IDAHO HABITAT EVALUATION
FOR OFF-SITE MITIGATION RECORD

Annual Report 1985

by

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EXECUTIVE SUMMARY

In 1984, the Idaho Department of Fish and Game (IDFG) undertook an evaluation of existing and proposed habitat improvement projects for anadromous fish in the Clearwater River and Salmon River drainages. Projects included in the evaluation are funded by or proposed for funding by the Bonneville Peer Administration (BPA) under the Northwest Power Planning Act as off-site mitigation for downstream hydropower development on the Snake and Columbia rivers.

Evaluation approaches to document a record of credit for mitigation were developed in 1984-1985 for most of the habitat projects. Restoration of upriver anadromous fish runs through increased passage survival at main stem Columbia and Snake River dams is essential to the establishment of an off-site mitigation record, as well as to the success of the entire Fish and Wildlife program. The mitigation record is being developed to use increased smolt production (ie., yield) at full-seeding as the basic measure of benefit from a habitat project.

The IDFG evaluation approach consists of three basic, integrated levels: general monitoring, standing crop evaluations, and 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 full-seeding levels. For most projects, smolt production will be estimated indirectly from standing crop estimates by factoring appropriate survival rates from parr to smolt stages. Intensive studies in a few key production streams will be initiated to determine these appropriate survival rates and provide other basic biological information that is needed for evaluation of the Fish and Wildlife program.

A common physical habitat and fish population data base is being developed for every BPA habitat project In Idaho to be integrated at each level of evaluation. Compatibility of data is also needed between Idaho and other agencies and tribes in the Columbia River basin.

No final determination of mitigation credit for any Idaho habitat enhancement project has been attainable to date. Because of the depressed nature of most anadromous stocks, it was not possible to observe full-seeding conditions at any of the projects in 1984-1985 and definition of full seeding for the various types of habitat has not been made. In addition, a mitigation record based on increased smolt yields cannot be developed until the intensive studies define appropriate conversion rates from parr to smolt stages.

Some measures of the relative effectiveness of the various enhancement techniques have been made at less than full-seeding levels. Data collected over the last two years have indicated that instream structures, such as log weirs, boulder weirs, log deflectors, and overhead cover devices, have not markedly increased salmon and steel head parr production. Off-channel pond and side-channel development have dramatically increased production potential in degraded streams. The addition of new increments of natural salmon and steelhead production appear to be one of the most cost-effective enhancement project types.

INTRODUCTION

The Idaho Department of Fish and Game (IDFG) conducted evaluation of existing and proposed habitat improvement projects for anadromous fish in the Clearwater River and Salmon River drainages during 1984 and 1985. Projects included in the evaluation are funded by or proposed for funding by the Bonneville Power Administration under the Northwest Power Planning Act.

The Clearwater River and Salmon River drainages (Fig. 1) account for virtually all of Idaho's wild and natural production of summer steelhead and spring and summer chinook salmon, as well as a remnant run of sockeye salmon. Approximately 5,687 miles of streams were once available to anadromous fish in Idaho, of which some 40% was lost due to dam construction on the Snake River and the North Fork of the Clearwater River (Mallet, 1974).

Although a majority of the habitat still available to steelhead and salmon is high quality, man's activity in Idaho has degraded many streams. Sedimentation has increased with widespread logging, road building, and associated activities. Intensive livestock grazing near streams has removed riparian vegetation, changed stream morphology, and accelerated soil erosion. Mining has had profound effects in parts of the drainages through stream channel alterations, discharge of toxic effluents, and increased sedimentation. Irrigation withdrawals have reduced flows and increased water temperatures, often to critical levels for steelhead and salmon during summer.

Presently, public agencies, including the US Forest Service (USFS), US Fish and Wildlife Service (USFWS), Idaho Department of Fish and Game, and the Shoshone-Bannock and Nez Perce tribes are cooperatively working on solutions to habitat problems for protection, enhancement, and mitigation of anadromous fish throughout the Clearwater River and Salmon River basins. Although it is generally accepted that habitat projects do increase juvenile production, actual increases and relative benefits have seldom been quantified in the field. Under the Fish and Wildlife program, quantification of benefits are required so that a record of credit for off-site mitigation on Columbia River tributaries can be established to compensate for losses due to the federal hydropower development system on the Snake and Columbia rivers.

Habitat enhancement projects are intended to either increase the amount of habitat or carrying capacity of existing (usually degraded) habitat or both. Migration barriers, such as waterfalls, culverts, and water diversions, can be modified to make habitat that is not being used or is underutilized by anadromous fish available. The BPA has funded or funding has been proposed for a number of these projects in Idaho on Eldorado Creek, Crooked Fork Creek, Crooked River, the upper Salmon River, Alturas Lake Creek, Pole Creek, Johnson Creek, and Boulder Creek (Fig. 1). Juvenile rearing habitat can also be added by connecting off-channel ponds to streams as on Crooked River. Control of toxic

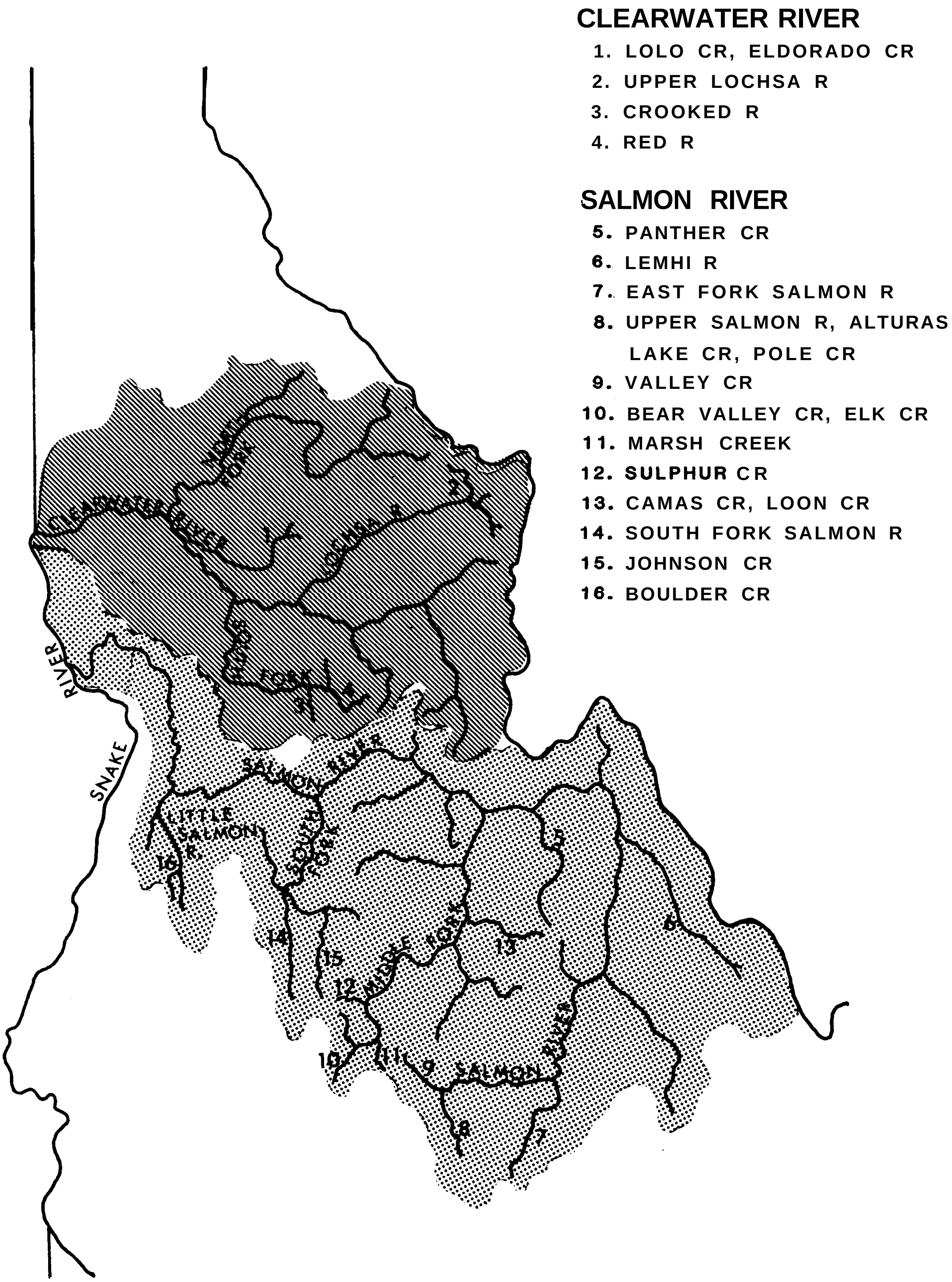

Figure 1. Project areas in Clearwater River and Salmon River drainages, Idaho.

discharge from mining areas (Panther Creek) can eliminate partial blocks to anadromous fish passage and bring polluted stream reaches back into production. The amount of sediment entering streams from major "point sources," such as mines, can be reduced (Bear Valley Creek) to increase juvenile survival and carrying capacity. The carrying capacity of streams potentially can be increased by strategic placement of instream structures to reduce sedimentation, increase quality of rearing habitat for juvenile salmonids, and increase hiding or spawning habitat for adults (Lolo Creek, Crooked Fork Creek, White Sand Creek, Crooked River, and Red River). High velocities in channelized reaches can be reduced to more optimal levels for rearing juvenile salmonids by reconstructing stream channels to simulate more natural conditions (Crooked River). Finally, riparian zones may be managed to reduce sedimentation and stabilize stream banks to increase carrying capacity by a variety of techniques, including livestock fencing, revegetation, and bank revetments.

Primary objectives of this evaluation project are: (1) document physical changes that result from habitat enhancement, (2) measure changes in steel head and chinook parr/smolt production attributable to all habitat enhancement projects, (3) determine project effectiveness to guide future enhancement activity, and (4) determine benefits in terms of increased smolt and adult-production resulting from each habitat enhancement project.

General level studies on each project will provide a large data base that can be used to predict response of increased or decreased fish production from a physical change in anadromous fish habitat. This data should assist sponsors of future habitat enhancement projects In more accurately estimating fishery benefits of their proposed projects. This data base will also assist in defining limiting habitat factors for the various types of streams in Idaho.

The data base that will be developed through this project will not only serve to determine the effectiveness of individual habitat enhancement projects but, will also serve to determine the effectiveness of major elements of the Fish and Wildlife program, such as:

Section 201	Program goals for anadromous fish
Section 304	Water budget and migrant survival
Section 404	Downstream migrant passage
Section 504	Ocean survival, harvest management, and escapement objectives
Section 704	Wild, natural, and hatchery propagation integration of natural and hatchery propagation

METHODS AND MATERIALS

Evaluation Approach

When the Idaho Department of Fish and Game initiated the Evaluation project, it was recognized that the best parameter for estimating the effectiveness of anadromous fish habitat enhancement projects was production of smolts. Since it is very difficult and costly to actually measure or estimate smolt production increases that result from habitat enhancement projects, an approach was adopted that will estimate changes in summer standing crop of salmon and steelhead parr at every BPA-funded habitat enhancement project in Idaho. In addition, physical changes in the anadromous fish habitat will be measured at every project. This general level of data collection can be accomplished for each project at a relatively low cost.

The need to convert parr response to smolt response was also recognized, and in 1986, intensive evaluation studies are being Initiated in the Salmon and Clearwater River drainages that will define the relationship of summer standing crop of parr to resultant smolt production. After the intensive studies have determined conversion factors that can be applied to estimated increases in parr production, we will use those conversion factors to estimate Increased smolt production for each project (Table 1).

