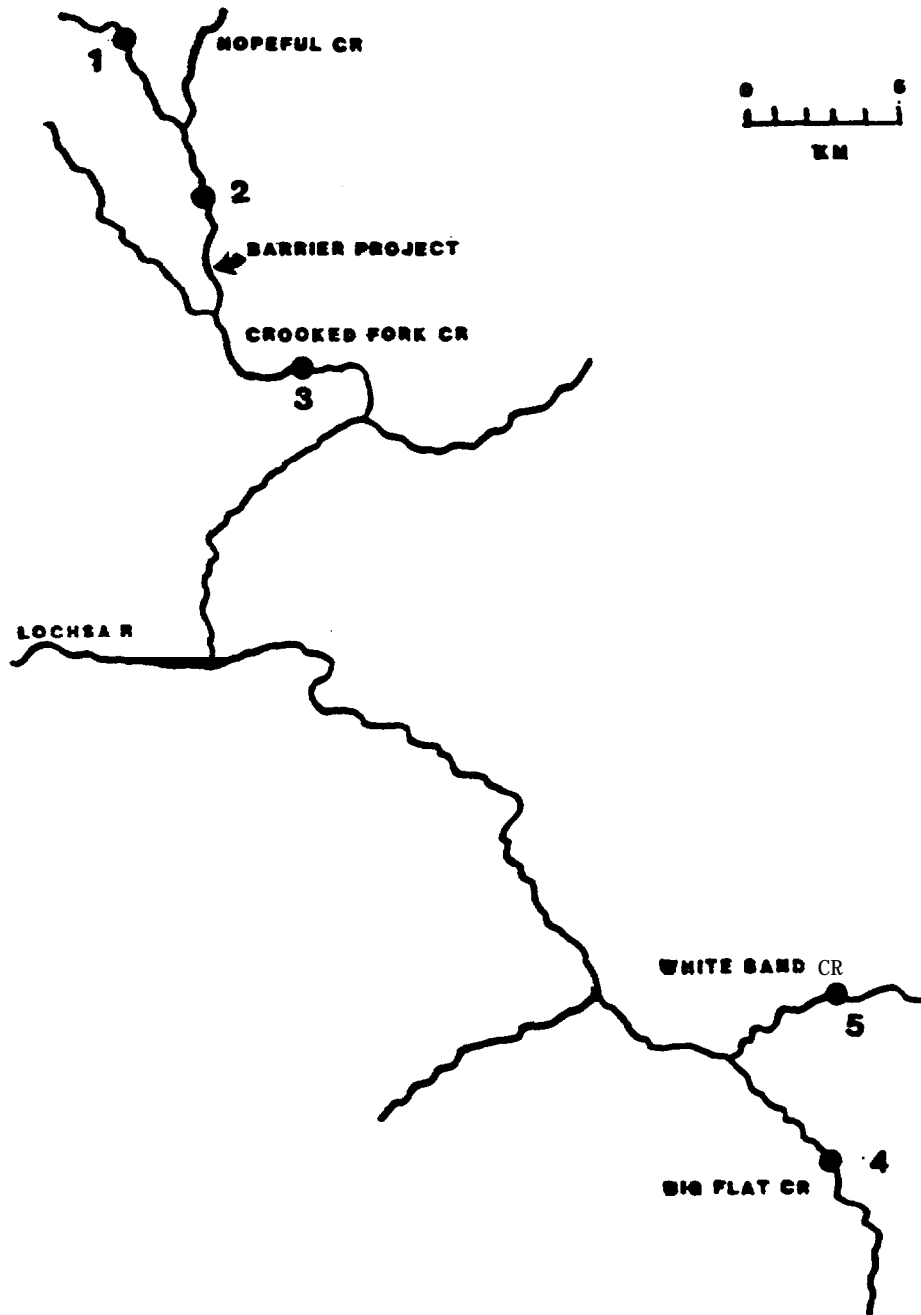
Figure 3. **Chinook fry stocking sites, upper** Lochsa **River tributaries,** 1987.

A site estimated to be 20 m wide would receive four times the number of fry stocked in a 5 m wide site (Table 3). Based on an initial expectation of 15% fry-to-parr survival (Petrosky and Holubetz 1988), the stocking rate in the upper Lochsa River tributaries would seed 1.16 km of stream at an average density of 100 parr/100 m^2.

To estimate survival of these 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 measured habitat variables and estimated fish densities during August 9-15, 1988. 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.

Parr migrated out of upper Johnson Creek prior to sampling in 1988. Thus, it was not possible to estimate fry-to-parr survival and chinook parr carrying capacity in Johnson Creek in 1988.

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).

Densities of age-O+ chinook from Salmon River streams in 1984-1988 were compared to densities of redds in IDFG spawning ground survey reaches of the same streams. The comparison was limited to low gradient (C channel) reaches that have a predominance of age-5_2 (age-5, two years in freshwater, three years in saltwater) spawners (Table 4). We classified the stream reaches by average percent substrate surface sand measured in the monitoring sections (<30%, 30-40%, and >40%). Linear and Beverton-Holt regressions were fitted to the data.

Chinook Egg-to-Parr Survival

A comparison was made between efficiencies of supplementation methods by stocking a known number of eyed eggs and fry in different streams. Abundance of the resulting parr were estimated the following summer. Estimated survival in hatcheries from green egg to eyed egg was assumed to be 85%, and from green egg to fry 75% (S. Huffaker, IDFG, personal communication).

Partial Project Benefits

Partial project benefits were estimated from 1985 through 1988 according to the project-specific approaches in Petrosky and Holubetz (1986) and

Table 2.   Number of sections where steelhead and chinook parr
           were monitored by BPA project 83-7 and the IDFG
           management and research programs from 1984 through
           1988.

Year	Number of steelhead sections	Number of chinook sections[a]
1984	160	37
1985	164	139
1986	190	156
1987	225	178
1988	225	175

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

Table 3. Chinook fry stocking summary for rearing-potential
         investigations, upper Lochsa River tributaries, 1988.

Stream, stocking site	Estimated width[a]	Chinook fry			
		Number	Number/lb.	Date	Method
Crooked Fork Creek					
1.	5.4	40,600	379	5/10/88	helicopter
Hopeful Creek					
2.	5.9	62,200	379	5/10/88	helicopter
Big Flat Creek					
3.	9.0	72,200	361	5/11/88	helicopter
White Sand Creek[b]					
4.	14.0	108,300	361	5/11/88	helicopter

[a]Estimated from past data and aerial inspection (4/27/87).
[b]An additional 19,500 fry were stocked near the mouth of White
 Sand Creek.

Table 4. Spawning ground survey reaches and parr monitoring sections of the Salmon
River and tributaries used to develop chinook reproduction curves, brood
years, 1983-1987.

Sand class	Stream	Spawning Ground survey reach upstream/downstream	Hectares	Mean percent sand	Density Monitoring Sections
< 30%	Salmon River	headwaters/diversion	3.5	19.7	8A,8B,9A,9B,10A,10B
		diversion/R. S. bridge	19.2	17.2	5B,6A,6B,7A,7B
		R.S. br./Sawtooth weir	33.6	17.2	3A,3B,4A,4B,5A
	Alturas Lake Cr.	Alpine Cr./Alturas Lake	2.6	29.0	1A,2A
		Cabin Cr. Bridge/mouth	4.1	10.0	3
	Pole Creek	headwaters/diversion	3.3	16.0	1A,1B,2A,2B
		diversion/mouth	2.8	20.5	3A,3B
	Valley Creek	Trap Cr./Stanley Lk. Cr.	8.4	26.0	3A,3B
	E. Fk. Salmon R.	weir/Herd Creek	15.2	15.0	5
	Marsh Creek	airstrip/Cape Horn Cr.	8.6	23.7	4B,5A,6A
	Knapp Creek	beaver ponds/mouth	2.1	27.0	1A
	Cape Horn Creek	Banner Cr. /mouth	5.1	13.5	1A,2B
	Beaver Creek	Bear Cr./bridge	8.0	8.0	1A,3B
	Loon Creek	Cabin Cr. /steep canyon	4.5	23.5	1,2
	Camas Creek	Castle Cr./Hammer Cr.	15.6	9.0	1.2
30-40%	Bear Valley Crk.	mine/Elk Creek	23.8	35.7	3A,5A,Big-mdw
	Sulphur Creek	Ranch/lower	5.2	33.0	4A,4B
≥ 40%	Valley Creek	Stanley Lk. Cr/mouth	19.3	46.0	1B
	Bear Valley Crk.	Elk Cr./Fir Cr.	26.1	57.0	2A,2B
	Elk Creek	W F. Elk Cr./Bearskin	11.3	45.0	2A,2B
		Bearskin Cr. / Bear Valley	14.6	46.0	1A,1B

Appendix B. The interim benefits are expressed in terms of parr production until reliable estimates of **parr-to-smolt** survival rates become available, beginning in 1989.

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 were rearing above the barrier removal site or within the off-channel developments. These analyses were done with stratified systematic sampling (Cochran 1963). In years when populations were not estimated, densities in the affected areas were monitored at one or more snorkeling sections.

The Clearwater and Nez **Perce** National Forests placed structures in Crooked River, Red River, and **Lolo** Creek as mitigation for habitat degradation resulting from mining, grazing, and logging activities. During the four 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 larger number of replicate sections were sampled to analyze responses of parr densities within a given year (Petrosky and Holubetz 1985, 1986, 1987). For this report, we analyzed monitoring data replicated annually from 1985 through 1988, from control and treatment sections in two strata (stream reaches) each of Crooked River, **Lolo** Creek, and Red River. We analyzed **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 **-2+** steelhead and age-0+ chinook.

For each stream, a two-factor analysis of variance with factors of treatment and stream stratum was used to test for density differences between treated and control sections. Data were then combined from the three streams and tested with a randomized block analysis of variance with repeated measures on years. The latter analysis increased degrees of freedom, sample size, and thus the power to detect differences. 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.

Data Base Management and Statistical Analyses

All biological and physical data from 1984 through 1988 were entered into dBase III+ files for easy access and arrangement for various analyses. These files are now available for use by project implementors, Tribes, and natural resource agencies upon request.

Summary statistics, analysis of variance, post-hoc comparisons, and regressions were done with the statistical software SYSTAT (SYSTAT 1988). Tests of significance were all at the 95% level.

RESULTS

Physical Habitat

We classified the monitoring sections according to two major channel types (Rosgen 1985) and compared parr density trends within channel types. Petrosky and Holubetz (1988) demonstrated the effect of channel type on both steelhead and chinook parr densities. A comparison of parr densities in Rosgen's C and B channels showed that chinook densities were higher in C channels, while steelhead densities were higher in B channels. B channels are confined in steep-sided 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. C channel streams, in contrast, meander through flat, alluvial valleys and are characterized by lower velocities and deposition of fine materials. 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.

The B and C channel classifications were qualitative and allowed an observer to look at a stream and determine if it had a B or C channel without measuring sinuosity, width-depth ratio, and other variables described by Rosgen. According to Rosgen's classification, B and C channel types separate at a gradient of 1.5%. Our channel type classification deviated slightly from Rosgen's in this respect. Of 99 monitoring sites (with measured gradients) that we classified as B channel, 64 had a gradient estimate of less than 1.5%, whereas only 5 of 78 measured C channel sections had gradients in excess of 1.5%. Gradients measured for the monitoring sections may have differed slightly from the average gradient over a longer stream reach. Overall, however, the mean gradient for B channels (2.4%) was 3.4 times greater than for C channels (0.7%), similar to Rosgen's values (Figure 4).

Mean width and depth of both channel types were similar (Figure 4), with both having a width-to-depth ratio of approximately 37. On average, sections classified as B channels had less pool and run habitat than C channels (55% versus 74%, respectively) and much more pocket water (26% versus 2%, respectively) (Figure 5). Pocket water is generally formed by boulders; a substrate type not commonly exposed in low gradient, depositional C channels.

The relative importance of boulders in B and C channels is further illustrated in the summaries of substrate. B channel substrate averaged 28% boulder, compared to 4% in C channels. Conversely, sand and gravel, materials most easily moved by stream flow, covered 71% of C channel bottoms, compared to only 38% in B channels (Figure 6).
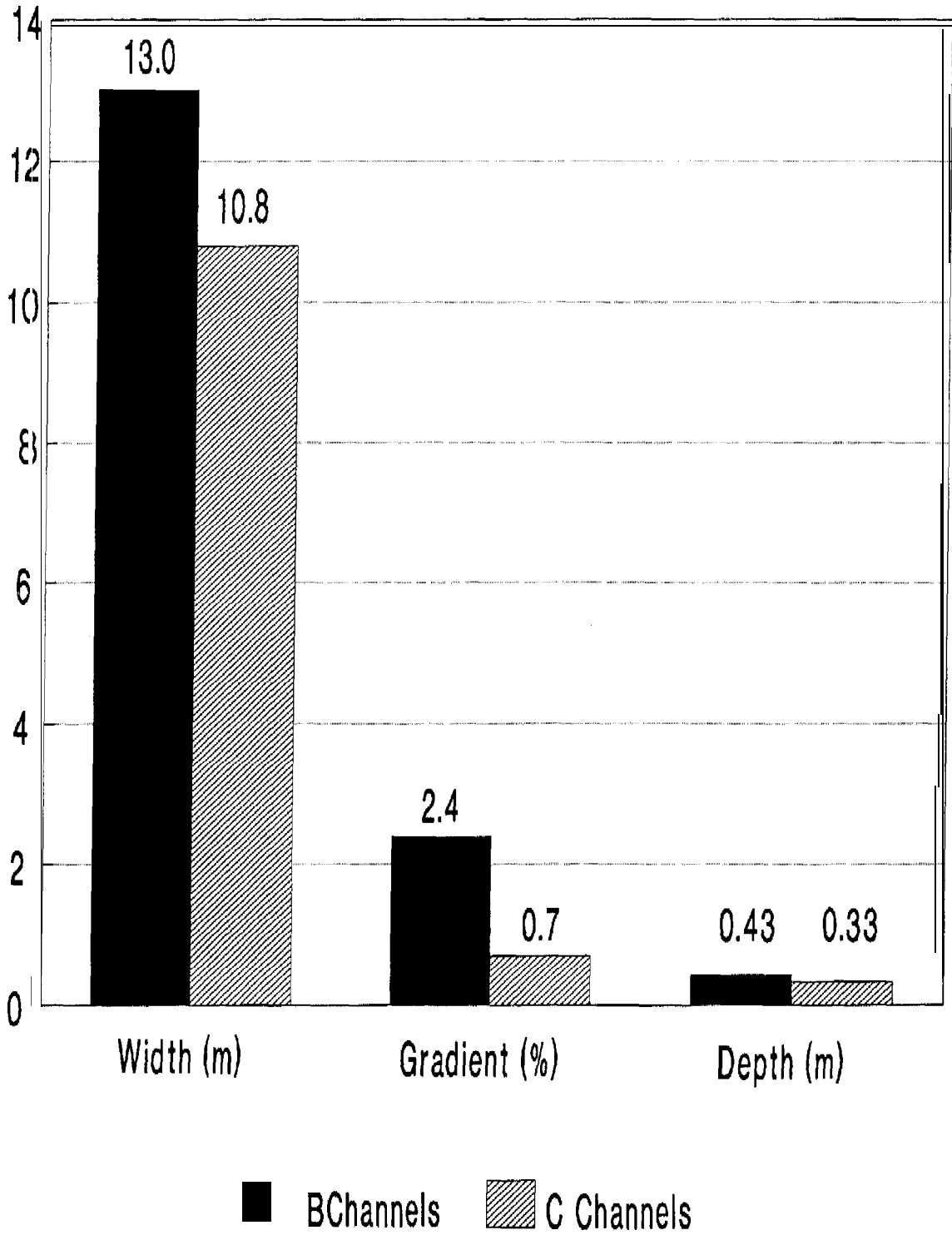
Figure 4, Mean width, depth, and gradient for B and C channels in monitoring sections,

Type B Channels

Pool-Run
55.4

n=125

Backwater
0.5

Riffle
18.6

Pocketwater
25.6

Type C Channels

n=96

Pool_Run
73.7

Backwater
0.8

Riffle
23.4

Pocketwater
1.8
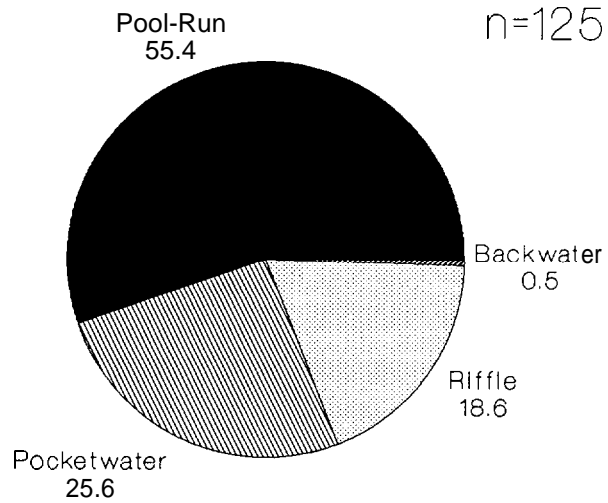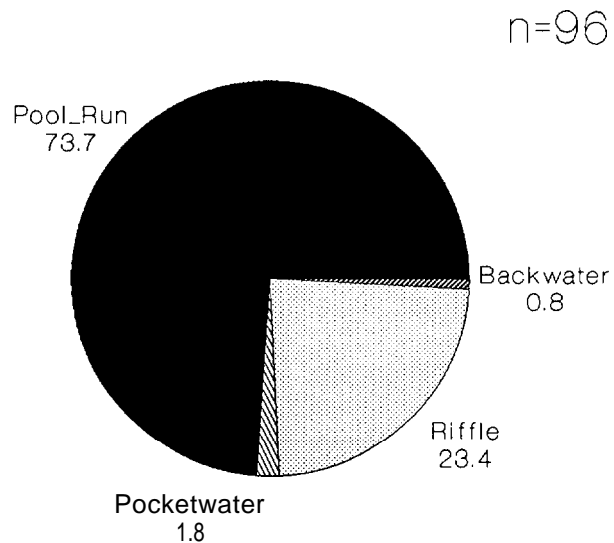
Figure 5.   Percentages of the different habitat types in B and
            C channel monitoring sections.

Type B channels

Gravel
25.5

n=116

Bedrock
0.1

Sand
12.9

Rubble
33.4

boulder
28.4

Type C channels

n=106

Sand
27.1

Gravel
43.7

Boulder
3.6

Bedrock
0.1

Rubble
25.9
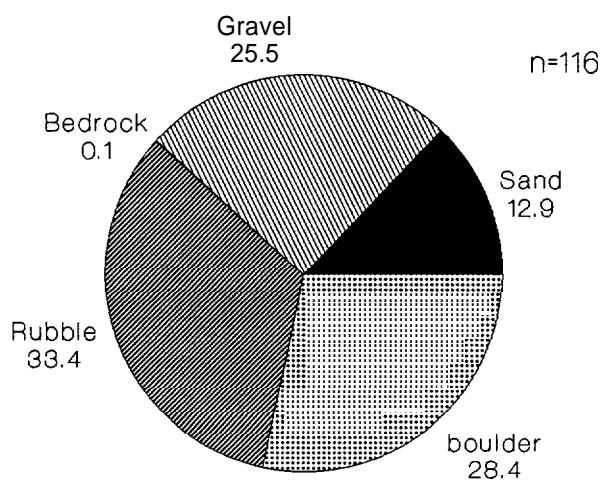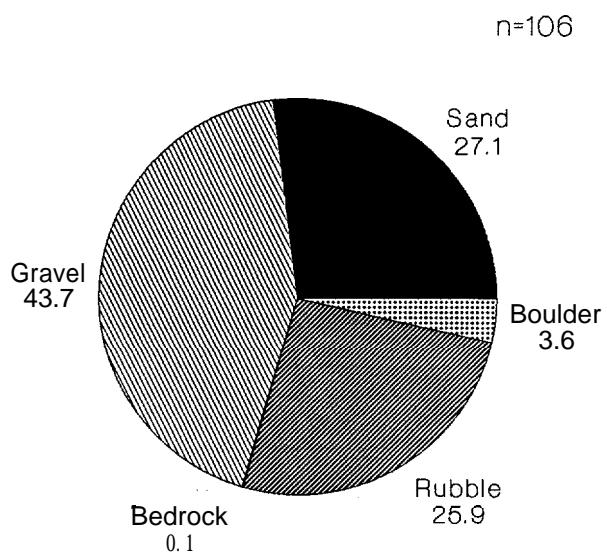
Figure 6.   Percentages of the different substrate categories in
B and C channel monitoring sections.

<u>Substrate Sand and Parr Densities</u>

Chinook Parr

This project has recorded percent sand at all **parr** monitoring sites using the IDFG ocular method (Torquemada and Platts 1988). C channel streams, because of their low gradient, generally contain sand. However, if the amount of sand becomes excessive, chinook egg survival and percent emergence decline (Chapman 1988).

OEA (1987a,b) demonstrated in the upper Salmon River and Middle Fork Salmon River drainages direct relationships between the amount of grazing that occurred upstream from a sampling site and the percent surface sand (particles <6.4 mm in diameter). Additionally, the OEA studies and Petrosky and Holubetz (1987) demonstrated inverse relationships between percent sand, percent gradient, and the density of chinook parr rearing in that stream section.

We ran one-way analysis of variance (AOV) comparisons of the effect of sand on chinook parr density. The AOV probably underestimated sediment effects however, because the tests did not account for the interactive effect of gradient on deposition of sand. Even though C channel sections are generally depositional areas, sections with the highest gradients (within the C channel classification) would have a positive effect on chinook density due to reduced sand, but a negative effect due to higher water velocity.

For all monitoring sections combined, the mean chinook parr density was lowest (14.1/100 m^2) in C channel streams where percent sand was <10% (Table 5). This percent sand interval also had the highest average gradient (1.0%), much higher than in the other percent sand classes (0.5-0.6%). These higher C channel gradients appear to represent a transition between B and C channels. Mean chinook density for all B channels was only 5.5/100 m^2.

Highest mean density of chinook parr for all monitoring sections combined was in the 10-20% sand interval, with density declining at a modest rate for each 10% increase in percent sand above 20%. Sections exceeding 40% sand averaged 15.9 chinook parr/100 m^2, 67% of the highest density interval. Gradient was lowest for this interval, which without sediment effects should have been desirable for chinook parr. AOV indicated that none of the mean values were significantly different.

We also summarized sediment data by the three intervals used by OEA (1987a,b): 0-30%, 30-40% and >40%. AOV indicated no significant difference in chinook parr densities for all C channel monitoring sections among the three classes.

Maximum chinook parr densities for all C channel sections showed no significant differences between any sediment classes (Table 5).

Unlike the data set for all C channel sections, the **MFSR** chinook parr densities differed significantly between sediment classes (Table 5). As sediment increased, mean and maximum MFSR densities decreased. The decline appeared to begin at sediment levels greater than 20% surface sand. Sample variance was relatively high, so that many apparent class differences did not differ significantly.

The MFSR data subset probably best represents sediment effects on chinook parr density because more of the extrinsic variation was controlled. The statewide data included areas that were supplemented and unsupplemented, as well as within basalt and batholith (granitic) watersheds, where different physical and biological responses might be expected. The MFSR data subset was entirely from batholith streams and these wild spring chinook stocks were subjected to similar smolt passage conditions and adult harvest rates.

Steelhead Parr

We compared steelhead parr (age-1+ and **-2+)** densities in different sediment classes of B channels (Table **6),** similar to above comparisons for chinook parr in C channels. The only significant decreases in steelhead parr density occurred between the **0-10%** and the **10-20%** intervals for the statewide means. Neither mean nor maximum densities of steelhead parr in B channel monitoring sites demonstrated a relationship with changes in percent sand where percent sand exceeded 10%.

No significant differences between sediment classes occurred in AOV tests for MFSR steelhead parr densities (Table **6),** possibly due to small sample size for several classes. The steelhead parr data from the MFSR drainage had few samples in the sections with greatest amounts of sand. To test the hypothesis that percent sand (from **0-40%)** has no effect on steelhead parr density, more samples would be needed from all areas with more than 10% sand.

Bear Valley/Elk Creek verses Control Streams

In the MFSR drainage we compared wild chinook and steelhead parr densities in monitoring sections of the heavily sedimented Bear Valley/Elk Creek drainage with sections in cleaner (control) batholith streams. Percentage of the substrate surface which was sand averaged 46% in Bear Valley/Elk Creek and 20% in control stream sections (Appendix **C).** Parr densities from these streams were analyzed by one-way analyses of variance with repeated measures on years. The SYSTAT model required that five sections which had one or more missing samples during 1985-88 be discarded from the data set since each measure must be repeated for each year. All 1984 data were removed since few sections were sampled that year. Appendix C reports only the stream sections used in the AOV. Chinook and steelhead parr densities in the control streams were significantly higher **(p<0.00)** than for the sedimented Bear Valley/Elk Creek drainage, averaging 13.5 and 9.3 times higher, respectively (Figure 7).

Table 5.   Mean and maximum chinook density by sediment class
           for C channel monitoring sections statewide and in the
           Middle Fork Salmon River **(MFSR)** drainage, 1984-88.

% sand	Statewide				MFSR			
	Mean dens.	(n)	Max. dens.	(n)	Mean dens.	(n)	Max. dens.	(n)
O-10	14.1	(56)	31.2	(14)	26.9	(16)	53.0	(4)
10-20	23.6	(81)	**33.8**	**(20)**	30.2	(19)	53.9	(**5**)
20-30	20.6	(68)	**31.2**	**(11)**	14.9	(27)	22.5	(7)
30-40	18.9	(39)	~.·.~		16.0	(12)	29.8	(3)
>40	15.9	(56)	**27.4**	(15)	1.5	**(32)**	3.6	(8)
P	0.16		0.62		0.01[a]		0.02[b]	
O-30	19.9	(205)	36.8	(56)	22.7	(62)	39.9	(16)
30-40	18.9	(39)	31.2	(11)	16.0	**(12)**	29.8	(3)
>40	15.9	(56)	27.4	(15)	1.5	(32)	3.6	(8)
P	0.54		0.64		0.00[c]		0.04[d]	

[a]Significant differences between means: 1.5<16.0, 14.9<30.2
[b]   "   "   "   " : 3.6<53.9
[c]   "   "   "   " : 1.5<16.0
[d]   "   "   "   " : 3.6<39.9

Table 6.   Mean and maximum ages-l+ and **-2+** steelhead parr
           density by sediment class for B channel monitoring
           sections statewide and in the Middle Fork Salmon
           River **(MFSR)** drainage, 1984-88.

% sand	Statewide				MFSR			
	Mean dens.	(n)	Max. dens.	(n)	Mean dens.	(n)	Max. dens.	(n)
O-10	7.6	(257)	11.4	(74)	3.8	(50)	6.7	(13)
10-20	3.6	(81)	6.5	(25)			9.4	(2)
	2.3	**(56)**			**5.1**	(8)	**2.3**	(3)
20-30	**5.1**	**(22)**	3.9	(10)	4.1	(10)	11.7	(1)
>40	2.4	(11)	2.9	(3)	no data		no data	
P	0.00[a]		0.00[b]		0.33		0.38	

[a]Significant differences between means: 3.6<7.6
[b]   "   "   "   " : 6.5<11.4

Chinook

Steelhead

■ Bear Valley/Elk Cr ▨ **MFSR** Control Streams
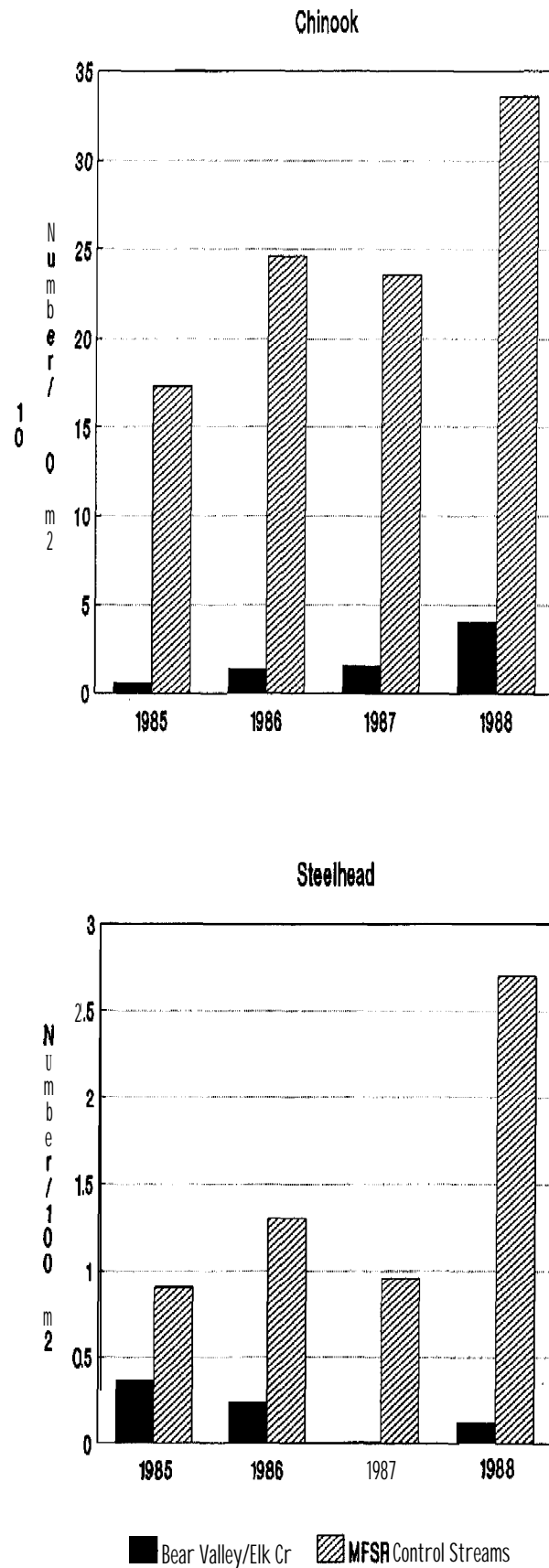
Figure 7. Average annual densities of chinook and steelhead parr in the heavily sedimented Bear Valley/Elk Creek drainage and Middle Fork Salmon River control streams.

<u>**Parr Density Monitoring**</u>

Steelhead Parr Monitoring

Mean annual steelhead parr densities ranged from 2-3 times greater in B channels than C channels during 1984-88 (Figure 8). Mean steelhead parr (ages-1+ and -2+) densities in B channels ($6.1/100 \ m^2$) and C channels ($2.5/100 \ m^2$), compared for all monitoring sections from 1984 to 1988, were significantly different ($p<0.00$). In areas where steelhead densities were low relative to carrying capacity, steelhead generally occupied preferred habitat. Thus, we suspect that differences in abundance of steelhead parr between years or between drainages may be most evident in B channels when seeding levels are low. With Idaho's generally underseeded steelhead stocks, relatively few steelhead parr inhabit the less preferred C channel habitat.

The density of age-1+ steelhead probably provides the best estimate of year-class strength and spawning success the previous year. Age-0+ steelhead still may be emerging from the gravel during the summer survey period (Thurow 1987), and some of the age-2+ steelhead would have already smolted and left the stream. Mature steelhead enter Idaho in the fall and spawn the following spring. Fry emerge that summer and become age-1+ parr a year later.

Mean densities of age-1+ steelhead parr for 1984-88 differed among years ($F=3.90$, $p<0.01$), with the 1986 density being significantly larger than densities in 1984, 1985, and 1987 (Table 7). Mean densities for ages-1+ and -2+ combined followed a similar pattern, but the only significant annual difference was between 1984 ($2.7/100 \ m^2$) and 1986 ($7.3/100 \ m^2$), ($F=2.71$, $p=0.03$).

PCC was estimated as the observed density of ages-1+ and -2+ steelhead parr divided by the rated carrying capacity, multiplied by 100. Steelhead PCC differed significantly ($F=2.74$, $p=0.03$) between 1984 and 1986 in the 1984-88 analysis.

The yearly comparisons above indicate that densities of steelhead parr were lowest in 1984, increased to the highest level in 1986 (7.3/100 m2 and 42.8% of carrying capacity overall), and have remained stable with an apparent but statistically insignificant decrease by 1988. This same trend is seen with just age-1+ steelhead (Table 7). Because these annual trends incorporate both supplemented and unsupplemented streams and wild and natural A-run and B-run populations, the overall means mask some relationships.

Steelhead Classification-Naturally spawning summer steelhead in Idaho are divided into two groups: A-run and B-run. These groups have been defined traditionally, for Columbia River harvest management, by run timing. A-run steelhead, by the traditional definition, ascended Bonneville Dam on the Columbia River between June 1 and August 25, while B-run steelhead passed Bonneville Dam
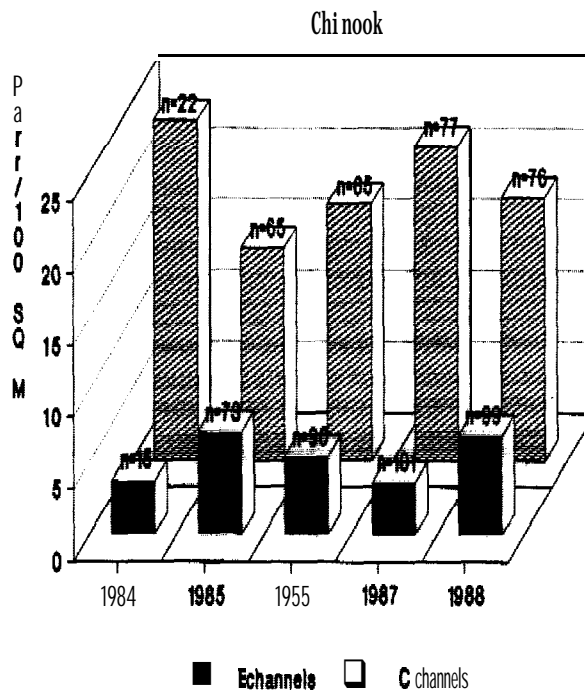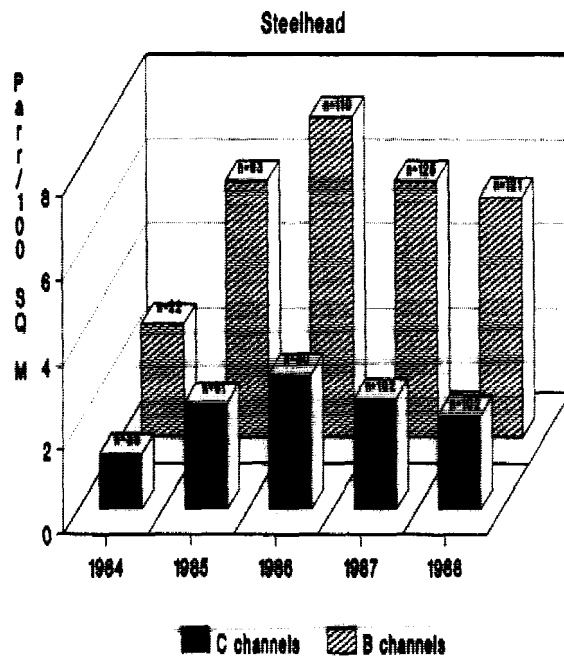
Steelhead

Chinook

Figure 8. An annual comparison of mean parr densities of both chinook (age-0+) and steelhead (ages-1+ and -2+) in B and C channels.

August 25 and after (TAC 1989). The run-timing differentiation of these two groups has recently become less reliable, primarily due to increased runs of late-entry, hatchery, and natural A-run steelhead into the lower Columbia River.

A-run and B-run steelhead also differ in their adult age and length distributions. A-run steelhead generally have slower ocean growth and spend less time in the ocean than do B-run steelhead. Most A-run steelhead leave the ocean after only one year, while most B-run steelhead spend two years at sea. These differences between runs in time spent in the ocean and ocean-growth rate causes most adult A-run steelhead to be less than 31" (77.5 cm) fork length and most B-run steelhead to exceed this length (K. Ball, IDFG, Personal communication). B-run steelhead predominate in the Clearwater River drainage upstream from Bedrock Creek (RM 25) and in the Middle Fork and South Fork Salmon River drainages. Historically, B-run steelhead may have occupied the upper Salmon River drainage as well (T.C. Bjornn, University of Idaho, personal communication). All other anadromous fish rivers and tributaries in Idaho are classified as A-run. Introduction of B-run steelhead from the Clearwater River's Dworshak Hatchery has occurred in other Salmon River tributaries in recent years, with special emphasis in establishing a population in the East Fork of the Salmon River. The present distribution of wild A-run and B-run steelhead production areas are shown in Figure 9.

Idaho steelhead are further classified as either wild or natural, where wild denotes indigenous, unsupplemented populations. Natural steelhead, in contrast, denote some hatchery background (IDFG 1985). Thus, there are four naturally spawning classes of summer steelhead in Idaho: wild A's, wild B's, natural A's, and natural B's. A fifth class could be called natural AB's, where B-run steelhead from hatcheries have been introduced into streams already containing A-run steelhead.

Mean densities in B channels of these five classes differed significantly (p<0.01) in 1985-88. The smallest density was for wild B's and the largest density was for wild A's, with the other three classes having intermediate densities (Table 8).

The same comparison on an annual basis demonstrated significant differences among class means each year from 1985 through 1988. (The wild A-run class was not sampled in 1984.) The difference in mean density of wild B-run and wild A-run steelhead parr was large and significant in each annual comparison. Annual densities were 3.5 to 6 times greater in wild A-run than wild B-run areas.

The relative densities of wild B-run and wild A-run steelhead parr was even more striking when both B and C channel data were considered together (Table 9, Figure IO). Annual densities were 5 to 8 times greater in wild A-run areas than wild B-run areas. This greater differentiation when both channel types were considered together emphasizes that a relatively smaller percent of wild B-run steelhead parr were being forced out of B channels into available but less desirable C channels.