The intensive studies will also provide data that will allow the estimation of increased adult production that resulted from each Individual habitat enhancement project. The combination of general and intensive data collection will allow an accurate mitigation record to be developed in Idaho.

In defining the relationship of general level studies to intensive studies, the data compartments depicted in Fig. 2 by square boxes will be components of both general level and intensive level evaluations. The general level studies will be confined to these types of data. The data collected through this evaluation project in 1984 and 1985 was confined to this general level-type data.

in 1986, the intensive level evaluation will be initiated and data compartments depicted in Fig. 2 by circles will be added in Idaho. Data collected through other management activity and research studies will complement the evaluation data base. These data compartments are depicted by hexagons In Fig. 2.

Integration of these data components will assist in defining realistic estimates of smolt production and adult production which are depicted In Fig. 2 by triangles.

Table 1. Hypothetical example of estimated mitigation benefits of BPA habitat enhancement projects.

Parameter	Hypothetical value
SMOLT YIELD FROM PROJECT	
1. Estimated increase in juvenile density (summer)[a]	20/100m^2
2. Area enhanced[a]	X100,000m^2
3. Estimated increase In juvenile standing crop (summer) within project area[a]	20,000
4. Estimated Increase in juvenile standing crop (summer) in downstream areas due to enhancement[ab]	+10,000
5. Total increase in juvenile standing crop	30,000
6. Survival factor (juvenile to smolt)[b]	X80%
7. OUTPUT - Annual smolt yield	24,000
POTENTIAL DOLLAR BENEFITS FROM PROJECT[c]	
7. Annual smolt yield	24,000
8. survival factor (smolt to adult)	X1.0%
9. Total increase in adult population	240
10. Dollar value/adult- (catch/escapement factor)	X$50
11. Value of increased adult production	$1,200
11. POTENTIAL OUTPUT - Total annual benefits	$1,200

[a] Determined from general monitoring and evaluation.

[b] Determined from intensive survival, production, and yield studies.

[c] Outside scope of habitat enhancement evaluations.

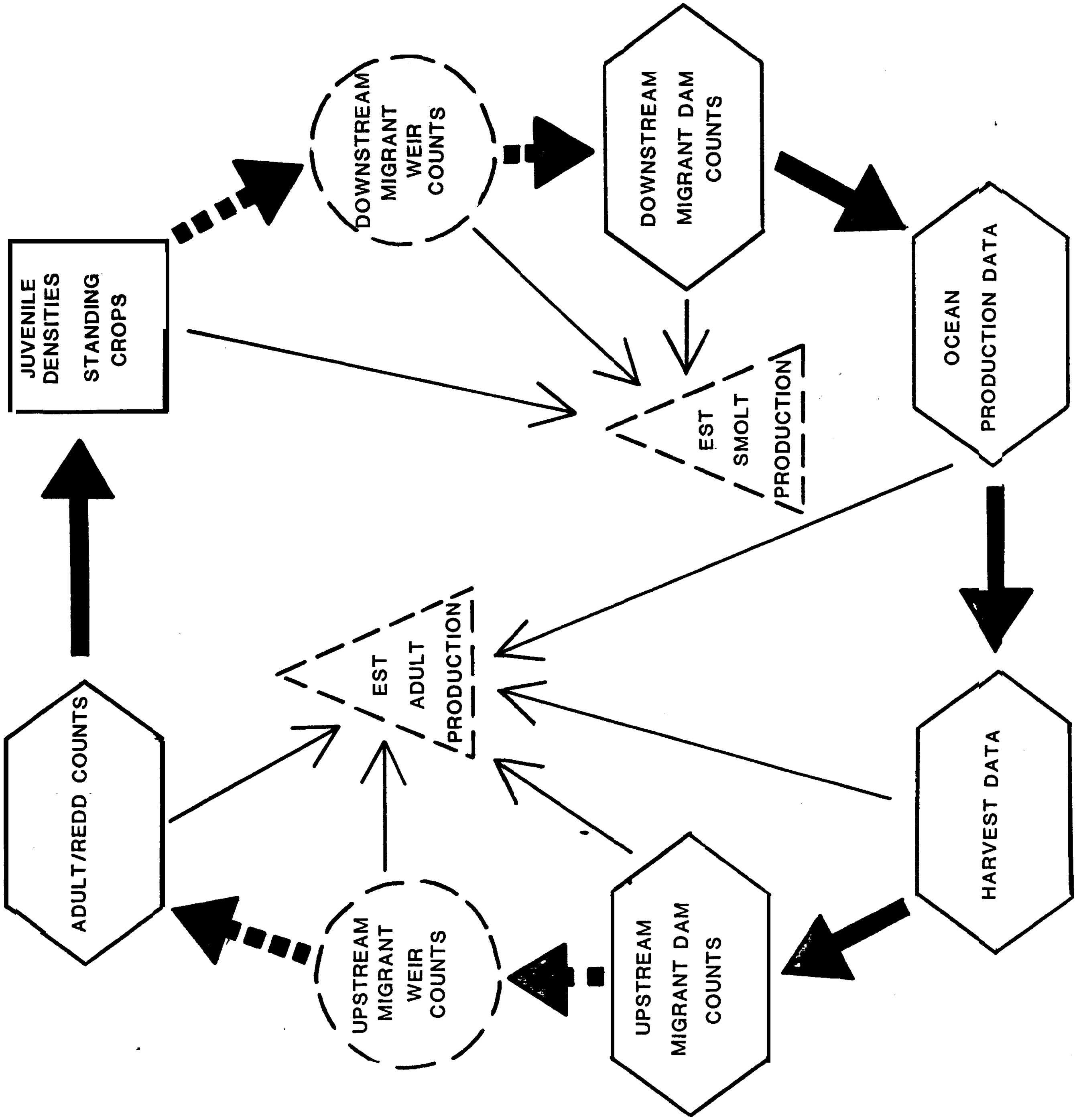

Figure 2 Relationships of major data compartments to estimated production of smolts and adults. General evaluation and monitoring will link (chinook) redd counts and juvenile densities or standing crops. Intensive studies will link actual spawning escapements, redd counts, juvenile densities, and downstream migrants.

Survival factors from smolt to adult will be available from ongoing migration studies in the Snake and Columbia rivers and from increased ability to estimate catch and escapement of adults. survival rates should increase from present low levels as passage problems at the dams are mitigated. Dollar values for adult fish have not been determined for Idaho stocks but will increase with time as escapement objectives can be met and larger proportions of the production can be harvested.

Partial benefits from habitat enhancement will begin to accrue as smolt production Increases in response to the projects. Full benefits will not be realized until smolt survival rates increase and stabilize and escapements increase to a level that available habitat can be fully seeded. Important, possibly intangible benefits will accrue immediately from enhancement activity that assists critically-depressed, wild stocks.

Final determination of individual project benefits for the purpose of establishing a mitigation record will not be made until fish response can be documented at full-seeding levels. Determination of the relative merits of various habitat enhancement measures can and should be made at the earl lest possible time and need not be dependent on full-seeding levels being attained. Comparison of partial responses of various types of enhancement measures may be sufficient to determine the relative merit of an individual technique. Supplementation with hatchery fish will in some cases be used to create full-seeding conditions immediately after project implementation to allow early realization and determination of project benefits.

Overfishing and low survival rates for migrants at the Snake and Columbia River dams have prevented full seeding in recent years. Densities that constitute full seeding remain undefined for most streams, however, because biologists in Idaho generally did not begin to measure rearing densities until after stocks declined drastically in the early 1970s. Defining full seeding levels or carrying capacity should be possible as escapements to Idaho return to pre-1970 levels. Currently, steelhead are recovering faster than are spring and summer chinook.

Steelhead returns to Idaho suffered serious declines in the early 1970s due largely to cumulative smolt mortality after construction of the lower Snake River dams: Ice Harbor, Lower Monumental, Little Goose, and Lower Granite. The number of adult steelhead passing Ice Harbor Dam into Idaho shows an incomplete recovery beginning in the late 1970s (Fig. 3). Because steelhead spawn during spring when water can be high and turbid, consistent yearly records of numbers of spawners are lacking for individual streams. Consequently, determination of numerical spawner-juvenile relationships for individual streams is difficult. For the upper Clearwater River in general, escapement of spawners has begun to return gradually to pre-1970 levels, Middle Fork Salmon River stocks went through a similar decline during the 1970s and escapements now represent about 40% of levels in 1971. Because recovery in numbers of steelhead

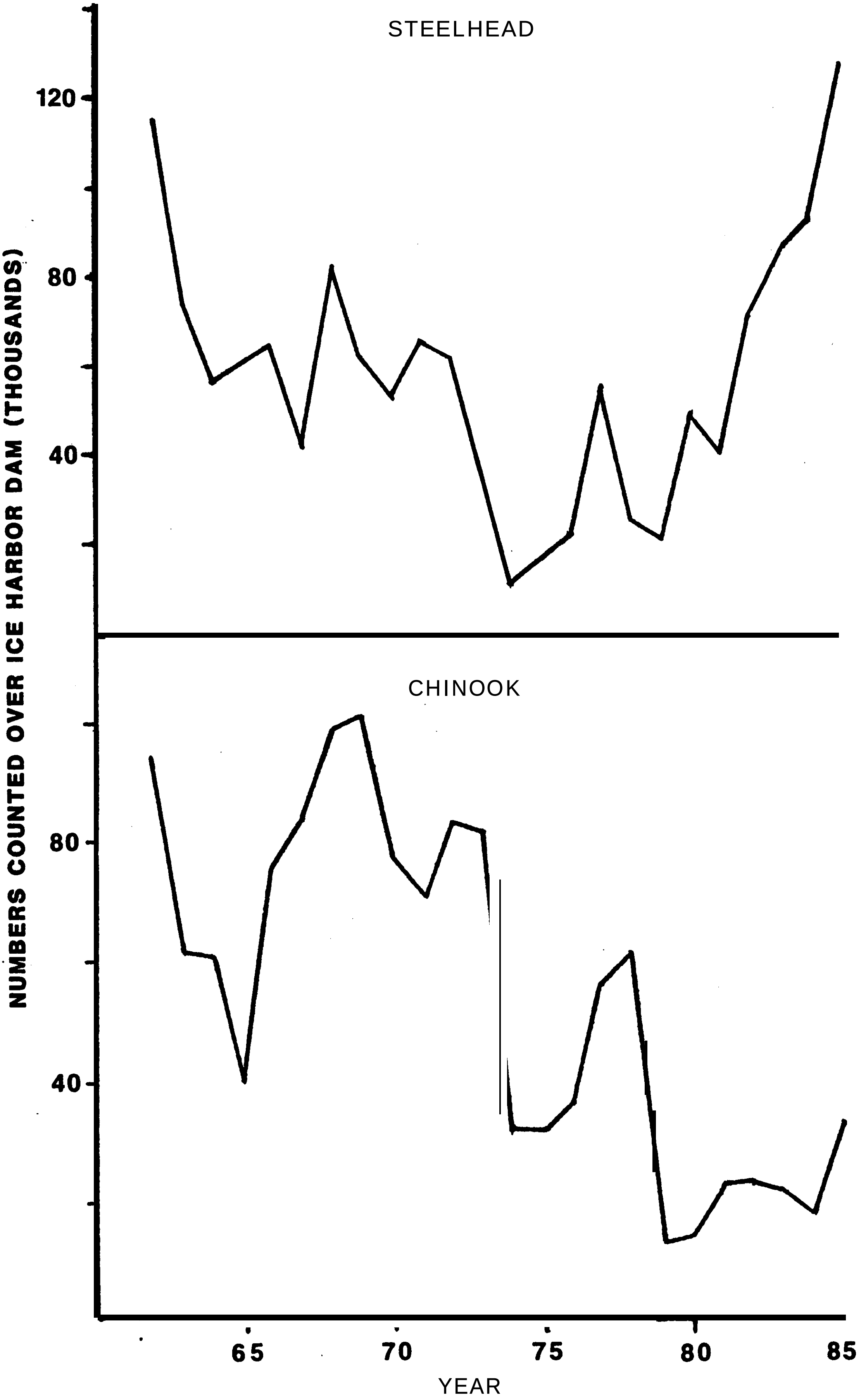

Figure 3. Number of adult steelhead and chinook passing Ice Harbor Dam into Idaho, 1962-85.

spawners is incomplete, we are not yet able to satisfactorily judge what constitutes juvenile steelhead carrying capacity on a stream-by-stream basis.

Chinook salmon suffered greater mortality due to construction of dams on the Columbia River and lower Snake River, suffered greater mortality due to more extensive overfishing in downriver areas and the Pacific Ocean and have shown less recovery than steelhead (Fig. 3). Because chinook spawn during a low-water period in late summer, their yearly spawning trends can be followed for individual streams. Redd counts in the Salmon River drainage still represent less than 20% of those during the 1960s but are gradually increasing (Table 2). Comparable, long-term records do not exist for Clearwater River streams because, until the mid-1960s, these runs were not fully reestablished after their depletion in the 1920s by passage problems at Lewiston Dam. Because of continued low escapements of chinook, it is unlikely that they are fully seeding habitat except on a rare and localized basis.

Full seeding is important to evaluate benefits from a habitat enhancement project whether the objective is to add rearing habitat or increase the carrying capacity. Benefits measured from less than full seeding conditions may underestimate true benefits where rearing habitat is added (e.g., barrier removal and be ambiguous where attempts are made to increase carrying capacity.

Where rearing habitat is added and carrying capacity is reached, measured increases in juvenile steelhead and chinook densities (apparent benefits) will approximate true benefits (Fig. 4A). If carrying capacity is not reached, true benefits will be underestimated by measured increases in juvenile fish densities (Fig. 48). Representative stream sections will be sampled before and after treatment to determine extent of use of a stream reach by anadromous fish. Control reaches (e. g., below a barrier) will also be sampled to follow annual trends in density, but these data likely will not be used in final calculations of benefits. Benefits will be calculated from the increase in density from pretreatment (usually zero) to post-treatment at full seeding.

Where the project objective is to increase carrying capacity, we expect that measured benefits will also approximate true benefits when full seeding occurs (Fig. 4C). Otherwise, densities of juvenile salmonids may bear little relationship to the quality of habitat and, thus, measured “benefits” would be misleading (Fig. 4D). Without full seeding by steelhead and chinook, we cannot determine whether a differential in densities between treated and untreated sections indicates only habitat preferences or true increases in rearing potential. Conversely, without full seeding, a lack of differential in densities does not necessarily imply that rearing potential was not changed by habitat enhancement. At full seeding, intraspecific competition for food and space will force juveniles to distribute,

Table 2. Chinook salmon redd counts in established trend areas during 1982-85 compared to 1960-69 average [Hall-Griswold and Cochnaur 1995).

Drainage and stream	1960-69 average	1982 --	1983	1984	1966	1982-E average	% of 1960-69 average
Clearwater River							
Crooked Fork Creek	32[a]	34	7	29	47	29	91%
South Fork Clearwater River							
Crooked River	--[b]	2	12	22	ID	12	-
Red River	--[b]	159	204	177	224	191	-
Salmon River							
Lemhi River	930	763	50	35	93	65	9%
East Fork Salmon River	661	42	190	16[c]	22[c]	66[c]	10%[c]
Upper Salmon River	656	42[d]	161[d]	76[d]	80[d]	90[d]	14%[d]
Alturas Lake Creek	81	9[d]	27[d]	3[d]	9[d]	12[d]	15%[d]
Valley Creek	311	9	36	21	2	17	5%
Middle Fork Salmon River							
Bear Valley Creek	479	39	56	55	134	71	15%
Elk Creek	422	9	39	27	29	26	6%
Harsh Creek drainage	445	40	33	60	109	60	14%
Sulphur Creek	152	3	9	0	10	5	3%
Camas Creek	206	33	39	11	21	26	12%
Loon Creek	180	23	7	4	26	16	s%
South Fork Salmon River							
Upper South Fork	1 ,062	111[e]	165[e]	165[e]	323[e]	IS6	16%[e]
Johnson Creek	251	37	63	17	75	46	19%

[a] 1965-69 average.

[b] Chinook salmon not yet re-established.

[C] Reduced by trapping at East Fork weir: 34 females in 1994; and 45 in 1985.

[d] Reduced by trapping at Sawtooth Hatchery: 111 females in 1982; 179 in 1993; 197 in 7994; and 360 in 1985.

[e] Reduced by trapping at South Fork weir: 147 females in 1982; 190 in 1983; 353 in 1964; end 495 in 1965.

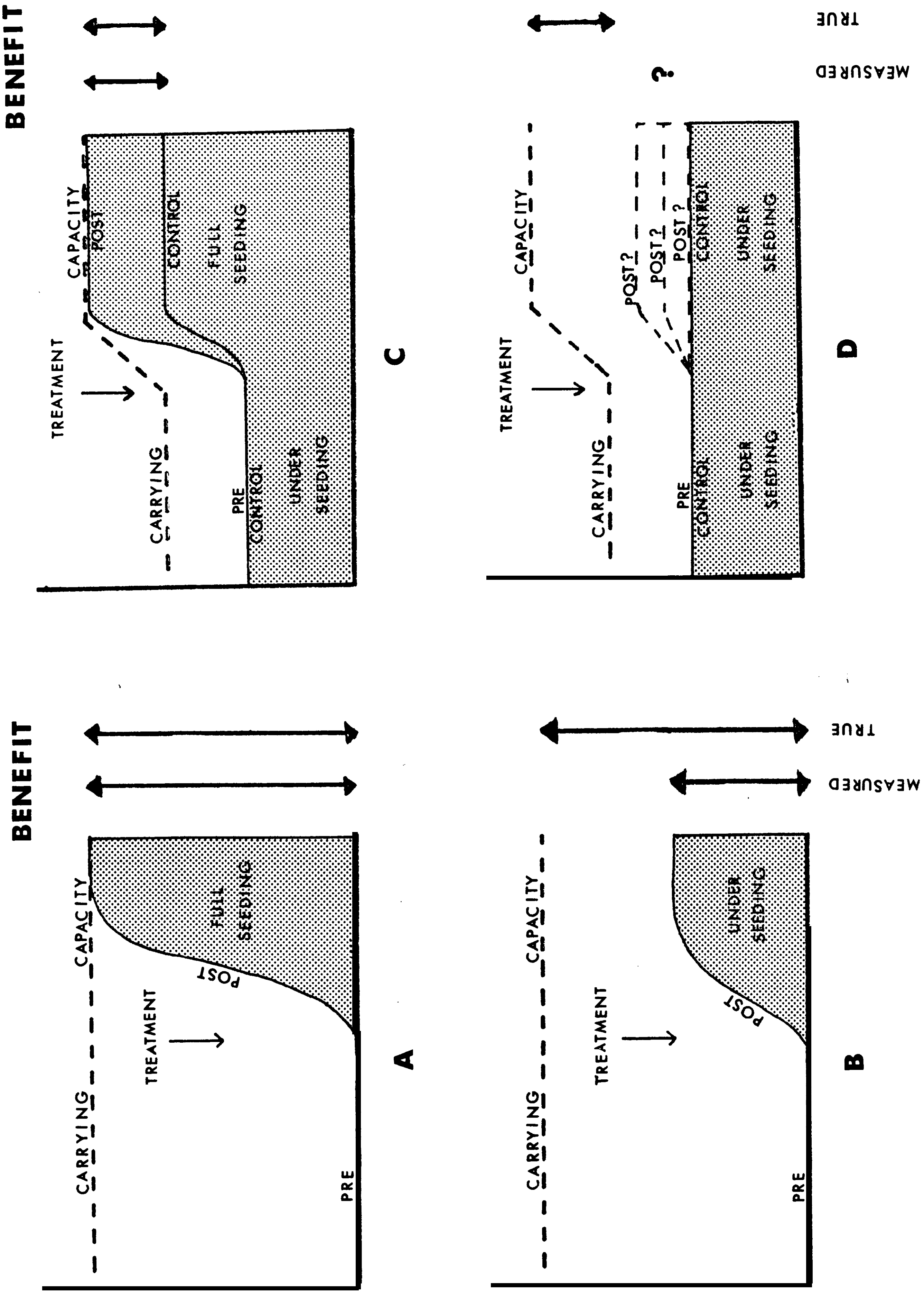

Figure 4. Expected measured and true benefits from projects that add habitat under conditions of full seeding (A) and partial seeding (B), and from projects that increase carrying capacity under conditions of full seeding (C) and partial seeding (D).

thus, assuring that juvenile densities will reflect rearing potential. At full seeding, benefits will be calculated from differences between posttreatment densities and densities in control sections. Pretreatment data will be necessary to establish comparative baselines for control and posttreatment sections.

There will be three basic phases to IDFG evaluation of habitat enhancement projects. A pretreatment phase will consist of estimates of anadromous fish densities and measurements of physical habitat. in sections or reaches to be treated and in control sections. The second phase will consist of estimation of partial benefits at lower seeding levels and annual monitoring of trend sections until juvenile densities approach carrying capacity. Hypothetically, carrying capacity for a stream reach can be estimated as the level at which juvenile fish densities stabilize while adult escapements continue to increase (Fig. 5). Adult escapements will be monitored by spawning ground surveys for chinook and estimated escapements to a drainage for steelhead. Final project evaluation will occur in the third phase, at full seeding. Post-treatment evaluation will include estimates of juvenile fish densities and measurements of physical habitat in treated and untreated sections.

Difficulty of quantifying benefits for mitigation purposes will vary from project to project. Easiest to quantify will be those projects that add a new increment of production potential, such as barrier removals. Where complete barriers are removed, benefits can be calculated simply from the final estimates of numbers of anadromous fish reared at full seeding; where partial barriers are removed, some downward adjustment of estimated benefits based on pretreatment potential will be needed.

Localized increases in carrying capacity (e.g., instream structures and riparian fencing) will also be relatively easy to measure. For these projects which improve rearing habitat locally, the benefits can be measured at full seeding from the increase in density relative to untreated sections.

It will be difficult and costly to estimate benefits for some types of general land treatments, such as road paving, cut-bank seeding, and other projects designed to decrease sedimentation, especially where a minor facet of a multi-faceted problem is treated. Costs of evaluation could easily exceed projected benefits for such projects.

In some cases, stocking the habitat with hatchery steelhead and chinook will be required to establish a run or estimate full seeding density. Stocks to be used will be compatible with IDFG (1985) Idaho Anadromous Fish Management Plan. Number of fish stocked will depend on availability of hatchery fish. The alternative to estimating final benefits at full seeding- projecting potential benefits from current depressed seeding levels- is not acceptable to IDFG. We do not consider existing models reliable enough to accurately predict potential benefits that could be used to develop a mitigation record.