One-way analyses of variance were used to test for annual density differences for both wild A-run and wild B-run steelhead. Analyses were done
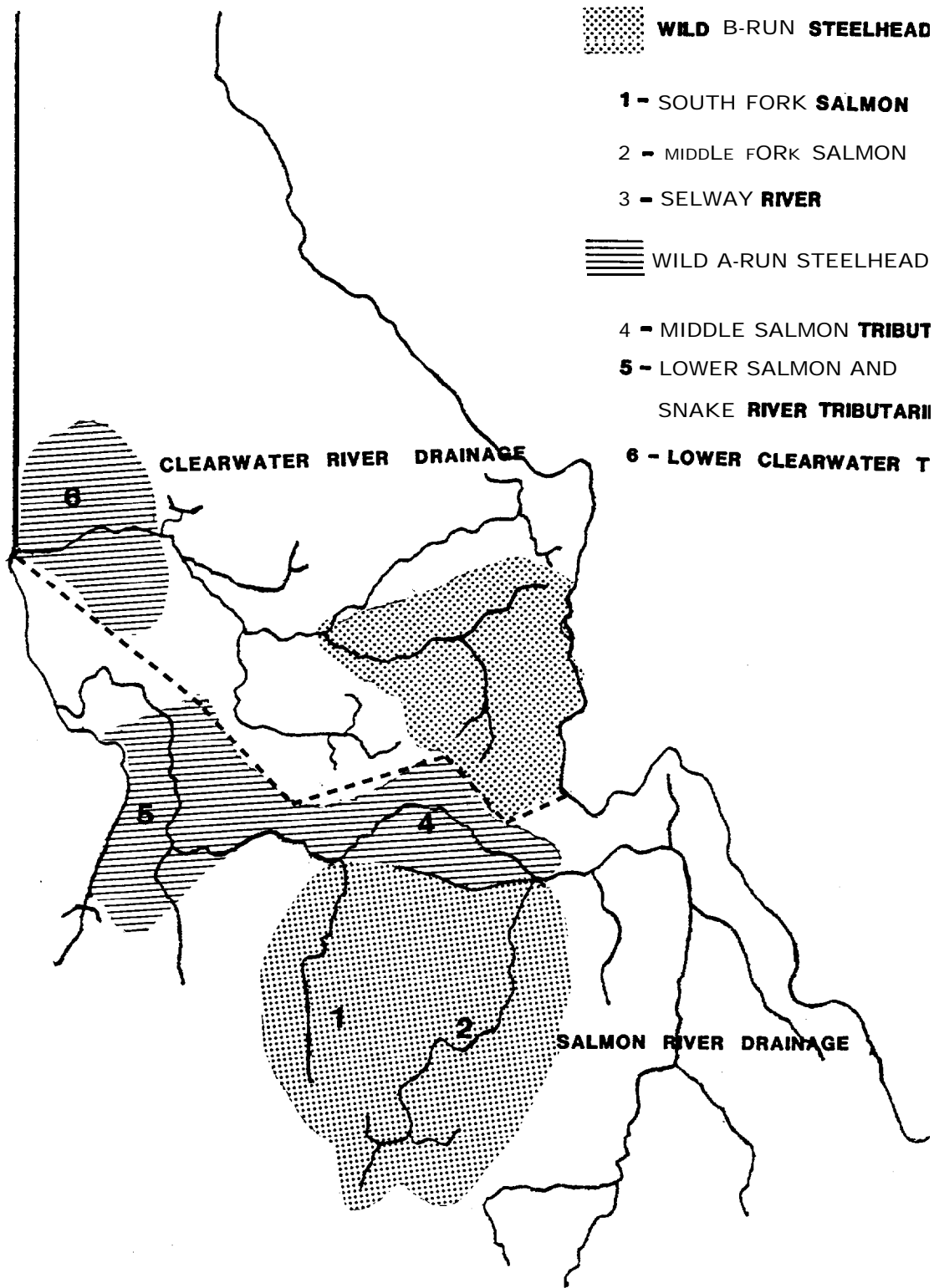
Figure 9. Present distribution of wild A-run and B-run
steelhead production areas in Idaho.

Table 7. Annual means, standard errors and sample sizes for densities and percent carrying capacities (PCC) of ages-I+ and -2+ steelhead parr combined and for densities of age-l+ steelhead alone.

	1984	1985	1986	1987	1988
Age-1+ & -2+					
Densities					
means	2.7	**5.4**	7.3	5.4	5.6
SE	0.7	**0.8**	0.8	0.6	0.6
PCC					
Means	16.1	31.4	42.8	31.2	33.9
SE	4.2	4.3	4.2	3.6	3.6
Age-1+ only					
Densities					
Means	1.7	3.3	**5.2**	3.3	**4.1**
SE	0.5	0.5	**0.6**	0.4	**0.4**
n	22	91	108	121	**119**

Table 8. Annual mean densities (number/100 m^2) of five classes of age-l+ and -2+ steelhead parr in B channels from 1985 through 1988.

Class	1985	1986	1987	1988	1985-88 Mean
Wild **B's**	2.6	3.5	2.4	2.9	1.9
		5.7			4.9
Nat. **AB's**	7.0	8.4	6.8	6.7	6.8
Nat. **A's**	6.7	9.5	3.8	10.1	4.9
Wild **A's**	**11.3**	15.0	**14.3**	10.4	12.8
P	to.01	co.01	to.01	co.01	co.01

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20

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10

5

0

*

1985 1986 1987 1988 average

B Combined C channels
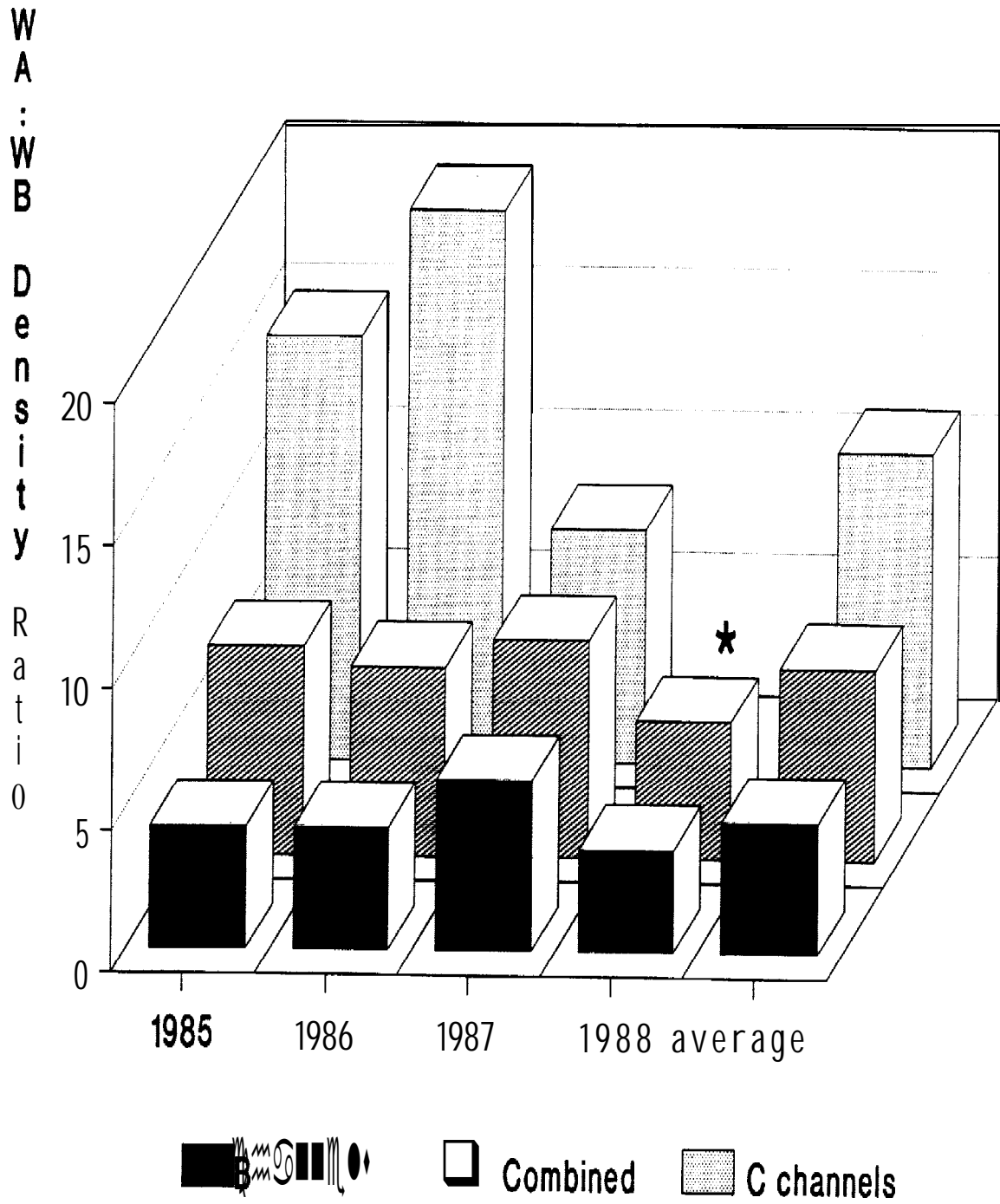
*missing wild group A data

Figure 10. Annual density ratios of wild A-run:wild B-run steelhead by channel type,
for ages-1+ and 2+, 1985-1988.

for wild rather than natural steelhead, since wild populations should show the clearest trend in response to spawning escapements.

To eliminate the masking effect on density of parr from two consecutive brood years (age-1+ and -2+) parr, the analyses were done only on age-1+ parr which generally account for 2/3 of the age-1+ and -2+ density. Mean annual densities of wild A-run steelhead ranged from 10.4/100 m^2 to 15.0/100 m^2 during 1985-88 (Table 9). Wild B-run steelhead densities ranged from 1.5/100 m^2 to 2.3/100 m^2 during 1984-88. Within groups, densities did not differ significantly among years at the 0.05 level using one-way analysis of variance (Table IO).

Drainacre and Group **Catesories-We** partitioned steelhead streams into **12** divisions or cells, considering classes (wild and natural, and A-run and B-run combinations) and drainages. The cells were:

Wild **B-run**

1. Selway River and its tributaries.
2. Middle Fork Salmon River tributaries.
3. South Fork Salmon River and its tributaries.

Natural B-run

4. **Lochsa** River and its tributaries.
5. South Fork Clearwater River tributaries.
6. **Lolo** Creek and its tributary, Eldorado Creek.

Natural AB

7. Little Salmon River and its tributary, Hazard Creek; Slate Creek and the East Fork Salmon River.

Natural A-run

8. Upper Salmon River and its tributaries.
9. North Fork Salmon, Pahsimeroi, and Lemhi Rivers and the latter's tributaries, and Panther Creek and its tributary, Moyer Creek.
10. Snake River tributaries of Captain John and Granite Creeks and the Little Salmon River tributary of Boulder Creek.

Wild A-run

11. Middle Salmon River tributaries of Bargamin, Chamberlain, Horse, and Sheep Creeks.
12. Snake River tributaries of Sheep and Wolf Creeks; the lower Clearwater River tributary of Big Canyon Creek; the lower Salmon River tributary of Whitebird Creek; and the Little Salmon River tributary of Rapid River.

Mean densities and sample sizes for age-1+ and -2+ steelhead parr in each cell for 1984 through 1988 in B channels are presented in Table 11. No annual

Table 9. Annual mean densities of wild A-run and wild B-run steelhead parr for all (both B and C channels) monitoring sections and the annual ratio of wild A-run to wild B-run densities from 1985 to 1988.

	1985	1986	1987	1988
Mean Wild A Density	11.2	15.0	13.6	10.4
Mean Wild B Density	1.5	2.3	1.7	2.2
Wild **A:Wild** B Density Ratio	7.3	6.6	8.2	4.8

Table 10. Results of one-way analyses of variance on age-1+ wild steelhead mean densities for all wild A-run and B-run parr and for those groups in B channels only.

Group Analysed	Years Compared	Probability of Wisher F-value	Significance
All wild **A's**	1985-88	0.198	NS
All wild **B's**	1984-88	0.091	NS
Wild **A's** in B channels	1985-88	0.280	NS
Wild **B's** in B channels	1984-88	0.537	NS

Table 11.   Mean densities (number/100 m^2) and sample sizes (in parentheses)
            of age-1+ and -2+ steelhead parr in 12 cells encompassing
            Idaho's anadromous fish waters, in B channels.

Cell Class	1984	1985	1986	1987	1988
Wild B-run					
1.		1.2 (10)	0.8 (9)	2.1 (13)	2.6 (12)
2.		3.6 (17)	5.0 (20)	2.7 (19)	3.3 (18)
3.	3.6 (3)	0.3 (1)	3.0 (13)	2.3 (13)	2.8 (15)
Natural B-run					
4.	3.7 (3)	0.9 (5)	1.0 (5)	1.2 (5)	2.4 (5)
5.	0.4 (5)	1.5 (7)	6.6 (10)	6.0 (8)	8.0 (19)
6.	6.4 (2)	3.3 (4)	8.0 (6)	6.9 (6)	6.1 (6)
Natural AB's					
7.		7.0 (7)	8.4 (7)	6.7 (9)	10.1 (3)
Natural A-run					
8.	0.3 (4)	2.3 (11)	3.5 (6)	0.4 (17)	1.9 (17)
9.	0.4 (2)	5.1 (5)	4.0 (5)	2.7 (5)	3.7 (5)
10.	7.2 (3)	13.7 (8)	18.4 (7)	11.7 (8)	20.0 (6)
Wild A-run					
11.		5.6 (7)	13.3 (10)	15.8 (10)	8.2 (8)
12.		15.8 (9)	16.6 (10)	12.8 (10)	13.9 (5)

trend in wild steelhead density was apparent during the period (Figure 11). There was an obvious difference, however, in the densities of wild A-run and wild B-run steelhead, which was consistent among cells for each classification. The three wild B-run cells had consistently low densities, while both wild A-run cells had consistently higher densities.

There was no consistent difference between natural A-run and natural B-run steelhead parr densities (Figure 12) because differences in supplementation masked differences in escapement. There was no obvious density trend through time in any cell. The natural A-run cell (10) from the Snake River tributaries of Sheep and Captain John Creek and the Little Salmon River tributary of Boulder Creek has had little direct supplementation, and densities there were similar to those in wild A-run streams.

With the exception of the upper Salmon River, the areas with highest densities generally had A-run steelhead. One-way analysis of variances done separately for each year from 1985 through 1988 showed highly significant differences between cells of age-l+ steelhead in B channels (Table 12). Density of wild A's from the Snake, lower Salmon, and Clearwater Rivers were always significantly greater than any of the three drainages containing wild B's. Densities of natural A's from the Snake and lower Salmon Rivers were also significantly greater than densities in wild B drainages, except in 1987. All A-run steelhead drainages, except for the upper Salmon River, generally had higher densities than wild B steelhead drainages.

Densities of natural A-run steelhead parr in the upper Salmon River may be depressed for several reasons. The former Sunbeam Dam, near the mouth of the Yankee Fork, may have eliminated part of the genetic component of the upriver steelhead run that arrived at the dam when extreme high or low river discharges created a migration barrier. The stock of A-run steelhead used to supplement the upper Salmon River was not the indigenous stock, but rather was taken from the Snake River in Hells Canyon, just prior to the elimination of that stock's spawning and rearing area by the construction of Idaho Power's Hells Canyon dam complex. The donor stock may have had ecological requirements not well satisfied by the high elevation of upper Salmon River drainage. Finally, much of the upper Salmon River watershed is intensively managed for cattle production and suffers the associated negative effects of riparian grazing and irrigation withdrawals (Kiefer and Forster 1990).

Although none of the mean densities for B-run steelhead approach the highest densities seen for A-run steelhead, the difference appears to be due to escapements rather than to group-specific carrying capacities. Maximum densities for combined age-l + and -2+ B-run steelhead parr in some natural productions areas of the South Fork Clearwater River drainage and some wild production areas of the Middle Fork Salmon River drainage have approached or exceeded the theoretical maximum density of $20/100$ m^2 in B channels and $14/100$ m^2 in C channels (Table 13).

The extremely depressed densities in all wild B-run drainages exist even in pristine drainages and despite termination of sport harvest of wild steelhead in Idaho in the Salmon and Snake Rivers in 1982 and the Clearwater River in
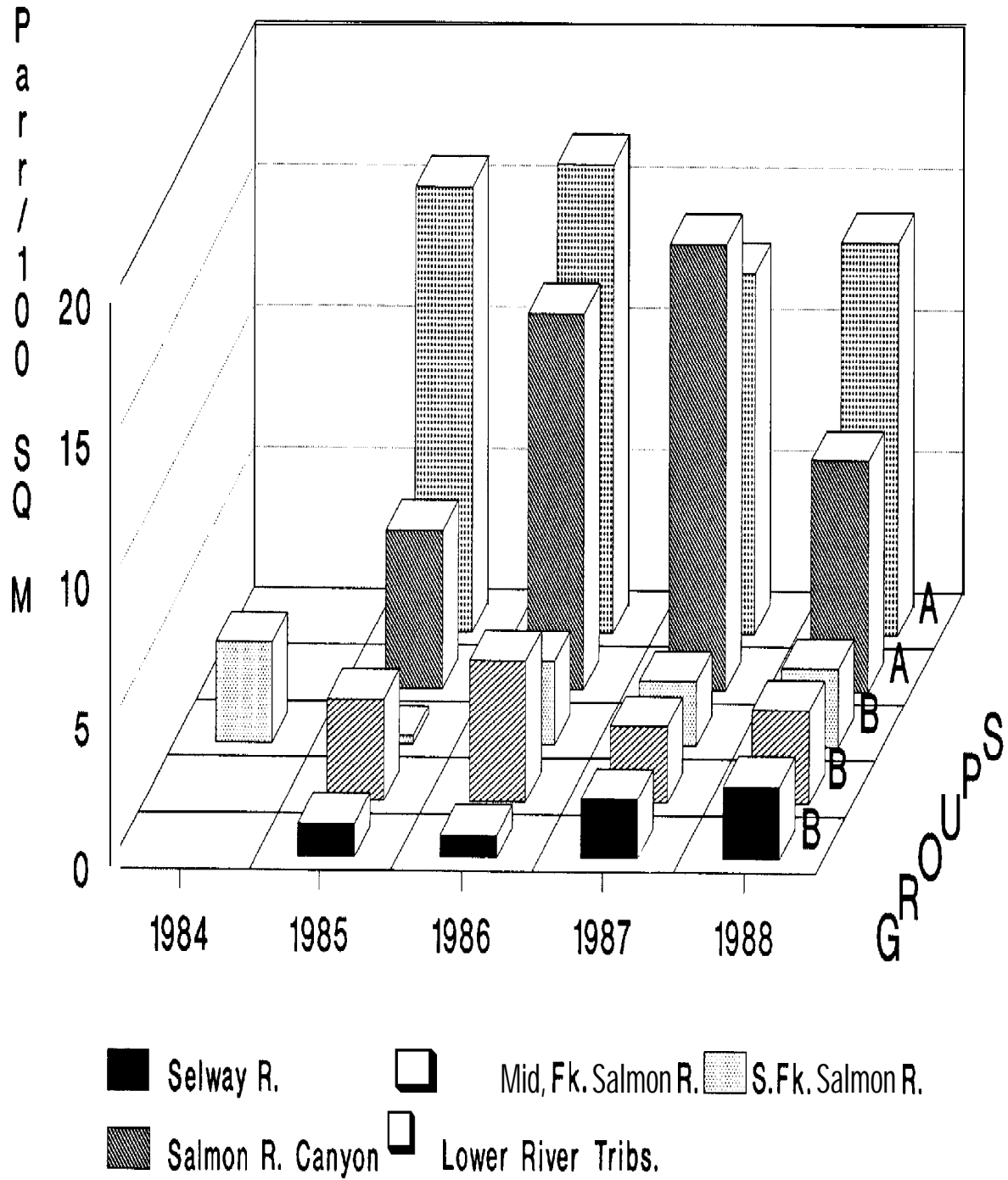
Figure 11, Mean annual densities of age-1+ and -2+ wild steelhead parr in two A-run areas
and three B-run areas, in B channels, 1984- 1988,

P
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Q
M

25

20

15

10

5

0

1984   1985   1986   1987   1988

G R O U P S

A
A
A
B
B
B

☐ Lochs R.   ☐ S.FkClwtrR.   ▨ Lolo Cr. & tribs

▨ Upper Salmon R.   ☐ East Salmon R.*   ☐ Mid. Snake R.
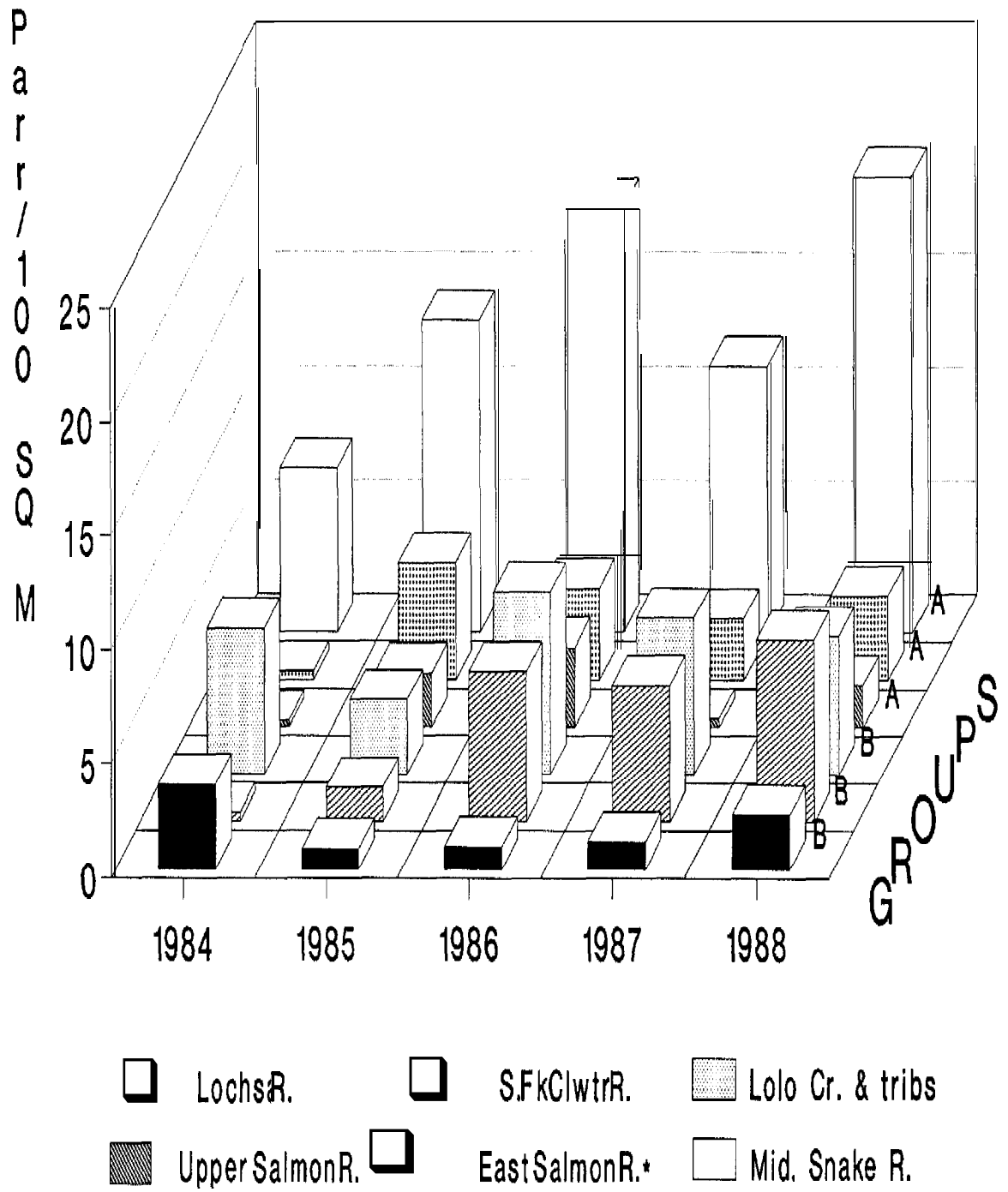
Figure 12. Mean annual densities of age-lt and -2-t natural steelhead parr in three A-run areas
and three B-run areas, in B channels, 1984-1988. *The East Salmon River includes
tributaries from Panther Creek through Pahsimeroi River,

Table 12. Mean annual densities (number/100 m^2) of age-1+ steelhead parr in B channels from 1985 through 1988. There were highly significant differences between mean cell densities within each year.

			Densities			
Cell	Drainage	Class	1985	1986	1987	1988
1.	Selway R.	Wild B's	0.6	0.6	0.8	1.9
2.	Salmon R., M. Fk.	" "	2.3	2.8	1.4	2.0
3.	Salmon R., S. Fk.	" "	1.9	1.9	1.4	2.0
4.	Lochsa R.,	Nat. B's	0.3	0.7	0.8	1.6
5.	Clearwater R, S. Fk	" "	0.8	6.2	4.7	7.4
6.	Lolo Cr.	" "	2.0	7.2	5.5	5.0
7.	E. Fk & L. Salmon R. & Slate Cr.	Nat. AB's	3.6	5.6	3.7	7.0
8.	Upper Salmon R.	Nat. A's	1.7	2.8	0.2	1.4
9.	Pahsimeroi, Lemhi N. Fk Salmon R.	" "	4.4	3.0	1.8	2.7
10.	Snake & Lower Salmon R. tribs.	" "	9.7	13.9	7.9	12.6
11.	Mid-Salmon R. Tribs	Wild A's	2.0	6.9	7.0	5.2
12.	Clearwater R. Tribs, Hells Canyon, Lower Salmon	" "	9.0	12.5	8.8	9.0

1986. The majority of the Selway and Middle Fork Salmon River drainages are in wilderness and have experienced only localized damage from land use practices.

Chinook Parr

Wild, indigenous chinook populations in Idaho presently occur in the entire Middle Fork Salmon River drainage, as well as in **a few** smaller Salmon River tributaries (Figure 13). The remainder of Idaho's chinook salmon waters are classified as natural populations.

There are two races of chinook, spring and summer, which have parr that rear one year in Idaho streams. These two chinook races have similar life histories. Spawning occurs in August-September, with emergence in early spring, The parr rear one year in tributaries and main stems and **smolt** the following April-May. A third race, fall chinook, produce sub-yearling smolts from spawning areas in lower, main stem rivers and are not monitored by this project.

We identified four classes of chinook, wild spring, wild summer, natural spring, and natural summer, in our monitoring **areas.** Because of small sample sizes of summer chinook (Table **14),** we pooled spring and summer chinook data and compared wild and natural chinook production.

Chinook parr prefer the pool habitat of low gradient, meandering streams (**C** channels). Average density of chinook parr in C channels for 1985-88 was 18.2/100 m^2, 3.5 times greater than the mean of 5.2 in B channels. PCC in B and C channels were 9.2% and **22.4%,** respectively. Both of these indicated severely depressed populations. Mean PCC for B channels was significantly lower **(p=0.01),** indicating that at low seeding levels there was little need for chinook parr to occupy the less desirable B channels. Average annual density of chinook parr in C channels ranged from 14.6 in 1985 to 20.6 in 1987 with no significant differences between years **(p=0.34).**

Wild verses Natural Production-We classified chinook monitoring data for 1985-88 as either wild or natural and did **two-way** AOV for both density and PCC on: **1)** all sections, **2)** B channel sections, and **3)** C channel sections. Factors in the analyses were year and production class (wild or natural).

There were no significant differences between years for any of the six analyses (Table **15).** For both density **and PCC,** means for natural production were significantly higher than for wild production areas for B and C channels combined and for B channels alone, but not for C channels alone.

These analyses imply that there has been no trend in 1985-88 of either rebuilding or decline for chinook parr density or PCC. Additionally, both density **and** PCC were significantly higher for natural than wild chinook parr where all sections and B channels alone were considered. Where only the preferred C channel sections were considered, differences between the wild and
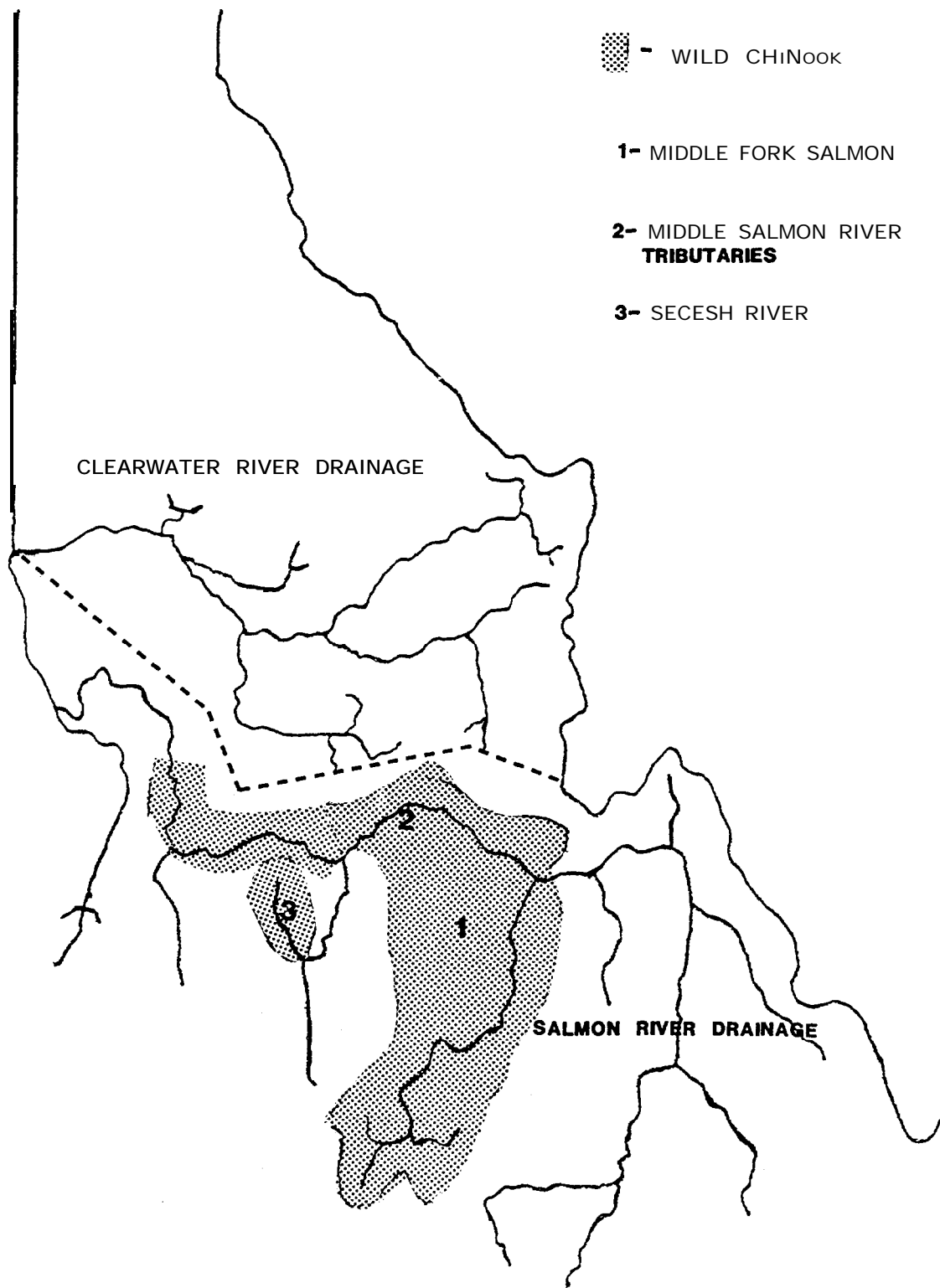
Figure 13. Present distribution of wild chinook production areas in Idaho.

Table 13. Streams, stratum-section locations, channel types, years sampled and densities recorded for ages-1+ and -2+ steelhead parr for samples where densities have exceeded 75% of rated carrying capacities in streams with B-run steelhead stocks.

Stream	Stratum	Section	Channel Type	Year	Ages-1+ & -2+ Density
Loon Cr.		L1	B	1986	17.6
Big Cr.	Lower	L1	B	1986	16.2
Big Cr.	Lower	L1	B	1987	16.1
Crooked R.	2	Trt2	B	1987	19.5
Crooked R.	2	Trt2	B	1988	15.5
Relief Cr.	2	Relief2	B	1986	16.5
Red R.	5	Ctrl2	C	1986	19.1
Red R.	5	Trt2	C	1986	11.4
Amer. R.		1	C	1986	10.7
Amer. R.		2	C	1986	16.7
Amer. R.		2	C	1987	14.5
Meadow Cr.	Mdw	Grazed	C	1987	15.0
Relief Cr.	2	Relief 1	C	1988	26.7

Table 14. Number of monitoring sections for four classes of chinook salmon parr.

Classes	n
Wild Spring Chinook	65
Wild Summer Chinook	8
Natural Spring Chinook	107
Natural Summer Chinook	19

Table 15.   Mean annual chinook densities (number/100 m^2) and
            percents of carrying capacity (PCC) for all monitoring
            sections and separately for B and C channel
            sections. Probabilities of mean values being
            significantly different between years and between
            classes are included.

	1985	1986	1987	1988
Densities				
All Sections (mean comparisons: years p=0.89, W/N p=0.02)				
Wild	6.7 (60)	7.8 (69)	11.0 (75)	9.1 (61)
Natural	12.9 (84)	12.1 (92)	11.4 (108)	12.3 (119)
B Channels (mean comparisons: years p=0.59, W/N p=0.00)				
Wild	2.5 (34)	2.9 (41)	2.0 (42)	**3.1 (31)**
Natural	9.9 (44)	6.8 (54)	4.5 (63)	**7.2 (73)**
C Channels (mean comparisons: years p=0.29, W/N p=0.27)				
Wild	12.2 (26)	14.9 (28)	22.4 (33)	15.3 (30)
Natural	16.2 (40)	19.6 (38)	21.0 (45)	20.3 (46)
PCC				
All Sections (mean comparisons: years p=0.92, W/N p=0.00)				
Wild	7.8	10.7	12.8	12.8
Natural	17.9	17.2	16.4	18.4
B Channels (mean comparisons: years p=0.59, W/N p=0.00)				
Wild	**3.8**	5.6	**3.7**	6.0
Natural	**15.7**	11.5	**8.4**	13.2
C Channels (mean comparisons: years p=0.36, W/N p=0.06)				
Wild	13.2	18.2	24.5	16.8
Natural	20.3	25.4	27.6	26.6

natural means were not significant, although the differences for PCC was nearly significant **(p=0.06).**

Mean annual densities for wild chinook parr in C channels ranged from **12.2/100 m^2** in 1985 to **22.4/100 m^2** in 1987, **a** much greater range than for natural chinook **parr,** i.e., 16.2 in 1985 to 21.0 in 1987. Mean annual PCC for wild chinook parr in C channels ranged from 13.2% in 1985 to 24.5% in 1987.

Although annual differences were not significant, mean values fluctuated more for wild than natural populations. Natural population abundance was affected by varying levels of hatchery plants of fry, eggs, and adults. Densities and PCC in wild areas, in contrast, should be strongly influenced by redd density, outmigration flow/passage conditions, and harvest.

Class and Drainage Cells-We assigned Idaho's chinook production areas to 13 cells based on geographical distribution and their wild or natural status. The cells are as follows:

<u>Cell</u>	<u>Location/Description</u>	<u>Wild/Natural</u>
1.	Middle Fork Salmon R. tributaries (without Bear Valley Cr. drainage)	Wild
2.	Lower reaches of the Salmon R. Canyon tributaries	Wild
3.	All wild summer chinook areas (from Mid. Fk, S. Fk and Main Salmon R.)	Wild
4.	Chamberlain Basin	Wild
5.	Bear Valley Cr. and its tributaries	Wild
6.	Upper Salmon R. and E. Fk. Salmon R.	Natural
7.	Pahsimeroi, Lemhi and **N.** Fk. Salmon R. and Panther Cr.	Natural
8.	South Fork Salmon River	Natural
9.	Little Salmon River	Natural
10.	Selway River	Natural
11.	**Lochsa** River	Natural
12.	South Fork **Clearwater River**	Natural
13.	Lo10 Creek and tributaries	Natural

The mean PCC for 1985-88 ranged from 1.5% in the wild chinook production area of lower reaches of the middle Salmon River canyon (cell 2) to 40.1% in the heavily supplemented South Fork Clearwater River tributaries (cell 12) (Table 16). However, poor and moderate levels of production were observed in both wild and natural cells (Figures 14 and 15). The lowest PCC among natural production areas occurred in the Selway (2.1%) and Lochsa (2.9%) drainages, both tributaries of the Clearwater River.

The entire Clearwater River drainage lost all but remnant chinook salmon populations due to inadequate adult passage facilities at the Washington Water Power (WWP) dam near the river mouth. The dam was removed in 1973 after operating 47 years. The Selway chinook population was reestablished from a combination of wild fish transfers and hatchery stocking from the 1960s until 1981, with an additional stocking in 1985 (Lindland and Bowler 1986). There was no chinook supplementation in the Lochsa drainage from 1980 through 1986. Recent Lochsa drainage fry plants were not near the parr monitoring sections and should not have influenced the observed densities.

The wild production area of Bear Valley Creek and its tributaries, Elk and Bearskin Creeks (cell 5), were affected by loss of riparian cover, stream bank instability and sedimentation resulting from cattle grazing (OEA 1987b). Additionally, placer mining, which occurred prior to the mid-1950s (Konopacky et al. 1985) contributed substantially to Bear Valley Creek sedimentation. This was the only cell in which chinook parr density was higher in B channels than in C channels and may reflect fish response to the extreme sedimentation in the depositional C channels. The Bear Valley drainage had among the lowest average chinook parr density ($2.2/100 m^2$), and its average PCC was 4.0%.

The highest PCC in natural production areas occurred in Lo10 Creek (24.8%) and the South Fork Clearwater River tributaries (40.1%), areas which were heavily supplemented with fry during the study. Highest mean PCC in wild production areas were in Chamberlain Basin (30.5%) and the Middle Fork Salmon River tributaries (17.5%), areas which have been least affected by land and water uses and contain large areas of C channel spawning and rearing habitat. Although there are trends apparent in the annual mean values within several of the cells (Table 17), simple linear regression of PCC on years did not produce any significant regressions among the 13 cells. There is insufficient evidence to demonstrate a trend in chinook PCC from 1985 to 1988 in any of the cells.

It is not possible to determine how populations of chinook fared in areas where intense supplementation has occurred in recent years because of continual additions of hatchery fish in natural production areas (e.g., South Fork Clearwater and South Fork Salmon rivers and Lo10 Creek). However, it is apparent that in unsupplemented or lightly supplemented drainages, the level of seeding relative to carrying capacities was extremely low.

Wild chinook populations in good to excellent habitat achieved 18-30% of carrying capacities. In areas a few kilometers from the spawning sites, such as the lower reaches of the Salmon River canyon tributaries, few parr were

Table 16. Mean chinook parr densities (number/100 m^2) and percent carrying capacities (PCC) for chinook parr in 13 class/ drainage cells, from 1985 through 1988. Sample sizes are in parentheses.