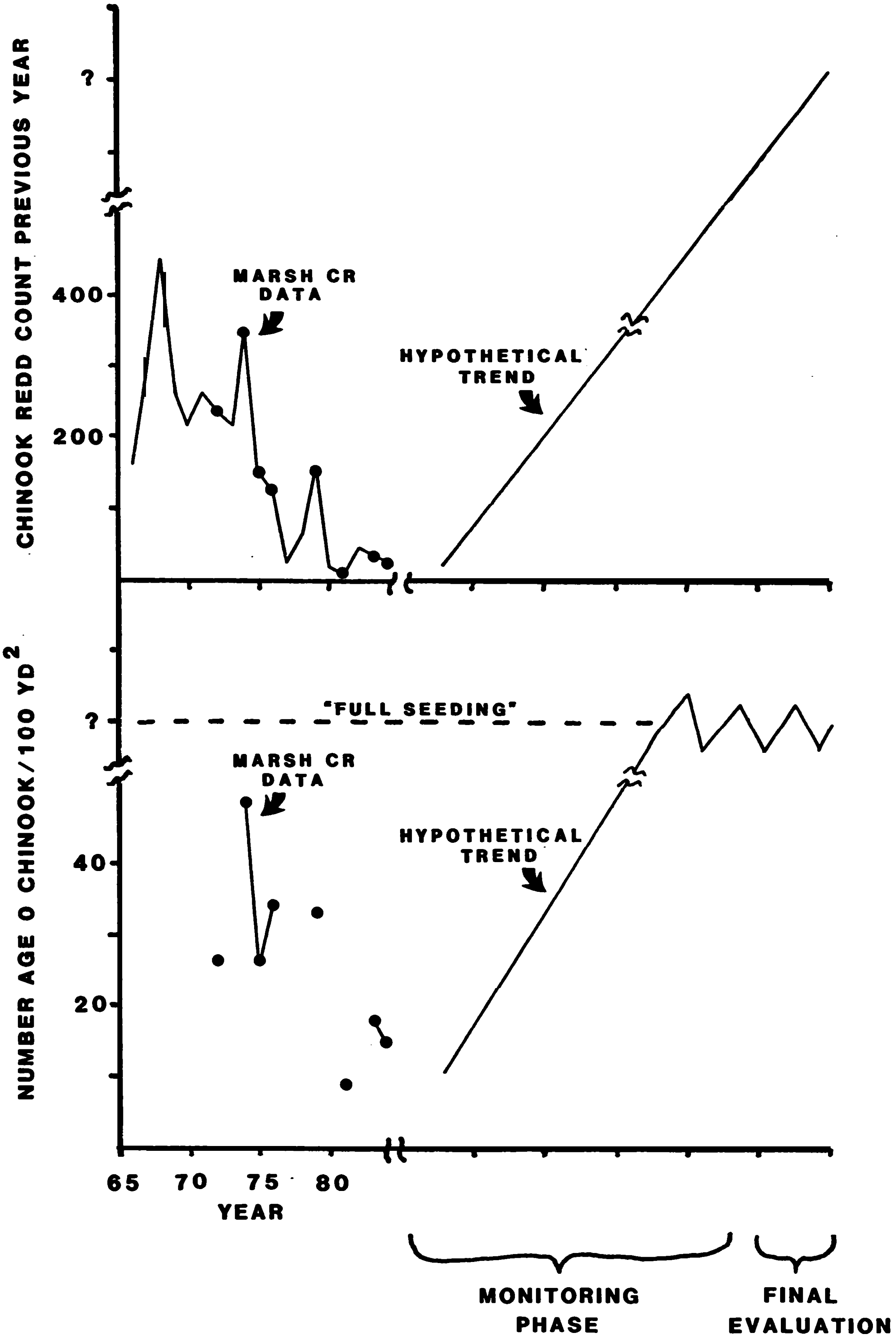

Figure 5. Phases of IDFG general evaluation showing recent decline in chinook escapements and summer densities, and expected response of densities to future increased escapements.

Development and verification of reliable, habitat-standing crop models should be possible as seeding levels increase and the appropriate data is accumulated; but most importantly, no benefits would be realized by increasing potential of the habitat to rear fish unless juvenile production also increases.

Methods

In 1984, IDFG began evaluation of existing and proposed BPA-funded enhancement projects for anadromous salmonid habitat in the state. The first phase of evaluation included identification of how benefits will be measured as seeding levels increase. We wanted to develop a flexible evaluation approach in which intensity of sampling effort for the projects could vary with time because: (1) lag time for responses of habitat and fish populations will vary among projects; (2) intensive studies repeated every year cannot be justified for most projects at current low seeding levels; and (3) in many cases, once basic sample designs are established and seeding levels increase, the number of sample sections can be increased to gain precision in posttreatment evaluations.

In July-August 1984, we primarily collected pretreatment and control information on fish densities and physical habitat (Table 3) to set the stage for evaluation. For a few projects implemented in 1983 (Instream structures in Lolo Creek, Crooked Fork Creek, and White Sand Creek and improvement of an irrigation diversion in Pole Creek), we could measure only post-treatment and control conditions.

In 1984, we also sampled a number of potential project areas before specific enhancement activity was proposed. We intended data from this limited sampling in project streams (Elk Creek, Marsh Creek, and Camas Creek) and possible control streams (Sulphur Creek and South Fork Salmon River) to help put into perspective current seeding levels and Interpret future trends. Once enhancement proposals become more specific, we can establish appropriate sampling designs for these streams.

Sections were established to be monitored in 1984 and future years. For each habitat type identified (e.g., pocket water, meandering meadow, run habitat with or without instream structures, etc.), we established a minimum of two sections that were about 100 m long. Upper and lower ends of each section were either flagged with surveyors' tape or staked and photographed to facilitate future sampling. We estimated fish abundance and densities and measured physical habitat variables in the section primarily during July and August 1984-1985.

Table 3. Schedule of BPA project implementation (I) and evaluation activities (P = pre-treatment evaluation; M = monitoring; E = post-treatment evaluation) in Idaho, 1983-85.

Project	Project Type^a	1983	1984	1985
Lolo Creek	IS	I	I,P,E	E
Eldorado Creek	PA	-	I,P	I,M
Upper Lochsa	IS	I	I,E	M
Crooked Fork	PA	-	I,P	I,P
Crooked River	PA		I,P	M
	IS		I,P	I,P,M
	BC		P	I,P
	OC		I,M	I,M
Red River	BC	I	I,M	M
	IS	I,M	I,M	I,M
	RR			
Panther Creek	SP		P	M
Lemhi	IF			P
Upper Salmon River	IF		P	P
	RR		M	P
Alturas Lake Creek	IF		P	M
Pole Creek	PA	I	M	M
	RR		M	P
Valley Creek	RR			P
Bear Valley Creek	SP	-	I,P	I,P
	RR		M	P
Elk Creek	RR	-	M	P
Marsh Creek	RR		M	P
Camas Creek	RR		M	M
	BC		M	M
Johnson Creek	PA		I,P	I,E
South Fork Tributaries	PA	-		
Boulder Creek	PA		P	I,P

Table 3. Continued.

Project	Project Type[a]	1983	1984	1985
Loon Creek	CO	-	-	M
Sulphur Creek	CO	-	M	M
South Fork Salmon	CO	-	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; SP = sedimentation and pollution control.

Fish abundance by species and age group or length class in the sections was estimated primarily from snorkeling observations. Depending on the size of stream and crew availability, from one to five observers snorkeled slowly upstream counting numbers of age 0 and 1+ chinook and numbers of trout, whitefish, and other species by 25 mm length class. The final crew member recorded the counts and other observations (i. e., approximate fish distributions, associations with structures, and presence of adult chinook). Field forms for fish population data are presented in Appendix D.

We calculated fish densities (number/100 m^2) by species and age group for each section. Young-of-year and yearling chinook did not overlap in length and could be readily distinguished visually. Lengths of age groups for other species, however, overlapped considerably. Steelhead and resident rainbow trout which were visually indistinguishable were separated into four age groups based on length frequency and scale analysis by Thurow (1983). For most streams in July-August, young-of-year rainbow-steelhead were less than 75 mm long; ages I, II, and III and older corresponded approximately to length classes 75-149 mm, 150-224, and greater than 225 mm, respectively.

In 1984-1985, IDFG developed a short list of physical habitat variables based on Platts et al. (1983) that we intend to measure in every general monitoring section. We kept the variable list short so that at least some comparable data could be collected in every project stream without the process becoming cumbersome and costly. Physical habitat variables were measured across transects as described in Petrosky and Holubetz (1985). Basic variables include section length, width, gradient, habitat type (pool, run, riffle, and pocket water), depth, velocity at 0.6 depth, estimated substrate composition, embeddedness class, undercut banks, and overhanging vegetation (Appendix D).

Where more detailed habitat measurements were desired, IDFG subcontracted W. S. Platts' team (Intermountain Forest and Range Experiment Station, USFS, Boise). These instances included proposed channel changes in Crooked River, structure applications in Red River, and pretreatment evaluations of habitat in Bear Valley Creek and Elk Creek (Appendix C).

CLEARWATER RIVER

Lolo Creek

Lolo Creek, 68 km long, enters the Clearwater River above Greer at river kilometer 87. The upper 29 km of stream, including the project area, lie within the Clearwater National Forest (Fig. 6). The lower stream runs through an area of mixed ownership which includes private,

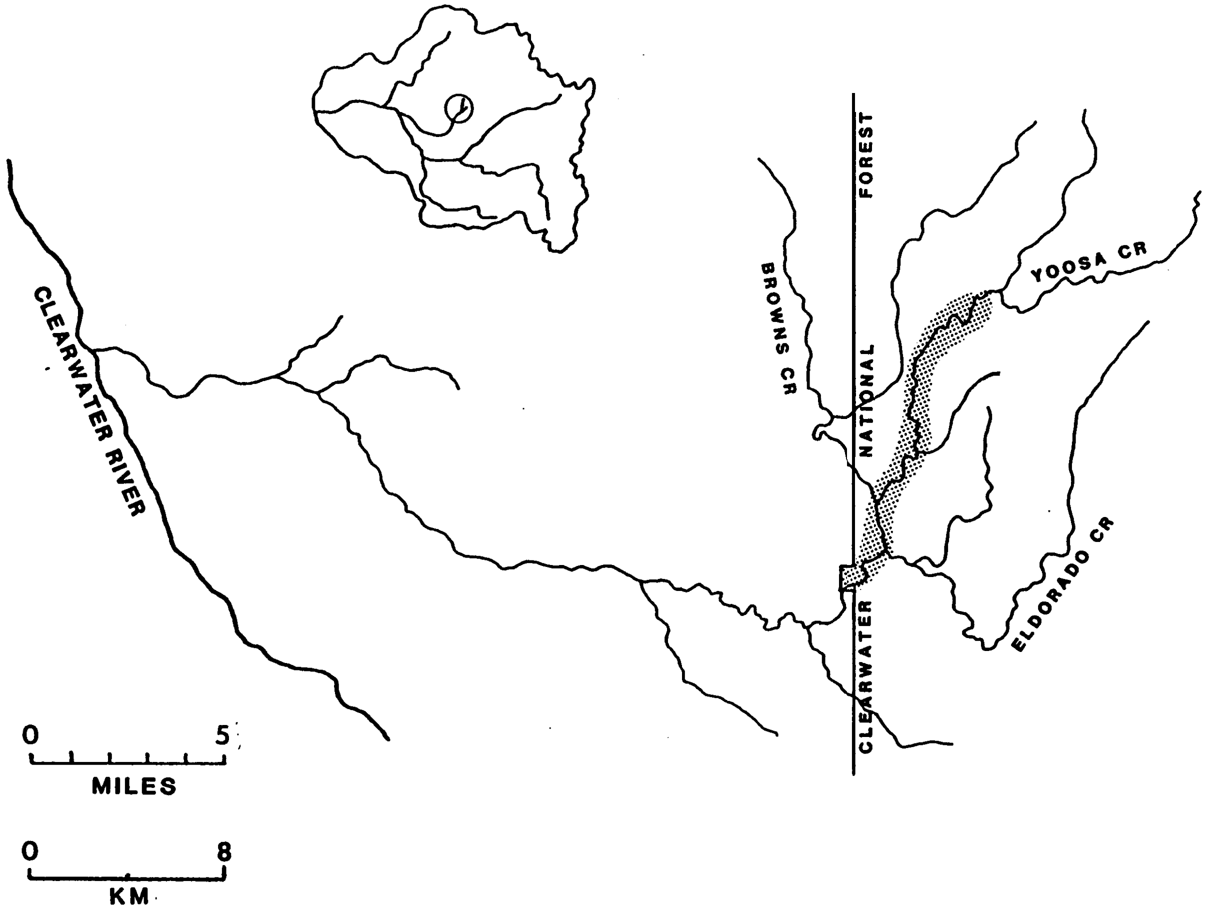

Figure 6. Location of 1983-85 habitat enhancement project (shaded) on Lolo Creek.

state, Nez Perce tribal, and US Bureau of Land Management interests. Within the forest boundaries, Lolo Creek drains a watershed of about 30,000 hectares (Espinosa 1984). Lolo Creek drops 1,200 m from its source to its confluence with the Clearwater River (1.8% average gradient). Within the project area, gradient is a more moderate 1.0%.