Cell	Production Class	All Sections	B Channel sections	C Channel Sections
Densities				
1	Wild	14.7 (119)	3.9 (59)	25.3 (60)
2	Wild	0.7 (52)	0.7 (52)	*
3	Wild	9.2 (20)	2.1 (8)	14.0 (12)
4	Wild	25.1 (10)	15.2 (6)	40:o (4)
5	Wild	2.3 (41)	3.3 (3)	2.2 (38)
6	Natural	10.2 (115)	5.1 (38)	12.7 (77)
7	Natural	6.5 (44)	5.1 (12)	7.0 (32)
8	Natural	13.9 (44)	5.5 (33)	38.9 (11)
9	Natural	5.5 (27)		*
10	Natural	1.7 (48)	5.5 (27)	11.0 (4)
11	Natural	2.1 (20)	0.9 (44) [20]	*
12	Natural	26.2 (80)	19.8 (42)	33.3 (38)
13	Natural	17.9 (25)	6.3 (18)	47.9 (7)
Percent of Carrying Capacities				
			7.3	27.6
a	Wild Wild	17.5 1.5	1.5	*
3	Wild	11.5	3.1	17.0
4	Wild	30.5	25.5	38.0
5		4.0	4.3	4.0
6	Wild Natural	11.9	6.4	14.6
7	Natural	7.2	6.6	7.4
8	Natural	23.6	9.7	65.0
9	Natural	12.5	12.5	*
11	Natural	2.1	1.3	10.2
12	Natural Natural	40.1 2.9	2.9	*
			36.2	44.4
13	Natural	24.8	10.2	62.2

* = No sections with C channels.
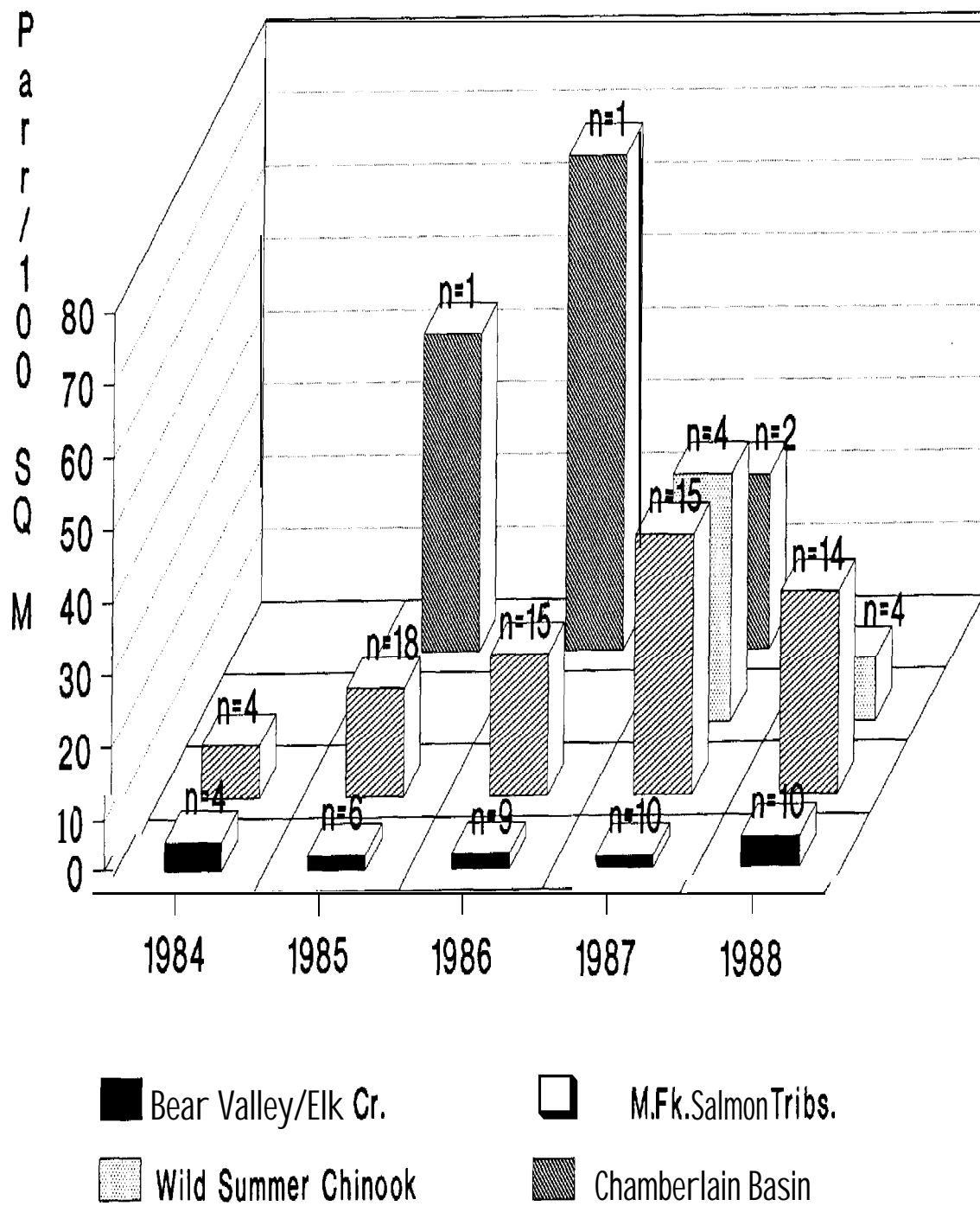
Figure 14. Mean annual densities of age-0+ chinook parr in C channels in four wild chinook production areas, 1984-1988.
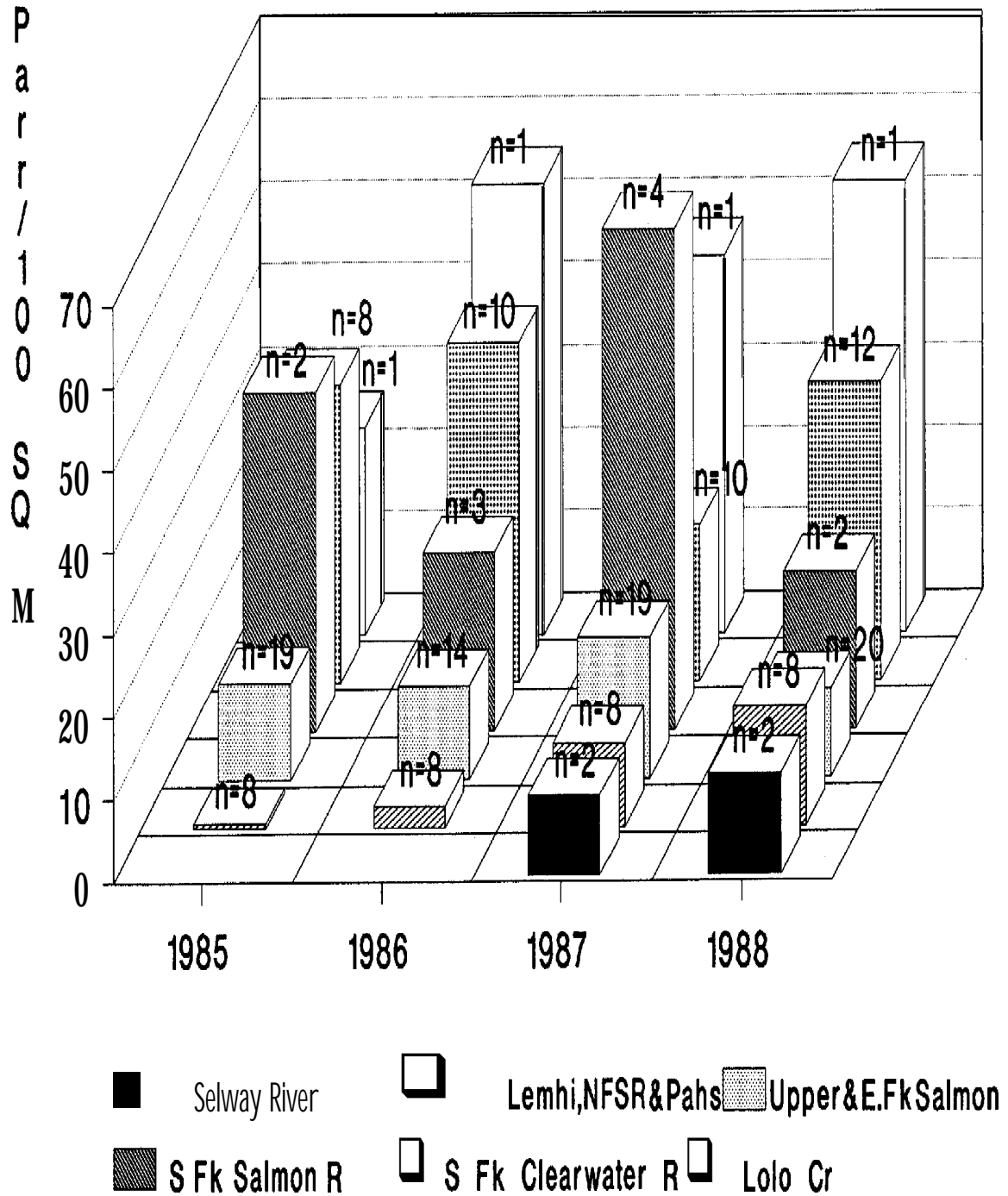
Figure 15. Mean annual densities of age-0+ chinook parr in four natural chinook production areas, 1984-1988.

observed because the low escapements precluded significant seeding of these areas.

In summary, where spawning and rearing habitat are in good condition and the indigenous genetic stock is in tact, chinook production was fair (18-30% PCC) in localized areas. Chinook parr production was limited by low escapement, due primarily to continued poor main stem flow and passage conditions.

Parr Densities in Main Stem Corridors

Snorkel counts were made by IDFG regional management personnel in corridor sections on main stems of the Selway River and the Middle and South Forks of the Salmon Rivers during 1985-88. We compared densities in the headwater and tributary monitoring sections with the densities in main stem corridor sections. Although the snorkeling methods differed in these two stream classes, parr densities should be comparable.

Densities in the main stem rivers were much lower than in headwater and tributary sections (Table 18). Chinook densities in main stem corridors ranged from 3-10% of those in monitoring sections, and steelhead densities in main stem corridors represented 20-107% of densities in monitoring sections.

Chinook parr densities in the main stem Selway River were generally much lower than in the main stem of the South and Middle Forks of the Salmon River. Steelhead parr densities were generally the lowest in the Selway River also, but the differences were not as great as with chinook. Sample sizes in the Selway were too small to provide precise estimates (Table 19).

Comparing the Middle and South Forks of the Salmon River, the differences in mean densities of both chinook (p=0.003) and steelhead (p=0.001) were highly significant. There were no significant density differences in either drainage for each species between years. The highest mean densities of both chinook and steelhead were in the South Fork Salmon River.

Although some spawning occurs in main stem rivers, the main stems are important primarily as rearing **areas for parr** that are produced higher in the drainage. At low escapements, we would expect extremely low parr densities because of a lack of density-dependent dispersal from the primary spawning and rearing areas. We would also expect relatively more use of main stems by steelhead than by chinook parr at low escapements because of life history differences between the two species.

Steelhead Rearing Potential

For the generally underseeded steelhead populations in Idaho, we hypothesized that **a** subset of the parr densities exhibiting higher densities would provide a conservative estimate of carrying capacity (CC). The steelhead

Table 17. Mean annual densities of age-O+ chinook parr in
individual drainage cells from 1985 through 1988
in C channels.

Cell locations	Chinook parr/100 m²			
	1985	1986	1987	1988
Wild Production Areas:				
Middle Fork Salmon River (without Bear Valley Creek)	16.2	20.8	38.3	27.8
Salmon R. Canyon utaries (Without Chamberlain Basin)	*	*	*	*
All wild summer chinook areas	0.6	2.2	27.8	5.3
Chamberlain Cr, upper basin	43.8	68.2	24.1	ND
Bear Valley Cr. and tribs.	1.8	1.4	1.5	3.8
Natural Production Areas:				
Upper & East Fk. Salmon R.	11.7	11.3	17.1	10.7
Pahsimeroi, Lemhi and North Fork Salmon rivers	0.6	2.6	10.1	14.5
South Fork Salmon River	41.2	21.6	60.6	19.0
Little Salmon River and tribs (Boulder & Hazard crs.)	*	*	*	*
Selway River	ND	ND	9.7	12.3
Lochsa River	*	*	*	*
S. Fk. Clearwater River	36.2	41.2	19.0	36.2
Lolo Creek	25.2	54.5	45.8	54.6

 * = No sections with C channels.
ND = No data.

Table 18. Mean chinook and steelhead densities (number/100m²)
from 1985 to 1988 in corridor sections of three
main stem rivers and in monitoring sections of the
same drainages.

River systems	Chinook densities				Steelhead densities			
	Corr.	(n)	Mon.	(n)	Corr.	(n)	Mon.	(n)
S. Fk. Salmon R.	1.4	(26)	14.1	(56)	1.7	(26)	1.6	(90)
M. Fk. Salmon R.	0.3	(125)	10.8	(176)	0.4	(125)	2.0	(184)
Selway River	0.1	(10)	1.7	(48)	0.5	(IO)	1.8	(48)

Table 19. Mean annual densities of chinook and steelhead parr
           in main stem corridor snorkeling sites of three
           major Idaho drainages.

Drainages	1985	1986	1987	1988
	Chinook Parr Densities and (sample sizes)			
S. Fk. Salmon R.	----	0.9 (9)	2.9 (8)	0.6 (9)
M Fk. Salmon R.	<0.1 (25)	0.5 (51)	0.5 (20)	0.3 (29)
Selway River	0.1 (2)	<0.1 (1)	<0.1 (6)	0.5 (1)
	Steelhead Parr Densities and (sample sizes)			
S. Fk. Salmon R.	----	1.6 (9)	1.7 (8)	1.8 (9)
M Fk. Salmon R.	0.4 (25)	0.4 (51)	0.4 (20)	0.6 (29)
Selway River	0.2 (2)	0.2 (1)	0.7 (6)	0.4 (1)

CC ratings of 6, 10, 14, and 20 for ages-l+ and -2+ parr for poor, fair, good, and excellent rearing habitat were compared with a subset of monitoring sections where densities exceeded 75% of the rated CC (Table 20). The average densities from the subset exceeded the rated carrying capacity for each rating by an average of 25% (Table 21). This suggests that steelhead carrying capacity ratings are near the true CC and are conservative.

Chinook Rearing Potential

We hypothesized for chinook, as for steelhead, that a subset of higher chinook parr densities would provide a conservative estimate of carrying capacity. Chinook CC ratings of 12, 44, 77, and 108 for poor, fair, good, and excellent habitat were compared with a subset of monitoring sections where densities exceeded 75% of the rated carrying capacity (Table 22). There were no densities with poor ratings which exceeded the criterion. Densities in fair and good habitats averaged 116% of the rated capacity. However, the average density for excellent habitat was only 86% of the rating (Table 21). In order to further evaluate the CC for chinook parr in excellent habitat, we averaged chinook parr density in both monitoring and evaluation sections (where chinook fry were stocked in excess during May) where parr density exceeded 75% of the rated carrying capacity in excellent habitat. Average density of 57 samples from July and August was 116 parr/100 m^2, or 107% of the rated carrying capacity. As was observed with steelhead, the parr density ratings for chinook appear slightly conservative.

Chinook Reproduction Curves

The chinook salmon reproduction curves for the upper and Middle Fork Salmon River and tributaries were further developed using redd counts from 1987 and parr densities from 1988 in 20 monitoring sections. This increased the data set to 88 observations, including redd counts from 1983 through 1987 and parr densities from 1984 through 1988. All sections were in unstocked, C channel habitats. To reduce potential leverage of outliers at low escapements, we included only observations where parr density (R) exceeded l/l 00 m^2 and P/R >1, where P = redds/ha.

The data set was incomplete, however, since only eight exceeded 5 redds/ha and only two observations, 10 redds/ha. Thus, the critical part of the relationship is missing where parr densities approach carrying capacity. This would not be so important if a linear relationship existed between redd and parr density, but the actual relationship will be a curve, where additional parr/100 m^2 decrease for each incremental increase in redds/ha until an asymptote is reached (i.e. the carrying capacity). Such a curve is appropriate when there is a ceiling in parr abundance imposed by available spawning or rearing habitat (Ricker 1975). In the 1960s, redd densities in Marsh Creek, a stream within the present data set, averaged 18.7 redds/ha (Petrosky and Holubetz 1988) and

Table 20. Monitoring sections where densities (number/100 m^2) of steelhead parr (ages-1+ and -2+) exceeded 75% of rated carrying capacity in B and C channels.

Stream Name	Strata	Section	Channel Type	Year	Observed Steelhead Parr Density	Rated Carrying Capacity	Percent Carrying Capacity
** Channel Type B							
BIG CANYON C			5	1988	4.85	6	80.83
BIG CANYON C			B	1987	9.70	6	161.67
BIG CANYON C			B	1986	8.48	6	141.33
BIG CANYON C		1	B	1985	16.97	6	282.83
SALMON R, S FK E FK		3	B	1987	9.17	10	91.70
ELDORADO CR	ABOVE	1HG	B	1986	11.08	10	110.80
ELDORADO CR	ABOVE	1HG	B	1987	7.88	10	78.80
ELDORADO CR	BELOW	1B	B	1987	*7.55*	10	75.50
ELDORADO CR	BELOW	15	B	1988	*12.59*	10	125.90
ELDORADO CR	BELOW	1B	B	1986	8.65	10	86.50
CROOKED R	I	CONTROL1	5	1988	11.16	14	79.71
CROOKED R	I	SILL-LOG-B	5	1988	13.06	14	93.29
CROOKED R	II	CONTROL2	B	1986	13.96	14	99.71
CROOKED R	II	TREAT1	B	1988	14.49	14	103.50
CROOKED R	II	TREAT2	B	1988	15.54	14	111.00
CROOKED R	II	TREAT2	5	1987	19.50	14	139.29
CROOKED R	II	TREAT2	8	1986	13.66	14	97.57
CROOKED R	III	CANYON3	B	1988	14.34	14	102.43
CROOKED R	III	CANYON4	B	1988	14.90	14	106.43
LOLO CR	DOWNSTREAM	DS6	B	1986	16.47	14	117.64
LOLO CR	UPSTREAM	RUN7	5	1987	11.29	14	80.64
MEADOW CR	CANYON	MILEPOST2	B	1987	11.62	14	83.00
MONUMENTAL C		MON3	5	1985	13.40	14	95.71
SALMONR	10	A	B	1988	12.63	14	90.21
SALMON R	10	A	5	1986	15.67	14	111.93
WHITEBIRD CR		1	B	1986	23.79	14	169.93
BIG CR	LOWER	L1	B	1986	16.22	20	81.10
BIG CR	LOWER	L1	5	1987	16.07	20	80.35
BOULDER CR	BELOW	3	B	1988	17.73	20	88.65
BOULDER CR	BELOW	5	5	1986	23.80	20	119.00
BOULDER CR	BELOW	5	5	1987	20.21	20	101.05
CAPTAIN JOHN CR			5	1986	23.37	20	116.85
CAPTAIN JOHN CR		2	5	1986	29.44	20	147.20
CHAMBERLAIN CR		L1	B	1987	30.28	20	151.40
CHAMBERLAIN CR		L1	B	1986	17.61	20	88.05
CHAMBERLAIN CR		L2	B	1987	33.70	20	168.50
CHAMBERLAIN CR		L2	B	1986	16.85	20	84.25
GRANITE CR		1	B	1985	19.37	20	96.85
GRANITE CR			B	1988	24.78	20	123.90
GRANITE CR		2	B	1988	15.76	20	78.80
GRANITE CR		2	B	1985	22.41	20	112.05
GRANITE CR		3	B	1986	24.00	20	120.00
GRANITE CR		3	B	1988	36.00	20	180.00

Table 20.   (Cont.)

Stream		Site	Type	Year	Value	N	Total
HAZARD CR		HAZ1	B	1988	19.44	20	97.20
HORSE CR		L1	B	1986	20.62	20	103.10
HORSE CR		L2	B	1987	18.98	20	94.90
LOON CR		L1	B	1986	*17.58*	20	87.90
RAPID R		RAP2	B	1988	21.84	20	109.20
RELIEF CR	2	RELIEF-CR2	B	1988	15.87	20	*79.35*
SALMON R, N FK		DAHLONEGA	B	1985	24.33	20	121.65
SALMON R. N FK		DAHLONEGA	B	1986	15.22	20	76.10
SHEEP CR, (SM)		L2	B	1988	16.00	20	80.00
SHEEP CR, (SM)		L2	B	1986	*27.17*	20	135.85
SHEEP CR, (SM)		L2	B	1987	*29.35*	20	146.75
SHEEP CR, (SN)			B	1988	22.13	20	110.65
SHEEP CR, (SN)			B	1987	30.33	20	151.65
SHEEP CR, (SN)			B	1986	31.97	20	159.85
SHEEP CR, (SN)			B	1985	21.31	20	106.55
WHTBRD CR, N FK		2	B	1987	16.26	20	81.30
WHTBRD CR, N FK		2	B	1986	29.08	20	145.40
WHTBRD CR, N FK		2	B	1985	19.46	20	97.30
WHTBRD CR, S FK		3	B	1987	26.01	20	130.05
WHTBRD CR, S FK		3	B	1986	31.44	20	157.20
WHTBRD CR, S FK		3	B	1985	*27.46*	20	137.30
WHTBRD CR, S FK		4	B	1985	19.01	20	95.05
WOLF CR		1	B	1985	*17.54*	20	87.*JO*

** Channel Type C

Stream		Site	Type	Year	Value	N	Total
POLE CR	2	B	C	*1987*	10.40	10	104.00
RED R	V	CONTROL2	C	1986	19.05	10	190.50
RED R	V	CONTROL2	C	*1987*	*7.93*	10	79.30
RED R	V	TREAT2	C	1986	11.39	10	113.90
AMERICAN R			C	1986	10.72	14	*76.57*
AMERICAN R		2	C	1986	16.67	14	119.07
AMERICAN R		2	C	*1987*	14.51	14	103.64
CHAMBERLAIN CR, W FK		CHA2	C	1986	15.92	14	113.71
MEADOW CR	MEADOW	GRAZED	C	1987	14.95	14	106.79
SALMON R	3	BRA	C	1985	14.21	14	101.50
SALMON R	9	A	C	1986	11.11	14	79.36
BIG SPRINGS	LEM1	A	C	1985	39.43	20	*197.15*
BIG SPRINGS	LEM1	A	C	*1987*	19.52	20	*97.60*
BOULDER CR	ABOVE	1	C	*1987*	15.12	20	75.60
LEMHI R	LEM2	B	C	1988	20.00	20	100.00
LEMHI R	LEM2	B	C	1987	16.74	20	83.70
LEMHI R	LEM2	B	C	1985	16.70	20	83.50
MOYER CR	ABOVE	MO1	C	1988	15.54	20	77.70
PAHSIMEROI R		DWNLANE	C	*1987*	17.24	20	86.20
PAHSIMEROI R		LOWER	C	1985	61.60	20	308.00
PAHSIMEROI R		LOWER	C	1986	32.80	20	164.00
PAHSIMEROI R		LOWER	C	1987	80.00	20	400.00
RELIEF CR	2	RELIEF-CR1	C	1988	26.69	20	133.45

Table 21.   Mean density and percent of carrying capacity
            (PCC) for steelhead and chinook parr in
            samples where density exceeded 75% of rated
            carrying capacity (CC).

Species	cc	Density	PCC	n
Steelhead				
	6	10.0	167	4
	10	10.6	106	10
	14	14.5	104	23
	20	24.4	122	52
Chinook				
	12	--	--	0
	44	57.4	131	9
	77	77.8	101	17
	108	93.4	86	5

Table 22.   Monitoring sections where densities (number/100 m^2) of chinook parr (age-O+) exceeded 75% of rated carrying capacity in B and C channels.

Stream Name	Stratum	Section	Channel Type	Year	Chinook Parr Density	Rated Carrying Capacity	Percent Carrying Capacity
** Channel Type B							
BOULDER CR	BELOW	5	B	*1987*	40.89	44	92.93
CHAMBERLAIN CR		CHA1	B	1986	34.34	44	78.05
RED R	II	TREAT2	B	1985	75.42	44	171.41
RED R	II	CONTROL2	B	1985	39.00	44	90.64
CROOKED R	I	SILL-LOG-B	B	1988	57.21	44	130.02
CROOKED R	I	BOULDER-B	B	1988	78.94	44	179.41
RED R	II	TREAT2	B	1987	48.13	44	109.39
CROOKED R	II	CONTROL2	B	1985	90.18	77	117.12
** Channel Type C							
LOON CR		2	C	1986	44.82	44	101.86
SALMON R, S FK		5	C	1987	97.22	44	220.95
MONUMENTAL CR, W FK		MON4	C	1987	121.22	77	157.43
SALMON R. S FK	STOLLE	1	C	1985	74.96	77	97.35
SALMON R, S FK	STOLLE	2	C	1987	91.46	77	118.78
SALMON R	3	BRA	C	1987	88.76	77	115.27
CROOKED R	III	NATURAL1	C	1986	59.67	77	77.49
RED R	IV	TREAT2	C	1985	57.94	77	75.25
RED R	IV	TREAT2	C	1988	63.49	77	82.45
CROOKED R	IV	MEANDER1	C	1985	91.87	77	119.31
CROOKED R	IV	MEANDER1	C	1986	93.42	*77*	121.32
CROOKED R	IV	MEANDER2	C	1986	66.80	77	86.75
LOLO CR	UPSTREAM	RUN1	C	1986	70.71	77	91.83
RED R	IV	CONTROL2	C	1985	77.78	77	101.01
SALMON R	3	BRA	C	1986	70.65	77	91.75
LOLO CR	UPSTREAM	RUN1	C	1988	69.70	77	90.52
AMERICAN R		1	C	1988	74.83	77	*97.18*
LOLO CR	UPSTREAM	8303	C	1987	58.31	77	75.73
CAPE HORN CR	2	B	C	1987	96.81	108	89.64
SALMON R	7	B	C	1984	97.76	108	90.52
ALTURAS LK CR	DS-DVRSN	3	C	1984	81.92	108	75.85
MARSH CR	5	A	C	1987	89.32	108	82.70
SALMONR	8	A	C	1984	100.96	108	93.40

the maximum redd density recorded in the 1960s was 36.6/ha. Unfortunately, there were no corresponding parr density data from those years.

Acknowledging these data limitations, we present the following models, not as representations of the actual reproduction curves for the Upper and Middle Fork Salmon River chinook stock, but to describe the analyses which will lead to such a representation and to show what information we have and what is still needed.

The chinook redd and parr data were separated into three data sets based on substrate surface sand in the areas where parr densities were collected. The sand class intervals were 0-30%, 30-40% and >40%. Since sand has a negative effect on emergence of chinook fry, the number of redds/ha should be higher to achieve parr carrying capacity in sedimented streams. Two types of regression analyses were done using redds/ha (P) as an independent variable. One was linear with chinook parr (R) as the dependent recruitment variable, and the other uses the ratio P/R as the dependent variable. The former is linear, i.e. it assumes the spawning areas have "infinite productivity," while the latter is a hyperbolic (Beverton-Holt) function which recognizes there is an upper limit, or carrying capacity. Table 23 presents the regression coefficients for both linear and hyperbolic models and their associated coefficients of determinations. Sample sizes were small for the two highest percent sand classes. Therefore, the hyperbolic relation, where percent sand exceeded 40%, should be considered cautiously despite being significant (p=0.016).

Although the regressions were significant for both the linear and hyperbolic models with less than 30% surface sand, the coefficient of determination for the linear model is much higher (0.46 verses 0.19), indicating that the 1985-1988 redd densities were not approaching parr carrying capacity. Until higher densities of redds occur, the reproduction curve for redds and parr densities cannot be determined.

The linear and hyperbolic curves where sediment was low is shown in Figure 16. The carrying capacity for parr in excellent rearing habitat (108/100 m^2, based on fry planting studies) is superimposed on the relationship to show where we believe the hyperbolic asymptote will occur when sufficiently high redd density data are available.

An extrapolation of the hyperbolic curve for the low sediment class would predict a carrying capacity of 87 parr/100 m^2 when 60 redds/ha occurred. Although data are not presently available to directly estimate the carrying capacity, the estimate of 108/100 m^2 from fry stocking in Lochsa River tributaries and the historical high densities of 35 redds/ha may approximate carrying capacity. Both are at least five times greater than present densities.

It is encouraging that the regressions show strong differences in predicted parr densities for the different percent sand intervals. This corresponds to the observation that increased sand results in lower parr densities. For example, at 60 redds/100 m^2 the hyperbolic equations predict densities of 87, 42, and 5 for the low, moderate, and high sediment classes, respectively. Although the linear equations show the same inverse relationships, they predict

Table 23.   Regression coefficients, significance levels (prob.) and coefficients of determinations (r^2) for linear and Beverton-Holt hyperbolic reproduction curves for parr density samples where percent surface substrate sand was $\leq$ 30%, 30-40% and 140%. The relations are between the parental redds/ha (P) and the recruited parr/100 m (R).

| % Sand | Regression Coefficients | | | r^2 | n | Predicted R at P=: | |
	Intercept	Slope	Prob.			30	60
Linear:							
0 to 30%	9.05	4.99	o.ooo*	0.46	49	158	308
30 to 40%	12.96	1.41	0.442	0.09	9	55	98
› 40%	8.08	-1.44	0.370	0.08	12	-35	-78
Bev.-Holt:							
0 to 30%	0.09	0.01	0,002"	0.19	49	77	87
30 TO 40%	0.23	0.02	0.365	0.12	9	36	42
› 40%	0.20	0.18	0.016"	0.46	12	5	5

* = significant at p = 0.05.
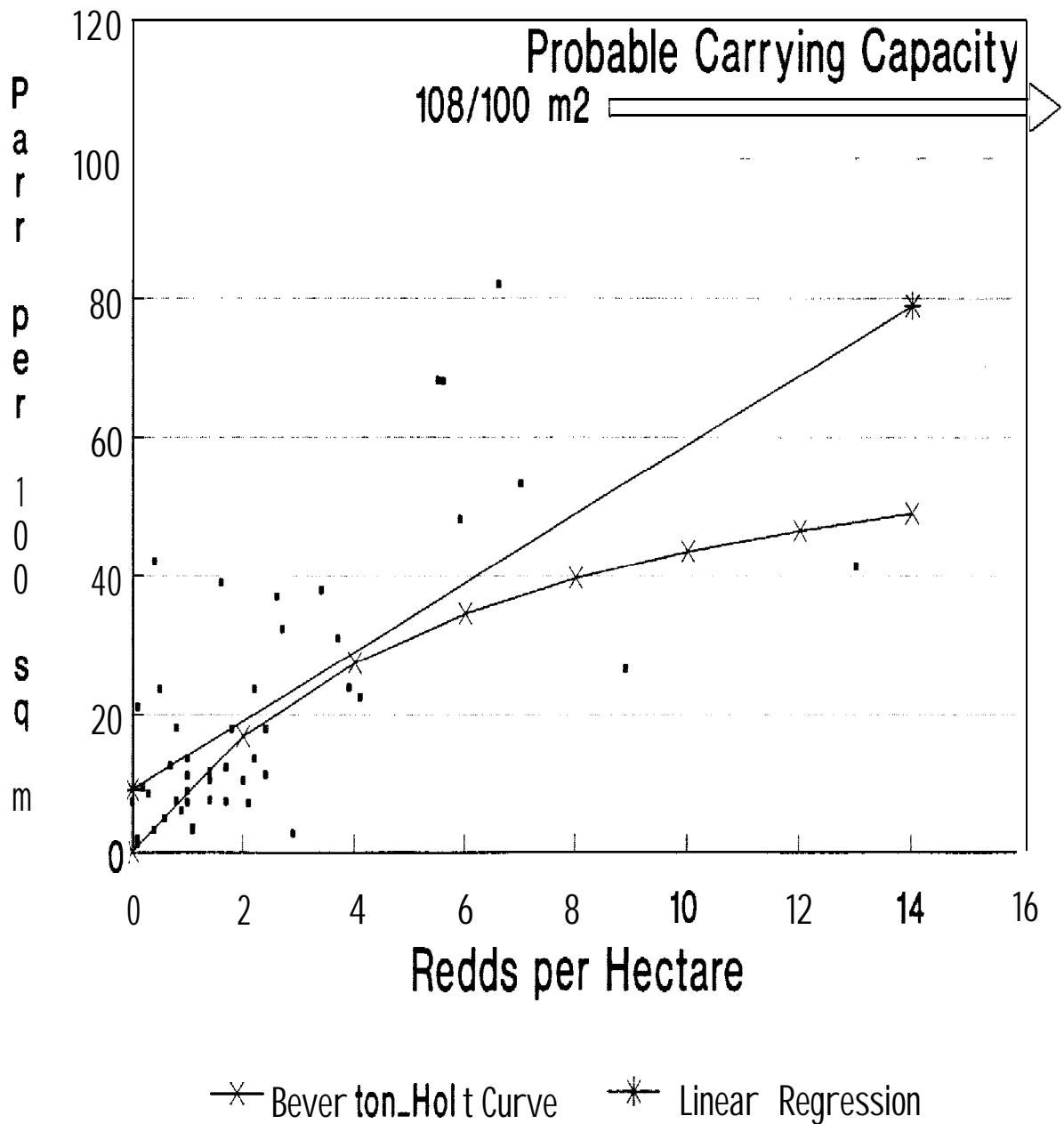
Figure 16. Linear and Beverton-Holt regression lines for the density of chinook parr expected as redds per hectare increase. The large arrow represents our best estimate of parr carrying capacity. Scatter points represent redds/ha:parr/100 m^2 data from the upper and Middle Fork Salmon River for brood years 1983-1987, for streams with <30% substrate surface sand.

unattainable high densities in the low sediment class and nonsensical negative densities in the high sediment class.

Chinook Egg-to-Parr Survival

Chinook fry have been stocked in upper Lochsa River tributaries (White Sand and Crooked Fork Creek drainages), Eldorado, Boulder, and Johnson Creeks from 1986 to 1988 to initiate populations above barrier removal projects and/or to estimate chinook parr carrying capacities.

The mean unweighted survival rate from mid-May to mid-August for the 13 fry plant evaluations was 19.8% (Table 24). Survival ranged from 11.1 to 32.9%. The streams stocked included both basalt and granitic geologies, as well as wilderness and multiple use drainages. Green egg-to-fry survival in Idaho hatcheries averages approximately 75% (Steve Huffaker, IDFG, personal communication). Therefore, the actual mean survival of the supplemented fry from green egg to parr was 19.8 x 75% or 14.9%.

Chinook fry stocking in the upper Lochsa River in 1988 probably did not fully seed stream reaches in the vicinity of the stocking sites. Chinook parr densities were summarized by location and habitat to estimate summer rearing potential and fry-to-parr survival. Thirteen to I5 weeks after stocking (mid August 1988), the fry had dispersed substantially, primarily downstream from the stocking sites (Table 25). Densities within 2 km downstream of the stocking sites averaged $60.6/100 \ m^2$, (range from 38 to $112.2/100 \ m^2$, 60% B channel); $42.3/100 \ m^2$ in Hopeful Creek (range from 26.9 to $55.3/100 \ m^2$, 80% B channel); $83.7/100 \ m^2$ in Big Flat Creek (range from 67.9 to $96.9/100 \ m^2$, 100% C channel); and $75.1/100 \ m^2$ in White Sand Creek (range from 62.7 to $100.0/100 \ m^2$, 100% c channel).

Fewer fry were available for stocking in 1988 than in 1987. This resulted in lower mean densities in the study area. There were 18,200 fewer fry stocked in upper Crooked Fork Creek, 25,800 fewer in Big Flat Creek, and 44,150 fewer in White Sand Creek in 1988.

The systematic stratified sampling design produced precise but conservative estimates of chinook parr abundance and survival (Table 26). Bounds on the error of estimation ($\pm$ 2 SE) averaged 9.5% of the estimated totals for all four sites. The error of estimation was considerably higher in the B channel streams (13.6% in Crooked Fork and Hopeful Creeks) than in the C channel streams (5.4% in Big Flat and White Sand Creeks). Estimated chinook fry-to-parr survival (May to August) averaged 23.3% for the four sites. Survival was lower in the B channel streams (18.0%) compared to the C channel streams (28.7%). Survival estimates were conservative because some parr probably dispersed outside the study area.

Chinook eyed eggs were stocked in "artificial" redds (White 1980) in four Idaho streams in the fall of 1987. Survival of eggs to mid summer parr averaged 0.7% and ranged from 0.3% to 1.2% (Table 27). Since 85% of green eggs generally survive to the eyed-egg stage in Idaho hatcheries (Steve Huffaker, IDFG, personal

Table 24.   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 ($\pm$ 2SE as a %)	% survival
White Sand Cr.	1987	152,200	45,064 $\pm$ 23.0%	29.6
	1988	108,300	26,470 $\pm$ 5.9%	24.4
Big Flat Cr.	1987	97,800	22,106 $\pm$ 13.0%	22.6
	1988	72,200	23,753 $\pm$ 4.8%	32.9
Crooked Fork Cr.	1986	101,100	11,457 $\pm$ 53.0%	11.3
	1987	164,300	32,568 $\pm$ 25.0%	19.8
	1988	40,600	8,860 $\pm$ 16.8%	21.8
Hopeful Cr.	1986	55,100	6,131 $\pm$ 136.0%	11.1
	1988	62,200	8,796 $\pm$ 9.0%	14.1
Eldorado Cr.	1986	199,000	30,203 $\pm$ 44.0%	15.2
Boulder Cr.	1986	99,900	28,112 $\pm$ 88.0%	28.1
Johnson Cr.	1986	186,000	23,711 $\pm$ 43.0%	12.8
	1987	34,500	3,102 $\pm$ 92.0%	13.3

| | | | unweighted mean % survival: | 19.8 |
| | | Green egg to parr survival (= 75% of 19.8): | | 14.9 |

Table 25. **Summary of chinook parr density** (number/100m^2) **13 to 15 weeks after stocking near four sites, Upper Lochsa River, August 1988.**

Stream stocking site	1988 Date	Stratum	Section	Density	Channel type	Percent gradient	Mean width(m)	Percent Pool, run	Percent sand
Crooked Fork Creek									
1.	8/10-12	U1	0.5U	0.0	B	3.7	3.1	40	26
		D1	0.00	52.6	C	0.2	3.4	78	27
			0.50	112.2	B	0.9	3.2	47	19
			1.00	43.2	C	2.3	3.0	58	5
		D2	1.50	56.5	B	1.2	3.5	67	3
			2.00	38.4	B	2.4	4.1	0	5
		D3	2.50	64.1	B		4.5		
Hopeful Creek									
2.	8/10-11	U1	1.0U	0.9	B	3.6	3.2	25	4
			0.5U	0.0	B	1.9	5.8	93	7
		D1	0.00	26.9	C	1.2	6.0	93	4
			0.50	42.3	B	1.8	5.1	58	6
			1.00	50.0	B	1.4	6.5	58	2
		D2	1.50	37.2	B	2.8	6.1	58	0
			2.00	55.3	B	1.9	7.6	42	12
		D3	2.50	28.6	B		6.8		
Big Flat Creek									
3.	8/14	U1	1.5U	53.3	C	0.5	8.6	83	20
			1.0U	28.0	C	0.1	7.4	75	25
			0.5U	56.6	C	0.1	7.4	75	13
		D1	0.00	86.0	C	1.1	6.0	92	21
			0.5D	67.9	C	0.1	8.7	83	38
			1.00	74.7	C	0.1	9.5	100	44
		D2	1.50	92.8	C		8.3	100	20
			2.00	96.9	C	0.1	8.1	83	14
		D3	2.50	54.2	C	0.3	8.8	92	40
			3.00	11.8	C	0.1	8.7	80	12
White Sand Creek									
4.	8/13-14	U1	1.0U	0.0	C	0.4	8.4	75	1
			0.5U	0.9	B	0.1	8.9	83	10
		D1	0.00	62.7	C	0.5	8.8	75	2
			0.50	loo:o	C	0.1	7.8	100	11
			1.00	69.5	C	0.2	10.2	92	20
		D2	1.50	81.4	C	0.1	15.0	100	94
			2.0D	61.9	C	0.1	11.6	100	63
		D3	2.5D	9.9	C	0.1	12.3	92	11
			3.00	2.3	B	0.7	10.4	50	5

Table 26.   Total abundance and fry-to-parr survival estimates
            for age-0 chinook, at four stocking sites, upper
            Lochsa River, August 1988.

Stream stocking site	Stratum	Stratum area (m²)	Number of sections	Total abundance + 2SE	% of number stocked
Crooked Fork Creek					
1.	U1		1	0 ± 0	0
	D1	6,400	3	4,438 ± 2,767	10.9
	D2-3	7,015	3	3,719 ± 1,070	9 . 2
	Total:	13,415	7	8,157 ± 1,367	21.8*
Hopeful Creek					
2.	U1	4,500	2	19 ± 38	‹0.1
	Dl	8,800	3	3,495 ± 1,194	5.6
	D2	10,250	3	4,135 ± 1,610	6 . 6
	Total:	23,550	8	7,649 ± 792	14.1*
Big Flat Creek					
3.	U1	11,688	3	3,899 ± 2,843	5.4
	D1	12,100	3	9,220 ± 1,278	12.8
	D2	8,175	2	7,751 ± 337	10.7
	D3	8,728	2	2,883 ± 3,700	4 . 0
	Total:	40,691	10	23,753 ± 1,151	32.9
White Sand Creek					
4.	U1	10,781	2	51 ± 101	0.1
	Dl	17,900	3	13,852 ± 4,108	12.8
	D2	16,375	2	11,875 ± 3,235	11.0
	D3	11,350	2	692 + 852	0 . 6
	Total:	56,606	9	26,470 ± 1,564	24.4

* = Estimate includes chinook in that portion of Crooked Fork Creek
    below the mouth of Hopeful Creek. Chinook from both creeks dispersed
    and reared in this area.

communication), the actual survival estimate from green egg to mid-summer parr was 0.7 x 85% or 0.6%.