Lolo Creek is a major producer of anadromous fish for the lower Clearwater River. Summer steelhead and spring chinook spawn and rear in the stream. Both species have been stocked extensively in the system. A partial migration barrier upstream from Eldorado Creek was removed by USFS blasting projects in 1974 and 1978 to allow more complete utilization of the upper area. in recent years, juvenile rainbow-steelhead trout have dominated the fish community of upper Lolo Creek. Juvenile rainbow-steel head made up 71% of all fish observed in population surveys during 1975-1979 (Espinosa 1984); juvenile chinook made up 21%.

Nonanadromous salmonids reported in Lolo Creek are rainbow trout, cutthroat trout, brook trout, and mountain whitefish (Mallet 1974).

Lolo Creek has been degraded by excessive sedimentation from such timber management activities as road construction and riparian harvesting. To a lesser degree, placer mining for gold has also introduced sediment to the system. Most of the habitat degradation on forest lands occurred during the 1950s and 1960s. Espinosa and Branch (1979) found no significant improvements and some declines in habitat quality in the project area since 1974.

Espinosa (1984) identified several factors as potentially limiting to anadromous fish production in Lolo Creek. Pool/riffle structure, pool quality, and habitat diversity, including bank cover and instream organic debris, were rated suboptimal. Sedimentation was rated excessive in both spawning and rearing habitats.

A BPA-funded habitat enhancement project was implemented in 1983 and continued in 1984-1985. Objectives of the project were: (1) increase rearing potential for juvenile steel head and chinook, (2) increase pool frequency and quality, (3) increase hiding and resting cover for adult spawners, (4) reduce instream sediment loads through increased scour capability, and (5) increase natural production of steel head and chinook consistent with IDFG (1985) Idaho Anadromous Fish Management Plan for Subbasin CL-3.

Anadromous Fish Management Considerations

In 1985, juvenile salmon and steelhead production above the mouth of Eldorado Creek was exclusively natural production. The stream below the mouth of Eldorado Creek received a large number of steelhead fry that drifted from Eldorado Creek. These fry were progeny of surplus spawners stocked out of Dworshak Hatchery in the spring of 1985. Lolo

Creek has been supplemented with hatchery-produced, Group "B" juvenile steelhead during the period 1973 to 1985. Fingerling chinook were stocked in Lolo Creek In 1977.

Idaho's Anadromous Fish Management Plan calls for supplementation of natural salmon and steelhead production in Lolo Creek with surplus spawners, fry, and fingerlings from appropriate artificial propagation facilities. Over the next two to three years, large numbers of chinook salmon and steelhead fry will be stocked in this drainage.

1983-1985 Habitat Enhancement Project

Eldorado Creek to Yoosa Creek. During 1983-1984, USFS project personnel installed structures in Lolo Creek in a 160km reach between Yoosa Creek and Eldorado Creek confluences (Fig. 6). Structures were intended to diversify habitat primarily by creating pools and increasing pool quality and cover. In run (and pool) habitat, treatments consisted primarily of placements of sill logs or "K" dams, deflector logs, and root wads. Boulder clusters were placed primarily in riffles to create pocket-water habitat. A few bank-cover devices were also constructed. Activities in 1985 included minor additions of structures and structure maintenance.

Downstream of Eldorado Creek. The reach downstream of Eldorado Creek was treated in 1984 with deflector logs primarily in run habitat.

Project Evaluation

Evaluation status. Final evaluations for mitigation purposes of instream structure projects should be conducted at full seeding and after sufficient time has elapsed to allow structures to fully alter the habitat. Two levels of evaluation are planned for the Lolo Creek project. General monitoring of fish densities will be used to determine full-seeding levels. Statistical. comparisons of treated and control sections will be used to define benefits of the project for rearing anadromous fish. Through 1985, monitoring sections have been established and sampled and early evaluations of benefits to rearing of anadromous fish have been made.

The IDFG evaluation of the Lolo Creek project began In 1984, one year after implementation began. We identified types of treatments that would be evaluated and selected treated and control sections in run and riffle habitat upstream of Eldorado Creek (Petrosky and Holubetz 1985). Control sections were identified by USFS personnel as habitat that they would have treated except for lack of access for heavy equipment.

Evaluation of instream structures in July 1984 indicated possible benefits (higher densities) for older, larger rainbow-steel head but no evidence of benefits for yearlings. Juvenile chinook were too sparsely and unevenly distributed in 1984 to define any improvements in rearing conditions due to the structures.

The IDFG evaluation of the Lolo Creek project in 1985 was based on comparisons of densities in treated and control sections in early July and early September. Sampling was conducted within the framework of a one-way analysis of variance (42 sections and eight section types) with repeated measures on period (Table 4). In run (or pool) habitat upstream of Eldorado Creek confluence, we selected untreated sections and sections from three types of instream structure applications: sill logs (placed perpendicularly to the flow), deflector logs (placed diagonally to the flow), and root wads (cabled into place in runs and pools). In upstream riffle habitat, we selected sections from untreated areas and cluster placements of boulders. Downstream from Eldorado Creek, we chose sections from untreated run habitat and runs treated with deflector logs.

Other sampling in 1985 included physical habitat measurements of all established sections in late July, additional observations of juvenile fish in August and October, and observations of adult chinook and redds in early September. An annual redd count for Lolo Creek was also established in 1985 by IDFG, Region 2, Lewiston.

Juvenile rainbow-steelhead. Lolo Creek was under-seeded by rainbow-steelhead in 1985 (Table 5). However, compared to other Clearwater River tributaries surveyed in 1985, juvenile rainbow-steelhead densities were moderately high (Appendix Al-A5). Rainbow-steelhead fry had just begun emergence during the July sampling period.

Densities of all age groups of rainbow-steelhead in the 1985 evaluation varied significantly ($P < 0.05$) by section type and time period (interaction term) (Table 6). However, these interaction terms contain several comparisons that do not relate directly to structure effectiveness. For example, the F tests reflect that mean density of age 0 rainbow-steelhead was significantly lower in upstream control riffles during July than in downstream, treated runs during September (Fig. 7). The comparisons that apply directly to structure effectiveness are those grouped within time period and habitat type (upstream run, upstream riffle, and downstream run) (Table 7).

We detected no measurable benefit of instream structures for rearing of rainbow-steel head fry in 1985. Few fry had emerged in Lolo Creek upstream from Eldorado Creek confluence by early July (Fig. 7). Presence of fry downstream of Eldorado Creek in early July may have been due partially to earlier emergence in this reach but was probably due largely to dawnstream drift of steel head fry from Eldorado Creek following adult out-plants in 1985. By September, densities of

Table 4. Sections sampled in Lolo Creek, July 1-4 and September 3-5, 1985. Section numbers for treated sections were assigned by USFS project personnel in 1983 and 1984.

Habitat, treatment	Section	Km above USFS boundary	% gradient	Section width(m)		Section area(m^2)		% Habitat Type		
				July	Sep	July	Sep	pool run	riffle	pocket water
Upstream run										
Untreated	1	19.0	1.0	11.3	11.2	282	280	100	.0	0
	IA	18.1	0.8	11.7	11.0	383	340	100	0	0
	2	15.4	1.8	10.8	10.0	306	280	78	22	0
	3	14.3	1.1	11.8	11.5	330	323	78	22	0
	4	12.9	0.9	9.2	-a	304	-a	100	0	0
	5	10.9	1.9	13.8	12.9	317	287	58	22	22
	7	7.4	0.8	12.5	10.8	512	443	100	0	0
Sill log	8303	17.7	1.4	12.5	11.9	478	451	100	0	0
	8328	15.0	1.0	13.9	12.8	809	556	87	13	0
	8343	12.4	1.2	10.7	10.3	546	528	100	0	0
	8349	11.1	1.7	14.8	13.7	474	437	100	0	0
	9341	7.9	1.2	8.3	9.1	588	843	100	0	0
	8357	8.3	1.9	10.5	10.1	421	402	87	13	0
	8380	5.9	1.4	14.2	14.4	541	546	75	25	0
Deflector log	8342	12.7	1.0	11.2	13.8	292	354	89	11	0
	8343	12.4	1.5	12.0	10.5	323	283	79	22	0
	8344	11.7	1.0	15.4	11.0	400	287	89	11	0
	8352	10.0	1.8	14.8	13.5	409	379	87	33	0
	8437	7.8	1.9	11.2	9.1	292	237	78	22	0
Root wad	8311	18.3	0.8	13.3	13.1	411	487	100	0	0
	8343A	12.4	0.5	13.7	12.8	274	252	100	0	0
	83438	12.4	2.0	15.3	14.1	352	324	78	22	0
	8349A	10.3	1.2	13.1	13.4	289	294	91	8	0
	83498	10.3	1.8	13.4	13.8	267	272	100	0	0
	9425	9.5	1.9	10.4	9.3	250	224	87	33	0
Upstream riffle										
Untreated	1	18.4	2.0	11.5	11.8	230	235	0	89	11
	2	18.0	1.1	12.3	12.1	370	384	33	87	0
	3	13.8	1.4	11.8	10.0	405	348	17	83	0
	4	10.1	1.5	17.2	14.5	395	334	44	58	0
	5	7.5	1.1	13.9	13.5	320	310	11	89	0
	6	8.8	2.5	14.0	13.2	279	285	0	100	0
Boulder cluster	8404	17.2	1.4	9.1	7.9	291	254	33	17	50
	8410	15.9	1.3	11.8	10.5	418	379	25	42	33
	8323	15.3	1.9	12.2	10.9	389	349	17	42	42
	9359	8.0	1.0	12.4	11.1	559	501	40	80	0
	9449	4.9	2.0	17.3	17.2	484	481	11	87	22

Table 4. Continued.

Habitat, treatment	Section	Km above USFS boundary	% gradient	Section width(m) July	Section width(m) Sep	Section area(m^2) July	Section area(m^2) Sep	% Habitat Type pool run	% Habitat Type riffle	% Habitat Type pocket water
Downstream run										
Untreated	1	1.4	0.8	22.8	21.8	995	958	100	0	0
	5	0.2	1.1	15.7	13.5	724	820	89	11	0
	8	0	1.0	18.8	14.7	670	599	100	0	0
Deflector log	1	1.4	1.0	20.4	15.3	939	826	80	20	0
	2	1.4	1.4	22.8	20.9	902	838	75	25	0
	8	0.3	1.3	18.2	18.8	748	890	100	0	0

[a] Flooded by maintenance of K-dam after July sampling period.

Table 5. Density (number/100m^2) by age group of rainbow-steelhead and chinook, in treated and untreated sections, Lolo Creek, July 1-4 and September 3-5, 1985.

Section type:		July						September					
habitat,		Rainbow-steelhead				Chinook		Rainbow-steelhead				Chinook	
treatment	Section	0	1	2	>3	0	I+	0	1	2	>3	0	I+
Upstream run Untreated	1	0	0	2.4	0.4	7.1	0.4	28.0	0.3	0	0	33.3	0
	1A	0.3	0	0.8	0	20.4	0.8	9.4	0.3	0.3	0	17.1	0
	2	0	1.3	1.6	0.3	9.1	0.3	5.0	0.7	0	0	1.4	0
	3	0	3.0	2.4	0	1.9	0.9	13.0	0.9	0	0	24.1	0.9
	4	0	3.8	3.0	0	19.1	0.3						
	5	0	5.0	4.1	0.3	2.5	0.3	15.8	4.4	0	0	15.2	0
	7	0	0.8	2.5	0.2	0.2	1.2	8.1	0.2	0.2	0	3.2	0.5
Sill log	8303	0	2.1	1.5	0	25.2	0.8	14.4	1.1	0	0	23.3	0.7
	8328	0	4.4	2.5	0	0.5	2.0	1.8	2.7	0.9	0	9.0	0
	8343	0	2.4	1.5	0	10.7	0.7	4.2	0.8	0	0	5.1	0.2
	8348	0	4.9	2.5	0	2.7	2.3	11.0	5.5	0.9	0	12.4	0
	8431	0	1.5	5.8	0.2	8.9	0	9.0	2.3	0.9	0.2	9.5	0.3
	8357	0	5.7	5.7	1.2	3.9	5.0	8.5	8.0	1.0	0	7.7	1.2
	8380	0	5.0	1.3	0	0.8	0.8	5.8	3.1	0.2	0	2.0	0.4
Deflector log	8342	0	9.8	3.1	0	992	0	19.2	2.3	0.8	0	8.8	0
	8343	0	5.8	1.5	0	27.8	0.8	8.8	1.40		0	8.1	0
	8344	0.2	3.0	2.5	0	18.8	0	12.2	1.4	0	0	13.2	0
	8352	0	3.9	2.7	0	8.8	0	12.9	1.1	0	0	7.1	0
	9437	1.0	1.0	3.1	0	1.4	0.7	18.8	4.8	0.8	0	5.9	0
Root wed	8311	0	0	0.2	0.5	3.8	0	12.0	0.2	0.2	0	8.8	0
	8343A	0	1.1	5.8	0	14.8	1.5	7.5	8.0	0.4	0	25.4	0.8
	83438	0	4.3	3.4	0	8.0	0.8	8.2	2.8	0.3	0	12.0	0.3
	934914	0	5.9	8.9	0	89.8	0	2.0	2.4	0.3	0	23.5	0
	83488	0	0.7	1.5	0	31.1	0	3.7	1.8	0.4	0	8.9	0
	8425	0	1.8	4.0	0	2.0	0.4	8.2	2.7	2.2	0	0	0
Upstream riffle Untreated	1	0	1.2	3.4	0	0.9	0	11.5	0.4	0	0	13.8	0
	2	0	0.5	2.7	0	5.7	0	19.2	0.5	0	0	17.8	0
	3	0.5	4.2	3.0	0	1.2	1.0	7.4	0.3	0	0	4.0	0
	4	0	2.0	1.3	0	4.8	0	13.8	1.2	0.3	0	1.8	0
	5	0	0.9	2.5	0	0.3	0.8	5.8	1.0	0	0	0	0
	8	0	9.7	1.1	0	0	0	2.3	0.9	0	0	0	0
Boulder cluster	8404	0	4.1	5.5	0	1.0	2.7	18.1	1.8	0.4	0	20.9	0
	8410	1.4	1.4	5.0	0	0	0.2	14.2	1.8	0.3	0	12.4	0
	8323	0.5	1.5	3.1	0	0	0.3	5.7	0.3	0	0	0	0
	8359	0.2	8.8	5.5	0	0.2	0.5	2.8	0.2	0	0	0.8	0
	8449	0	3.7	4.3	0.2	0	0	3.1	2.1	0.2	0	0	0

Table 5. Continued.

Section type: habitat, treatment	Section	July						September					
		Rainbow-steelhead				Chinook		Rainbow-steelhead				Chinook	
		0	1	2	>3	0	1+	0	1	2	>3	0	1+
Darnstream													
Untreated	1	18.5	0.2	0.3	0.1	0.1	0	11.8	1.1	0.1	0	0.3	0
	5	13.7	0.7	0.8	0.1	0.1	0	9.1	8.1	0.2	0	1.1	0
	8	24.0	0.3	0.1	0	0	0.1	11.4	3.2	0.2	0	2.0	0
Deflector log	1	11.2	1.3	1.1	0	0.5	0	15.0	4.0	0.2	0	1.3	0.2
	2	8.2	1.0	0.3	0	0.4	0	12.3	4.7	0.1	0	1.1	0
	8	15.2	0.1	0.8	0	0.7	0	11.8	5.9	0.4	0.1	5.5	1.0

Table 8. Analysis of variance summary for age-groups of rainbow-steelhead and chinook intreated and untreated sections, Lolo Creek, July and September 1985.

Source of variation	df	F (p > F)				
		Rainbow-steelhead				Chinook
		age 0	age 1	age 2	≥ age 1	age 0
Section type	7	7.8 [<0.01]	1.0 [0.43]	3.5 [<0.01]	1.3 [0.28]	2.4 [0.04]
Section type X replicate (Error a)	34	-				
Period	1	53.9 [<0.01]	0.1 [0.91]	98.4 [<0.01]	24.9 [<0.01]	0.7 [0.40]
Section type X period	7	5.9 [<0.01]	3.5 [<0.01]	3.8 [<0.01]	5.8 [<0.01]	1.4 [0.24]
Error b	33	-	-	-	-	-
Total	82					

Table 7. Least square mean densities by treatments and probabilities of greater t, Lolo Creek, July and September 1985. Differences significant at = 0.05 are denoted by *.

Species, age group	Habitat type[a]	Treatment[b]	Mean number/100m^2			p > /t/, under null hypothesis
			Treatment	Control	Difference	
			July I-4			
Rainbow-steelhead						
0	URUN	SILL	0	0.04	-0.04	0.98
		DEFL	0.24	0.04	0.20	0.93
		ROOT	0	0.04	-0.04	0.99
	URIFF	BOUL	0.42	0.08	0.34	0.89
	DRUN	DEFL	10.87	18.73	-7.88	0.02*
	URUN	SILL	3.71	1.93	1.78	0.08
		DEFL	4.82	1.93	2.89	0.02*
		ROOT	2.27	1.83	0.34	0.74
	URIFF	BOUL	3.48	3.08	0.38	0.73
	DRUN	DEFL	0.80	0.40	0.41	0.79
	URUN	SILL	2.94	2.33	0.81	0.28
		DEFL	2.59	2.33	0.28	0.87
		ROOT	3.83	2.33	1.30	0.02*
	URIF	BOUL	4.88	2.33	2.35	<0.01*
	DRUN	DEFL	0.78	0.33	0.43	0.80
>I	URUN	SILL	8.88	4.43	2.43	0.03+
		DEFL	7.20	4.43	2.77	0.03*
		ROOT	5.98	4.43	1.55	0.18
	URIF	BOUL	8.08	5.42	2.66	0.04*
	DRUN	DEFL	1.57	0.80	0.77	0.85
Chinook						
0	URUN	SILL	7.10	8.80	-1.50	0.73
		DEFL	12.72	8.60	4.12	0.39
		ROOT	21.48	9.60	12.88	0.01[c]
	URIF	BOUL	4.06	2.15	1.91	0.70
	DRUN	DEFL	0.54	0.07	0.47	0.94

Table 7. Continued.

Species, age group	Habitat[a] type	Treatment[b]	Mean number/100m² Treatment	Control	Difference	p > /t/, under null hypothesis
			September 3-5			
Rainbow-steelhead						
0	URUN	SILL	7.82	12.54	-4.72	0.04*
		DEFL	14.00	12.54	1.48	0.55
		ROOT	8.27	12.54	-8.27	0.01*
	URIF	BOUL	8.74	10.00	-1.28	0.59
	DRUN	DEFL	13.03	10.43	2.80	0.42
	URUN	SILL	3.04	1.41	1.83	0.13
		DEFL	2.18	1.41	0.75	0.51
		ROOT	2.85	1.41	1.24	0.28
	URIF	BOUL	1.18	0.70	0.48	0.88
	DRUN	DEFL	4.87	3.47	1.40	0.35
	URUN	SILL	0.58	0.20	0.38	0.53
		DEFL	0.28	0.30	0.08	0.99
		ROOT	0.83	0.20	0.43	0.47
	URIF	BOUL	0.18	0.05	0.13	0.83
	DRUN	DEFL	0.23	0.17	0.08	0.94
≥1	URUN	SILL	3.83	1.58	2.05	0.09
		DEFL	2.44	1.58	0.88	0.50
		ROOT	3.12	1.58	1.54	0.21
	URIF	BOUL	1.34	0.77	0.57	0.84
	DRUN	DEFL	5.13	3.83	1.50	0.37
Chinook						
0	URUN	SILL	9.98	17.47	-7.81	0.11
		DEFL	9.82	17.47	-8.95	0.09
		ROOT	12.90	17.47	-4.57	0.35
	URIF	BOUL	8.78	8.17	0.81	0.90
	DRUN	DEFL	2.83	1.13	1.50	0.82

[a] Habitat types: URUN = upstream run; URIF = upstream riffle; DRUN = downstream run.

[b] Treatments: SILL = sill log; DEFL = deflector log; ROCK = root wad; BOUL = boulder cluster.

[c] t-test not protected by significant F-test in the analysis of variance.