Egg-to-Parr survival for wild and natural chinook spawning was estimated in the upper Salmon River and the Middle Fork of the Salmon River tributaries (Table 28). Assuming an average fecundity of 5,900 eggs and 1.5 redds per female, mean egg-to-parr survival for all streams combined was 15.2%, similar to that for fry planting. If the highly sedimented Bear Valley and Elk Creek data were excluded, resulting in a set of streams similar in *quality to those where fry planting evaluations occurred (Table 24), then egg-to-parr survival from wild/natural spawning was superior to that from fry planting (21.1% versus 14.9%). If we assumed only one redd per female (a conservative value) then the above comparison would change to 14.1% verses 14.9%.

Partial Project Benefits

Of the four types of habitat improvement projects evaluated barrier removals, off-channel developments, instream structures, and sediment reduction, the former has had the greatest benefit in terms of numbers of parr produced. From 1986 through 1988, 52% of steelhead and 72% of chinook parr produced as project benefits were the result of barrier removals (Tables 29 and 30).

The efficiency of barrier removal projects can be very high when large areas of spawning and rearing habitat are located above the barrier. For example, the Johnson Creek project made 395,000 m^2 of rearing area available to chinook. Unfortunately, there are few areas remaining where barrier removals would open up such large areas.

Parr production from all habitat projects are summarized in Tables 29 and 30. During the 1986 through 1988 interval, total parr production attributable to habitat improvement projects averaged 122,874 chinook and 14,618 steelhead. The 1989 annual report will define project benefits in terms of smolt production and expected adult returns, as well as parr production.

Success of some BPA-funded projects will depend on concurrent land management improvements. BPA sediment reduction projects in the Bear Valley/Elk Creek drainage can likely be ineffective unless accompanied by improvements in cattle grazing management and revegetation (Petrosky and Holubetz 1988). With improved land management and sediment reduction, however, we expect large benefits due to increased egg-to-parr survival and carrying capacity from these projects.

Expected Benefits from Flow/Passage and Habitat Improvement

The ongoing habitat improvement projects in the Salmon and Clearwater drainages can not, by themselves, increase depressed anadromous stocks from their present low levels to ones with abundant surpluses. Even Middle Fork

Table 27.   1988 mid August chinook parr survival estimates
            from the September 1987 eyed-egg plants and adult
            releases.

Stream	Year	Eyed-egg to parr % survival + 2 SE
Boulder Cr.	1988	1.1 ± 0.7
Beaver Cr.	1988	0.3 ± 0.5
Panther Cr.	1988	1.2 ± 1.3
Clear Cr.	1988	0.3 ± 0.3

eyed-egg to parr survival: $\bar{x}$ = 0.7%
egg-to-eyed egg survival: 8 5 %

green egg-to-parr survival: $\bar{x}$ = 0.6%

Table 28.   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
		$\bar{x}$ =	29.0
30-40%	Herd Cr.[a]	1986	13.0
		1987	13.3
		$\bar{x}$ =	13.2
>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
		$\bar{x}$ =	3.4

All habitats (Mean of sand category means): = 15.2%
Mean without Bear Valley and Elk Creeks:.   = 21.1%

"Shoshone-Bannock tribe data on parr abundance.

Table 29. Total abundance of steelhead parr (ages-1+ and -2+) attributed to benefits of implemented projects, 1985-1988. (See Appendix B for calculations and assumptions).

Project type, stream	Steelhead parr benefits				Potential parr benefits
	1985	1986	1987	1988	
Barrier Removal					
Complete					
Eldorado Cr.		7,310	5,266	1,306	14,384
Pine Cr.	(Adult passage infeasible)				0
Colt Cr.				0	**8,582**
Partial					
Crooked Fk. Cr.		277	85	0	54,521
Crooked R. (culvert)		1,375	1,174	1,958	**10,790**
Pole Cr. (screen)	210	23	32	381	1,943
Dollar Cr.			1.060	2.461	4,785
(Sub-total 1)	210	8,985	7,617	6,106	95,005
Off-Channel Development					
Crooked R.		323	3.076	1.108	912
Red R.			(-no data-)		28
(Sub-total 2)		32:	3,076	1,108	940
Instream Structures					
Lolo Cr.[a]	3,410	4,003	2,965	1,186	b
Upper Lochsa R.	(no measurable benefits)				
Crooked R.	-72	0	4,977	2,813	b
Red R.	704	**-235**	118	-1,058	b
(Sub-total 3)	4,042	3,768	8,060	2,941	
Sediment Reduction					
Bear Valley/Elk Cr.				-2,383	b
(Sub-total 4)				-2,383	
Grand Totals:	4,252	13,077	18,753	7,772	

[a] Additionally, in 1984, 1,109 steelhead parr were a benefit of the Lolo Creek instream structure project.
[b] Potential parr benefits from instream structures and sediment reduction projects are not measurable since the differences in carrying capacity before and after project maturity is unknown.

Table 30. Total abundance of chinook parr (age-O+) attributed to
           benefits of implemented projects, 1985-1988. (See
           Appendix B for calculations and assumptions).

Project type, stream	Chinook Parr Benefits				Potential parr benefits
	1985	1986	1987	1988	
Barrier Removal					
<u>Complete</u>					
Eldorado Cr.		30,206	13,328	5,936	110,478
Crooked Fk. Cr.		17,600	32,600	17,700	57,248
Johnson Cr.	7,206	23,711	17,700	52,086	294,750
Boulder Cr.		28,112	0	1,560	82,504
Meadow Cr.				15,000	39,036
Knapp Cr.				63	84,040
<u>Partial</u>					
Crooked R. (culvert)	5,351	3,707	742	7,061	18,562
Pole Cr. (screen)	0	0	0	8	14,962
Dollar Ct.			0	38	7,255
(Sub-total 1)	12,557	103,336	64,370	99,452	708,835
Off-Channel Development					
Crooked R.	5,351	3,707	742	7,061	37,123
Red R.		2 1 5	(-no	data-)	216
(Sub-total 2)	5,351	3,922	742	7,061	37,339
Instream Structures					
Lolo Cr.	7,116	-15,715	29,758	5,930	a
Upper Lochsa R. Crooked R.	-5,121	(no measurable benefits) -886	2,092	6,852	a
Red R.	9,291	9,526	19,052	21,874	a
(Sub-total 3)	11,286	-7,075	50,902	34,656	
Sediment Reduction					
Bear Valley/Elk Cr.				17,489	a
(Sub-total 4)				17,489	
Grand Totals:	23,843	100,595	115,481	157,521	

[a] Potential parr benefits from instream structures and sediment
 reduction projects is not measurable since the diference in
 carrying capacity before and after project maturation is
 unknown.

Salmon River tributaries in pristine condition, such as Sulphur Creek, are not functioning at that level. Inadequate flow and passage conditions during smolt migration remains the major factor preventing the rebound of wild/natural anadromous fish in Idaho.

What some habitat projects can do, however, is increase the egg-to-smolt survival in degraded streams to normal levels. This benefit might make the difference between local populations becoming extinct or remaining marginal. This seems a necessary precaution, since there is still no plan in place to achieve the necessary main stem flows. When improved flow and passage conditions are achieved, then egg-to-smolt survival and carrying capacity increases from habitat projects will contribute to productivity and harvest potential of the wild and natural populations.

The following is a discussion of benefits expected from Middle Fork Salmon River habitat enhancement projects on Elk and Knapp Creeks (BPA project 84-24), with and without improved flows and passage conditions. It should be stressed that the Elk Creek habitat enhancements must include reduction/elimination of negative sediment and riparian conditions caused by cattle grazing to have an impact sufficient to achieve the expected survival benefits. According to the Middle Fork and Upper Salmon River Implementation Plan (Andrews and Everson 1988), "grazing allotment management reviews to incorporate improved riparian management strategies in the allotment management plans are underway and will be complete by 1991." When cattle allotments are managed to eliminate detrimental effects to anadromous fish, then the proposed sediment removal, bank stabilization, channel rehabilitation, protective fencing, and riparian revegetation will jointly result in improved egg-to-smolt survival.

As examples of how flow and passage conditions affect habitat enhancement benefits for chinook, analyses were done on the sediment reduction project in the degraded Elk Creek and the barrier removal project in the relatively pristine Knapp Creek. These analyses incorporate expected changes in smolt-to-adult return rates (SAR) which are controlled largely by flow/passage conditions, as well as expected changes in smolt capacity and egg-to-smolt survival due to habitat improvement.

The simulations indicate that the Elk Creek chinook population faces extinction with or without the project if Snake River flows (measured at Lower Granite Dam) during the peak smolt migration period average 75,000 cfs or less (Table 31). The SAR predicted at flows of 75,000 cfs would be only 0.11%, and improvements in egg-to-smolt survival would not overcome the low SAR. If SAR averaged 0.36% (at the recommended minimum of 85,000 cfs), then the Elk Creek sediment reduction project and grazing management improvements could make the difference between an extinct or a marginally viable population. But the adult escapement would not be sufficient to allow a terminal harvest.

As main stem flow and SAR increase further, spawning escapements could be met and terminal harvests allowed. At an SAR of 0.98%, as predicted in current models when spring flow at Lower Granite Dam averages 100,000 cfs, a spawning escapement of 873 chinook could be met, with or without the sediment reduction project. The benefit of the habitat project, with this SAR, would be an increase

Table 31. Project benefits in terms of adult spawners and terminal harvest from projects that increase egg-to-smelt survival. Benefits were estimated from subbasin planning, existing monitoring data, and different smolt-to-adult return rates (SAR) for various main stem flow/passage conditions.

	Subbasin Planning Estimate		Monitoring Estimate		Monitoring Project
Parameter	pre-project	post-project	pre-project	post-project	
Example: Elk Creek sediment reduction - wild spring chinook					
Hectares improved	0	27.7	0	31.5	84-24
Surface Sand (X)	–		49%	30%[a]	84-24
Survival: egg-to-parr	–		3x	18%[b]	83-7;83-359
Parr potential			248,525	325,279	83-J
Smolt potential	181,939	238,192	166,511	217,937	83-J
SAR (post-implementation)	0.51	0.51	d	d	(preliminary) SMEP
Smolt production	33,642[c]	100,604[c]	d	d	83-J; SMEP
Spawners	147[c]	230[c]	d	d	IDFG;83-7;SMEP
Terminal harvest	16[c]	255[c]	d	d	IDFG; SBT; SMEP

SAR and Snake River flow scenarios - Elk Creek project benefits

	Mean kcfs at Lower Granite Dam during smolt migration			
Parameter	75	85	100	120
SAR[e]	0.11	0.36	0.98	1.31
Pre-project:				
smolt potential[f]	166,511	166,511	166,511	166,511
smolt production[f]	0	0	131,700	131,700
spawners[f]	0	0	873	a73
terminal harvest[f]	0	0	353	765
Post-project:				
smolt potential[f]	217,937	217,937	217,937	217,937
smolt production[f]	0	147,305	178,386	178,386
spawners[f]	0	504	873	873
terminal harvest[f]	0	0	787	1346
Difference (Post-Pre):				
smolt potential	51,426	51,426	51,426	51,426
smolt production[f]	0	147,305	46,686	46,686
spawners	0	504	0	0
terminal harvest[f]	0	0	434	581

[a]Project objective is to reduce sediment to 30% surface sand from combined BPA projects and improved USFS grazing/land management.
[b]Percent survival = 40.8 - 0.77(%sand) (Petrosky and Holubetz 1989).
[c]Equilibrium under MSY harvest management.
[d]Refer to scenarios below.
[e]Same as Knapp Creek.
[f]Equilibrium is where terminal harvest is managed for 1960's mean escapement (422 females, 768 spawners).

in terminal harvest from 353 to 787. At **an** SAR of **1.3%,** predicted for a flow of 120,000 **cfs,** the habitat project benefit would be an increase in terminal harvest from 765 to 1,346.

Of the four smolt migration flow scenarios displayed in Table 31 and above, it is clear that average flow must exceed 75,000 cfs or the Elk Creek chinook population will become extinct with or without the sediment reduction project. At minimum flow (85,000 **cfs),** the project could make the difference between a marginal, unharvestable population and extinction. At some flow exceeding 85,000 cfs the sediment reduction project would begin to make the difference between having, or not having, a harvestable surplus. At higher flows, the habitat project would contribute to the harvestable surplus.

A similar scenario is shown for the Knapp Creek barrier removal project (Table 32). At 75,000 **cfs,** the entire Middle Fork Salmon River chinook population would face extinction. At 85,000 cfs, projections indicate that a population of 96 spawners could develop above the barrier, too few to allow a terminal harvest. At approximately 100,000 cfs the sustainable adult escapement would stabilize in excess of the optimum 173 spawners, allowing an average annual harvest of 130 chinook. As migration flows exceed 100,000 cfs, benefits would accrue as harvestable surpluses.

Crooked River, Red River, and Lo10 Creek

With but one exception, there were no significant differences in either chinook or steelhead parr densities between treatment and control sections for Crooked River, Lo10 Creek, or Red River. The exception was for chinook parr in Lo10 Creek. The results are summarized in **Table** 33. Mean chinook densities were higher in treated reaches, but these differences were generally not significant (Figures 17, 18 and 19). Mean steelhead densities were generally higher in treated than control sections, with the exception of Red River, where steelhead densities were higher in control sections.

DISCUSSION

The need to use parr density data to document the status of Idaho's anadromous fish stocks is apparent. The number of salmon and steelhead entering the middle Snake River (above Lower Granite Dam) can be counted and the number of hatchery and wild/natural steelhead can be tallied separately (due to the adipose fin-clip on hatchery-produced steelhead smolts) as can the A-run and B-run steelhead. Beyond this classification is much uncertainty. How many spring and summer chinook salmon are hatchery, wild, or natural? How many of the wild/natural steelhead are wild and how many are natural? In the stocks classified as natural, how much has the productivity been altered through supplementation? Are the wild/natural B-run steelhead, which are severely depressed, composed mostly of descendants of supplemented stocks in the intensely supplemented South Fork Clearwater River and East Fork Salmon River? How many

Table 32. Project benefits in terms of adult spawners and terminal harvest from projects that add habitat or increase carrying capacity. Benefits were estimated from subbasin planning, existing monitoring data, and different smolt-to-adult return rates (SAR) for various main stem flow/passage conditions.

Example: Knapp Creek barrier removal – wild spring chinook.

Parameter	Subbasin Planning Estimate	Monitoring Estimate	Monitoring Project
Hectares added	7.6	5.9	84-24
Parr potential		63,720	83-7
Smolt potential	72,000	42,390	83-7(preliminary)
SAR (post-implementation)	0.51		SMEP
Smolt production	57,998[a]	b	83-7; SMEP
Spawners	137a	b	IDFG; 83-7; SMEP
Terminal harvest	144[a]	b	IDFG; SBT; SMEP

[a] Equilibrium under MSY harvest management.
[b] Refer to scenarios below.

SAR and Snake River flow scenarios – Knapp Creek project benefits.

	Mean kcfs at Lower Granite Dam during smolt migration			
Parameter	75	85	100	120
SAR[a]	0.11	0.36	0.98	1.31
Smolt potential[b]	42,300	42,300	42,300	42,300
Smolt production[b]	0	27,998	32,558	32,558
Spawners[b]		96	173	773
Terminal harvest[b]	0	0	130	232

[a] Empirical relationship for the Middle Fork of the Salmon River wild spring chinook, 1972-1985. SAR = $1.34/(1 + EXP(12.49-0.135*KCFS))$.
[b] Equilibrium where terminal harvest is managed for escapement to approximate the 1960's average for Marsh Creek (95 females, 173 adults).

Chinook Parr
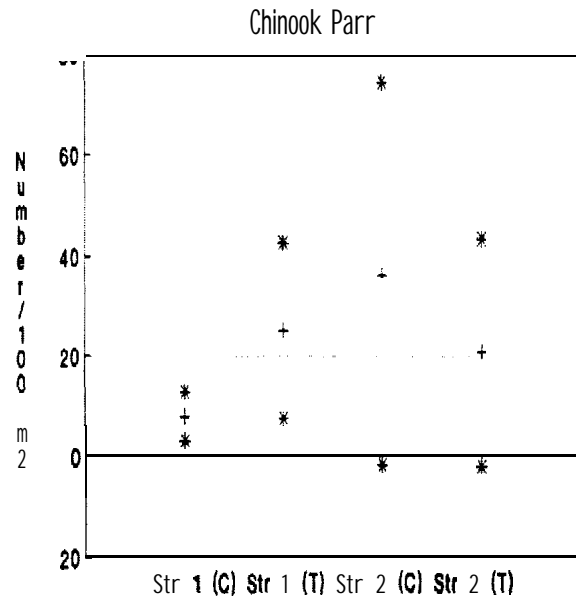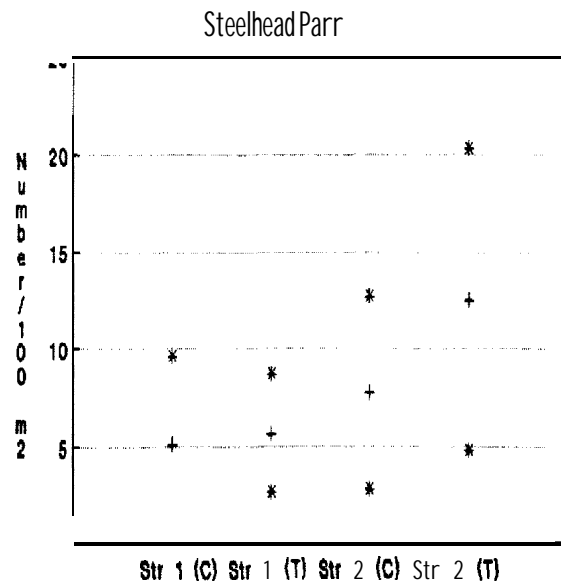
Steelhead Parr

Figure 17. Mean densities in control (C) and treatment (T) sections (and 95% confidence limits) of chinook and steelhead relative to instream structures placed in Crooked River. Values are average for 1985 through 1988.

Chinook Parr

Number/100 m2

50
40
30
20
10
0
10

Str 1 (C)   Str 1 (T)   Str 2 (C)   Str 2 (T)

* Upper Bound   + Mean   * Lower Bound

Steelhead Parr

Number/100 A2

16
14
12
10
8
6
4
2
-2

Str 1 (C)   Str 1 (T)   Str   2 (C)   Str 2 (T)

* Upper Bound   + Mean   * Lower Bound
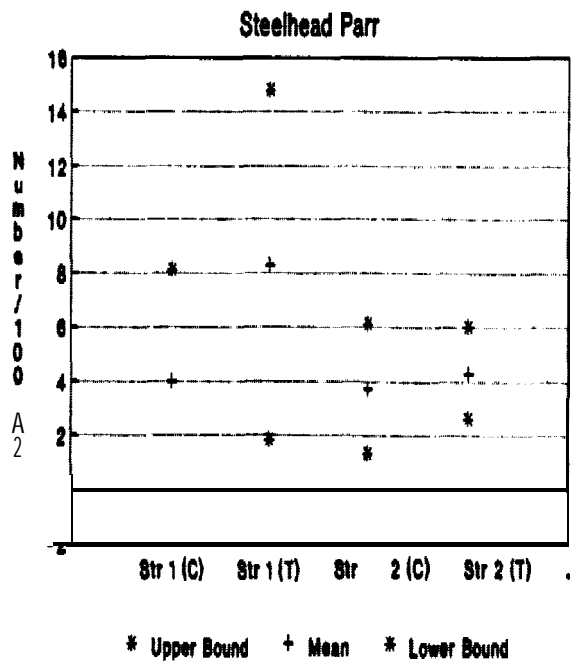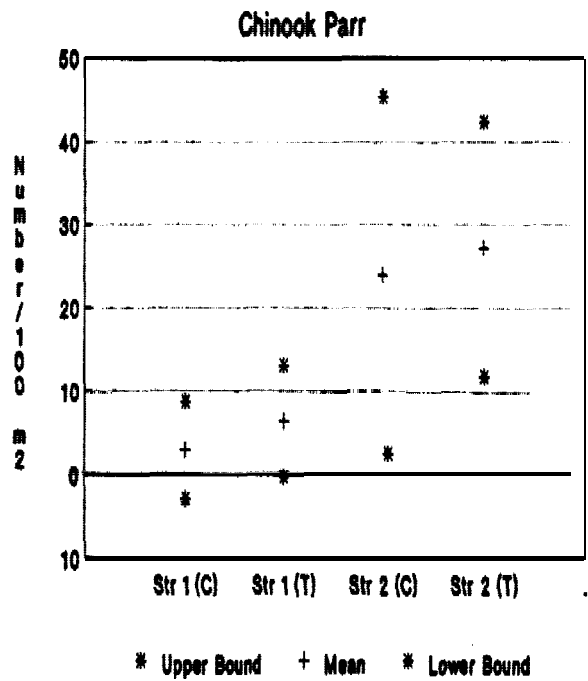
Figure 18. Mean densities in control (C) and treatment (T) sections (and 95% confidence limits) of chinook and steelhead relative to instream structures placed in Lolo Creek. Values are averages for 1985 through 1988.

Chinook Parr

* Upper Bound   + Mean   * Lower Bound

Steelhead Parr

* Upper Bound   + Mean   * Lower Bound
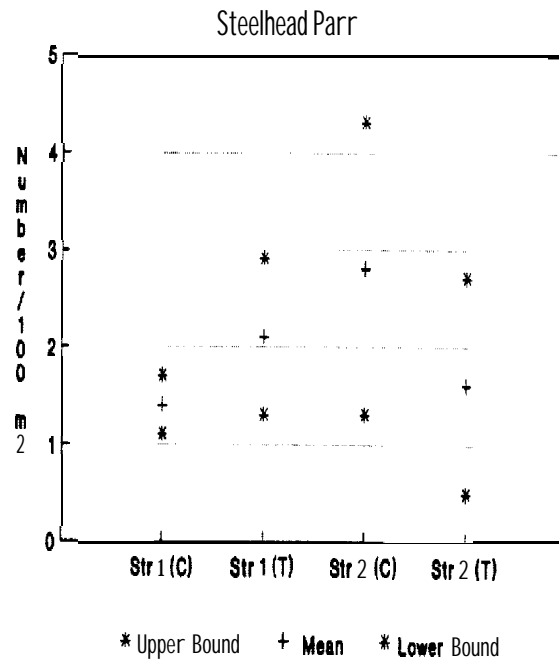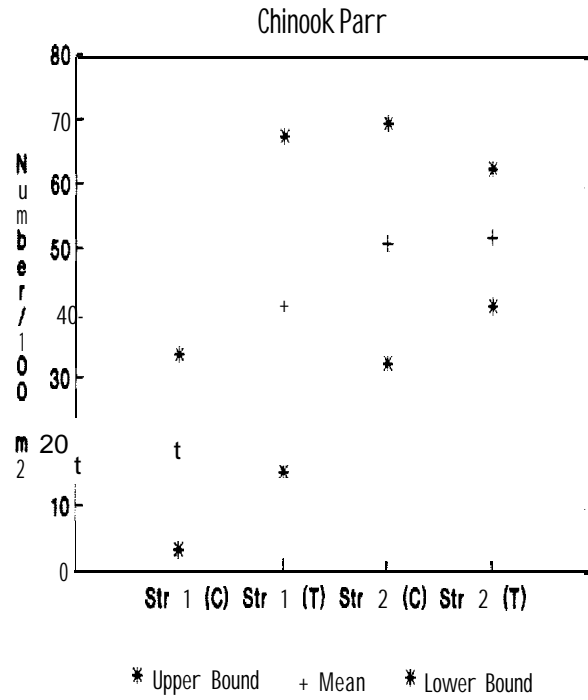
Figure 19. Mean densities in control (C) and treatment (T) sections (and 95% confidence limits) of chinook and steelhead relative to instream structures placed in Red River. Values are averages for 1985 through 1988.

wild B-run spawners are escaping to the Selway River, to the Middle Fork of the Salmon River, to the South Fork of the Salmon River? If parr densities are an index of spawning escapement, then there must be very few spawners reaching these rivers. How many are not destined for Idaho waters at all, but instead are returning to the Grande Ronde and Imnaha rivers of eastern Washington and Oregon?

The Idaho Department of Fish and Game has surveyed major chinook salmon spawning grounds since before the decline of Idaho chinook populations in the 1970s. Trends in chinook redds are a good indicator of health of these populations. Unfortunately, however, parr densities were not measured when redd densities were high, so the relationship between redds and parr (reproduction curve) is not yet known. We do not know precisely how many redds are needed to achieve full smolt (or **parr**) capacity. How many redds are needed before a terminal fishery is justified?

Although wild/natural B-run steelhead return to several Idaho rivers, we do not know what fraction of that run is destined for each river. In contrast to chinook redd counts which occur during late summer base flows, steelhead redds must be counted during high, often turbid flows. Strong flows prevent excavated gravel from piling high, and there is little periphyton on surface gravel to aid in redd identification. Steelhead redd counting in Idaho streams has been lacking or inconsistent.

Parr densities, in contrast, can be obtained by snorkeling or electrofishing in any of Idaho's streams during the base flow months of summer.

To validate the use of parr densities as an index of adult escapement, we need to regress parr density on adult escapement of both chinook and steelhead using the **Beverton-Holt** or alternate models. At existing IDFG weirs, adults are counted as they enter their spawning areas. Sufficient parr density monitoring should be done at random sections above these weirs to provide precise and accurate estimates of parr densities. Some additonal weirs will be needed such that the reproduction curves for each classification of chinook and steelhead can be evaluated. Existing and recommended new weir sites are listed in Table 34.

Although the relationship between adult escapement and parr density is yet to be quantified, there is corroborating information indicating that wild B-run steelhead stocks are at very low levels as suggested by parr density data. During the adult steelhead run years of 1985 through 1988 (for which there is data from Lower Granite Dam on the number of hatchery and wild/natural steelhead, separately by A-run and B-run), only 23% of the run has been wild/natural and only 6% has been wild/natural B-run steelhead (Kent Ball, IDFG, personal communication). This was an average annual run of 6,289 wild/natural B-run steelhead, which went to the three major wild B-run production drainages of the Selway River, South Fork Salmon River, and Middle Fork Salmon River. Additionally, part also returned to the heavily supplemented South Fork Clearwater River, Lolo Creek, East Fork Salmon River, and Lochsa River. Obviously, seeding level was very low for wild/natural B-run steelhead. Of great concern is to know what fraction of the limited wild/natural B-run spawners are actually wild. The genetic integrity of the B-run steelhead stocks may be

Table 33. Two-way ANOVA results for the instream structure evaluations on Crooked River, Red River, Lolo Creek separately and repeated measures analysis on all streams combined, 1985-1988.

	Chinook			Steelhead		
Stream	#/100m²	n	P level	#/100m²	n	P Level
Crooked River						
Treatment	23.0	8	0.968	9.1	12	0.435
Control	22.1	8		6.4	12	
	(Benefit = 4%)			(Benefit = 42%)		
Red River						
Treatment	46.8	8	0.472	1.9	8	0.874
Control	34.7	8		2.1	8	
	(Benefit = 35%)			(Benefit = -10%)		
Lolo Creek						
Treatment	20.2	12	0.033*	5.6	12	0.421
Control	17.0	12		3.8	12	
	(Benefit = 19%)			(Benefit = 47%)		
Combined				5.5		
Treatment	28.6	28	0.733	4.1	28	0.232
Control	23.5	28		4.1	28	
	(Benefit = 22%)			(Benefit = 34%)		

Table 34. Existing and potential weir site for monitoring passage of adult anadromous fish in Idaho.

	Anadromous Fish Classifications	
Existing Weirs	Steelhead	Chinook
Salmon River Subbasin:		
Rapid River	Wild A	Wild Summers
S. Fk Salmon River	Wild B	Natural Summers
Pahsimeroi River	Natural A	Natural Summers
Upper Salmon (Sawtooth)	Natural A	Natural Springs
E. Fk Salmon River	Natural B	Natural Summers
Clearwater River Subbasin:		
Crooked River	Natural B	Natural Springs
Red River	Natural B	Natural Springs
Powel	Natural B	Natural Springs
Additional weirs (potential sites)		
Fish Creek (Lochsa R. tributary)	Wild B	Natural Springs
Secesh River	Wild B	Wild Summers
Marsh Creek (repair old weir)	Wild B	Wild Springs
Rush Creek (tributary to Big Creek, near Taylor Ranch)	Wild B	Wild Summers (?)
Running Creek (tributary Selway River)	Wild B	Natural Springs

endangered by continued low escapements. We need to know if the wild B-run stocks are continuing their decline, and if so, manage these stocks accordingly.

Concerning habitat enhancement projects, each year one or more project should be thoroughly evaluated. Projects selected for evaluation should be those which are complete and have been in place long enough to allow parr production benefits to accrue. Parr densities and habitat variables should be compared for pre- verses post-project and treatment verses control areas. In years when a project is not being evaluated, partial benefits will be based on changes in parr densities as estimated from a small number of monitoring sections.

The analyses done in this report on the benefits of **instream** structures in **Lolo** Creek, Red River, and Crooked River found a significant parr increase only in **Lolo** Creek, and there only for chinook. The analyses compared treatment and control densities, stratified by stream reaches and blocked by years over the life of the projects. A comparison was done also with strata from all three streams combined. No significant differences were found in this latter analysis. This contrasts with results of Clearwater Biostudies, Inc (1988) which found that the **Lolo** Creek **instream** structures had significant benefits for steelhead parr but not for chinook **parr.** Because of the inconsistent evaluation results, we give mitigation credit to increases in mean densities observed in the three streams where **instream** structures were evaluated. A **final,** conclusive evaluation is needed, based on a study design agreed upon by project implementors and evaluators in consultation with a university statistician.

ACKNOWLEDGEMENTS

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APPENDICES

Appendix A-l   Monitoring section names and EPA stream reach locations,
                channel types (B or C), steelhead classification (wild or
                natural, A-run or B-run), chinook classification (wild or
                natural, springs or summers) and if chinook are monitored
                there.

Stream Name	Stratum	Section	EPA Stream Reach	Channel Type	Steelhead Class: W vs N A vs B	Chinook Class: W vs N Spr vs Sum	Program Sampling the Section
ALTURAS LK CR	DS-DVRSN	1A	1706020107700	B	NA	NSPR	IFMD368713
ALTURAS LK CR	DS-DVRSN	1B	1706020108100	C	NA	NSPR	IFMD368713
ALTURAS LK CR	DS-DVRSN	1C	1706020107700	C	NA	NSPR	IFMD368713
ALTURAS LK CR	US-DVRSN	2A	1706020107700	B	NA	NSPR	IFM0368713
ALTURAS LK CR	US-DVRSN	2B	1706020107700	8	NA	NSPR	IFMD368713
ALTURAS LK CR	US-LAKE	3A	1706020108100	C	NA	NSPR	IFMD368713
ALTURAS LK CR	US-LAKE	3B	1706020108100	C	NA	NSPR	IFMD368713
AMERICAN R		1	1706030504100	C	NB	NSPR	IFMD368712
AMERICAN R		2	1706030504100	C	NB	NSPR	IFMD368712
BARGAMIN CR		L1	1706020708000	B	WA	VSPR	IR6
BARGAMIN CR		L2	1706020708000	B	WA	VSPR	IR6
BEAR CR		1	1706030102400	B	WB	NSPR	IR2
BEAR CR		2	1706030102400	B	WB	NSPR	IR2
BEAR VALLEY CR	1	A	1706020502300	B	WB	VSPR	IFMD368712
BEAR VALLEY CR	2	A	1706020502500	C	WB	VSPR	IFMD368712
BEAR VALLEY CR	2	B	1706020502500	C	WB	VSPR	IFMD368712
BEAR VALLEY CR	3	A	1706020502700	C	WB	VSPR	IFMD368712
BEAR VALLEY CR	5	A	1706020502800	C	WB	VSPR	IFMD368712
BEAR VALLEY CR	7	BIG-MDW-L	1706020502800	C	WB	VSPR	IFMD368712
BEAR VALLEY CR	9	B	1706020502800	C	WB	VSPR	IFMD368712
BEAR VALLEY CR	HC1	B	1706020402600	C	NA	NSPR	IFMD368712
BEARSKIN CR	1	B	1706020508400	B	WB	VSPR	IFMD368712
BEAVER CR	1	A	1706020114700	C	NA	NSPR	IFMD368713
BEAVER CR	1	B	1706020114700	C	NA	NSPR	IFMD368713
BEAVER CR	2	A	1706020114700	C	NA	NSPR	IFMD368711
BEAVER CR	2	B	1706020114700	C	NA	NSPR	IFM36871:
BEAVER CR	3	B	1706020503600	C	WB	VSPR	IFM0368712
BIG CANYON CR		1	1706030602200	B	WA	NSPR	IR2
BIG CR	LOWER	L1	1706020600700	B	WB	VSPR	IR6
BIG CR	MIDDLE	TAYLOR1	1706020601100	C	WB	W S P R	IFM0368712
BIG CR	UPPER	BIG1	1706020603200	B	WB	VSPR	IR3
BIG SPRINGS CR	LEM1	A	1706020408300	C	NA	NSPR	IFM0368712
BOULDER CR	ABOVE	1	1706021000900	C	NA	NSPR	IFM0368712
BOULDER CR	ABOVE	2	1706021000900	B	NA	NSPR	IFM0368712
BOULDER CR	BELOW	3	1706021000900	B	NA	NSPR	IFM0368712
BOULDER CR	BELOW	5	1706021000900	B	NA	NSPR	IFM0368712
BRUSHY FK CR		1	1706030304300	B	NB	NSPR	IFR
BRUSHY FK CR		2	1706030304300	B	NB	NSPR	IFR
CAMAS CR		1	1706020605200	C	WB	VSPR	IFMD36871;
CAMAS CR		2	1706020605200	C	WB	VSPR	IFMD36871:
CAMAS CR		CAM1	1706020605200	B	WB	VSPR	IFM0368711
CAMAS CR		L1	1706020605100	B	WB	VSPR	IR6
CAPE HORN CR	1	A	1706020503400	C	WB	VSPR	IFMD36871:
CAPE HORN CR	2	B	1706020503400	C	WB	VSPR	IFMD36871

CAPTAIN JOHN CR		1	1706010303900	B	NA	WSPR	IR2
CAPTAIN JOHN CR		2	1706010303900	B	NA	WSPR	IR2
CHAMBERLAIN CR		CHA1	1706020704200	B	WA	WSPR	IFM0368712
CHAMBERLAIN CR		CHA4	1706020704400	C	WA	WSPR	IFM0368712
CHAMBERLAIN CR		L1	1706020703800	B	WA	WSPR	IR6
CHAMBERLAIN CR		L2	1706020703800	B	WA	WSPR	IR6
CHAMBERLAIN CR, W FK		CHAP	1706020704300	C	WA	WSPR	IFM0368712
CHAMBERLAIN CR, W FK		CHA3	1706020704300	B	WA	WSPR	IFM0368712
CROOKED FK CR		1	1706030304600	B	NB	NSPR	IFR
CROOKED FK CR		2	1706030304600	B	NB	NSPR	IFR
CROOKED FK CR	BELOW	1B	1706030304600	B	NB	NSPR	IFM0368712
CROOKED FK CR	BELOW	2B	1706030304200	B	NB	NSPR	IFM0368712
CROOKED R	C	CAN2	1706030503300	B	NB	NSPR	IFM0368712
CROOKED R	C	CAN3	1706030503300	B	NB	NSPR	IFM0368712
CROOKED R	C	CAN4	1706030503300	B	NB	NSPR	IFM0368712
CROOKED R	I	BOULDER-A	1706030503301	B	NB	NSPR	IFM0368712
CROCKED R	I	BOULDER-B	1706030503301	B	NB	NSPR	IFM0368712
CROOKED R	I	CONTROL1	1706030503300	B	NB	NSPR	IFM0368712
CROOKED R	I	SILL-LOG-A	1706030503300	B	NB	NSPR	IFM0368712
CROOKED R	I	SILL-LOG-B	1706030503300	B	NB	NSPR	IFM0368712
CROOKED R	II	CONTROL2	1706030503300	B	NB	NSPR	IFM0368712
CROOKED R	II	TREAT1	1706030503300	B	NB	NSPR	IFM0368712
CROOKED R	II	TREAT2	1706030503300	B	NB	NSPR	IFM0368712
CROOKED R	III	NATURAL1	1706030503300	C	NB	NSPR	IFM0368712
CROOKED R	IV	MEANDER1	1706030503300	C	NB	NSPR	IFM0368712
CROOKED R	IV	MEANDER2	1706030503300	C	NB	NSPR	IFM0368712
CROOKED R, E FK	H	EF1	1706030507200	B	NB	NSPR	IFM0368712
CROOKED R, E FK	H	EF2	1706030507200	B	NB	NSPR	IFM0368712
CROOKED R, W FK	H	WF1	1706030503302	B	NB	NSPR	IFM0368712
CROOKED R, W FK	H	WF2	1706030503302	B	NB	NSPR	IFM0368712
DEEP CR		CACTUS	1706030101900	B	WB	NSPR	IFM0368712
DEEP CR		SCIMITAR	1706030101900	C	WB	NSPR	IFM0368712
WLLAR CR		1	1706020803200	B	WB	NSUM	IFM0368712
ELDORADO CR	ABOVE	1HG	1706030603700	B	NB	NSPR	IFM0368712
ELDORADO CR	ABOVE	2LG	1706030603700	C	NB	NSPR	IFM0368712
ELDORADO CR	ABOVE	2M	1706030603700	C	NB	NSPR	IFM0368712
ELDORADO CR	BELOW	1B	1706030603700	B	NB	NSPR	IFM0368712
ELK CR	1	A	1706020502600	C	WB	WSPR	IFM0368712
ELK CR	1	B	1706020502600	C	WB	WSPR	IFM0368712
ELK CR	2	A	1706020502600	C	WB	WSPR	IFM0368712
ELK CR	2	B	1706020502600	C	WB	WSPR	IFM0368712
ELKHORN CREEK		BLM 1.25	1706020901800	B	WA	WSPR	BLM
FISH CR		1	1706030305400	B	NE	NSPR	IFR
FISH CR		2	1706030305400	B	NB	NSPR	IFR
GRANITE CR		1	1706010101000	B	NA	WSPR	IR2
GRANITE CR		2	1706010101000	B	NA	WSPR	IR2
GRANITE CR		3	1706010101000	B	NA	WSPR	IR2
HARD CREEK	LOWER	BLM A	1706021002700	B	NAB	NSPR	BLM
HARD CREEK	UPPER	BLM-B	1706021002700	B	NAB	NSPR	BLM
HAYDEN CR	HC2	B	1706020402800	B	NA	NSPR	IFM0368712
HAYDEN CR	HC3	B	1706020402400	B	NA	NSPR	IFM036871:
HAZARD CR		HAZ1	1706021002600	B	NAB	NSPR	IFM036871;
HAZARD CREEK	LOWER	BLM A	1706021002600	B	NAB	NSPR	BLM
HAZARD CREEK	UPPER	BLM B	1706021003000	B	NAB	NSPR	BLM

HORSE CR		L1	1706020707000	B	WA	WSPR	IR6
HORSE CR		L2	1706020707000	B	WA	WSPR	IR6
JOHNS CR	0. 5		1706030501600	B	NB	NSPR	IFR
JOHNS CR	1		1706030501600	B	NB	NSPR	IFR
JOHNS CR	2		1706030501600	B	NB	NSPR	IFR
JOHNSON CR	ABOVE	M	1706020804700	C	WB	NSUM	IFMD368712
JOHNSON CR	ABOVE	M2	1706020804700	C	WB	NSUM	IFMD368712
JOHNSON CR	ABOVE	M3	1706020804700	C	WB	NSUM	IFMD368712
JOHNSON CR	ABOVE	PW1A	1706020804700	B	WB	NSUM	IFMD368712
JOHNSON CR	ABOVE	PW3A	1706020804700	B	WB	NSUM	IFMD368712
JOHNSON CR	BELOW	PW3B	1706020804700	B	WB	NSUM	IFMD368712
JOHNSON CR	LOWER	L2	1706020804400	B	WB	NSUM	IR3
JOHNSON CR	LOWER	L3	1706020804400	B	WB	NSUM	IR3
KNAPP CR	1	A	1706020503503	C	WB	WSPR	IFMD368712
KNAPP CR	2	B	1706020503503	C	WB	WSPR	IFMD368712
LAKE CR		BURGWRF	1706020801700	C	WB	WSUM	IR3
LAKE CR		WILLOW	1706020801700	C	WB	WSUM	IR3
LEMHI R	LEM2	B	1706020403700	C	NA	NSPR	IFMD368712
LEMHI R	LEM3	A	1706020403700	C	NA	NSPR	IFMD368712
LICK CR		L3	1706020802000	B	WB	WSUM	IR3
LITTLE SALMON R		1	1706021001000	B	NAB	NSPR	IFM0368712
LITTLE SALMON R		2	1706021000700	B	NAB	NSPR	IFM0368712
LITTLE SLATE CR		4	1706020902600	B	WA	WSPR	IFR
LOCHSA R		L1	1706030302300	B	NB	NSPR	IFMD368712
LOCHSA R		L4	1706030300800	B	NB	NSPR	IFMD368712
LOLO CR	DOWNSTREAM	DS6	1706030603600	B	NB	NSPR	IFMD368712
LOLO CR	DOWNSTREAM	RUN6	1706030603600	B	NB	NSPR	IFMD368712
LOLO CR	UPSTREAM	8303	1706030603900	C	NB	NSPR	IFMD368712
LOLO CR	UPSTREAM	8360	1706030603900	B	NB	NSPR	IFMD368712
LOLO CR	UPSTREAM	RUN1	1706030603900	B	NB	NSPR	IFMD368712
LOLO CR	UPSTREAM	RUN7	1706030603900	B	NB	NSPR	IFMD368712
LOON CR		1	1706020505000	C	WB	WSPR	IFM0368712
LOON CR		2	1706020505000	C	WB	WSPR	IFMD368712
LOON CR		L1	1706020505000	B	WB	WSPR	IR6
LOON CR		L2	1706020505000	B	WB	WSPR	IR6
LOON CR		LNM1	1706020505000	B	WB	WSPR	IFMD368712
MARBLE CR	LOWER	L1	1706020500300	B	WB	WSPR	IR6
MARBLE CR	UPPER	MAR1	1706020500600	B	WB	WSPR	IR3
MARBLE CR	UPPER	MAR2	1706020500600	B	WB	WSPR	IR3
MARSH CR	1	A	1706020503200	B	WB	WSPR	IFM0368712
MARSH CR	1	B	1706020503200	B	WB	WSPR	IFMD368712
MARSH CR	4	B	1706020503500	C	WB	WSPR	IFMD368712
MARSH CR	5	A	1706020503502	C	WB	WSPR	IFMD368712
MARSH CR	6	A	1706020506300	C	WB	WSPR	IFMD368712
MEADOW CR		SLIMS-CAMP	1706030200500	B	WB	NSPR	IR2
MEADOW CR	CANYON	MILEPOST2	1706030504800	B	NB	NSPR	IFM0368712 I
MEADOW CR	MEADOW	GRAZED	1706030504800	C	NB	NSPR	IFMD368712 I
MONUMENTAL CR		MON1	1706020603800	B	WB	WSPR	IR3
MONUMENTAL CR		MON2	1706020603800	B	WB	WSPR	IR3
MONUMENTAL CR		MON3	1706020603800	B	WB	WSPR	IR3
MONUMENTAL CR		MON5	1706020603600	C	WB	WSPR	IR3
MONUMENTAL CR, W FK		MON4	1706020603700	C	WB	WSPR	IR3
MOOSE CR		1	1706030201400	B	WB	NSPR	IR2
MOOSE CR		2	1706030201400	B	WB	NSPR	IFR

MOOSE **CR**		3	1706030201500	B	WB	NSPR	IFR
MOOSE **CR, N FK**		2	1706030203000	B	WB	NSPR	IR2
MORGAN CR	**UPPER**	**BLM CAMP**	1706020100200	C	NA	NSPR	IFMD368712
MOYER CR	**ABOVE**	MO1	1706020302300	C	NA	NSPR	I FMD368712
NEWSOME **CR**		1	1706030504300		NB	NSPR	IR2
NEWSOME **CR**		MOUTH	1706030504300		NB	NSPR	FAO
NEWSOME **CR**	MAIN	4M	1706030504300		NB	NSPR	FAO
OLD MAN CR			1706030300600	B	NB	NSPR	IFR
OTTER CR			1706030201000		WB	NSPR	IFR
PAHSIMEROI R		DWTNLANE	1706020200100	C	NA	NSUM	IR6
PAHSIMEROI R		LOWER	1706020200100	C	NA	NSUM	IR6
PANTHER CR	**ABOVE**	PC10	1706020302200	C	NA	NSPR	IFMD368712
PANTHER CR	**ABOVE**	PC9	1706020302000	C	NA	NSPR	IFMD368712
PANTHER CR	**DS-BIGD**	PC4	1706020301000	B	NA	NSPR	IFMD368712
PANTHER CR	**DS-BLACKB**	PC6	1706020301400	C	NA	NSPR	IFMD368712
PANTHER CR	**DS-CLEAR**	PC1	1706020300600	B	NA	NSPR	IFMD368712
PISTOL CR		L1	1706020501100	B	WB	WSPR	IR6
PISTOL CR		L2	1706020501100	B	WB	WSPR	IR6
POLE **CR**		A	1706020114900	C	NA	NSPR	IFMD368713
POLE **CR**	I	B	1706020114900	C	NA	NSPR	IFMD368713
POLE CR	II	A	1706020114900	C	NA	NSPR	I FMD368713
POLE CR	II	B	1706020114900	C	NA	NSPR	IFMD368713
POLE CR	III	A	1706020114900	C	NA	NSPR	IFMD368713
POLE CR	III	8	1706020114900	C	NA	NSPR	IFMD368713
POLE CR	IV	A	1706020114900	C	NA	NSPR	IFMD368713
POLE CR	IV	B	1706020114900	B	NA	NSPR	IFM0368713
POLE CR	V	A	1706020114900	C	NA	NSPR	IFMD368713
POLE CR	V	B	1706020114900	C	NA	NSPR	IFMD368713
POST OFFICE CR		1	1706030301800	B	NB	NSPR	IFR
POST OFFICE CR		2	1706030301800	B	NB	NSPR	IFR
RAPID R		RAP2	1706021000200	B	WA	NSUM	IFM0368712
RAPID R, W FK		RAP1	1706021000300	B	WA	NSUM	IFM0368712
RED R	I	CONTROL1	1706030503600	C	NB	NSPR	IFMD368712
RED R	I	CONTROL2	1706030503800	C	NB	NSPR	IFMD368712
RED R	II	CONTROL2	1706030503800	B	NB	NSPR	IFMD368712
RED R	II	TREAT2	1706030503800	B	NB	NSPR	IFM0368712
RED R	IV	CONTROL2	1706030503600	C	NB	NSPR	IFMD368712
RED R	IV	TREAT2	1706030503600	C	NB	NSPR	IFM0368712
RED R	V	CONTROL2	1706030503600	C	NB	NSPR	IFMD368712
RED R	V	TREAT2	1706030503600	C	NB	NSPR	IFM0368712
REDFISH **LK CR**		LOWER	1706020106100	B	NA	NSPR	IFMD368712
REDFISH **LK CR**		WEIR-DS	1706020106100	B	NA	NSPR	IFM0368712
RELIEF CR	**RC**	**RELIEF-CR1**	1706030507100	C	NB	NSPR	IFM0368712
RELIEF CR	**RC**	**RELIEF-CR2**	1706030507100	B	NB	NSPR	IFM0368712
ROCK CR	**ABOVE**	M	1706020809800	C	WB	NSUM	IFMD368712
RUNNING CR		1	1706030100800	B	WB	NSPR	IR2
RUNNING CR		2	1706030100800	B	WB	NSPR	IR2
SALMON R		RBNSN-BAR	1706020103900	B	NA	WSUM	I FMD368712
SALMON R	10	A	1706020108400	B	NA	NSPR	IFMD368713
SALMON R	10	B	1706020108400	C	NA	NSPR	IFMD368713
SALMON R	2	B	1706020106000	B	NA	NSPR	IFMD368713
SALMON R	3	A	1706020106900	B	NA	NSPR	IFM0368713
SALMON R	3	B	1706020106900	B	NA	NSPR	IFM0368713

SALMON R	3	BRA	1706020106900	C	NA	NSPR	IFMD368713
SALMON R	3	BRB	1706020106900	C	NA	NSPR	IFMD368713
SALMON R	3	BRB-RCH	1706020106900	C	NA	NSPR	IFMD368713
SALMON R	4	A	1706020107001	C	NA	NSPR	IFMD368713
SALMON R	4	B	1706020107100	C	NA	NSPR	IFMD368713
SALMONR	4	BRA	1706020107000.5	C	NA	NSPR	IFMD368713
SALMON R	4	BRB	1706020107000	C	NA	NSPR	IFMD368713
SALMON R	5	A	1706020107100	B	NA	NSPR	IFMD368713
SALMON R	5	B	1706020107500	B	NA	NSPR	IFMD368713
SALMON R	6	A	1706020107501	C	NA	NSPR	IFMD368713
SALMON R	6	B	1706020107501	B	NA	NSPR	IFMD368713
SALMON R	7	A	1706020108200	C	NA	NSPR	IFMD368713
SALMON R	7	B	1706020108200	C	NA	NSPR	IFMD368713
SALMON R	8	A	1706020108200	C	NA	NSPR	IFMD368713
SALMON R	8	B	1706020108200	C	NA	NSPR	IFMD368713
SALMON R	9	A	1706020108400	C	NA	NSPR	IFMD368713
SALMON R	9	B	1706020108400	B	NA	NSPR	IFMD368713
SALMON R, E FK	ABOVE-WEIR	2	1706020110700	C	NAB	NSPR	IFMD368712
SALMON R, E FK	ABOVE-WEIR	3	1706020110700	C	NAB	NSPR	IFMD368712
SALMON R, E FK	BELOW WEIR	5	1706020110300	C	NAB	NSPR	IFMD368712
SALMON R, E FK	BELOW WEIR	8	1706020109800	C	NAB	NSPR	IFMD368712
SALMON R, N FK		DAHLONEGA	1706020307700	B	NA	NSPR	IFMD368712
SALMON R, N FK		HUGHES	1706020307500	C	NA	NSPR	IFMD368712
SALMON R, S FK		11	1706020802900	B	WB	NSUM	IR3
SALMON R, S FK		14	1706020802400	B	WB	NSUM	IR3
SALMON R, S FK		16	1706020802200	B	WB	NSUM	IR3
SALMON R, S FK		5	1706020803400	C	WB	NSUM	IR3
SALMON R, S FK			1706020803300	B	WB	NSUM	IR3
SALMON R, S FK		POVERTY	1706020802900	C	WB	NSUM	IFMD368712
SALMON R, S FK	STOLLE		1706020803600	C	WB	NSUM	IFMD368712
SALMON R, S FK	STOLLE	2	1706020803600	C	WB	NSUM	IFM0368712
SALMON R, S FK E FK		3	1706020805100	B	WB	NSUM	IR3
SALMON R, S FK E FK		6	1706020804300	B	WB	NSUM	IR3
SALMON R, S FK E FK			1706020804200	B	WB	NSUM	IR3
SAND CR	ABOVE	M2	1706020807400	C	WB	NSUM	IFMD368712
SECESH R		GROUSE	1706020801601	B	WB	WSUM	IR3
SECESH R		LONG-GULCH	1706020801601	C	WB	WSUM	IR3
SECESH R		U-SCSH-MDW	1706020801601	C	WB	WSUM	IR3
SELWAY R		HELLSHALF	1706030101400	B	WB	NSPR	IFMD368712
SELWAY R		LITTLE-CW	1706030101300	B	WB	NSPR	IFMD368712
SELWAY R		MAG-XING	1706030101300	C	WB	NSPR	IFMD368712
SHEEP CR			1706010101300	B	WA	WSPR	IR2
SHEEP CR		2	1706010101300	B	WA	WSPR	IR2
SHEEP CR		L1	1706020709300	B	WA	WSPR	IR6
SHEEP CR		L2	1706020709300	B	WA	WSPR	IR6
SLATE CR			1706020902500	B	WA	WSPR	IFR
SLATE CR		2	1706020902500	B	WA	WSPR	IFR
STATE CR		3	1706020902500	B	WA	WSPR	IFR
SLATE CR	12.1		1706020902500	B	WA	WSPR	IFR
SLATE CR	4.3		1706020902500	B	WA	WSPR	IFR
SLATE CR	6.7		1706020902500	B	WA	WSPR	IFR

Appendix A-1.   (Cont.)

SLATE CR	8.1		1706020902500	B	WA	WSPR	IFR
SMILEY CR		A	1706020108300	B	NA	NSPR	IFMD368713
SMILEY CR	,	B	1706020108300	C	NA	NSPR	IFMD368713
SMILEY CR	2	A	1706020108300	C	NA	NSPR	IFMD368713
SMILEY CR	2	B	1706020108300	C	NA	NSPR	I FM368713
SULPHUR CR	3	A	1706020502100	B	WB	WSPR	IFMD368712
SULPHUR CR	4	A	1706020502100	C	WB	WSPR	IFMD368712
SULPHUR CR	4	B	1706020502100	C	WB	WSPR	IFM0368712
THREE LINKS CR			1706030203900	B	WB	NSPR	IFR
VALLEY CR		B	1706020105200	C	NA	NSPR	IFMD368712
VALLEY CR	3	A	1706020105300	C	NA	NSPR	IFMD368712
VALLEY CR	3	B	1706020105400	C	NA	NSPR	IFMD368712
VALLEY CR	6	B	1706020105500	B	NA	NSPR	IFM0368712
WARM SPRINGS CR			1706030301900	B	NB	NSPR	IFR
WHITE CAP CR		BRIDGE	1706030102100	B	WB	NSPR	IFMD368712
WHITE CAP CR		UPPER	1706030102100	B	WB	NSPR	IFMD368712
WHITE CAP CR		WILDERNESS	1706030102100	B	WB	NSPR	IFMD368712
WHITE SAND CR	LOWER	WS1	1706030302700	B	NB	NSPR	IFMD368712
WHITEBIRD CR			1706020902900	B	WA	WSPR	IFR
WHITEBIRD CR		2	1706020903000	B	WA	WSPR	IFR
WHITEBIRD CR		3	1706020903000	B	WA	WSPR	IFR
WHITEBIRD CR. N FK		2	1706020903100	B	WA	WSPR	IFR
WHITEBIRD CR, S FK		3	1706020903000	B	WA	WSPR	IFR
WHITEBIRD CR, S FK		4	1706020903000	B	WA	WSPR	IFR
WOLF CR			1706010101400	B	WA	WSPR	IR2

Appendix A-2.   Main stem rivers and sections where corridor snorkeling is
                done.   EPA reach and steelhead and chinook classifications
                are listed.

Program Sampling the Section	Stream Name	Stratum	Section	EPA Stream Reach	Steelhead Class: W vs N A vs B	Chinook Class: W vs N Spr vs Sum
** Program IFR						
IFR	LOCHSA R			1706030300200	NB	NSPR
IFR	LOCHSA R		2	1706030300800	NB	NSPR
IFR	LOCHSA R		3	1706030301300	NB	NSPR
IFR	LOCHSA R		4	1706030302300	NB	NSPR
** Program IR2						
IR2	SELWAY R		DIVIDE	1706030100700	WB	NSPR
IR2	SELWAY R		HALFWAY	1706030100700	WB	NSPR
IR2	SELWAY R		LADLE	1706030100700	WB	NSPR
IR2	SELWAY R		MAIDEN	1706030100700	WB	NSPR
IR2	SELWAY R		RENSHAW	1706030100700	WB	NSPR
IR2	SELWAY R		RUN-BRIDGE	1706030100900	WB	NSPR
IR2	SELWAY R		RUN-CR-PL	1706030100700	WB	NSPR
** Program IR3						
IR3	SALMON R, S FK		18	1706020801000	WB	NSUM
IR3	SALMON R, S FK		19	1706020801000	WB	NSUM
IR3	SALMON R, S FK		20	1706020800800	WB	NSUM
IR3	SALMON R, S FK		21	1706020800600	WB	NSUM
IR3	SALMON R, S FK		22	1706020800300	WB	NSUM
IR3	SALMON R, S FK		24	1706020800200	WB	NSUM
IR3	SALMON R, S FK		25	1706020800100	WB	NSUM
IR3	SALMON R, S FK		26	1706020800100	WB	NSUM
IR3	SALMON R, S FK		28	1706020800100	WB	NSUM
** Program IR6						
IR6	SALMON R, M FK	I	BOUNDARY	1706020502200	WB	WSPR
IR6	SALMON R, M FK	I	ELKHORN	1706020501800	WB	WSPR
IR6	SALMON R, M FK	I	GRDLHOLE	1706020502000	WB	WSPR
IR6	SALMON R, M FK	I	GREYHOUND	1706020501700	WB	WSPR
IR6	SALMON R, M FK	I	INDIAN	1706020501000	WB	WSPR
IR6	SALMON R, M FK	I	RAPID-R	1706020501600	WB	WSPR
IR6	SALMON R, M FK	I	SHEEPEATER	1706020501800	WB	WSPR
IR6	SALMON R. M FK	I	VELVET	17060202502000	WB	WSPR
IR6	SALMON R, M FK	II	COUGAR	1706020500100	WB	WSPR
IR6	SALMON R, M FK	II	HOSPPL	1706020605000	WB	WSPR
IR6	SALMON R, M FK	II	HOSPRUN	1706020605000	WB	WSPR
IR6	SALMON R, M FK	II	LJACKASS	1706020500200	WB	WSPR
IR6	SALMON R, M FK	II	MARBLPL	1706020500800	WB	WSPR
IR6	SAWW R, M FK	II	PUNGO	1706020500800	WB	WSPR

IR6	SALMON R, M FK	II	ROCKIS	1706020500100	WB	WSPR
IR6	SALMON R, M FK	II	SKIJUMP	1706020500200	WB	WSPR
IR6	SALMON R, M FK	II	TAPPANPOOL	1706020605000	WB	WSPR
IR6	SALMON R, M FK	II	TAPPANRUN	1706020605000	WB	WSPR
IR6	SALMON R, M FK	II	WHITEYCX	1706020500100	WB	WSPR
IR6	SALMON R, M FK	III	AIRSTRIP	1706020604700	WB	WSPR
IR6	SALMON R, M FK	III	FLYING-B	1706020604700	WB	WSPR
IR6	SALMON R, M FK	III	SURVEY	1706020604500	WB	WSPR
IR6	SALMON R, M FK	IV	BIG-CR-BR	1706020604400	WB	WSPR
IR6	SALMON R, M FK	IV	GOATPOOL	1706020600200	WB	WSPR
IR6	SALMON R, M FK	IV	GOATRUN	1706020600200	WB	WSPR
IR6	SALMON R, M FK	IV	LITOUZEL	1706020600300	WB	WSPR
IR6	SALMON R, M FK	IV	LOVEBAR	1706020600600	WB	WSPR
IR6	SALMON R, M FK	IV	OTTERBAR	1706020600300	WB	WSPR
IR6	SALMON R, M FK	IV	SHIPISLAND	1706020600300	WB	WSPR

Appendix A-3.   Summary of hatchery chinook releases (in thousands) into natural
                production areas for BPA habitat project and monitoring streams,
                1984-1988.

Stream	Race[a]	Size	1984	1985	1986	1987	1988
Lo10 Creek	SP	egg	0	0	0	0	0
		fry	0	0	0	133	148
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Eldorado Creek	SP	egg	0	0	0	0	0
		fry	0	0	270	119	53
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Crooked Fork Cr.	SP	egg	0	0	0	0	0
		fry	0	0	200	349	138
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Crooked River	SP	egg	0	0	0	50	0
		fry	0	0	350	0	200
		smolt	0	0	0	479	0
		adult	0	0	0	0	0
Red River	SP	egg	0	0	0	331	0
		fry	0	0	0	0	50
		smolt	0	80	137	195	0
		adult	0	0	0	0	0
Meadow Creek	SP	egg	0	0	0	0	0
		fry	0	0	0	0	100
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Panther Creek	SP	egg	0	0	0	137	0
		fry	0	0	0	0	0
		smol t	0	0	0	0	0
		adult	0	0	3.38	0	0
Lemhi River	SP	egg	0	0	0	0	0
		fry	0	0	1	0	0
		smolt	0	0	0	0	0
		adult	0	0	0.02	0	0
E. Fk. Salmon R.	SP	egg	0	0	0	0	0
		fry	0	0	1	0	0
		smolt	0	0	109	195	249
		adult	0	0	0	0	0
Upper Salmon R.	SP	egg	0	0	0	0	0
		fry	0	0	0	0	0
		smolt	231	420	348	1,185	1,605
		adult	0	0	0	0.01	0
Alturas Lake Cr.	SP	egg	0	0	0	0	0
		fry	0	0	0	0	0
		smolt	0	0	0	0	0
		adult	0	0	0	0	0

Stream	Race[a]	Size	1984	1985	1986	1987	1988
Pole Creek	SP	egg	0	0	0	0	0
		fry	0	0	0	0	24
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Valley Creek	SP	egg	0	0	0	0	0.0
		fry	0	0	0	0	0
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
S. Fk. Salmon R.	su	egg	0	0	3	0	0
		fry	0	0	0	0	0
		smolt	270	564	970	958	1,060
		adult	0	0	0	0	0
Dollar Creek	su	egg	0	0	0	0	0
		fry	0	0	0	0	0
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Johnson Creek	su	egg	0	0	0	0	0
		fry	0	51	178	118	367
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Boulder Creek	SP	egg	0	0	0	140	141
		fry	0	0	101	0	0
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Little Salmon R.	SP	egg	0	0	0	0	0
		fry	0	0	0	0	30
		smolt	0	0	0	0	0
		adult	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 for BPA habitat project and monitoring streams, 1984-1988.

Stream	Race[a]	Size	1984	1985	1986	1987	1988
Lo10 Creek	SB	egg	0	0	0	0	0
		fry	0	0	0	0	0
		smolt	0	0	0	0	200
		adult	0	0	0	0	0
Eldorado Creek	SB	egg	0	0	0	0	0
		fry	0	0	0	0	0
		smolt	0	121	197	0	201
		adult	0	1.15	0.15	0	0
Crooked Fork Cr.	SB	egg	0	0	0	0	0
		fry	0	0	0	0	0
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Colt Creek	SB	egg	0	0	0	0	0
		fry	0	0	0	0	0
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Crooked River	SB	egg	0	0	0	0	0
		fry	0	0	88	0	0
		smolt	34	42	141	159	201
		adult	0	1.73	0	5.2	0
Red River	SB	egg	0	731	0	0	182
		fry	0	0	0	0	0
		smolt	74	80	0	0	0
		adult	0	0	0	0	0
Meadow Creek	SB	egg	0	0	0	770	1,022
		fry	0	0	0	0	0
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Panther Creek	SA	egg	0	0	0	0	0
		fry	305	485	625	378	0
		smolt	0	208	246	300	237
		adult	0.68	0.15	0.12	0	0
Pine Creek	SA	egg	0	0	0	0	0
		fry	25	0	0	0	0
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Lenhi River	SA	egg	0	0	0	0	0
		fry	270	923	718	185	175
		smolt	0	0	0	0	0
		adult	4.28	0.87	0.68	1.01	0
E. Fk. Salmon R.	SB	egg	0	0	0	0	0
		fry	0	19	789	0	0
		smolt	426	270	495	485	304
		adult	0	0	0.42	0.05	0

Appendix A-4. Continued.

Stream	Race[a]	Size	1984	1985	1986	1987	1988
Upper Salmon R.	SA	egg	0	0	0	0	0
		fry	0	503	533	0	327
		smolt	724	786	637	688	1,253
		adult	2.66	0	0	0	0.08
Alturas Lake Cr.	SA	egg	0	0	0	0	0
		fry	0	32	300	175	105
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Pole Creek	SA	egg	0	0	0	0	0
		fry	318	488	349	189	106
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Valley Creek	SA	egg	0	0	0	0	0
		fry	215	173	0	142	201
		smolt	0	0	0	0	0
		adult	1.55	0.10	0.52	0	0
Boulder Creek	SA	egg	0	0	0	0	0
		fry	149	0	27	0	0
		smolt	0	0	0	0	0
		adult	0	0	0	0	0
Little Salmon R.	SA	egg	0	0	0	0	0
		fry	0	82	126	0	0
		smolt	0	0	0	0	0
		adult	0	0	0	0	0

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

Appendix B. Mitigation benefits from habitat enhancement project.

     The following (16) sections describe habitat enhancement projects, surface
areas affected, and parr production from each project. Int the 1989 annual
report, project benefits will be described in terms of smolt production, 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 Lo10 Creek.

Project **Type:** **Instream** Structures

Year Implemented: 1983-1984

Sponsor: Clearwater National Forest

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

     Production Constraints: High sediment levels

     Definition of Benefits: Statistical comparison of steelhead and chinook
parr densities in treated and untreated sections will be done at **3-** to S-year
intervals to determine the difference in densities. Parr density benefits are
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 present 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).**

Appendix table Bl-ch

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   Lo10 Cr.**

SPECIES: Spring Chinook, Natural   PROJECT TYPE: Instream Structures

YEAR INITIATED: 1983-84   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
Eldorado/Brown's Cr.								
1706030603800	1.77	70.7	100	1.77	18882	3	44	8308
Brown's/Yoosa Cr.								
1706030603900	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
SAMPLE SIZE:	t=12,c=6	t=26,c=16	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
TREATMENT	4.7	9.4	13.3	25.7	33.2
CONTROL	0.8	4.6	23.9	12.4	29.2
BENEFIT DENSITY:	3.9	4.8	-10.6	13.3	4
% OF DENSITY FROM BENEFIT:	83	51	-44	52	12
TOTAL PARR FROM BENEFIT:	2693 a	10788	-23823	29891	8990

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 151,942 m2 x** (12.87/14.16) **x 0.5 =69,050 m2**

Appendix table Bl-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 (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR 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.								
1706030603600	5.632	17.1	100	3.17	53920	2	14	7549
				19.1	224744			31464

	1984	1985	1986	1987	1988
SAMPLE SIZE:	t=12,c=6	t=26,c=16	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
TREATMENT	12.1	6.4	6.7	7.2	4.9
CONTROL	10	4.1	4	5.2	4.1
BENEFIT DENSITY:	2.1	2.3	2.7	2	0.8
% OF DENSITY FROM BENEFIT:	17	36	40	28	16
TOTAL PARR FROM BENEFIT:	1109 a	5169	6068	4495	1798

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 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

| | Species Benefited | |
Enhancement	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 S-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 estimate for other years
are the product of mean density in monitoring sites and total production area
added. Chinook population abundance for 1987 and 1988 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): 50t

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
	=========	========	=========	=========	=========
SAMPLE SIZE:	c=4	c=6	t=17	t=3	t=3
PARR/100 M2:					
=========	=========	=========	=========	=========	=========
MEAN					
TREATMENT			29.9	58.1	26.9
CONTROL	0	0			
BENEFIT DENSITY:			29.9	58.1	26.9
% OF DENSITY FROM BENEFIT:			100	100	700
TOTAL PARR FROM BENEFIT:			30206 a	13328 b	5936 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 82-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): 50t

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	PARR POTENTIAL
Entire stream length 1706030603700	28.96	6.1	86	27.35	143478	3	10	14348

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

a. Population estimate derived from stratified sampling in August 1986.

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.

<u>Project</u> Type: **Instream** structures (lower White Sand and Crooked Fork Creeks)

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

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

	Species Benefited	
<u>Enhancement</u>	<u>B-Run Steelhead</u>	<u>**Spring** Chinook</u>
Production Type:	natural	natural
Hectares Added:	16.7	16.7

   <u>Production Constraints</u>:

   <u>Definition of Benefits</u>: 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.

   The deflector logs, which angle downstream from their attachment points on
shore, modify but a small portion of the stream width. After the first two to
three years, some were destroyed by ice and high water, others were stranded
mostly above water and all had lost their needles and most branches.

   Based on Kramer and Espinosa (1985), the 198 live trees and 63 "existing
debris" which were established by this project would create 1,415 m^2 of pool
habitat.   If all this habitat became excellent for parr rearing, then 108/100
m^2 * 1415/100 or 1528 chinook parr and 20/100 m^2 * 1415/100 or 283 steelhead parr
could be reared annually in the enhanced area.

Appendix table B3-ch

LOCATION OF AFFECTED REACH : Upper Lochsa River forks: '5.6 miles of Crooked Fork Creek and
3.4 miles of lower White Sand Creek.
DRAINAGE:Clearwater R, Lochsa R   STREAM Crooked Fk and White Sand creeks

SPECIES: Spring Chinook. Natural   PROJECT TYPE: Instream Structures

YEAR INITIATED: 1983   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
=========	=======	======	========	--------	===============	=======	=========
Crooked Fork Cr								
1706030304200	10.62	18.3	100	10.62	194346	2	77	149646.4
1706030304600	10.3	17.8	100	9.01	162631	2	77	125225.8
White Sand Cr								
1706030302700	4.99	30.5	100	4.99	152195	3	44	66965.8
1706030302800	10.14	30.5	100	5.47	166835	3	44	73407.4

	1984	1985	1986	1987	1988
	=========	========	=========	=========	=========
SAMPLE SIZE:	t=9,c=9	c=2	c=2	c=2	c=2
PARR/100 M2:					
=========	=========	=========	=========	=========	=========
MEAN	3				
TREATMENT	2.7				
CONTROL	3.3	0.4	4	8.9	6
BENEFIT DENSITY:	-0.6				
% OF DENSITY FROM BENEFIT:	-18				
TOTAL PARR FROM BENEFIT:					

Appendix table B3-sh

LOCATION OF AFFECTED REACH : Upper Lochsa River forks: '5.6 miles of Crooked Fork Creek and
                          3.4 miles of lower White Sand Creek.
DRAINAGE: Clearwater R, Lochsa R   STREAM   Crooked Fk and White Sand creeks

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

YEAR INITIATED: 1983   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
Crooked Fork Cr
1706030304200	10.62	18.3	100	10.62	194346	1	20	38869.2
1706030304600	10.3	17.8	100	9.01	162631	1	20	32526.2
White Sand Cr
1706030302700	4.99	30.5	100	4.99	152195	1	20	30439
1706030302800	10.14	30.5	100	5.47	166835	1	20	33367

	1984	1985	1986	1987	1988
SAMPLE SIZE:	t=9,c=9	c=2	c=2	c=2	c=2
PARR/100 M2:					
MEAN	2.2				
TREATMENT	2.1				
CONTROL	2.2	1.1	1.2	1.6	4.9
BENEFIT DENSITY:	-0.1				
% OF DENSITY FROM BENEFIT:	-5				
TOTAL PARR FROM BENEFIT:					

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	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 1988, 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, and 1988 following May fry plants of 156,200, 164,400, and
102,800, respectively. Estimated parr abundance was 17,600, 32,600, and 17,700,
respectively. Average survival rate for the three 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
SAMPLE SIZE:	c=4	c=4	t=13	t=22	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

a. Parr numbers estimated by stratified sampling in 1986, 1987 and 1988

Appendix table 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. 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
=========	========	=======	========	========	===============	=======	=========
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
	=========	========	=========	=========	=========
SAMPLE SIZE:	c=4	c=4	t=13	t=22	t=18

PARR/100 M2:

=========	=========	=========	=========	=========	=========
MEAN					
TREATMENT			0.29	0.09	0
CONTROL	0.03	0			
BENEFIT DENSITY:			0.26 a	0.08 a	
% OF DENSITY FROM BENEFIT:			90	90	90
TOTAL PARR FROM BENEFIT:			277	85	0 a

a. Assumes 90% of steelhead were blocked prior to barrier removal, thus
only 90% of parr density is a benefit.

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

	Species Benefited	
Enhancement	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).   Parr
abundance will be factored by parr-to-smolt survival rates.

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

Appendix table B5-sh

LOCATION OF AFFECTED REACH: Upper Colt Creek, beginning at the barrier removal project,
1/2 mile bove mouth.

DRAINAGE: Clearwater R, Lochsa R,   STREAM Colt Cr
         White Sand Cr

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

YEAR INITIATED: 1986   EXPECTED PROJECT LIFE (YRS):   50+

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	PARR POTENTIAL
1706030303800	20.92	3	100	20.11	61303	2	14	8582

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

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 of steelhead parr between the project and the confluence of
the East Fork and West Fork was 2,750 in 1986 and 2,347 in 1987. Total abundance
of chinook parr for these two years were **7,413** and **1,438,** respectively.   Total
abundance **estimates** in **1988 (3,915** steelhead and 14,122 chinook) additionally
included the two forks.

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 OF REACH (M)	PERCENT 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
	=========	=========	=========	=========	=========
SAMPLE SIZE:	C=11	t=4	t=16	t=3	t=11

PARR/100 M2:

=========	=========	=========	=========	=========	=========
MEAN					
TREATMENT			16.82		
CONTROL	0.23				

BENEFIT DENSITY:

% OF DENSITY
FROM BENEFIT:

TOTAL PARR FROM BENEFIT:		5351 a	3707 b	742 b	7061 b

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.

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 1986 and 1987
and included these two forks in 1988.

DRAINAGE: Clearwater R   STREAM Crooked R

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

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

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	PERCENT WIDTH OF REACH (M) 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	2	14	8914
Crooked R, E Fk 1706030507200	10.14	3.7	71	10.14	26638	1	20	5328
Crooked R, W Fk 1706030503302	7.56	4.9	100	7.56	37044	1	20	7409
					127352			21651

	1984	1985	1986	1987	1988
SAMPLE SIZE:	c=11	c=4	t=16	t=3	t=11
PARR/100 M2:					
MEAN					
TREATMENT					
CONTROL	0.28	0.97			
BENEFIT DENSITY:					
% OF DENSITY FROM BENEFIT:					
TOTAL PARR FROM BENEFIT:			1375 b	1174 b	1958 b
PRE-TREAT. No's:	178	618			

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

Appendix B-6b.   (Crooked R., 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 S-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 present 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 km upstream from the mouth, at the culvert removal site and continuing upstream 7.24 kms.**

DRAINAGE: Clearwater **R**   STREAM   **Crooked R**

SPECIES: **Spring Chinook, Natural**   PROJECT TYPE: Instream **Structures**

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

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	PARR POTENTIAL
=========	========	=======	========	========	================	=======	=======	=========
1706030503301	7.241	10.1	100	2.735	26627	3	44	11715.88
1706030503300	12.55	10.1	100	4.505	45501	2	77	35035.77
					================			=========
					72128			46751.65

	1984	1985	1986	1987	1988
	=========	========	=========	=========	=========
SAMPLE SIZE:		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
TREATMENT		42.1	19.8	3.5	26.4
CONTROL		49.9	21	0.6	16.9
BENEFIT DENSITY:		-7.1	-1.2	2.9	9.5
% OF DENSITY FROM BENEFIT:		-17	-6	83	36
TOTAL PARR FROM BENEFIT:		-5121	·886	2092	6852

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: 1984435   **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
1706030503301	7.241	10.1	100	2.735	26627	2	14	3727.78
1706030503300	12.55	10.1	100	4.505	45501	2	14	6370.14
					72128			10097.92

	1984	1985	1986	1987	1988
SAMPLE SIZE:		t=2,c=2	t=2,c=2	t=2,c=2	t=2,c=2
PARR/100 M2:					
MEAN		1.5	9.8	9.8	10
TREATMENT		1.4	9.8	13.2	11.8
CONTROL		1.5	9.8	6.3	7.9
BENEFIT DENSITY:		-0.1	0	6.9	3.9
% OF DENSITY FROM BENEFIT:		-7	0	52	33
TOTAL PARR FROM BENEFIT:		-72	0	4977	2813

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

<u>Project **Type**</u>:   Off-channel developments

<u>Year Implemented</u>:   **1984**-**1987**

<u>Sponsor</u>: Nez **Perce** National Forest

| | Species Benefited ||
Enhancement	B-Run Steelhead	Spring Chinook
Production Type:	natural	natural
Hectares Added:	0.65	0.65

    <u>Production Constraints</u>:   Pond and side channel habitat will primarily benefit chinook.

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

    An evaluation of off-channel rearing densities was conducted in **1986.**   The 0.8 hectares added to Crooked River through **1985** reared an estimated 69 rainbow-steelhead parr **(8/100 m^2)** and 739 chinook parr **(88/100 m^2)**.

Appendix 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):   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
1706030503301					6517	1	108	7038.36

	1984	1985	1986	1987	1988
SAMPLE SIZE:			t=5	t=1	t=2
PARR/100 M2:					
MEAN					
TREATMENT			63.2	3.2	90.9
CONTROL					
BENEFIT DENSITY:			63.2	3.2	90
% OF DENSITY FROM BENEFIT:			100	100	100
TOTAL PARR FROM BENEFIT:			4119	209	5865

Appendix table B6c-sh

LOCATION OF AFFECTED REACH: Ponds connnacted 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
1706030503301					6517	2	14	912.38

	1984	1985	1986	1987	1988
SAMPLE SIZE:			t=5	t=1	t=2
PARR/100 M2:					
MEAN					
TREATMENT			5	47.2	17
CONTROL					
BENEFIT DENSITY:			5	47.2	17
% OF DENSITY FROM BENEFIT:			100	100	100
TOTAL PARR FROM BENEFIT:			326	3076	1108

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

	Species Benefited	
Enhancement	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 present 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 table B7a-ch

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

DRAINAGE: Clearwater R   STREAM Red R

SPECIES: Spring Chinook, 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 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	2	77	28247
S Fk to Soda Cr								
1706030503800	9.493	10.1	100	8.05	80920	3	44	35605
					=========			=========
					117603			63852

	1984	1985	1986	1987	1988
	=========	========	=========	=========	=========
SAMPLE SIZE:		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
TREATMENT		66.7	31.6	47.8	43.7
CONTROL:		58.8	23.5	31.6	25.1
BENEFIT DENSITY:		7.9	8.1	16.2	18.6
% OF DENSITY FROM BENEFIT:		12	26	34	43
TOTAL PARR FROM BENEFIT:		9291	9526	19052	21874

Appendix table B7a-sh

LOCATION OF AFFECTED REACH: Within two non-adjacent reaches, Siegel Cr. to 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	9.493	10.1	100	8.05	80920	2	14	11328.8
					=========			=========
					117603			14997.2

	1984	1985	1986	1987	1988
	=========	========	=========	=========	=========
SAMPLE SIZE:		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
TREATMENT		1.5	2.3	3.1	1
CONTROL:		0.9	2.5	3	1.9
BENEFIT DENSITY:		0.6	-0.2	0.1	-0.9
% OF DENSITY FROM BENEFIT:		40	-9	30	-90
TOTAL PARR FROM BENEFIT:		706	-235	118	-1058

Appendix B-7b.   (Red R., 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 in **1987** or **1988,** 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

	Species Benefited
Enhancement	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 barriers removed were not sufficient to allow
adult steelhead to ascend Pine Creek, and that even with additional barrier
removals, the gradient will be too steep to ensure passage. We recommend that
parr density monitoring be terminated in Pine Creek.