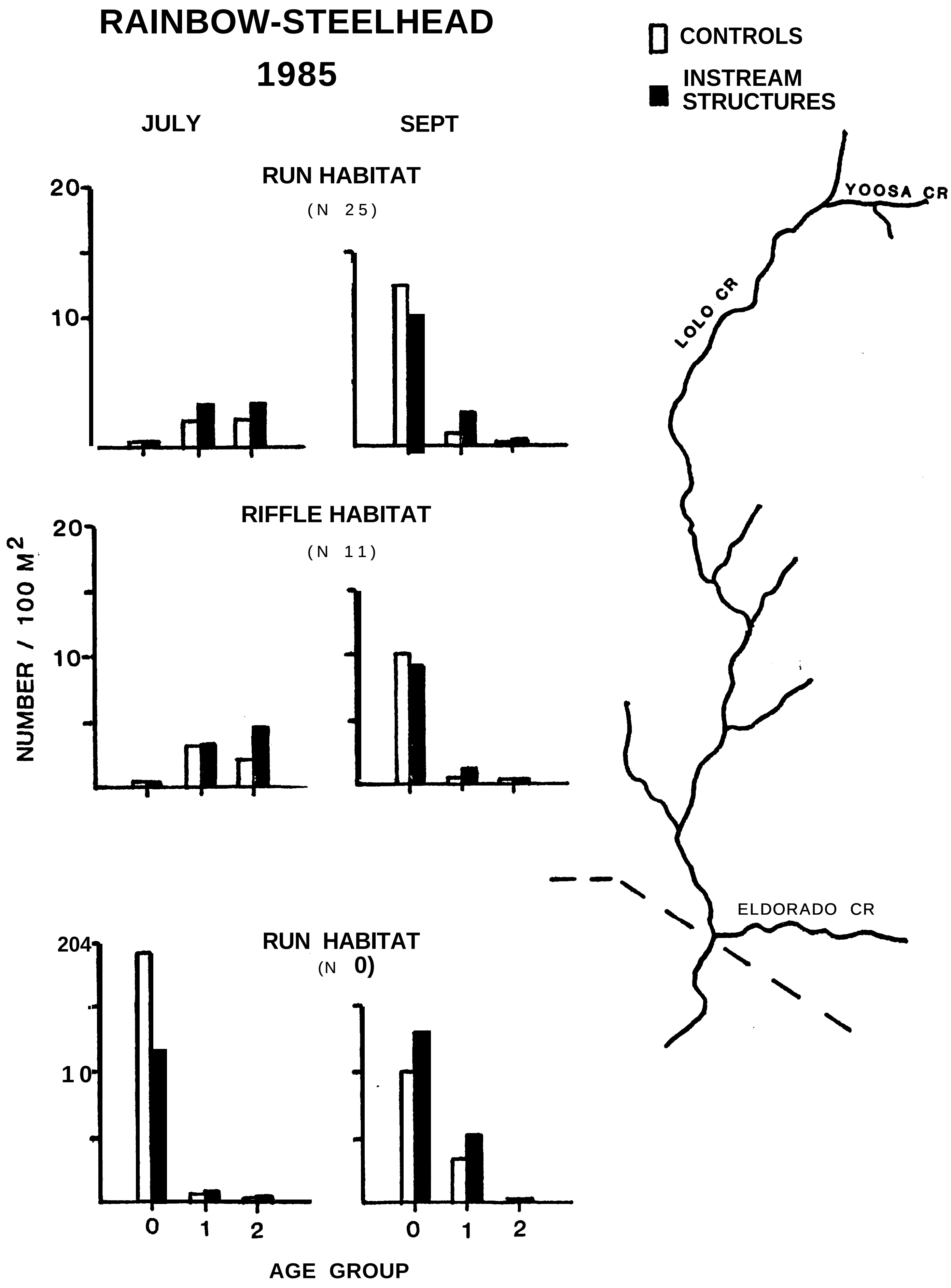

Figure 7. Density by age-group of rainbow-steelhead in treated and untreated sections, Lolo Creek, July and September, 1985. Major habitat classifications are run and riffle habitat upstream from Eldorado Creek and run habitat downstream from Eldorado Creek.

age 0 rainbow-steelhead were similar in all habitats. There was no indication that structures improved rearing conditions for age 0 rainbow-steelhead in either July or September. Fry were significantly less abundant than in controls for three contrasts: sill log treatments in September, root wad treatments in September, and downstream deflector log treatments in July (Table 7).

Densities of rainbow-steelhead parr were consistently higher in sections with structures than in sections without structures in both July and September 1985 (Table 5). Densities of yearlings decreased between July and September in the upstream reach while increasing in the downstream reach (Fig. 7). Older rainbow-steelhead parr virtually disappeared from the project area by early September. Based on means of all treatments, habitats, and both months, the sections with instream structures supported a density of yearlings and older fish that was 1.8 fish/l00m2 higher than in controls representing a 66% increase in rearing density.

Additional observations of rainbow-steelhead densities were made in a few sections in early August and October (Table 8). Rainbow-steel head of all age groups had sought winter cover by early October either in the substrate or in downstream areas.

Juvenile chinook. Most of Lolo Creek was severely under-seeded by juvenile chinook during the 1985 evaluation (Table 5). However, densities had increased over 1984 levels (Appendix A-l).

Posttreatment evaluation of Lolo Creek instream structures for chinook rearing was ambiguous in 1985 due to low seeding and variable, clumped fish distributions (Table 5). Significant differences in chinook densities occurred in the F tests only for the section-type term (Table 6) which identified statistically that upstream run habitat (regardless of treatment) supported higher densities than upstream riffle habitat or downstream run habitat (Fig. 8). Juvenile chinook tended to use treated and untreated riffle habitat to a greater extent in September than in July.

Juvenile chinook had disappeared from the water column by early October (Table 8). As in the case of rainbow-steel head, juvenile chinook had either entered the substrate or had emigrated to downstream areas by fall.

Adults and redds. We observed only eight live adult chinook in the Lolo Creek project area in 1985. Five were using some type of instream structure for cover (Table 9). During juvenile fish surveys (September 3-5), we observed 13 redds in the project area, only two of which were located in areas affected by instream structures. The 13 redds observed on the ground compared favorably with the aerial redd count of 12 redds on September 4.

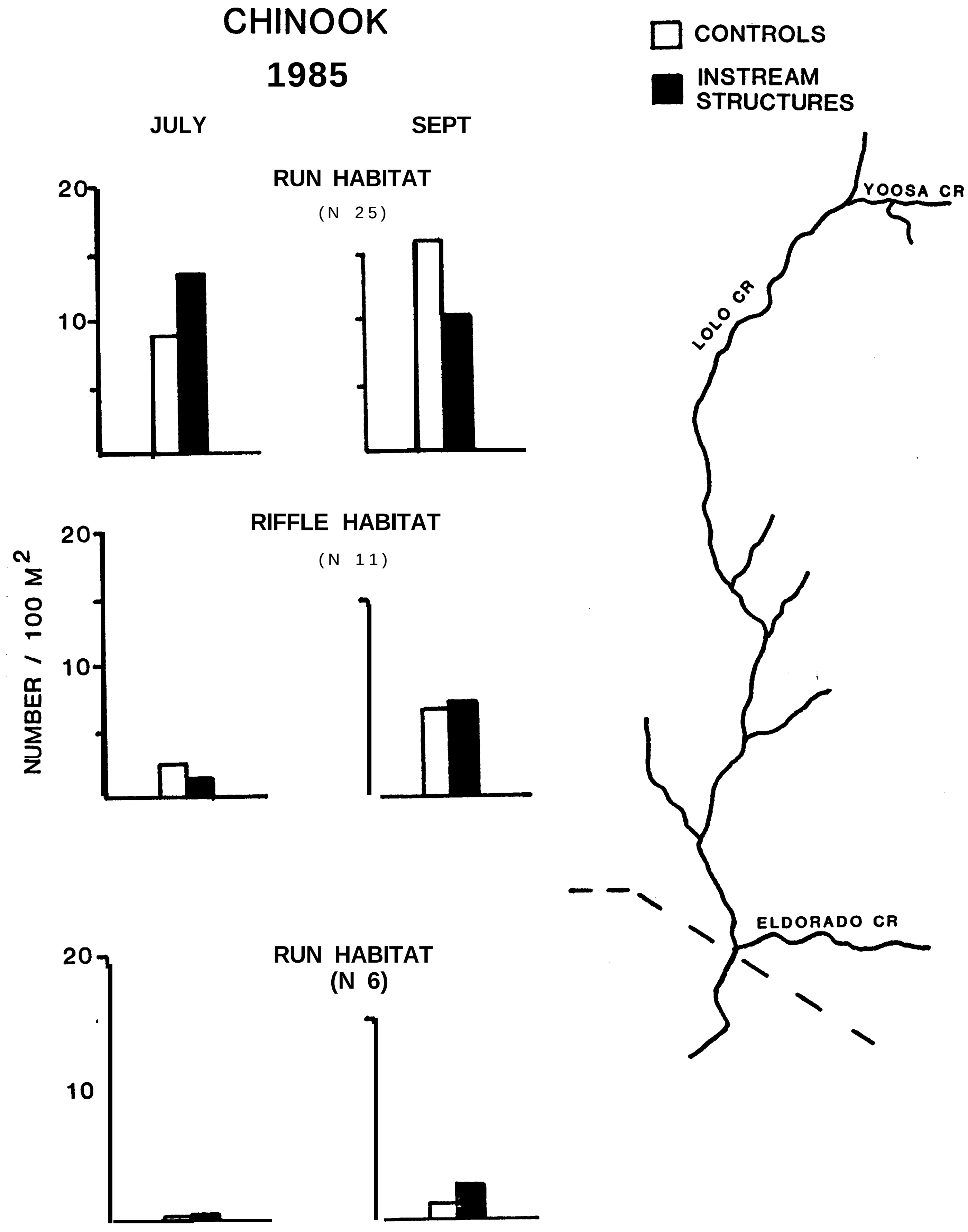

Figure 8. Density of age 0 chinook in treated and untreated sections, Lolo Creek, July and September 1985. Major habitat classifications are run and riffle habitat, upstream from Eldorado Creek and run habitat downstream from Eldorado Creek.

Table 8. Monthly changes in density (number/100m^2) by age group of rainbow-steelhead and chinook in selected Lolo Creek sections, July-October 1985.

Section type: habitat, treatment	Section	1985 date	Rainbow-steelhead				Chinook	
			0	1	2	≥3	0	1+
Upstream Sill log	8303	7/2	0	2.1	1.5	0	25.2	0.6
		8/4	14.2	0.7	0.7	0.2	33.7	0.9
		9/4	14.4	1.1	0	0	23.3	0.7
		10/11	0	0	0	0	0	0
Upstream run Sill log	8357	7/3	0	5.7	5.7	1.2	3.8	5.0
		8/4	8.7	3.9	5.1	0.7	5.8	2.7
		9/4	8.5	6.0	1.0	0	7.7	1.2
		10/11	0	0	0	0	0	0
Downstream run Deflector log	6	7/2	15.2	0.1	0.9	0	0.7	0
		8/4	-	-	-	-	-	-
		9/5	11.8	5.9	0.4	0.1	5.5	1.0
		10/11	0	0	0	0	0	0

Table 9. Observations of adult chinook and redds, Lolo Creek, 1985.

1985 date	Treated(T) Untreated(U)	Km above USFS boundary	Number of adults live	Number of adults dead	Number of redds	Comments
7/l-4	T	-	0	0	0	
	U	-	0	0	0	
7/29-31	T	7.9	2	0	0	Fish using natural bank cover, upstream pool of sill log.
	U	16.1	1	0	0	Fish using natural bankcover.
913-5	T	17.7	2	0	0	Fish using pool of sill log.
	T	16.4	0	0	1	Redd in tail-out of sill log pool.
	T	15.9	0	0	1	Redd in tail-out of sill log pool.
	T	0.3	1	0	0	Fish using deflector log for cover.
	U	17.7	1	0	4	Redds in natural gravel.
	U	16.1	0	1	4	Redds in natural gravel.
	U	15.9	0	0	1	Redds in natural gravel.
	U	14.3	1	0	2	Redds in natural gravel.

Resident salmonids. Resident trout and whitefish were present in the Lolo Creek project area in low densities in 1985 (Table 10). We observed cutthroat trout, brook trout, and hatchery rainbow trout only upstream of Eldorado Creek confluence; neither brook trout, nor cutthroat trout, had been observed in 1984. Whitefish were more abundant downstream than upstream of Eldorado Creek both years.

Physical habitat. Because evaluations began after project Implementation, habitat changes were measured indirectly in 1985 as a comparison of post-treatment conditions in treated and untreated sections (Table 11). Full effects of scour and deposition due to the structures were not evident in 1985, nor had the structures been subjected to a heavy run-off event.

In 1985, habitat was changed the most by sill-log applications in upstream run habitat. Compared to controls, sections with sill logs were deeper, slower, and contained more deposited sand (Table 11); benefits of scour pools and increased gravel sorting downstream of the sills were offset partially by sand deposition upstream of the sills.