   Pine Creek was sampled in 1987 and 1988, but future sampling will be
discontinued until complete barrier removal, if possible, occurs.

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

Project Type: Diversion screen

<u>year Implemented</u>:   **1983-1984**

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

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

    <u>Production Constraints</u>:   Juvenile steelhead upstream passage is impeded.

    <u>Definition of Benefits</u>:   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.

    Estimated total abundance of steelhead parr upstream of the diversion was
420 in **1985** and 63 in **1987.**   Chinook have not been available for introduction
upstream of the diversion.

Appendix table 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 OF REACH (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	1988
SAMPLE SIZE:	c=6	t=6	t=2	t=6	t=6
PARR/100 M2:					
MEAN					
TREATMENT		0	0	0	0.04
CONTROL	0				
BENEFIT DENSITY:					0.02
% OF DENSITY FROM BENEFIT:					50
TOTAL PARR FROM BENEFIT:					8

Appendix table B9-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 OF REACH (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
SAMPLE SIZE:	c=6	t=6	t=2	t=6	t=6
PARR/100 M2:					
MEAN					
TREATMENT		1	0.11	0	1.96
CONTROL	0				
BENEFIT DENSITY:		0.5	0.06		0.98
% OF DENSITY FROM BENEFIT:		50	50		50
TOTAL PARR FROM BENEFIT:		210 a	23	32 a	381

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-10. **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	
	Middle Fork Salmon River	
Enhancement	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 and fish-sediment** relationships, b) improvements in egg deposition **to parr survival, 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 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 1987. The ratios were 5.5, 2.5, 1.8, 0.8, and 1.3 respectively (mean = 2.5). The average value for **this ratio among other Middle Fork and upper Salmon River** sections was 18.7. **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** = 0.0. **The average treatment/control density ratio for** chinook **averaged 0.05 in the pretreatment years of 1985 through 1987. The ratio in** 1988 after **some sediment work, which began in 1987, was 0.12. 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 1)**

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 C).**

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Appendix table B10-ch

LOCATION OF AFFECTED REACH: All of Bear Valley Creek and its tributaries
                              of Elk Creek and 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 OF (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR WTENTIAL
See below (a)	73.85	7.2	95.7	71.87	757085	2 & 3	70	534948

	1984	1985	1986	1987	1988
SAMPLE SIZE:	pt=7,c=1 (b)	pt=10,c=9	pt=9,c=9	pt=10,c=9	t=10,c=7

PARR/100 M2:

TREATMENT:	2.8	0.6	1.4	1.6	4
CONTROL: (c)	9.2	17.4	24.5	30	33.7
TREATMENT RATIO:	(d)	0.03	0.06	0.05	0.12
MEAN 1985-1987 T/C RATIO					0.05
EXPECTED DENSITY AT T/C=0.05:					1.69
BENEFIT DENSITY (OBSERVED-EXPECTED):					2.31
PARR FROM BENEFIT:					17489

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 inprovenents began in 1987, no significant reduction
in sedinent and fish density response is expected until approxinately 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 treatnent/control ratio in 1984.

Appendix Figure 1. Ratio of mean annual chinook parr density in Bear Valley/Elk Creek drainage relative to chinook parr densities in Middle Fork Salmon River control streams.

Appendix table B10-sh

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

SPECIES: Sum Steelhead, Wild B's   PROJECT TYPE: Sedimentation Reduction and
                                                     Riparian Re-vegetation
YEAR INITIATED: 1987-91   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	PARR POTENTIAL
See below (a)	73.85	7.2	100	73.85	768737	-3	13.7	105333

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

---

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 inprovements 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

	Species benefited
Enhancement	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.   Parr density estimates in
1987 and 1988 were based on one sample each year. Once obvious 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 7-21% 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,   STREAM   Knapp Cr
          Marsh Cr
SPECIES: Spring Chinook, Wild   PROJECT TYPE: Barrier (partial) removal

YEAR INITIATED: 1987   EXPECTED PROJECT LIFE (YRS):   5ot

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
SAMPLE SIZE:		c=2	c=1	c=1	t=1
PARR/100 M2:					
MEAN					
TREATMENT					0.16
CONTROL		0.29	0	0.15	
BENEFIT DENSITY:					0.08
% OF DENSITY FROM BENEFIT:					50
TOTAL PARR FROM BENEFIT:		226 a		117 a	63

a. Barrier removal during the summer of 1987 could have provided for upstream passage for adults that year. Chinook parr from the 1987 brood year would be monitored in 1988.

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.

A total of 50,744, 177,606, 118,424, and 366,800 summer chinook fry were
stocked into the upper Johnson Creek drainage in 1985, 1986, 1987, and 1988.
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
and 1988, 14.2% **fry-to-parr** survival was used.

Appendix table B12-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,   STREAM Johnson Cr
         E Fk S Fk Salmon R
SPECIES: Summer Chinook, Natural   PROJECT TYPE: Barrier Removal

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

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	PARR POTENTIAL
See below (a)	64.68	8.04	85.9	49.14	395119	1-3	74.6	294750

	1984	1985	1986	1987	1988
SAMPLE SIZE:	c=23	t=10	t=10	t=11	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 |

a. EPA reaches affected all begin with 170602080 and end with: 4700, 4701, 4701.13, 4701.24, 4702,
4703. 4704, 9800, 7400, 9600, 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 OF (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	9.33	4.6	52	2.4	22187	3	44	9762
					32976			14509

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

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

Appendix table 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 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	PARR POTENTIAL
=========	========	=======	========	========	===============	=======	========	=========
mouth to N Fk 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 Fk Dollar Cr 1706020808700	6.11	2.4	100	2.4	14909	2	14	2087
					=========			=========
					68365			9570

	1984	1985	1986	1987	1988
	=========	========	=========	=========	=========
SAMPLE SIZE:			c=1	t=1	t=1
PARR/100 M2:					
----------	=========	=========	=========	=========	=========
MEAN					
TREATMENT				3.1	7.1
CONTROL			1.9		
BENEFIT DENSITY:				1.6 a	3.6 a
% OF DENSITY FROM BENEFIT:				50	50
TOTAL PARR FROM BENEFIT:				1060	2461

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

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

	Species Benefited
Enhancement	**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.

Appendix table 14-ch

LOCATION OF 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 Boulder Cr

SPECIES: Spring Chinook, Natural   PROJECT TYPE: Barrier removal

YEAR INITIATED: 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	HABITAT RATING	#/M2	PARR POTENTIAL
Squirrel to Pony Cr 1706021000901	3.06	10.7	100	1.13	12015	3	44	5287
Pony Cr to Headwaters 1706021000902	22.85	6.1	72	22.85	100282	2	77	77217
					112297			82504

	1984	1985	1986	1987	1988
SAMPLE SIZE:	c=2	c=2	t=10	t=2	t=7
PARR/100 M2:					
MEAN					
TREATMENT			28.9	0	7.8
CONTROL	0	0.2			
BENEFIT DENSITY:			28.9	0	7.8
% OF DENSITY FROM BENEFIT:			100	100	100
TOTAL PARR FROM BENEFIT:		(225) b	28112 a	0 b	1560 a

a. Estimates from stratified sampling.

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

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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 100,000 chinook fry were planted above the barrier in the spring of
1988. Parr density was monitored at two sections in 1988, 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, STREAM Meadow Cr
        S Fk Clearwater R

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
1706030504800	21.72	6.1	67	21.72	88710	3	44	39036

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

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

Appendix B-16. Proposed definition of mitigation benefits for implemented
project on Valley Creek.

Project Type: Passage Barrier (irrigation diversion)

Year implemented: 1988

Sponsor: Boise National Forest

	Species Benefited
Enhancement	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. 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.

Appendix table B16-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								
1706020105500	19.63	6.1	100	19.63	199663	2	77	92141

	1984	1985	1986	1987	1988
SAMPLE SIZE:		c=8	c=1	c=1	c=1
PARR/100 M2:					
MEAN					
TREATMENT					
CONTROL		12.4	0	5	0
BENEFIT DENSITY:					
% OF DENSITY FROM BENEFIT:					
TOTAL PARR FROM BENEFIT:					

Appendix C. 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, 1985-1988.

Stream Condition	Stream	Section	Percent Sand	Chinook Parr/100 m²				Steelhead Parr/100 m²			
				1985	1986	1987	1988	1985	1986	1987	1988
Sediment	Bear Valley	2A	43	1.9	3.0	0.9	4.2	0.1	0.1	0.0	0.0
Reduction	Creek	2B	71	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Required	"	3A	25	1.0	4.7	7.7	5.6	0.0	0.8	0.1	0.3
	"	5A	28	0.2	4.1	1.3	2.9	0.0	0.0	0.0	0.2
	"	9B	55	0.0	0.0	2.2	2.6	0.0	0.0	0.0	0.0
	Elk Creek	1A	44	0.4	0.0	0.1	0.1	0.4	0.0	0.0	0.1
	"	1B	54	1.4	0.6	0.1	11.9	7.4	0.6	0.0	0.3
	"	2A	53	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0
	"	2B	37	1.1	0.2	3.8	11.6	1.1	0.2	0.0	0.3
	Treatment Means:		45.6	0.7	1.4	1.8	4.3	0.3	0.2	0.0	0.1
Control	Knapp Cr.	1A	26	23.6	7.2	10.4	11.1	1.1	0.7	3.5	3.4
Streams	Beaver Cr.	1A	4	12.9	7.2	0.5	9.8	1.4	0.0	0.1	1.2
	"	3B	11	10.8	28.6	5.9	26.8	7.2	2.1	0.7	2.4
	Cape Horn Cr.	2B	20	49.0	10.7	96.8	55.7	0.2	0.0	0.0	0.0
	"	1A	8	34.7	14.5	39.4	40.7	0.1	0.6	0.9	4.2
	Sulphur Cr.	4A	36	0.1	25.8	39.9	24.1	0.0	0.3	3.2	3.4
	"	4B	30	18.1	62.6	18.8	67.9	1.0	1.0	0.2	4.4
	Control Means:		19.6	21.3	22.4	30.2	33.7	0.7	0.7	1.2	2.7

Appendix C. 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, 1985-1988.

Stream Condition	Stream	Section	Percent Sand	Chinook Parr/100 m²				Steelhead Parr/100 m²			
				1985	1986	1987	1988	1985	1986	1987	1988
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Required	"	3A	25	1.0	4.7	7.7	5.6	0.0	0.8	0.1	0.3
	"	5A	28	0.2	4.1	1.3	2.9	0.0	0.0	0.0	0.2
	"	9B	55	0.0	0.0	2.2	2.6	0.0	0.0	0.0	0.0
	Elk Creek	1A	44	0.4	0.0	0.1	0.1	0.4	0.0	0.0	0.1
	"	1B	54	1.4	0.6	0.1	11.9	1.4	0.6	0.0	0.3
	"	2A	53	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0
	"	2B	37	1.1	0.2	3.8	11.6	1.1	0.2	0.0	0.3
	Treatment Means:		45.6	0.7	1.4	1.8	4.3	0.3	0.2	0.0	0.1
Control	Knapp Cr.	1A	26	23.6	7.2	10.4	11.1	1.1	0.7	3.5	3.4
Streams	Beaver Cr.	1A	4	12.9	7.2	0.5	9.8	1.4	0.0	0.1	1.2
	"	3B	11	10.8	28.6	5.9	26.8	1.2	2.1	0.7	2.4
	Cape Horn Cr.	2B	20	49.0	10.7	96.8	55.1	0.2	0.0	0.0	0.0
	"	1A	8	34.7	14.5	39.4	40.7	0.1	0.6	0.9	4.2
	Sulphur Cr.	4A	36	0.1	25.8	39.9	24.1	0.0	0.3	3.2	3.4
	"	4B	30	18.1	62.6	18.8	67.9	1.0	1.0	0.2	4.4
	Control Means:		19.6	21.3	22.4	30.2	33.7	0.7	0.7	1.2	2.7

PART II

SUBPROJECT II

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

Annual Report 1988

Prepared by

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And

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IDAHO DEPARTMENT OF FISH AND GANE

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INTRODUCTION

The overall objective of Project 83-7 is to quantify changes in physical habitat and in chinook salmon Oncorhvnchus tshawvtscha and steelhead trout O. mykiss smolt production relating to Bonneville Power Administration (BPA) funded habitat improvement projects. It has been generally accepted that habitat improvement projects can lead to increased fish production, and in anadromous populations the change in smolt production would be the best measure of a project's effectiveness. The actual increase in smolt production, however, has never been statistically quantified in the field (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 in two typical anadromous stream reaches; and 3) to use the determined **parr-to-smolt** survival rates as a basis for BPA mitigation accounting.

Work began on the intensive monitoring subproject in September 1986. The primary objectives of the intensive monitoring subproject are to determine: 1) smolt production from two typical 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; 5) the most effective methods of supplementing natural anadromous fish production with hatchery production; 6) habitat rearing potential, potential smolt production, and reproductive potential for the two study streams; and 7) which factors limit wild and natural smolt production.

STUDY SITES

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 located upstream from the Sawtooth Hatchery, 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, cutthroat trout, bull trout, mountain whitefish, and non-native brook trout (Mallet 1974).

Historically, sockeye salmon existed in all moraine lakes in the Stanley Basin (Everman 1895). An extremely depressed, remnant run of sockeye 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 (ALC) (K. Ball, Idaho Department of Fish and Game (IDFG), personal communication), but an irrigation diversion that completely dewaters
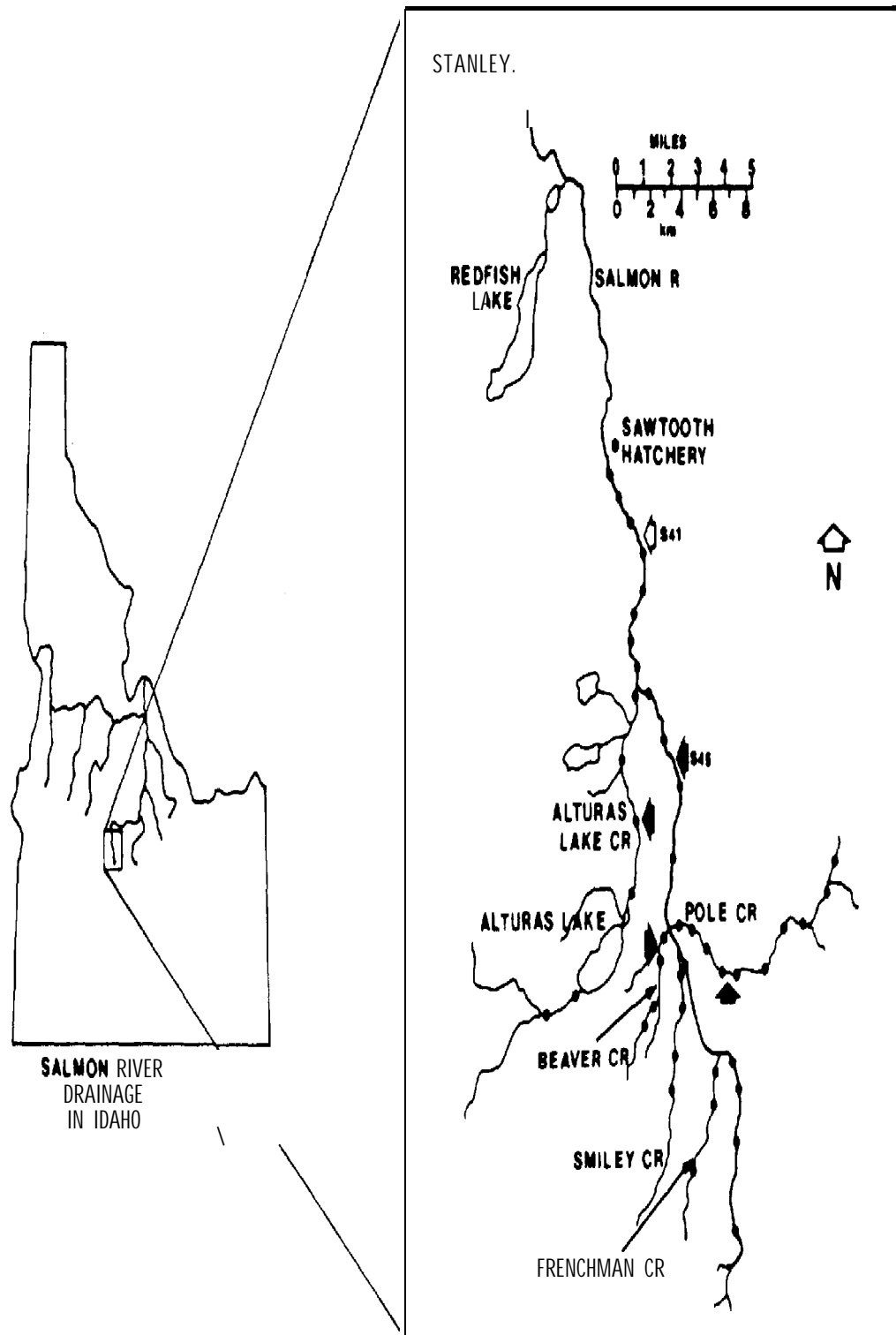
Figure 1. Location of the USR study area and study sections (•).
Solid arrow indicates major irrigation diversions,

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 1.73-3.46 **cms** from July through April, to highs of 11.21-23.31 **cms** during May and June.

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.

The Busterback (**S45**) diversion between ALC 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 in 1983-1984. Steelhead fry have been outplanted into upper Pole Creek every year since 1985 (IDFG, unpublished data). This project's **outplant** of 34 chinook adults in 1988 was the first time chinook have been available for reintroduction into Pole Creek.

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. Approximately 700,000 steelhead smolts were released from the hatchery in 1986 (T. Rogers, IDFG, personal communication). 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 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 (CR) drainage. Chinook and steelhead runs were eliminated historically by the construction of Harpster Dam on the South Fork Clearwater River in 1927. Spring chinook and B-run summer steelhead were reestablished in CR following removal of the dam in 1962. Resident salmonids in the CR drainage are mountain whitefish, rainbow trout, bull trout, and cutthroat trout (Petrosky and Holubetz 1986).
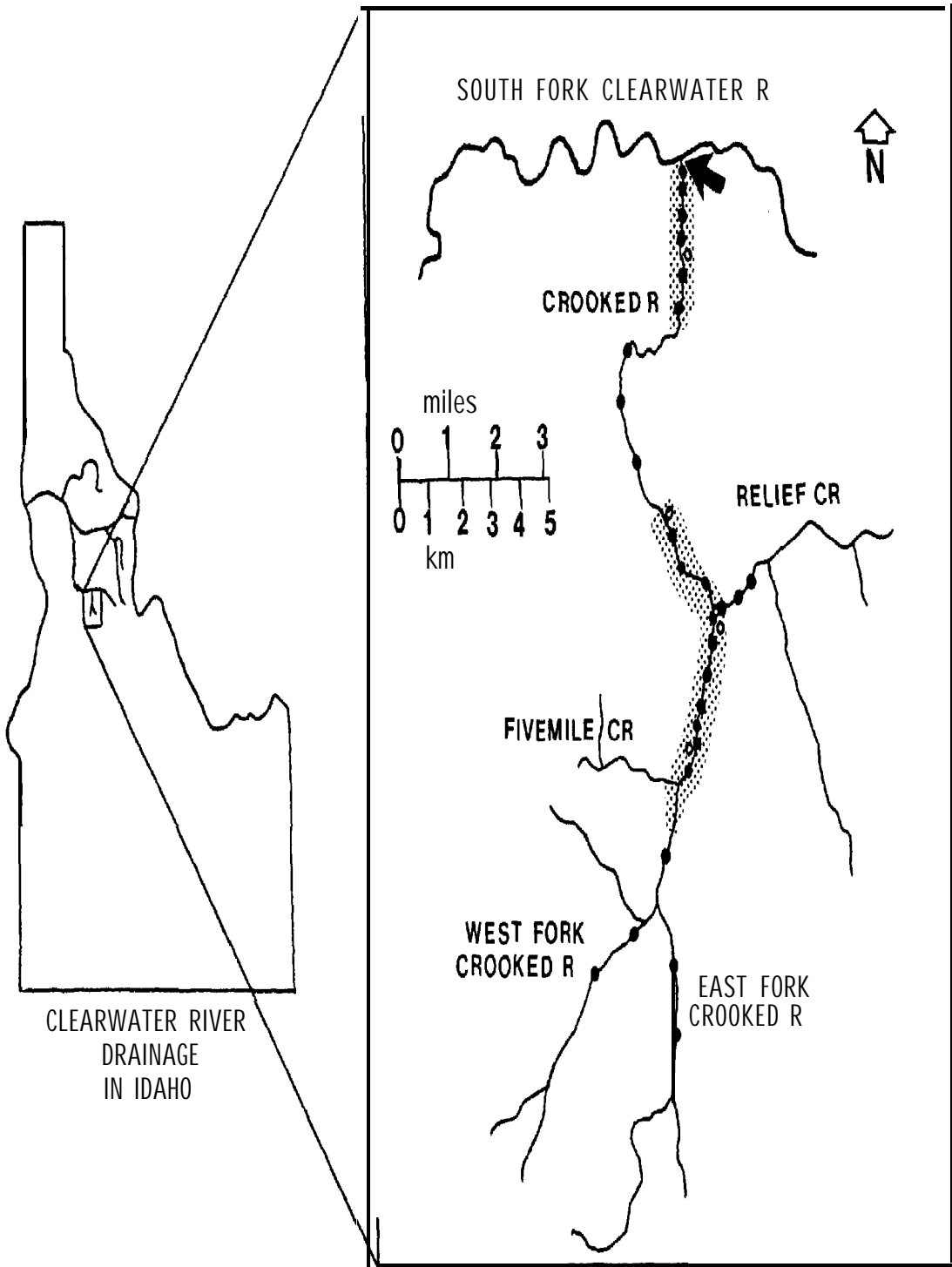
Figure 2. Location of the CR study area, pond (o) and river(*) study
sections, and meadows degraded by dredging (shaded), Arrow
indicates location of trapping facility.

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. Water flows on CR were measured from May to September and ranged from 152-7 **cms (Mann** and Von Linder 1986).

Fish density and habitat surveys were initiated in 1984 by 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 relatively lower than those in other Idaho streams. Densities of fish in the few pools and high velocity sections were similar, indicating the lack of a relationship between juvenile density and habitat type. 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.

MATERIALS AND METHODS

Habitat Evaluation

Project personnel conducted physical habitat surveys on 22 sections on CR, and two sections on the USR using the Idaho ocular method (Petrosky and Holubetz 1987). USFS personnel (BPA project 84-24) also used this method for 26 study sites in the USR in 1988.

The Idaho ocular method was derived from Platts et al. (1983). In this method, transects were established at 10 m intervals within each study section, and stream width was measured at each transect. Depth, velocity, substrate composition, embeddedness, and habitat type (ie. pool, run, riffle, pocketwater, or backwater) as described by Shepard (1983) were measured or determined at the one-quarter, one-half, and three-quarter points of each stream transect. Proportions of sand (O-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 were estimated visually. Embeddedness (the proportion of surface area of gravel, rubble, and boulder surrounded by sand) was classified as 0%, **0-5%, 5-25%, 25-50%, 50-75%, 75-100%,** and 100%. Stream gradient **was** 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 was classified according to Rosgen (1985). All sections were flagged and photographed for future repeated measurements.

Project data for 1987-88 have been entered into the IDFG physical habitat database for future analysis. The management of this database is handled by Subproject I personnel.

Adult Escapement and Redd Counts

Actual escapements for chinook and steelhead in the USR were obtained from Sawtooth Hatchery records. Except for the possibility of a small percentage of early and late fish in 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 the respective regional fisheries personnel (Hall-Griswold 1988). The trend count for the USR was a **one-**day peak count by helicopter during the first week of 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 first week in September.

Total chinook ground counts were conducted in both the USR and CR study areas to determine natural spawning. Counts were done using guidelines identified by IDFG personnel (Redd Count Manual 1987). 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 August **31** and September 1, 1988. On CR, the ground count was conducted from the mouth to the forks on September 8, 1988.

Ground 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 for chinook; 5,000 for steelhead). In CR the number of female chinook spawners was estimated assuming approximately one redd per female as observed in the USR. Chinook fecundity for CR (4,200) was based on estimates from the nearby Red River trapping facility.

Hatchery Supplementation

The experimental design for chinook supplementation evaluation for the USR identified eight separate strata so that two replicates of four supplementation methods could be evaluated. Supplementation evaluation efforts in the USR currently concentrate on chinook for brood **year 1987** because of their critical status relative to A-run natural steelhead. The life stages outplanted and their respective strata were: adults into Frenchman Creek and upper Pole Creek; eyed eggs into Beaver Creek and upper Alturas Lake Creek; fry into lower Pole Creek and Smiley Creek; and parr into the Salmon River headwaters and lower Alturas Lake Creek.

Annual seeding levels for supplementation were selected based upon the availability of chinook adults and the levels needed for evaluation. Numbers of eyed eggs, fry and fall released parr were equivalent to the estimated egg deposition of the outplanted adults times the estimated survival in the hatchery to each respective life stage. We evaluated **outplant** success as survival from green egg to parr and smolt stages. We estimated total parr abundance in July by stratified sampling (three strata, six sections) ranging from **1** km above to 2 km below the **outplant** site.

Fifteen pair of adult chinook were released into Frenchman Creek at study section 2-A during August 28-September 6, 1988. The release site was located within a grazing enclosure that also **was** sampled for sediment monitoring (Torquemada and Platts 1988). No cattle were in the enclosure while the chinook were spawning. A total of 19 male and 15 female adult chinook were released into Pole Creek at study section 3-B during August 28-September 6, 1988. 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. We monitored spawning activity on alternate days. Water temperatures were measured to predict emergence dates. Carcasses were cut open to confirm sex and determine completeness of spawning, and fork length was measured.

A total of 28,000 chinook eyed eggs were buried in artificial redds into both Beaver Creek and ALC during October 3-4, 1988. Redd design was based on findings by Chapman (1988). The site selected for **outplant** on Beaver Creek was in stratum 2, 4.5 km above the mouth. The **outplant** site for ALC was above Alturas Lake at study site 3-B. In both study sites, the eggs were buried in 14 artificial redds (2,000 **eggs/redd)** according to the directions of White (1980). Due to poor success with eyed egg outplants in 1987, we only outplanted the number of eggs that five females would have produced (5 females X 5,600 eggs/female = 28,000 eggs). Fecundity was based on the 1981-84 average at Sawtooth Hatchery.

On May 25, 1988, chinook fry were outplanted in Smiley Creek at study site 2-A and in Pole Creek at study site 2-B. A total of 24,000 fry were released into each site.

On October 12, 1988, a group of 21,500 chinook parr were released into the Salmon River at study site 10-A and on October 11, 1988 into lower ALC at the

second bridge, 5 km above the mouth. Before the release, we PIT-tagged a representative sample of 300 parr from each of these groups to estimate survival. The parr were held in hatchery raceways for two weeks after tagging to determine delayed mortality and check for lost tags.

Fish Densities

Fish abundance by species and age-class was estimated by snorkeling through established sections (Petrosky and Holubetz 1989). Surveys were conducted in 26 sections on CR during July 7-10, 1988, and in 72 sections on the USR during July 18-24, 1988. Total abundance of steelhead and chinook parr were estimated by stratified sampling (Schaeffer et al. 1979). Bounds on the error of estimation were expressed as $\pm$ 2 S$_E$.

PIT Tagging

Chinook and steelhead parr were PIT-tagged in their summer rearing areas during August 15-24, 1988 for the USR and August 2-9, 1988 on CR. National Marine Fisheries Service (NMFS) personnel cooperated in chinook tagging in both study areas.

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 primarily used to sample pools, and the electrofisher was used to sample riffles.

The electrofisher was operated with the following configuration and settings: 30.5 cm diameter anode ring on a 2 m pole, 2.4 m rattail cathode, voltage setting between 200 and 400 V, and pulse rates of 90/sec when fishing primarily for chinook and 30/sec for steelhead. Conductivity in the USR drainage ranges from 37-218 μ mhos/cm (Emmett 1975). The conductivity on CR ranges from 35-50 μ mhos/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 without a reduction of capture effectiveness.

Additional parr were PIT-tagged during the outmigration trapping operations. We anesthetized fish with MS-222 and injected 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 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/decoding device (Prentice et al. 1986). NMFS has found that once a functional tag has been successfully implanted in a fish, the tag failure rate has been less than 1%. Fork length was measured to the nearest millimeter on all parr that were PIT-tagged. Fish weight was measured to the nearest tenth of a gram on most of the fish tagged using a Port-O-Gram balance. Perforated

5 x 4 m plastic tote boxes were used to hold fish before being tagged, during recovery, and for 24-h delayed-mortality tests.

The hand-held PIT tag detector was used to detect and send the tag codes to a Tandy 102 portable micro-computer. The micro-computer used a BASIC program supplied by NMFS to organize the tag codes and associated data into tag files. These PIT tag data files were downloaded daily to a COMPAQ personal computer for storage and printing.

We conducted tests on chinook and steelhead in both study areas to determine delayed mortality or tag loss. Fish were held 24 hours in the 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. Tags were retrieved from all tagging mortalities.

In the USR, five delayed mortality tests were conducted on chinook and steelhead that we collected by either electrofishing or seining. Electrofishing samples were from Pole Creek at study section I-B, Alturas Lake Creek at study section I-C, and on the main stem of the Salmon River in stratum 9. Seining samples were from Frenchman Creek in stratum 2, and in the Salmon River at study section 7-A.

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 1 at study site Sill Log B, and on Relief Creek at study site 1. Delayed mortality tests for seined chinook and steelhead were conducted in stratum 2 at pond U, and in stratum 3 at the Natural 3 study section.

Downstream Migrant Trapping

We monitored the outmigration 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 weir. Water was funneled to the trap from a 3.1 m wide bay of the weir and a picket weir covered with 6 mm hardware cloth. To evaluate the spring 1988 outmigration, the trap was operated from March 18-June 16. The trap was operated from August 16-October 31 to evaluate fall outmigration. A modified Krey-Meekin trap was operated at the Sawtooth Hatchery intake structure from March 19-April 7 to collect additional smolts for tagging. This trap was taken out of operation early (April 7) due to high water.

To evaluate the 1988 fall outmigration on CR, the modified Krey-Meekin trap was used due to a construction delay of two scoop traps. It operated from August 16-November 2. A rock weir was installed by the USFS to funnel fish to the trap. Trap efficiency was estimated by mark and recapture of PIT-tagged fish released upstream.

UPPER SALMON RIVER

RESULTS AND DISCUSSION

Adult Escapement and Redd Counts

Accurate female and total escapement numbers have been available since 1985 for the USR with the operation of the Sawtooth Fish Hatchery weir and adult trap. Total egg deposition for both chinook and steelhead were calculated in 1984-88 using known female escapement and fecundity estimates from Sawtooth Hatchery. Known escapements will be correlated with redd counts for chinook and attempted for steelhead.

Chinook redd counts were conducted in 1988 on the ground and by helicopter over the entire probable spawning area of the USR. A one-pass ground count was conducted during August 30-September 1. When chinook redds were discovered by helicopter above the ALC diversion, outside the "probable spawning area," we conducted a ground count in this stratum on September 13. The helicopter count of the USR was conducted by the IDFG Region 6 Fishery Manager on September 7. A total of 261 chinook redds were observed during ground counts, compared to the helicopter count of 76 (Table l). The ground and helicopter counts represented 95% and 28% of the known female escapement, respectively. Several (approximately 15) 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. Other reasons for the discrepancy between ground and helicopter counts might be that from the air multiple redds were counted as singles, and overhanging vegetation hid some of the redds. Ground and helicopter redd counts will be conducted for two more years in the USR to develop a correction factor for helicopter counts.

Steelhead redd counts were not conducted on the USR in 1988 because of difficulties in conducting redd counts during spring run-off and because accurate escapement numbers were available from Sawtooth Fish Hatchery. In 1989 a helicopter count will be conducted to determine the usefulness of aerial steelhead redd counts.

Hatchery Supplementation

Hatchery supplementation data in the USR for brood years 1984-88 are summarized in Tables 2 and 3. Egg-to-Parr survival rates by outplant method brood year 1987 were estimated to be: adults 32%; eyed eggs 0.4%; and fry 16% (Table 4). Parr-to-smolt survival rates from these outplants will be calculated during winter 1990. Egg-to-Parr survival rate estimates were based on single samples in an atypical, low flow year. However, survival from the fry and adult outplants were similar to those estimated by Scully et al. (1990). We believe that the poor survival from the eyed-egg outplant was primarily a result of the artificial redd design. The artificial redds were constructed level with the

Table 1. Adult escapement, redd counts, and estimate of eggs deposited for USR.

	Chinook salmon				
	Brood year				
	1984	1985	1986	1987	1988
Total escapement	205	625	876	506	552
Female escapement	65[a]	180	248	252	275
Helicopter count	74	83	105	124	76
Ground count					261
Eggs/female[b]	6,017	4,530	5,156	5,399	5,653
Estimated number eggs deposited	391,105	815,400	**1,278,688**	**1,360,548**	**1,554,575**

	Steelhead trout				
	Brood year				
	1984	1985	1986	1987	1988
Total escapement		206	1,056	979	365
Female escapement	22[a]	92	322	383	136
Eggs/female[b]	3,969	5,640	4,468	4,854	5,069
Estimated number eggs deposited	87,318	518,880	**1,438,696**	**1,859,082**	689,384

[a]In 1984, a temporary weir was used and escapement was probably greater.
[b]Number is average eggs/female observed at Sawtooth Fish Hatchery.

Table 2.   Upper Salmon River chinook supplementation, summary by brood year 1984-88.

	Brood year				
	1984	1985	1986	1987	1988
Adult females	0	19	0	6	30
Eyed eggs	0	0	0	28,000	56,530
Fry	0	0	0	48,000	275,000
Fall parr	0	0	0	43,000	0
Smolts	0	0	0	0	0

Table 3.   Upper Salmon River steelhead supplementation, summary by brood year 1984-88.

	Brood year				
	1984	1985	1986	1987	1988
Adult females	1,271	0	1,056	0	83
Fry	317,500	**1,276,501**	832,414	678,680	537,700
Fall parr	0	0	0	0	0
Smolts	0	0	0	0	0

Table 4. Estimated parr production and survival by **outplant** method from chinook supplementation evaluation in USR, brood year 1987-88.

Outplant method	Population parameter	Brood year 1987	Brood year 1988
Adult	Females outplanted	6[a]	30
	Egg deposition	26,995	169,590
	Parr production	8,625	--
	Egg-to-Parr survival (%)	32.0	--
Eyed-egg	Egg deposition	28,000	56,530
	Parr production	109	--
	Egg-to-Parr survival (%)	0.4	--
Fry[b]	Hatchery egg requirement	28,000	169,590
	Fry outplanted	24,000	--
	Parr production	4,525	--
	Egg-to-Parr survival (%)	16.2	--

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

[b]Most of the fry outplanted into lower Pole Creek outmigrated immediately after the **outplant** and are not included in the **egg-to-parr** survival estimates.

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.

The fry **outplant** into lower Pole Creek was excluded as atypical for the brood year 1987 calculations.   Many of these fish outmigrated from Pole Creek immediately after the **outplant** (Gary Gadwa, IDFG personal communication).   This apparently was in response to extremely low flows below the Pole Creek diversion. Since most of these fish did not stay in the **outplant** area, we could not estimate the parr population and **egg-to-parr** survival.

Fish Density and Physical Habitat Analysis

Project data for 1985 through 1988 have been entered into the IDFG fish density and physical habitat data bases.   The management of these databases is being handled by Subproject I personnel.   During winter 1990, we will begin to correlate fish density and physical habitat data for the USR.

The densities of age-0 chinook changed during 1984-88 (Table 5).   Most significant was a general reduction of chinook parr densities above the S45 diversion during the low flow years 1987-88.   Natural populations were reduced beginning with brood year 1984 (1985 density) by trapping adults at Sawtooth Hatchery.   Aerial redd counts declined from 161 in 1983 to 71 in 1984.   During low flow years, the S45 diversion completely dewatered the Salmon River for approximately 3 km from mid-July through September, and only early returning adult chinook could spawn above the diversion. The higher chinook parr densities observed in stratum 7 of the Salmon River and stratum 1 of ALC indicate that adult chinook stacked up and spawned below these major diversions.

A reduction in steelhead parr densities occurred in 1984-88, primarily in the areas above the S45 diversion (Table **6).**   The diversion may be the major cause in the reduction of the steelhead parr population observed during the period.

Estimates for total parr abundance in the USR during summer 1988 were: age-0 chinook = 88,103 $\pm$ 43,772; age-1 steelhead = 5,325 $\pm$ 2,006; and age-2+ steelhead = 2,090 $\pm$ 1,531.

The 1988 chinook age-0 population estimate was slightly higher than in two recent years in which estimates were made: 1985 (73,548) and 1987 (65,739) (Kiefer and Apperson 1988). Populations all three years were reduced by trapping adults for Sawtooth Hatchery brood stock. The first year that Sawtooth Hatchery supplemented chinook back into the USR was 1988.   An estimated total of 17,784 chinook parr were the result of supplementation in 1988 (Table 4). This estimate assumes that the fry that outmigrated from Pole Creek survived at the same rate as those outplanted into Smiley Creek.

Table 5.   Density (number/100 m^2) of age-0 chinook in the USR, 1984-1988.

Stratum	1984	1985	1986	1987	1988
Salmon River					
3, 4	–	15.97		7.00	13.80
5, 6	–	2.27		0.28	4.10
7	67.95	14.00	10.95	20.25	13.26
8	55.15	1.30	12.25	10.33	3.86
9	–	8.40		7.42	1.44
10	–	3.55		0.11	0
Salmon River side channels					
3, 4	–	14.20			16.00
5, 6	–	0.35			17.93
7	–	0.50			16.12
8, 9, 10	–	0.25			6.75
Pole Creek					
1	–	0	–	25.73	1.95
2	30.20	0	0.15	2.89	4.25
3	0	0	0	0	0.12
4	–	0		0	0
5	–	0		0	0
Alturas Lake Creek					
1	47.23	12.50		18.34	8.64
2	3.46			0.60	0.91
3	0.65	0	0.05	0.06	0
Smiley Creek					
1	–	0.10		35.17	6.94
2	–	1.65		1.10	13.50
Beaver Creek					
1	–	0.15			2.12
2	–	0			0.39
Frenchman Creek					
1	–			0	0.61
2	–			0	41.39

Table 6. Density (number/100 m^2) of age-1/age-2+ steelhead parr in the USR, 1984-1988.

Stream, Stratum	1984	1985	1986	1987	1988
Salmon River					
3, 4		0.62/0.33	–	0.05/0.02	0.20/0.08
5, 6	–	0.20/0.17	–	0.01/0.02	0.07/0.05
7	0.35/0.47	0.20/0.80	0.35[a]	0.72/0.00	0.37/0.12
8	0.17/0.77	0.45/0.05	0.90[a]	0.39/0.22	0.38/0.11
9	–	4.20/0.20	–	8.51/2.09	2.75/0.80
10	–	2.15/3.30	–	7.27/2.37	3.51/2.98
Salmon River side channel					
3, 4	–	2.62/0.72	–		0.56/0
5, 6	–	0/0	–		0/0
7	–	0.60/0.10	–		0/0
8, 9, 10	–	0/0			0.25/0
Pole Creek					
1	–	0.10/0.15	–	2.98/1.16	2.05/0.59
2	0/0.41	1.25/0.35	1.95[a]	5.11/1.60	0/0
3	0/0	0/0	0.10[a]	0/0.13	0/0
4	–	2.90/0.10	–	1.33/1.33	4.75/0.50
5	–	0/0	–	0/0.13	0/0.73
Alturas Lake Creek					
1	0/0.54	0.70/0.10	–	0.83/0.03	0.58/0.05
2	0/0.11	–	–	0.90/0.47	0.38/0.31
3	0/0	0.05/0	0[a]	0/0	0.12/0.12
Smiley Creek					
1	–	0/0	–	0.18/0.56	o/o
2	–	0.15/0.10	–	0/0.05	0.16/0.05
Beaver Creek					
1	–	0.30/0.15	–		0.48/0
2	–	0/0	–		0.20/0.02
Frenchman Creek					
1	–	–	–	1.79/2.23	0/0.61
2	–	–	–	o.oo/o.oo	0.11/0.11

[a] Steelhead age-2+ and age-1 data were combined in 1986.

Egg-to-Parr survival rates were estimated for naturally produced chinook in three of the past four years in the USR (Table 7). Estimated egg-to-parr survival rate for brood year 1984 (18.8%) was significantly higher than for brood year 1986 (5.1%) and brood year 1987 (5.2%). The brood year 1984 results were probably inflated by uncounted adults getting through the temporary weir used that year. The survival rates for brood years 1986 and 1987 were similar and significantly lower than those calculated for the 1987 Frenchman Creek adult outplant (Table 4) and for similar Idaho streams (Scully et al. 1990). Possible explanations for the low survival include unusually low flows (winter and summer) for brood years 1986-87, habitat quality problems below the S45 diversion and ALC diversion, and spring outmigration of fry. We have observed large numbers of chinook fry outmigrating from the USR during trapping operations from March to May, 1987-88. The magnitude of this outmigration and contributions of this segment of the population will be investigated by the University of Idaho through subcontract beginning spring 1990.

The steelhead parr population estimate in 1988 (7,325 age-1 + and -2+ combined) showed a drastic reduction compared to 1985 (12,579) and 1987 (20,132). Reasons for this drop are not apparent from either the steelhead escapement or supplementation numbers (Table 1, 3). These data indicate 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. There are indications that the Sawtooth Hatchery weir is a barrier to upstream migrating parr that outmigrated in the fall to overwinter downstream. In addition, the estimated survival rate based on parr population estimates for brood year 1986 steelhead age-1 to age-2+ was unexpectedly low (14.6%). This low survival rate probably resulted from one or a combination of the following factors: high angling mortality, high mortality caused by the S45 diversion (67% of 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 had overwintered below the weir.

PIT Tagging

During summer 1988, chinook and steelhead parr were tagged with an overall acute mortality of 0.4% (Table 8). Adjustments made in tagging procedures helped reduce the tagging mortality experienced in 1987 (3.1%). High mortalities were encountered only on one occasion in 1988 when steelhead were anesthetized and tagged immediately after carrying them in buckets about 400 m from the collection site in hot weather. Seven out of 84 steelhead died. We believe that had we allowed the fish to acclimate in a live box before tagging, these mortalities could have been avoided.

We PIT-tagged parr in the USR during August 15-24. During the first four days, we tagged cooperatively with a NMFS tagging crew supervised by Steve Achord, targeting on chinook parr. For the last five days the IDFG crew targeted on steelhead parr.

Table 7.   Egg-to-Parr survival rates for natural chinook in USR.

	Brood year				
	1984	1985	1986	1987	1988
Estimated number of egg deposition=	391,105[b]	815,400	1,278,688	1,360,548	1,724,165
Parr production	73,548	-	65,739	70,319	-
Egg-to-Parr survival	18.8%		5.1%	5.2%	

[a]Table 2.
[b]1984 escapement was probably underestimated by use of temporary weir.

Table 8.   Collection and PIT tagging mortalities for USR, August 1988.

	Chinook	Steelhead	Total
Number tagged	3,872	597	4,468
Collecting mortality			
Number	3	0	3
Percent	0.1%	0%	0.1%
Tagging mortality			
Number	7	7	14
Percent	0.2%	1.2%	0.3%
Total mortality			
Number	10	7	17
Percent	0.3%	1.2%	0.4%

Five different 24-h delayed-mortality tests were conducted during the USR field tagging and resulted in a delayed mortality of 0.9% for chinook and 2.6% for steelhead (Table 9). A delayed-mortality test on Frenchman Creek chinook was conducted because the fish were extremely small (mean length 59 mm). In addition to the two chinook that died in the Frenchman Creek test, one chinook (0.3%) lost its tag. This was the only incidence of tag loss in any of the 1987-88 tests and probably resulted from small fish size.

Tests by NMFS (Prentice et al. 1986) and IDFG at Sawtooth Hatchery (unpublished data) showed that mortalities beyond 24 hours are negligible.

Length and weight data were collected on chinook and steelhead parr **PIT**-tagged during August 1987 and 1988. We summarized length data by location and by production type for chinook: natural spawning, adult outplants, and fry outplants (Table 10). The average length of naturally produced chinook parr in the USR were not significantly different between August 1987 (74 mm) (Kiefer and Apperson **1988)** and August 1988 (76 mm). For naturally produced chinook parr length was similar in most locations in 1987 and 1988. However, chinook parr from ALC were the smallest naturally produced parr in 1987 (72 mm) and the largest in 1988 (83 mm). The density of chinook in the ALC study section **ALC-1C** was **37.6/100 m^2** in 1987 and **23.6/100 m^2** in 1988. Although the chinook density was greater in 1987, it was well below the estimated carrying capacity of **108/100 m^2** (Petrosky and **Holubetz** 19881, and we do not believe that it was high enough to suppress the growth of chinook parr to the extent indicated by the length data. Since 1987 and 1988 were similar low water years, flow did not seem to be the factor controlling growth. Stream temperature, which may have controlled growth rates, was not monitored.

The small size of the chinook parr from the adult **outplant** in Frenchman Creek was probably a result of a combination of several factors. First, the adults outplanted were from the last of the run (September l-4) so the eggs were deposited later than most naturally produced fish. Second, the temperature measurements we made during July-August indicate that Frenchman Creek is usually colder than the Salmon River (unpublished data), so the parr would have had fewer thermal units for growth. Third, the adults outplanted were confined and spawned in an area with high percent fines. Chapman (1988) reported that as the percent fines in a redd increase, the dissolved oxygen in the egg pocket decreases and the emerging fry are smaller.

We assumed that chinook parr tagged in Pole Creek and Smiley Creek were from the fry outplants since no chinook redds were observed in these areas in 1987. The outplanted chinook parr were longer (91 mm) than any other group because of the advanced growth they received in Sawtooth Hatchery. Of the three sites where outplanted chinook parr were tagged, those from **PC-2B** had a smaller mean size (85 mm) than those from PC-IB (99 mm) or SC-l (98 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

Table 9.   Twenty-four hour delayed mortality test results for USR.

Tag site	Collection method	# held	# morts.	% morts.
		Chinook		
FC-2A	Seine	305	2	0.7%
PC-1B	Shock	34	0	0.0%
SR-7A	Seine	125	2	1.6%
ALC-1C	Shock	78	1	1.3%
SR-9	Shock	14	0	0.0%
Total	Seine	430	4	0.9%
Total	Shock	126	1	0.8%
Overall totals		556	5	0.9%
		Steelhead		
PC-1B	Shock	56	1	1.8%
SR-7A	Seine	21	0	0.0%
ALC-1C	Shock	17	1	5.9%
SR-9	Shock	62	2	3.2%
Total	Shock	135	4	3.0%
Total	Seine	21	0	0.0%
Overall totals		156	4	2.6%

Table 10. Average lenghts of PIT-tagged parr from USR.

Tag Site	Chinook rearing type	# chinook tagged	Chinook-avg. length (mm)	# Steelhead tagged	Steelhead-avg. length (mm)
FC-2A	Adult outplant	302	59	0	
FC- 1	Natural	8	79	45	143
ALC-1C	Natural	414	83	32	135
SR-3A	Natural	45	72	0	-
SR-3B	Natural	992	76	23	80
SR-35A	Natural	610	71	5	94
SR-4BRB	Natural	761	76	4	117
SR-7A	Natural	309	80	3	143
SR-10A	Natural	0	-	78	147
PC-1B	Fry outplant	46	99	62	146
PC-2B	Fry outplant	215	85	24	122
SC-1	Fry outplant	107	98	45	140
SR-8A	Mixed	22	80	163	140
SR-9	Mixed	33	88	112	142
Total	Adult outplant	302	59	-	-
Total	Natural	3,139	76	-	-
Total	Fry outplant	368	91	-	-
Total	Mixed	55	85	-	-
Overall total		3,872	76	597	138

water years, such as 1988, most of Pole Creek is diverted for hay field 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, water temperature immediately above and below the return point was **25.5°C** and **12.0°C,** respectively.

The mean length of the steelhead parr tagged in August 1988 was 138 mm, somewhat larger than parr tagged in August 1987 (130 mm). This difference in length was surprising, since in 1987 we primarily tagged only age-1 + and **-2+** steelhead **parr,** whereas in 1988 we tagged any steelhead parr larger than 60 mm. We believe this is a result of the low population of age-1 steelhead as observed during our snorkel counts.

Spring 1988 Outmigration Trapping

In spring 1988, the Sawtooth Weir trap **(SWT)** operating alone had a trapping efficiency of 6.7% for chinook and 2.9% for age-1+ and **-2+** steelhead. When both SWT and the Sawtooth intake trap (SIT) were operated, the combined trapping efficiency was 8.2% for chinook and 3.3% for age-1+ and **-2+** steelhead. Overall, during spring 1988 we captured 1,679 chinook smolts, with a trapping efficiency of **7.4%,** and a total estimated run of 22,643. For steelhead age-1+ and **-2+** the overall numbers were 275 captured, trapping efficiency of **3.0%,** and a run estimate of 9,200. Based on the summer 1987 parr population estimates (Table **7),** we estimate that 34.4% of chinook parr and 45.7% of the age-1 + and **-2+** steelhead parr outmigrated in spring 1988.

We used the combined SWT and SIT trap efficiency and daily catch data to determine the timing of the spring 1988 outmigration from USR (Figure 3). Peak spring outmigration for both species occurred between April 4 and April 16, when 46% of the chinook and 54% of the steelhead outmigrated. Although both species had the same period of maximum migration and a moderate peak in the graph between May 7 and May 15, chinook had a relatively higher percent of outmigrants before April 4, and in general left slightly before the steelhead.

The spring 1988 outmigration timing was compared to water depth at the sill at Sawtooth Hatchery weir as a preliminary attempt to determine stimuli that initiates migration (Figure 4). In spring 1988, migration of steelhead and chinook appeared to be initiated by the approach of storms. Factors that stimulate outmigration (photoperiod, barometric pressure, temperature, and flows) will be investigated in future analyses to improve predictions of arrival of wild/natural smolts to Lower Granite **(LGR)** Pool.

Fall 1988 Outmisration Trapping

In fall 1988, the SWT was operated from August **16-October** 31. The SWT had an overall trapping efficiency of 8.4% for chinook and 9.7% for steelhead. The SWT captured a total of 4,732 chinook for a run estimate of 56,134, and 347
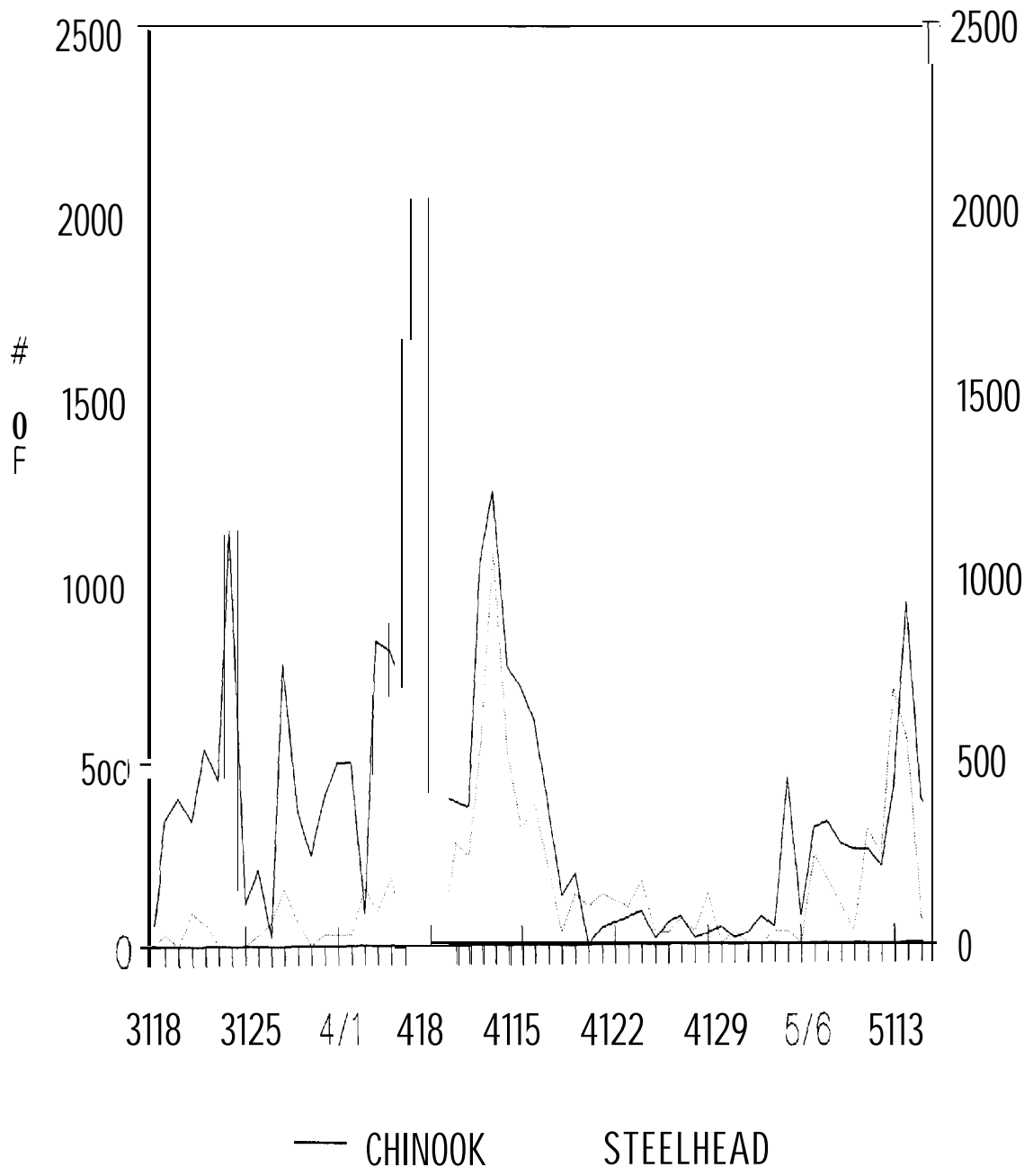
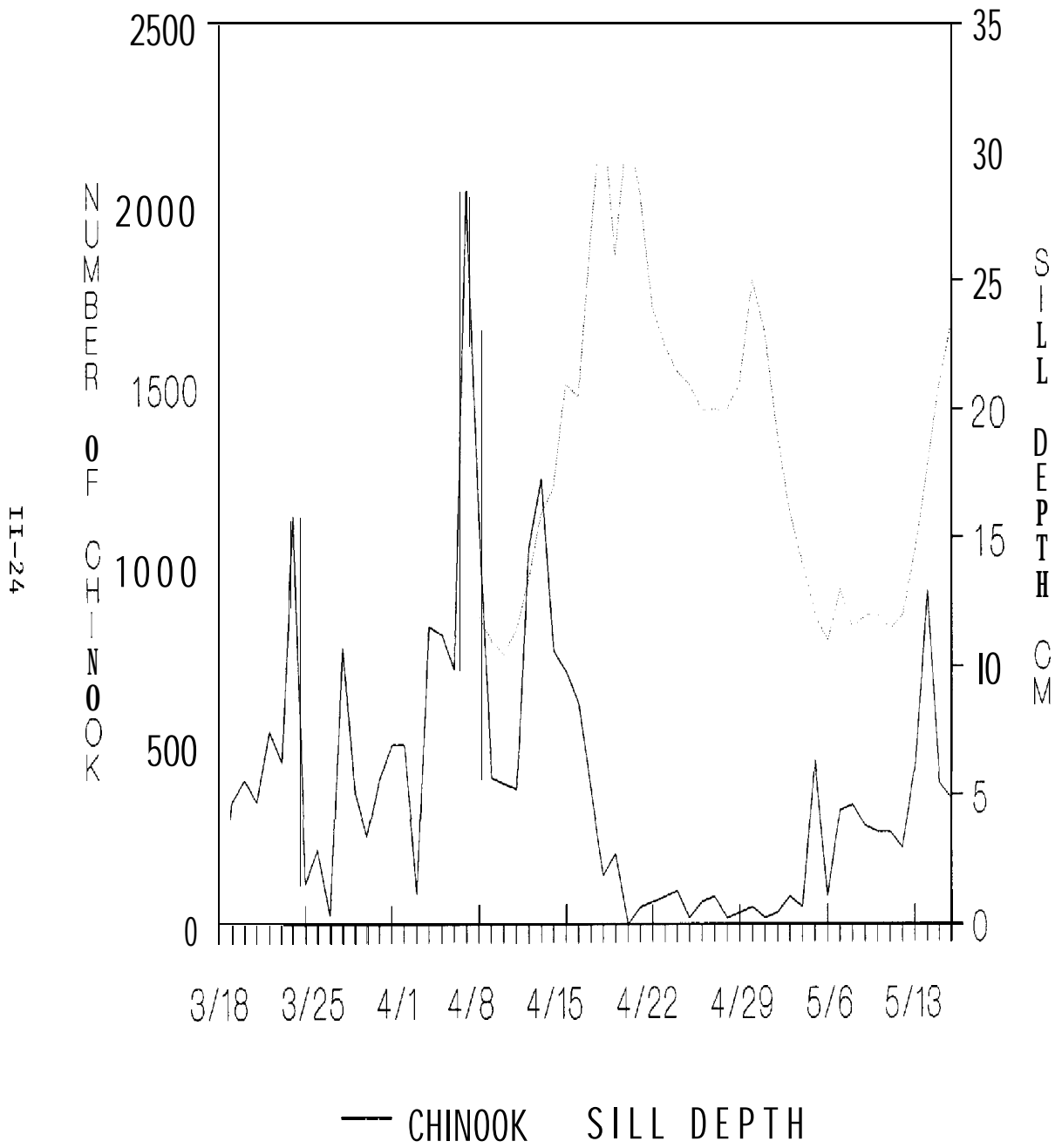Figure 3. Spring 1988 USR run estimates.

Figure 4. Spring 1988 USR chinook run estimate and sill depth.

steelhead for a run estimate of 3,570. Based on the summer 1988 parr population estimates, 64% of the chinook and 48% of the steelhead outmigrated in fall 1988.

During the fall 1988 trapping season, we conducted tests to determine if there was a difference in the recapture efficiency of fish released immediately after tagging (day release) or those held until dusk in perforated live boxes (night release). The night released parr of both species were recaptured at a higher rate; chinook day release 7.2% and night release **12.4%,** and steelhead day release 9.6% and night release 12.2%. The reason behind this difference in trap efficiency depending on time of release is not known. The combined trap efficiency estimates will be used in the calculations until we are able to determine which is the better estimator.

As in spring 1988, the fall 1988 SWT data show that both chinook and steelhead had migration peaks on the same days (Figure **5),** indicating that both species keyed to the same stimuli. Whereas the spring 1988 data suggest that the fish moved just before storm events, the fall 1988 data suggest that they moved during storm events (Figures 6 and 7). Storm events show up as sharp drops in temperature and rises in sill depth on the same days. During fall 1988, both species migrated at similar times, with most of the migration occurring between mid-August and mid-October.

In addition to sampling fish reared in natural habitat, we outplanted two groups of 21,000 chinook **parr,** of which 300 from each group were PIT-tagged. One group was released on October 11 into lower ALC, and the other group was released on October 12 into the headwaters of the Salmon River. We recaptured a total of 26 PIT-tagged parr from these release groups, with the SWT during fall 1988. All PIT tag recaptures were from the ALC release. The 26 recaptures at SWT represent 8.7% of the total tagged for that group. Since the recapture rate for the release group into ALC and the overall SWT recapture rate for chinook (8.4%) were not significantly different, we believe that virtually all the release group into ALC outmigrated during the fall. Untagged parr from these releases could be visually differentiated from natural parr by size and body color. SWT captured a total of 1,537 parr from these outplants, for a run estimate of 18,298 or 87% of the ALC outplant. These hatchery parr were not included in the natural run estimates for USR. Apparently the chinook parr released into the Salmon River headwaters were unable to migrate past the dewatered section below S45 diversion. When the 1989 dam detections are analyzed, we will investigate the impact of the dewatering on the survival of the USR release group.
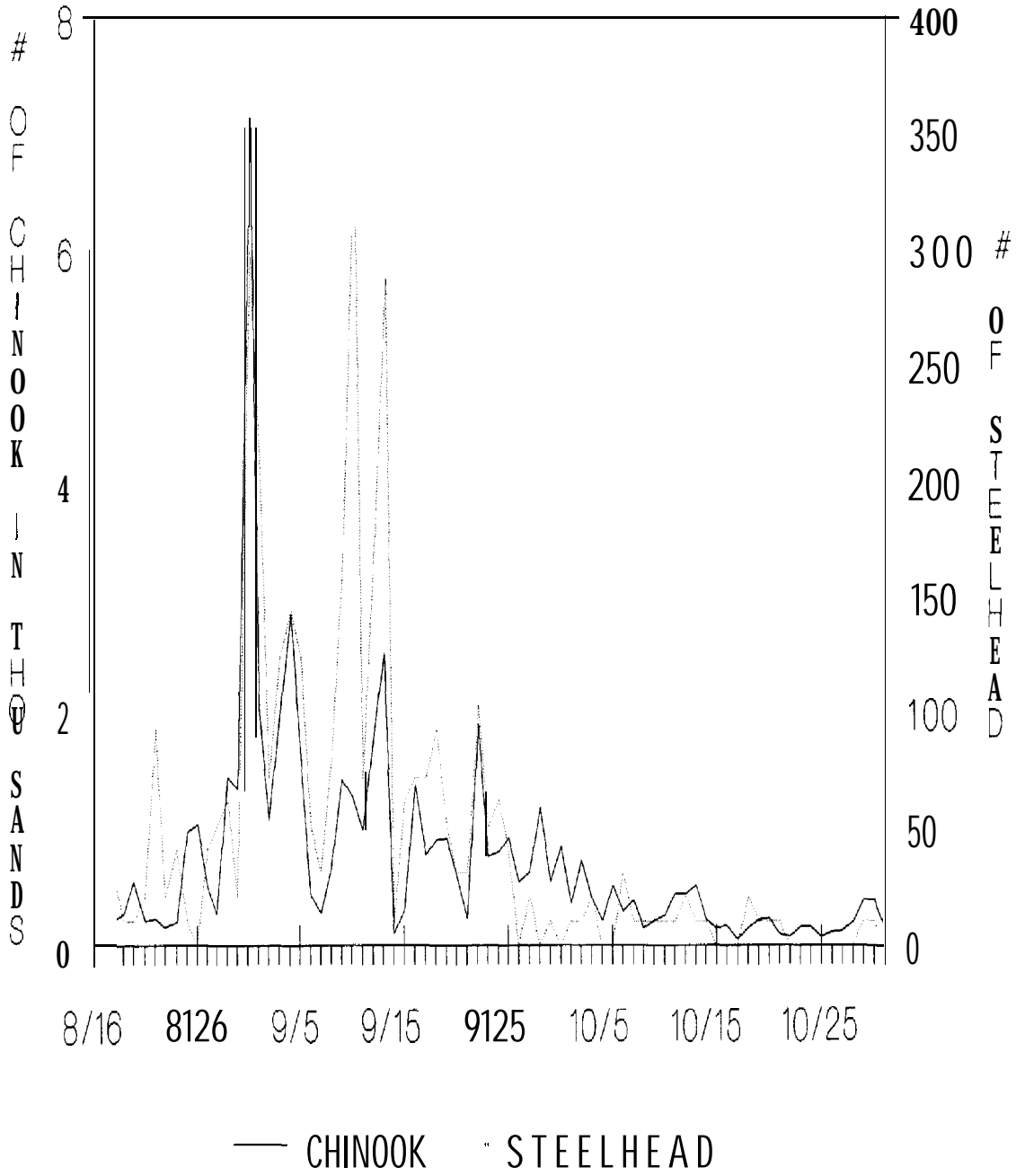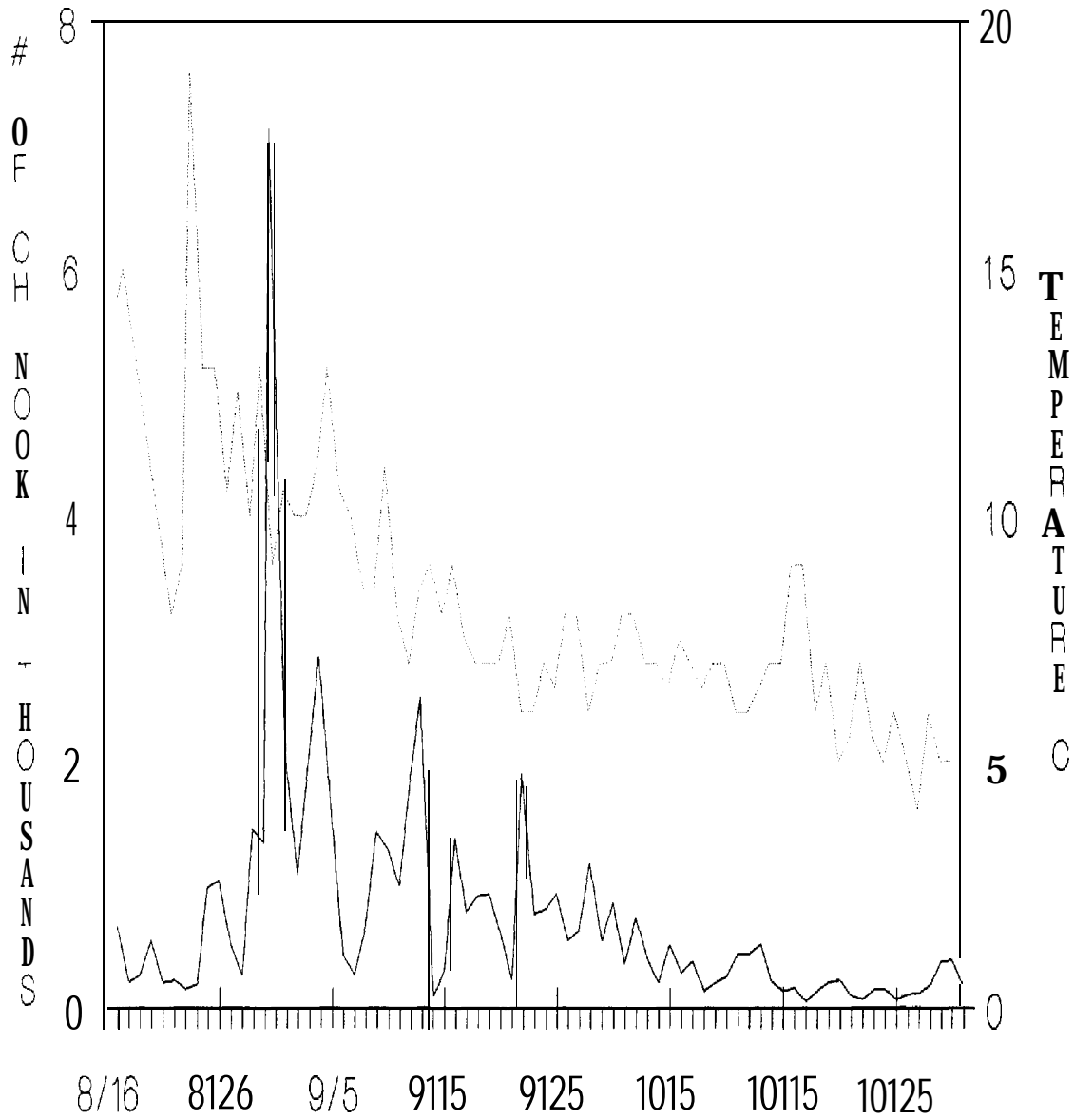
Figure . Fa   1988 USR run estimates.

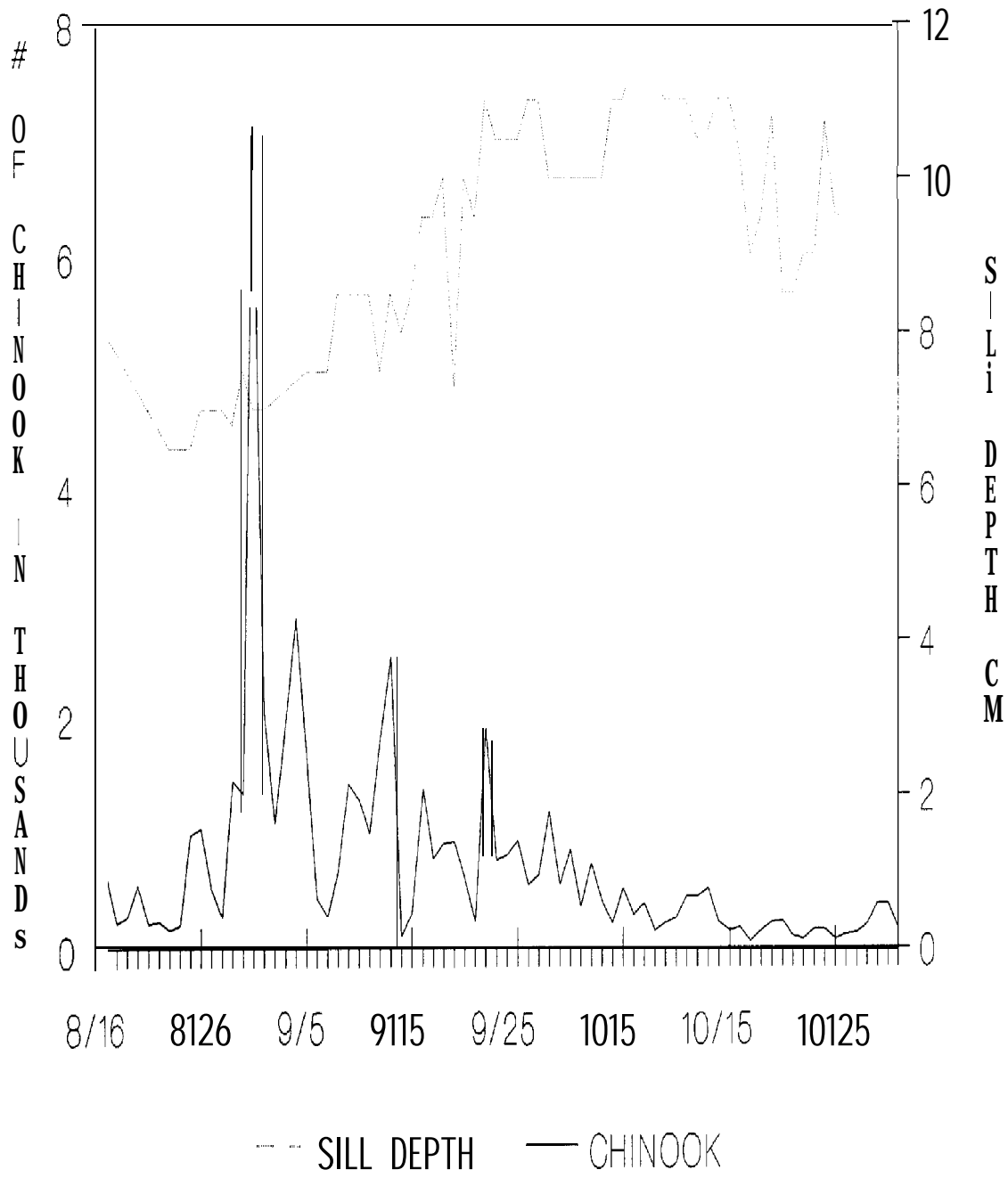Figure 6. Fall 1988 USR chinook run estimate and daily (10:00 am) stream temperature.

Figure 7. Fall 1988 chinook run estimate and sill depth.

During the spring 1988 outmigration we captured and PIT-tagged chinook and steelhead smolts at SWT that were later detected at Lower Granite (LGR) Dam. We then calculated mean travel time. We observed three patterns for chinook travel time (Figure 8). First, from the first date of trapping, March 18, until the beginning of peak migration, April 4, the travel time decreased progressively from about 65 days to 45 days. Second, during the period of peak migration, April 5-19, the travel time averaged 43 days. Third, after the peak migration, April 20-May 16, the travel time decreased to about 25 days. With fewer data points for steelhead we could only determine that the pattern was similar to that for chinook, and on almost all release dates steelhead traveled faster to LGR dam.

PIT-tagged chinook from the USR arrived later than the peak of the total chinook run at LGR Dam (Figure 9). There are two possible reasons for the later arrival for USR chinook. First, it takes the USR smolts longer to get to LGR Dam because they have farther to migrate than any other smolts passing the dam. Second, natural/wild chinook smolts may have a later migration timing than hatchery smolts, and the larger number of hatchery smolts moves up the peak of the total migration.

Because all hatchery steelhead smolts had adipose fin clips, the arrival of USR natural steelhead can be compared with total wild/natural steelhead at LGR Dam. The USR natural steelhead arrived during the same time as the total wild/natural smolt run and with basically the same peaks (Figure 10). The natural chinook from USR also arrive at LGR Dam during this same period (Figure 11). Water Budget decisions based solely on peaks of the run could therefore affect specific populations in different ways.

Nelson and Buettner (1989) observed average travel times through LGR Reservoir of 15 days for chinook and 4 days for steelhead in 1988. We used these travel times to estimate that the peak of the USR smolt runs in 1988 arrived at LGR Pool between April 27 and May 20 for chinook and between May 12 and June 4 for steelhead. 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 12). Thus, it is possible that the USR smolts reached the head of LGR Pool before the estimated dates and were delayed until flows increased.

We estimated survival of USR chinook from the parr stage to smolt stage at the head of LGR Pool. In spring 1988, 4.1% of all USR chinook parr PIT-tagged in 1987 were detected at LGR Dam. Nelson and Buettner (1989) found that the mean detection at LGR Dam was 33.4% for chinook smolts that they PIT-tagged at the Snake River trap at the head of LGR Pool in 1988. These data imply that 12.3% of the chinook parr from USR in summer 1987 survived to smolts at the head of LGR Pool. Thus, the estimated 65,739 chinook **parr** in USR during summer 1987 produced an estimated 8,070 chinook smolts to the head of LGR Pool.

For steelhead, LGR Dam facilities detected 4.0% of the age-1+ and -2+ parr tagged in the USR in summer 1987. Nelson and Buettner (1989) found a mean
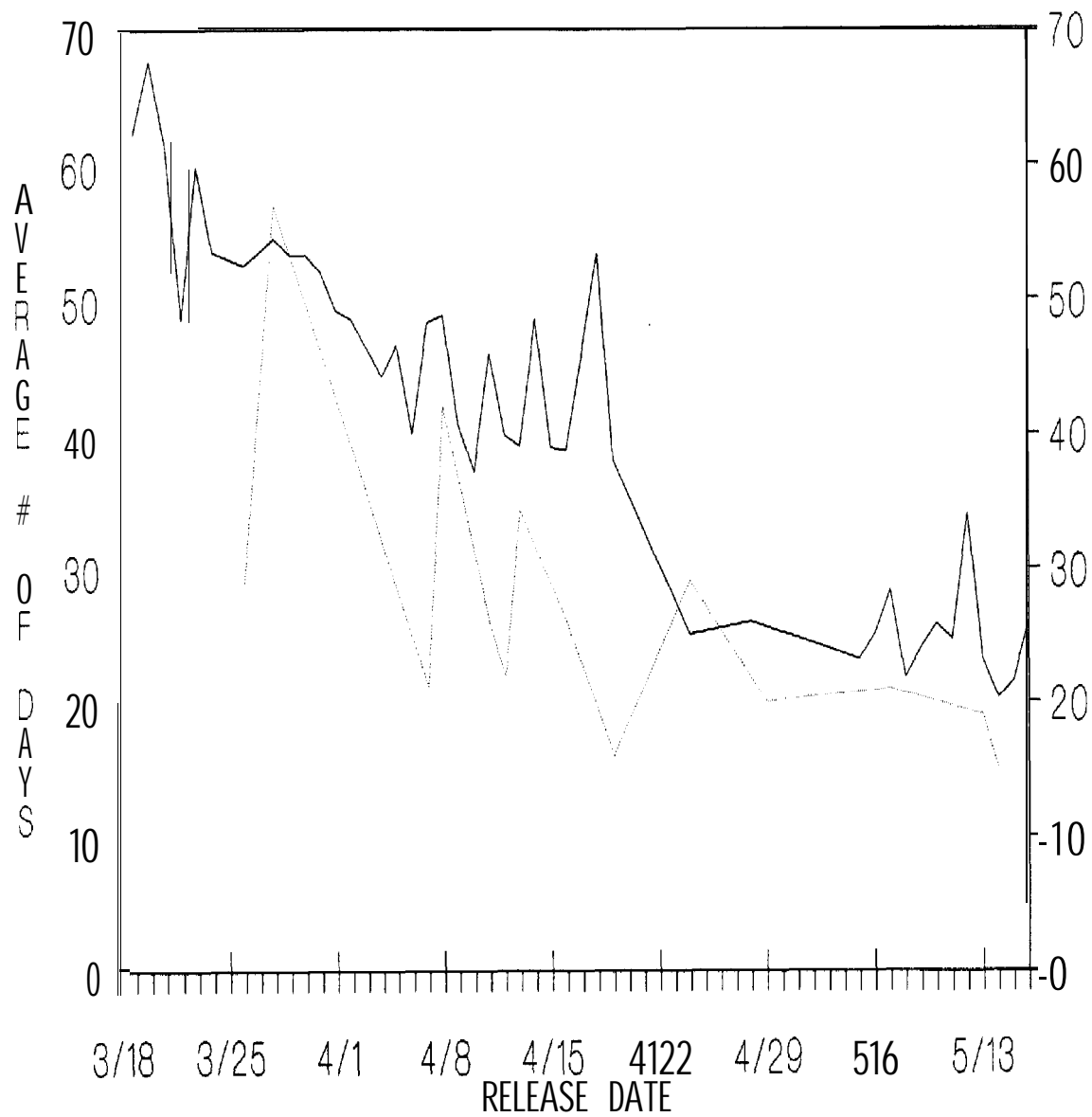
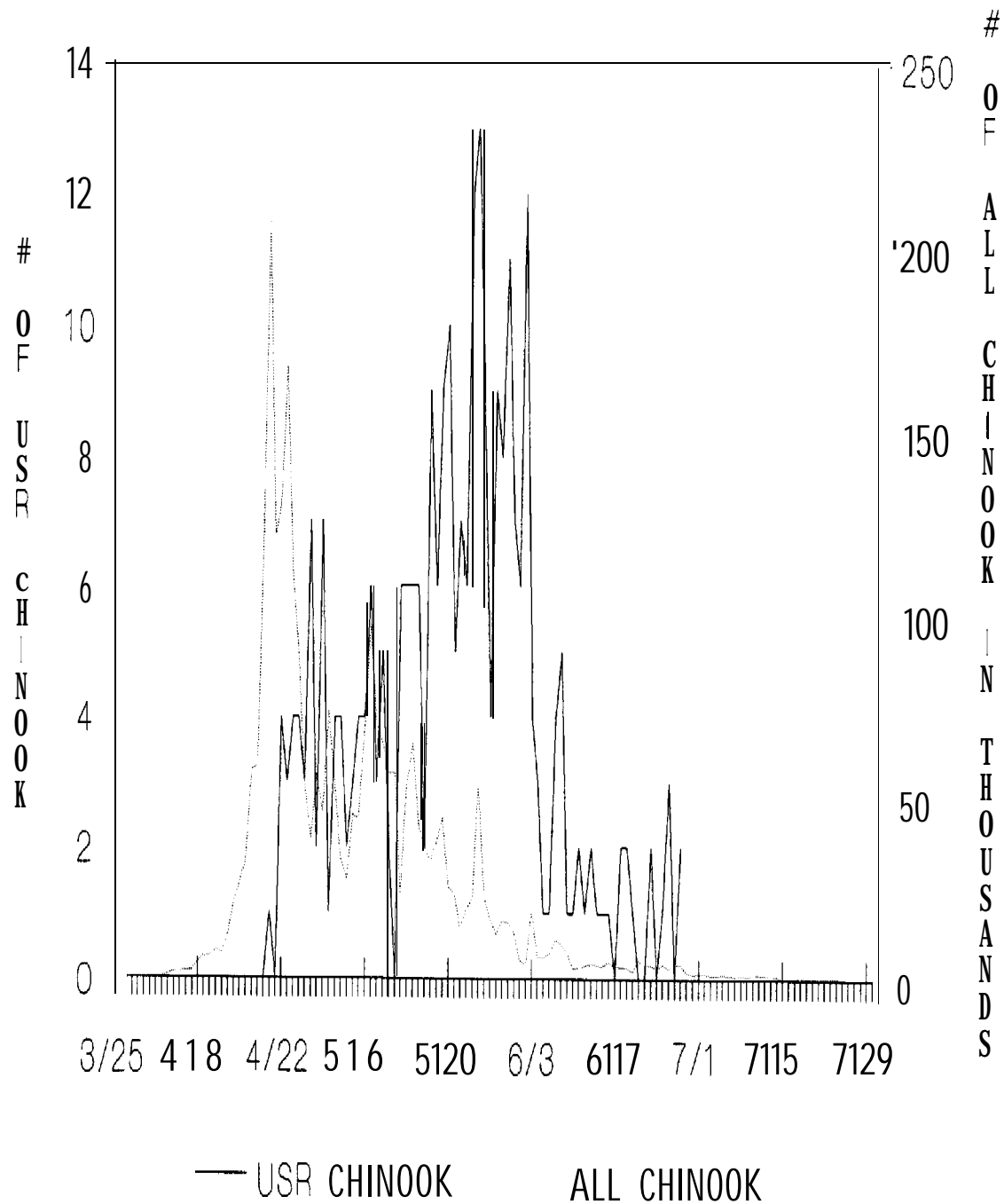Figure 8. Spring 1988 travel time for smolts tagged at SWT and detected at LGR dam.

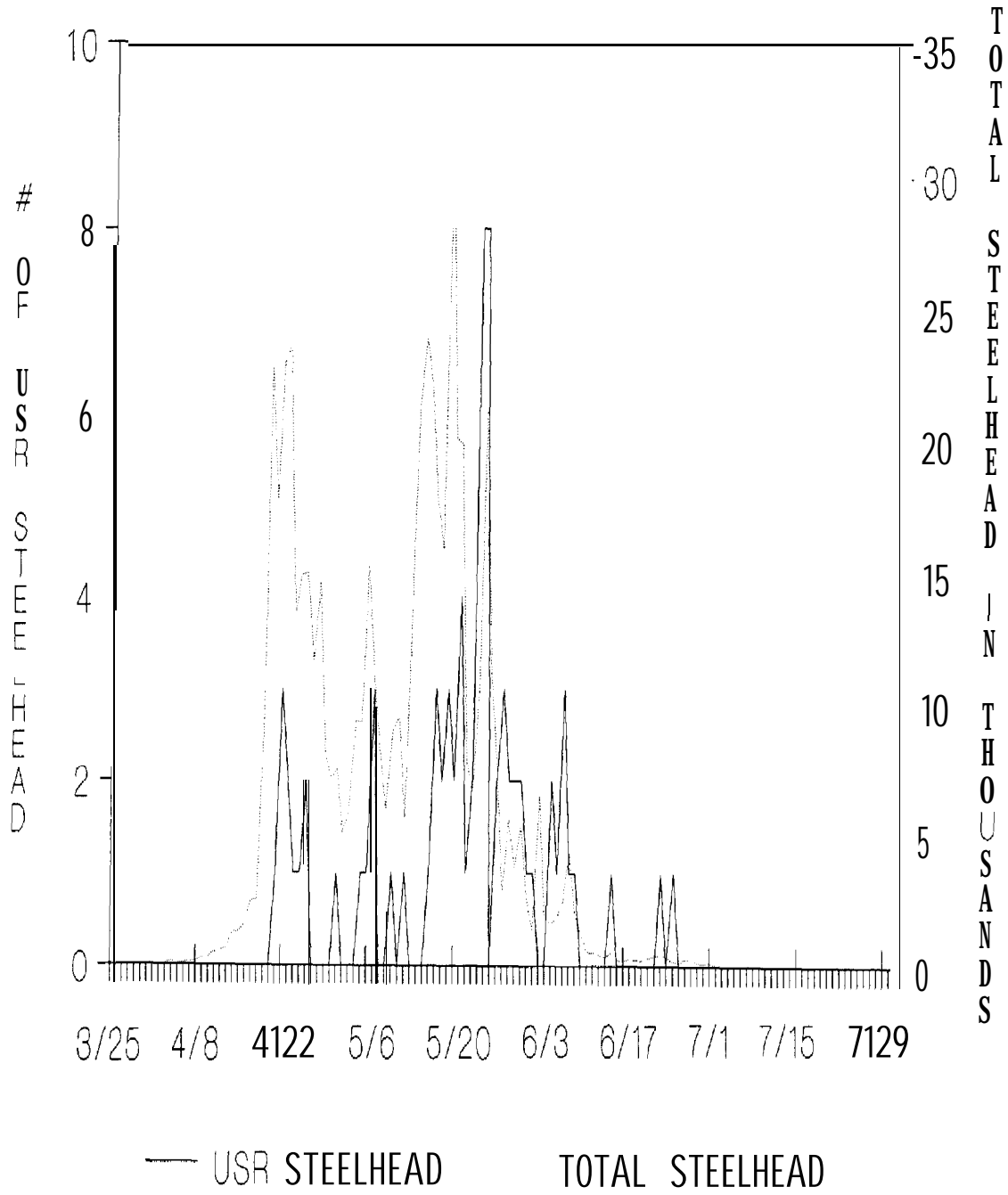Figure 9. Spring 1988 daily number of USR chinook detections at LGR dam and daily chinook run estimates at LGR dam.

Figure 10. Spring 1988 daily number of USR steelhead detections at LGR dam and daily total ild/natural steelhead run estimates at LGR dam.
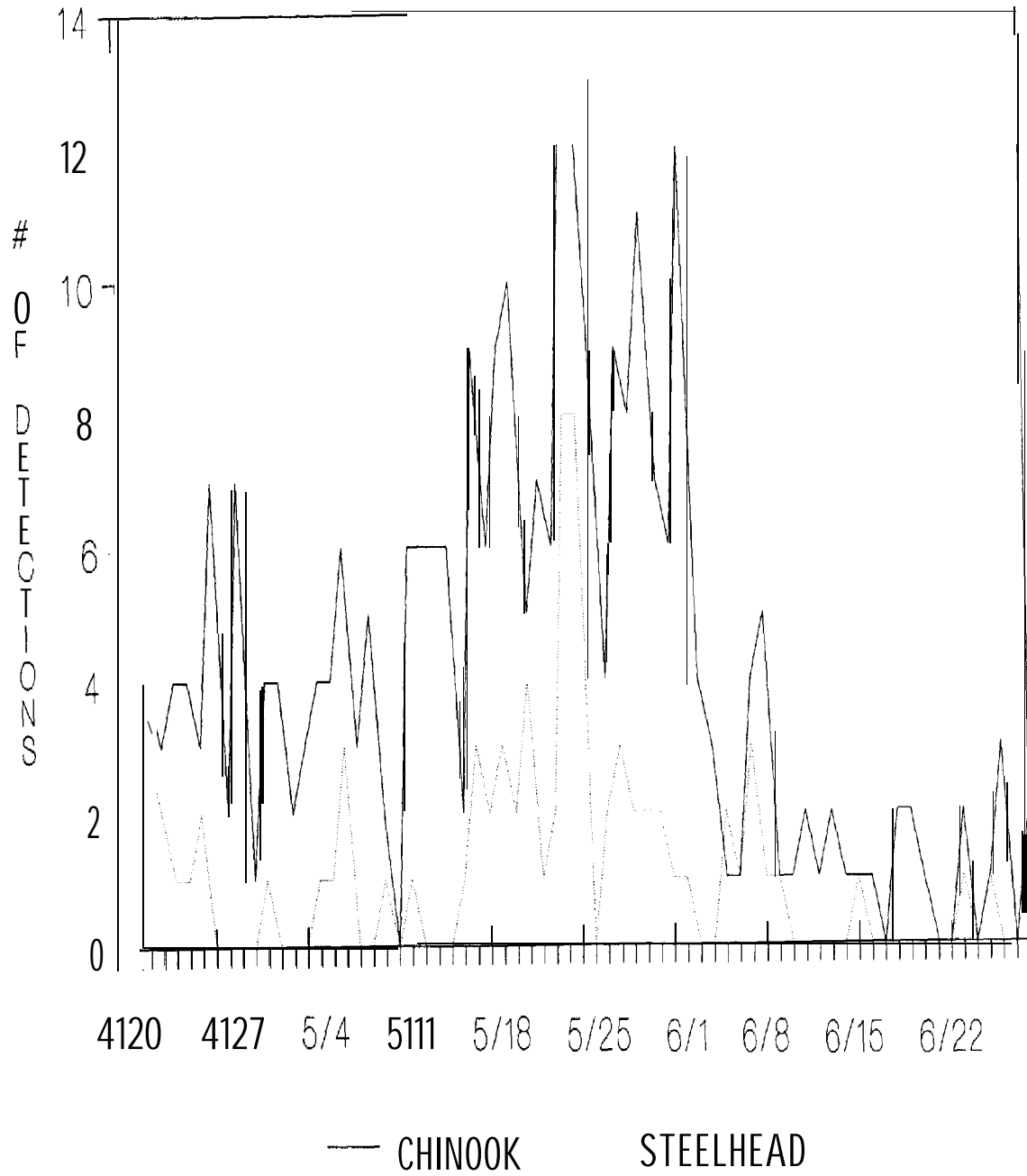
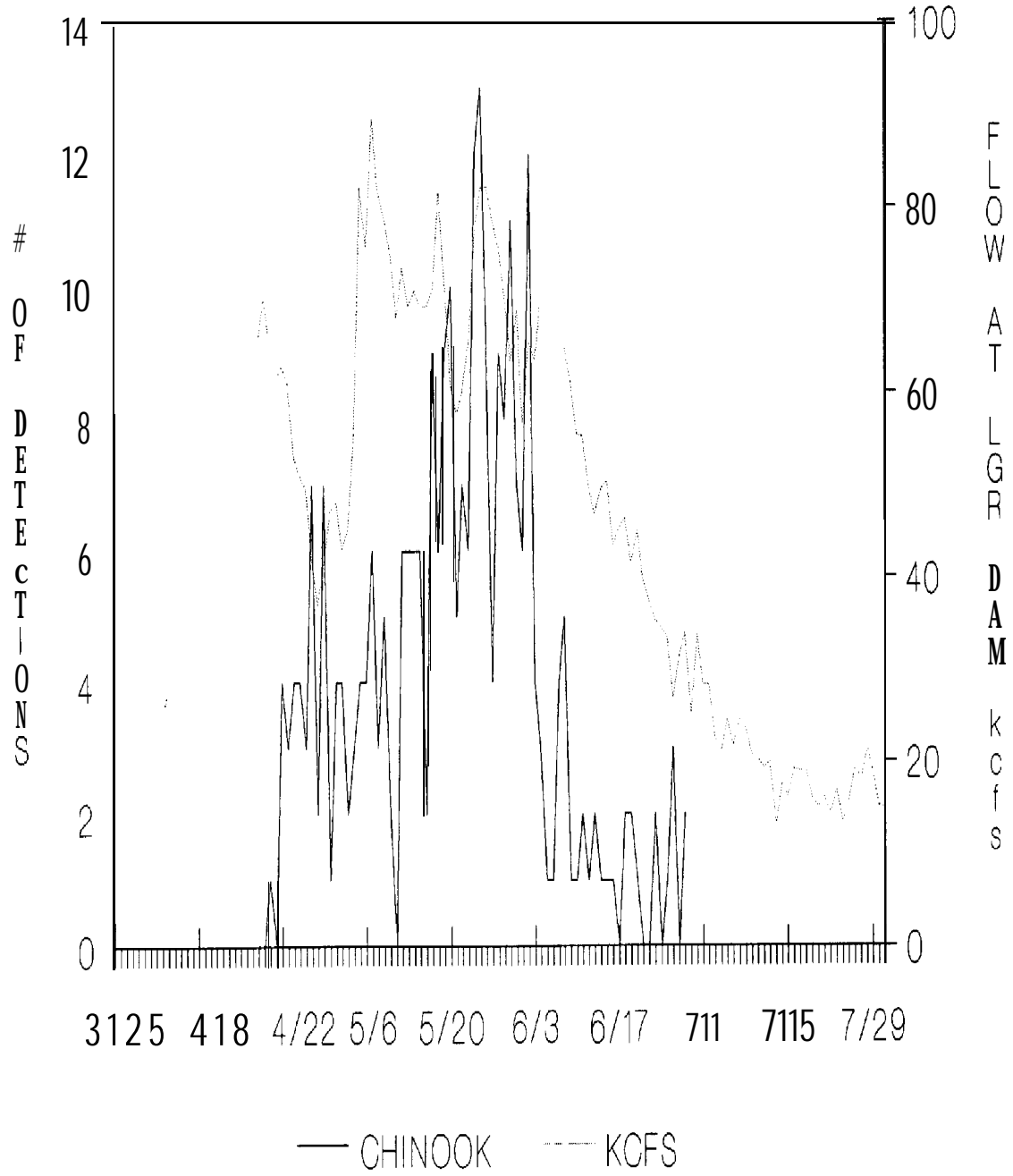Figure 1.. 1988 USR chinook and steelhead detections at LGR dam.

Figure 12. Spring 1988 daily number of USR chinook detections at LGR dam and flows (kcfs) at LGR dam.

detection rate of 59.9% at LGR Dam for the steelhead smolts that were PIT-tagged at the Snake River trap in 1988. These data imply that out of the 20,132 **age-**1+ and **-2+** steelhead in the USR during summer 1987, 6.8% (1,361) smolted and survived the head of LGR Pool. The estimated steelhead **parr-to-smolt** survival rate was low because many of the steelhead that we PIT-tagged in summer 1987 were below smolting size. The estimate of the number of steelhead smolts produced should be fairly accurate because the percent survival and the summer 1987 parr population used in the calculations are both from age-1+ and **-2+** steelhead. The dam detections show that very few age-1 steelhead (**<130** mm) from USR successfully smolted in 1988 (Table **11).** If we assume that the estimated 1,361 steelhead smolts were only from the 5,852 age-2+ steelhead **parr,** then we can calculate a USR age-2+ steelhead parr to LGR Pool **smolt** survival rate of 23.3%. Better definition of age and size at smolting will be necessary for steelhead in future studies.

Size of fish influenced survival to LGR Dam. Smaller chinook smolts (**<70** mm) that were PIT-tagged in spring 1988 survived at nearly two-thirds the rate of large smolts (**>90** mm), better than we had anticipated. Steelhead smaller than 130 mm were not detected in any significant numbers at LGR Dam. Thurow (1985) found 130 mm to be the separation point between age-1 and age-2+ steelhead for similar Idaho streams. This suggests that only age-2+ steelhead from USR **smolt.** The smaller steelhead probably rear another year before smolting.

The PIT tag detections at LGR Dam indicate that the S45 diversion was a major source of mortality for both chinook and steelhead parr rearing above it (Table 12). The impact of the S45 diversion was probably greater on steelhead because approximately **2/3** of the total steelhead population occurred above the diversion.

The method used to capture chinook parr for PIT tagging appeared to affect their survival. Chinook collected below the S45 diversion by electrofisher were detected at a rate of 4.7% at LGR Dam, while chinook collected with a seine from the same area were detected at a rate of 7.5%. Chinook collected by electrofisher may have experienced a delayed mortality beyond the 24-h tests. We did not collect enough steelhead by seine in any area to compare the method of collection with survival rate.

CROOKED RIVER

RESULTS AND DISCUSSION

Adult Escapement and Redd Counts

Total and female 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.

Table 11. Fish length and smolt success for USR, 1988.

Length (mm)	% detection
Chinook < 70	18.8
Chinook 70 - 79	22.6
Chinook 80 - 89	25.3
Chinook > 89	29.5
Steelhead < 130	0.6
Steelhead 130 - 139	10.0
Steelhead 140 - 149	12.5
Steelhead 150 - 159	25.0
Steelhead > 159	37.0

Table 12. Percent detection of 1987 PIT tagged USR parr
by smolt collecting dams, 1988.

Species	Location	Number tagged	% detection
Chinook	Above S45 Diversion	832	1.3
	Below S45 Diversion	1,929	5.3
Steelhead	Above S45 diversion	985	2.8
	Below S45 diversion	432	6.9

In 1988, a one-pass ground count of chinook redds over the total probable spawning area of CR was conducted on September 3 and September 8. We counted 43 redds for the total probable spawning area and 29 redds for the traditional trend count reach (narrows to the forks). The helicopter redd count for the traditional trend count reach was 27 redds.

Preliminary estimates of female escapement and total egg deposition for 1984-88 (Table 13) were made based on the ratio of the 1988 total redd count to trend count (43 total; 27 trend) and past trend counts. 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 stratum 4. 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. 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 1984-88.

A one-pass ground count for steelhead redds was attempted for CR on May 23, 1988. However, because of the moderately turbid water, only three redds were observed between the narrows and the forks, and the count was not considered usable. In 1989, a helicopter steelhead redd count will be attempted on CR in early May to determine the usefulness of aerial steelhead redd counts. Steelhead escapement and egg deposition cannot be estimated for CR from existing data.

Hatchery Sumlementation

Hatchery supplementation data for brood years 1984-88 are summarized in Tables 14 and 15. Supplementation research by this subproject is scheduled to begin in 1990.

Parr Density

Intensive monitoring of CR parr populations began in 1988. The general monitoring subproject has collected parr density data since 1984, with evaluations of the barrier removal, in-stream structures, and off-channel ponds in 1985 and 1986. Chinook densities for 1984-88 are summarized in Table 16. Chinook parr densities were lower in 1988 than in either 1985 or 1986 and higher than in 1987.

Chinook redd counts and hatchery supplementation partially explain parr densities observed in 1985-88. The two higher redd counts (22 in 1984 and 17 in 1987; Table 13) resulted in the relatively higher parr densities in 1985 and 1988 (Table 16). 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 connected ponds had the highest chinook parr densities in 1988, and one of the highest in 1986 (Table 16). We anticipate that the mitigation

Table 13.   Estimated chinook salmon adult escapement, redd counts,
            and number of eggs deposited for CR.

| | Chinook Salmon | | | | |
| | Brood **year** | | | | |
	1984	1985	1986	1987	1988
Trend redd count	22	10	9	17	27
Ground redd count	--	--	--	--	43
Estimated female escapement=	35	16	14	27	43
Eggs/female[b]	4,432	--	--	4,010	--
Estimated number eggs deposited	155,120	67,536	59,094	108,270	181,503

[a]**Female** escapement estimate based on **1:1** ratio of female escapement
 to ground redd counts observed in USR, and **43:27** ratio of ground
 to trend redd counts observed in 1988.

[b]**Average #** 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.

Table 14. CR chinook supplementation, summary by brood
year 1984-88.

	Brood year				
	1984	1985	1986	1987	1988
Adult females	0	0	0	0	0
Eyed eggs	0	0	0	0	0
Fry	0	349,650	0	200,100	
Fall parr	0	251,300	0	0	
Smolts	0	227,500	0	0	

Table 15. CR steelhead supplementation, summary by brood year
1984-88.

	Brood year				
	1984	1985	1986	1987	1988
Adult females	0	1,522	0	468	0
Fry	0	0	87,750	0	
Fall parr	0	0	0	0	
Smolts	42,235	140,825	158,538	201,325	

Table 16. Density (number/100 m^2) of age-0 chinook in CR, August 1984-1988.

Stratum	1984	1985	1986	1987	1988
Headwaters					0.03
I	0	20.80	13.97	3.01	23.77
II		71.30	21.67	1.08	16.47
Canyon					8.05
III	32.20		57.80	22.33	36.64
IV	3.80	66.30	71.75	15.37	42.21
Relief Creek					0.82
Connected Ponds			62.86	3.20	65.39

activities to connect additional off-channel ponds will result in significant increases in the rearing potential for chinook in CR.

We estimated the CR chinook parr abundance in 1988 to be 60,509 ± 19,831. If the 200,100 fry stocked in 1988 survived to the parr stage at a rate of 20% (Scully et al. 1990), approximately 40,000 of this total would have resulted directly from supplementation and approximately 20,500 from natural spawning. Based on the natural egg deposition of 108,000 (Table 13), these estimates and assumptions imply an egg-to-parr survival rate of 19% for brood year 1987. If the outplanted fry survived at a rate of 15%, natural egg-to-parr survival would be 28%.

Steelhead parr densities were similar in 1986, 1987, and 1988 and lower in 1984 and 1985 (Table 17). In 1985, approximately three times as many adult females (1,522) were outplanted into CR than in 1987 (468) (Table 15), 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. 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.

We estimated the CR steelhead parr abundance in 1988 to be 22,522 ± 4,046 age-1+ and 1,798 ± 958 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 PIT-tagged chinook and steelhead parr in CR from August 2-9, 1988. During the first four days, we tagged cooperatively with a NMFS crew headed by Steve Achord and targeted on chinook. For the last four days, the IDFG crew targeted on steelhead. We tagged a total of 3,717 chinook and steelhead parr, with an overall mortality of 0.8% (Table 18). This overall mortality was higher than observed in USR (0.4%) but still below our defined acceptable level of 5%.

We conducted six 24-h delayed-mortality tests of PIT-tagged parr from CR in 1988. We observed delayed mortalities of 1.2% for chinook and 6.5% for steelhead (Table 19). Although the number of steelhead that died was small (5), the relatively high delayed mortality indicated that there may be a problem and will be investigated further.

Length and weight were measured on PIT-tagged parr. The average length of chinook parr was similar among strata (Table 20). The average length of chinook parr from CR (69 mm) was smaller than those from USR (76 mm). The average length of steelhead ranged from 95 mm in lower CR (stratum 5) to 123 mm in the canyon. The overall average length of CR steelhead parr (111 mm) was smaller than those from USR (138 mm).

Table 17. Density (number/100 m^2) of age-1/age-2+ **steelhead** parr
for CR, 1984-1988.

Stream, Stratum	1984	1985	1986	1987	1988
Headwaters					
I	0.45[a]	1.00[a]	6.80/0.17	4.27/0.70	5.21/0.15
II		2.05[a]	11.67/1.07	10.82/3.74	8.82/0.38
Canyon					11.44/1.16
III	3.10[a]		6.20/0.20	6.09/2.82	10.32/0.50
IV	0.70[a]	0.25[a]	7.15/0.30	7.24/1.49	7.15/1.12
Relief Creek					19.01/0.55
Connected Ponds			4.73/0.33	42.40/4.80	17.84/1.66

[a]**Steelhead** age-1 and **-2+** are combined.

Table 18. PIT tagging mortalities for CR, summer 1988.

	Chinook	Steelhead	Total
Number tagged	2,481	1,236	3,717
Collecting mortality			
Number	7	3	10
Percent	0.3%	0.2%	0.3%
Tagging mortality			
Number	11	10	21
Percent	0.4%	0.8%	0.6%
Total mortality			
Number	18	13	31
Percent	0.7%	1.1%	0.8%

Table 19.   1988 twenty-four hour delayed mortality test results
for CR.

Tag site	Collection method	Number held	Number mortalities	% mortality
		Chinook		
Pond U (II)	Seine	128	2	1.5%
Sill Log B (I)	Shock	92	1	1.0%
Natural 1 (I)	Seine	75	1	1.3%
Relief CR 1	Shock	17	0	0%
Total	Seine	203	3	1.4%
Total	Shock	109	1	1.0%
Overall totals		312	4	1.2%
		Steelhead		
Pond U (II)	Seine	28	3	10.7%
Sill Log B (I)	Shock	28	1	3.6%
Natural 1 (I)	Seine	5	0	0%
Relief CR 1	Shock	116	1	0.8%
Total	Seine	33	3	9.1%
Total	Shock	144	2	2.2%
Overall totals		177	5	6.5%

Table 20. 1988 average lengths of PIT-tagged parr from CR.

| Stratum | Chinook | | Steelhead | |
	Number tassed	Mean FL (mm)	Number tassed	Mean FL (mm)
I	1,007	69	299	115
II	431	67	532	107
CAN	2	95	146	123
RC	0		157	113
III	696	68	76	100
IV	342	70	26	95

Outmigration Trapping

Outmigration trapping at CR began in fall **1988.** **A** modified **Krey-Meekin** trap was operated continuously from September S-October 30, except for September 12 when a mechanical failure took the trap out of operation. We trapped a total of 6,778 chinook **parr,** had a chinook trapping efficiency of **53.7%,** and a total chinook run estimate of 12,620. For steelhead **age-1+** and **-2+** the numbers were, **187** trapped, a trapping efficiency of **27.5%,** and **a** total run estimate of 690. The proportions of summer parr populations that outmigrated in the fall were 20.9% for chinook and 2.8% for **age-1+** steelhead. The magnitudes of the fall outmigrations in **1988** for both species from CR were smaller than those from USR (63.7% chinook and 48.1% **age-1+** steelhead). These data support the hypothesis that higher elevation and 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 outmigrate in the fall than steelhead **parr.**

Unlike the daily run estimates for USR, there were several days for CR in **1988** that peaks in the steelhead outmigration did not coincide with peaks in the chinook outmigration (Figure 13). Approximately one-third of the entire chinook fall outmigration occurred on one day (October 9). The **major** peak in the chinook outmigration occurred on a day with a moderate drop in temperature (Figure 14) and four days before a major storm event (Figure **15).**
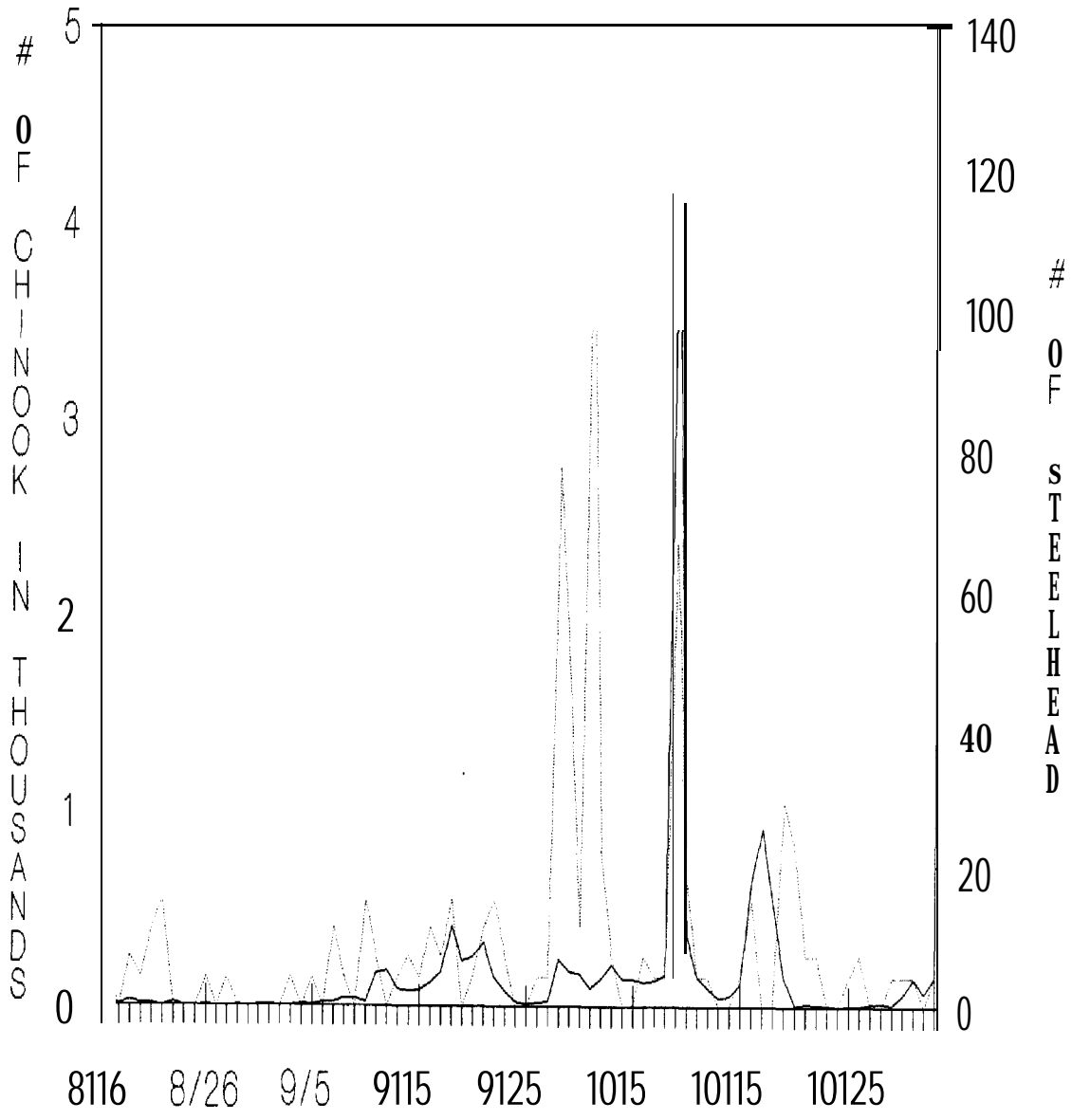
Dam **Detections**

The first dam detections from CR PIT-tagged parr occurred in spring 1989, and will be summarized in the **FY 1989** report.

RECOMMENDATIONS

We recommend a prompt resolution to the USR dewatering problem at the S45 and ALC diversions. Resolution of the dewatering problem would result in a significant increase in the smolt production potential of the USR. Adult chinook passage into headwater areas would be assured in all years. Egg-to-Parr survival upstream of the diversion in low gradient headwater streams appears to be much greater than below the diversion. PIT tag data showed that the **parr-to-smolt** mortality was three to four times greater for chinook and steelhead parr rearing above the diversion. We believe this additional parr mortality occurred in the fall when approximately 65% of the chinook parr and 50% of the steelhead parr attempted migration and encountered the dewatered conditions below these diversions. Resolution of the dewatering would improve adult chinook passage into the USR headwaters where higher **egg-to-parr** survival occurs, and improve the **parr-to-smolt** survival for both chinook and steelhead.
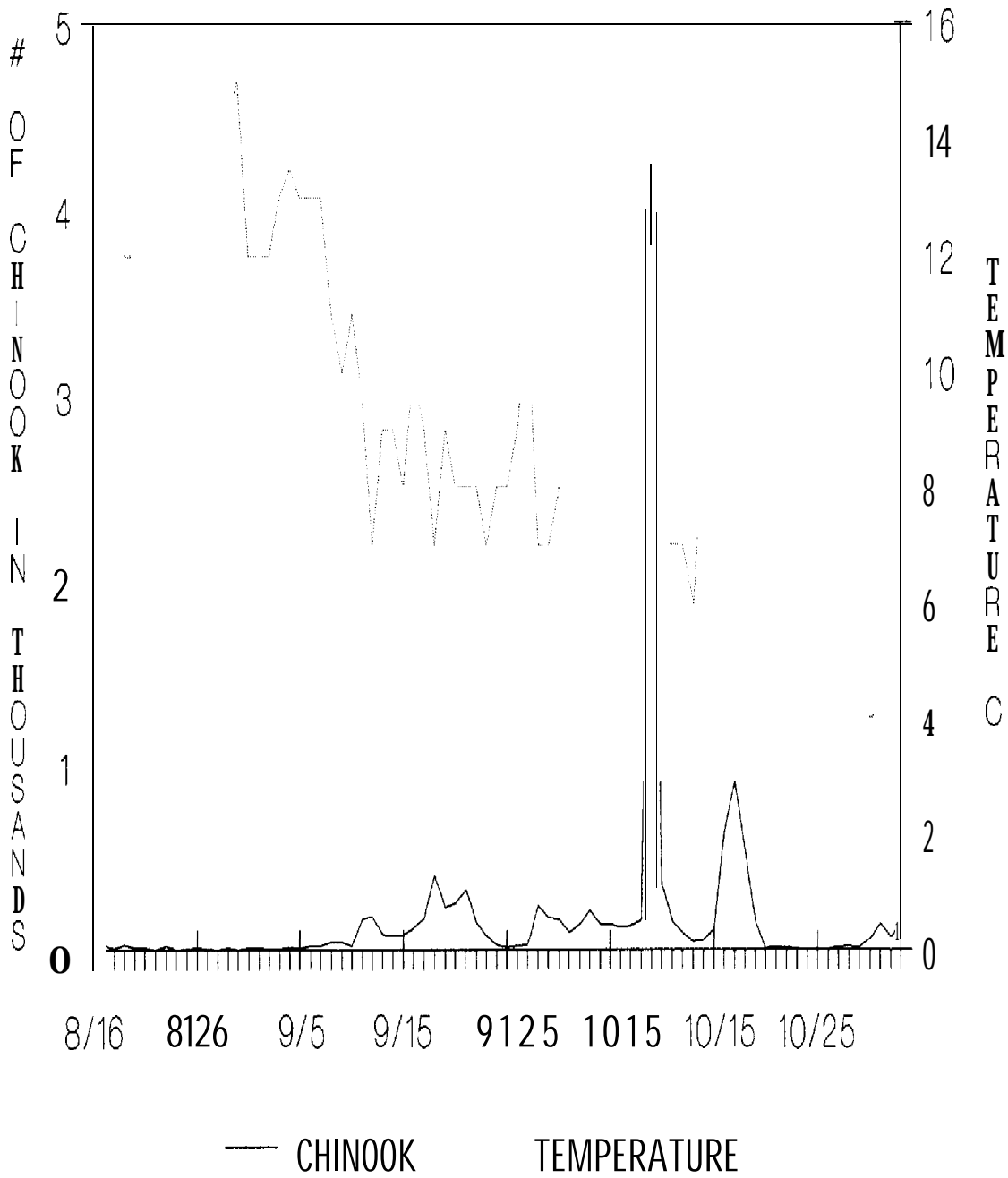
Figure 13. Fall 1988 CR outmigration run estimates.

Figure 4. Fall 1988 CR chinook run estimates and daily (10:00 am) water temperature.
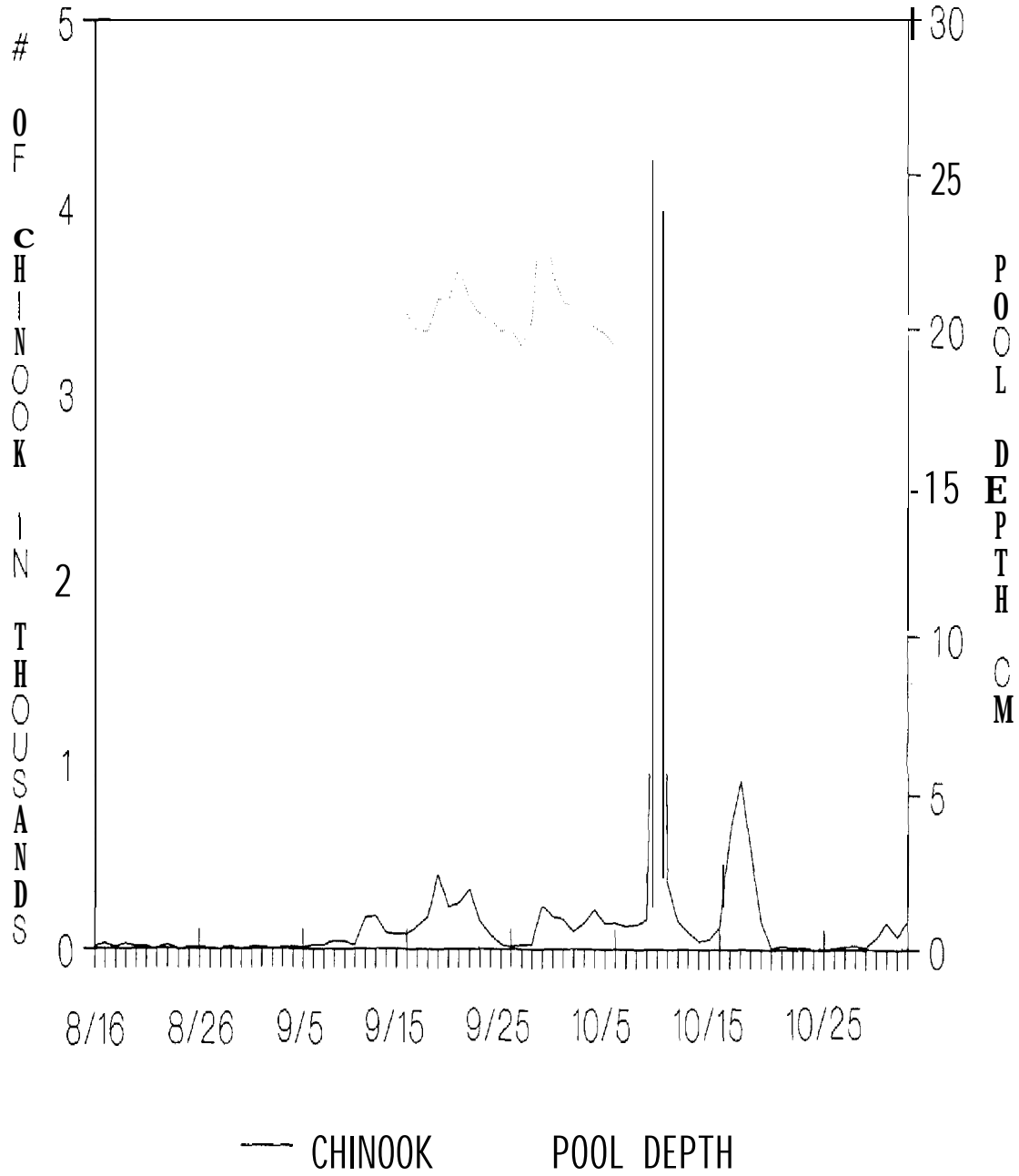
Figure 15. Fall 1988 CR chinook run estimate and pool depth reading,

We also recommend further **instream** flow improvement in Pole Creek. One possible solution would be to find an alternative power source for the sprinkler system and return to the stream water that is now used to power the system. During low water years, the water temperature in Pole Creek rises above levels optimal for salmonids in the reach from the diversion to the discharge point for the water used to power the sprinkler system. Most salmonids moved out of this area in 1988 to avoid the high temperatures, and those that stayed suffered from reduced growth rates.

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

Better definition of steelhead age and size at smolting is necessary to interpret PIT tag dam detections and to estimate **parr-to-smolt** survival in Idaho streams. The dam PIT tag detection data indicate that only steelhead larger than 130 mm (presumably **age-2+)** successfully smolt.

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