Future Evaluation and Recommendations

Localized improvements in rearing habitat due to structure installations in Lolo Creek should be reevaluated in about 3-5 years provided that rainbow-steelhead and chinook densities have been increased to approximate full-seeding conditions. The 1985 sampling design should be maintained with some minor modifications. An additional three treated and three control sections should be added in the downstream reach. A mean tendency in 1985 for control runs to be farther upstream and lower gradient than treated runs (Table 4) should be corrected by addition of more control run sections. The rate of structure failure should be determined and factored into estimates of structure benefits.

Eldorado Creek

Eldorado Creek is 26 km long and enters Lolo Creek at stream kilometer 42 (Fig. 9). About 1 .6 km from its confluence with Lolo Creek, three natural basalt falls and a boulder constriction adjacent to USFS Road 500 restricted passage of anadromous fish. Removal of the barriers will bring an estimated 16-20 hectares of spawning and rearing habitat into production for steelhead and chinook.

The barriers had been a total block to both steelhead and chinook in recent years. Nez Perce tribal biologists surveyed Eldorado Creek in 1983 (Fuller et al. 1984) and found cutthroat trout to be the only salmonid above the barriers and found cutthroat trout to be the only

Table 10. Mean density (number/100m^2) by age group of cutthroat (CT), brook trout (BK), whitefish (WF), and hatchery rainbow trout (HRB), by habitat and treatment, Lolo Creek, July 1-4 and September 3-5, 1985.

Section type:	July						September					
habitat,	CT	BK		WF			CT	BK		WF		
treatment	>1	0	>1	0	>1	HRB	>1	0	>1	0	>1	HRB
Upstrewn run												
Untreated	0	0	+	0	+	0	0	+	0	0	0	+
Sill log	0.1	0	0.1	0.1	0	0.2	0	+	0.1	0	0.2	0.2
Deflector log	0	0	0	0	0	0	0	0	0	0	0	0.2
Root wad	0.1	0	0	0	0	0.1	0	0	0	0	0	0.1
Upstream riffle												
Untreated	0	0	0	0	0	0	0	0	0	0	0	0
Boulder cluster	+	0	0	0	0	0	0	0.1	0	0	+	+
Downstream run												
Untreated	0	0	0	0	0.2	0	0	0	0	0	0.4	0
Deflector log	0	0	0	0	0.1	0	0	0	0	0	0.3	0

Table 11. Summary of physical habitat measurements (by percent) in treated and untreated sections, Lolo Creek, July 29-31, 1985.

Section type:	Depth(m)					Velocity(mps)					Substrate[b]				Embeddedness (%)				
habitat		0.2-	0.5-	0.8-			0.3-	0.6-	0.9-							5-	25-	50-	
treatment	<0.2	0.4	0.7	1.0	>1.1	<0.3	0.5	0.8	1.1	>1.2	S	G	R	B	<5	25	50	75	>75
Upstream run																			
CONT	14.7	68.0	17.3	0	0	58.6	38.0	6.3	0	0	26.2	38.8	18.8	16.1	30.7	21.3	18.7	12.0	17.3
SILL	5.5	63.8	22.2	7.4	0.9	71.3	27.7	0.8	0	0	40.5	33.3	22.3	2.8	15.0	15.0	15.0	14.0	41.1
DEFL	26.6	73.3	0	0	0	46.6	48.8	4.4	0	0	23.4	47.3	22.0	7.2	44.4	22.2	4.4	0.7	22.2
ROOT	15.8	50.1	26.3	1.8	0	70.2	28.1	1.8	0	0	26.4	31.7	20.2	22.7	20.8	14.0	12.3	18.3	24.6
Upstream riffle																			
CONT	43.4	53.3	3.3	0	0	40.0	46.7	11.6	1.7	0	16,5	48.4	24.0	8.2	48.7	25.0	11.7	6.0	11.7
DEFL	18.3	76.7	6.1	0	0	43.0	33.3	17.6	3.5	1.7	16.7	44.0	27.2	12.2	53.3	20.0	10.0	6.0	11.7
Downstream run																			
CONT	4.2	85.8	0	0	0	8.3	87.5	4.2	0	0	8.2	48.8	42.3	3.0	41.7	37.5	16.7	4.2	0
DEFL	13.8	88.1	0	0	0	19.5	58.4	22.3	0	0	10.0	32.1	52.8	5.3	61.1	22.2	13.0	0	2.0

[a] CONT = control; SILL = sill log; DEFL = deflector log; ROOT = root wad; BOUL = boulder cluster.

[b] S = sand; G = gravel; R = rubble; B = boulder.

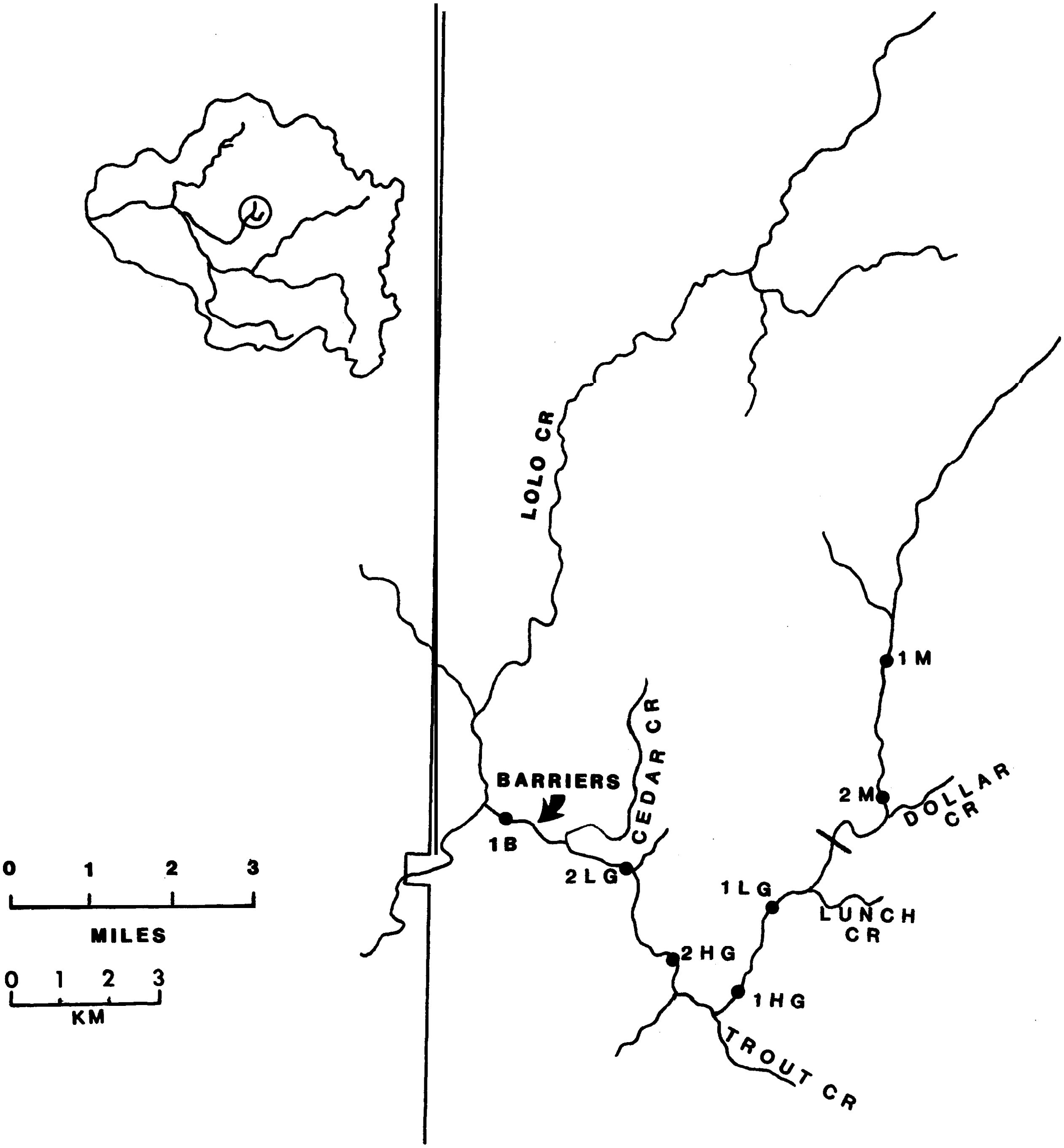

Figure 9. Location of 1984-85 barrier removal project on Eldorado Creek and established monitoring sections.

salmonid above the barriers. A few resident rainbow trout had also been reported above the barriers prior to barrier removal (W. Murphy, USFS, Kamiah, Idaho, personal communication).

Eldorado Creek has been degraded to a similar degree as Lolo Creek from past timber harvesting and road construction. This BPA habitat project addresses only the adult passage problems at the barriers.

Objectives of this project are: (1) provide access for adult steelhead and chinook into spawning and rearing areas of Eldorado Creek, (2) introduce populations of suitable stock into habitat made available by the Barrier Removal project, and (3) increase natural production of steelhead and chinook consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin CL-3.

Anadromous Fish Management Considerations

Management plans call for hatchery supplementation of Eldorado Creek whenever seeding of natural production capacity is below the full-seeding level. With the barrier being removed in 1985, stocking of hatchery-produced juvenile salmon and steelhead into Eldorado Creek will be extensive over the next several years. Introductions of summer steelhead (Clearwater "B" - Dworshak NFH) began in 1985 into Eldorado Creek above the barriers. A total of 1,150 adult steelhead (248 males and 902 females) were outplanted from Dworshak NFH in April 17-19, 1985, and allowed to spawn naturally. During April 29-May 1, 1985, 121,284 steel head smolts were outplanted above the barriers; all smolts were marked with an adipose clip. Two-ocean adults should return to spawn in 1988 from the 1985 smolt releases and in 1990 from the 1985 adult releases.

Spring chinook had not been introduced into Eldorado Creek above the barriers through 1985 due to a lack of availability of appropriate stock.

Portions of Eldorado Creek were probably full seeded with steelhead fry in 1985 from the spawning of 1,150 surplus spawners from Dworshak Hatchery.

1984-1985 Barrier Removal Project

Four migration barriers on Eldorado Creek were successfully modified by blasting in 1984-1985 to allow upstream passage of adult steelhead and chinook (Murphy and Espinosa, 1985). No further work on the barriers should be necessary.

Project Evaluation

Evaluation status. Because the barriers completely blocked upstream passage of adult steel head and chinook, evaluations will be based on the estimated standing crops of anadromous fish that can be supported above the barriers at full seeding. Two levels of evaluation are planned for the Eldorado Creek project. General monitoring of fish densi ties will be used to determine full-seeding levels, and standi ng crop estimates will be made when anadromous populations are determined to be close to potential. Through 1985, monitoring sections have been established and sampled. A post-treatment standing crop estimate for the drainage is planned for 1986.

The IDFG evaluation of the Eldorado Creek project began in 1984 as a pretreatment assessment of anadromous and resident fish populations. We found no evidence of anadromous fish use above the barriers in 1984 (Petrosky and Holubetz 1985). Cutthroat trout was the only salmonid species observed above the barriers in 1984 and, also, in a 1983 survey by the Nez Perce tribe (Fuller et al. 1984).

The IDFG established new monitoring sections in 1985 selected to be more easily identified for repeatability in future monitoring. Two sections (1M and 2M) were established in the upper low-gradient meadow above Lunch Creek confluence (Fig. 9 and Table 12). We identified two general habitat types in the reach between the barriers and Lunch Creek and selected two sections from each type. Low-gradient areas (1% and less, Sections 1LG and 2LG) in this reach were characterized by long, slow runs with few riffles. Relatively higher-gradient portions (Sections 1HG and 21-G 1 of the reach contained more riffle area and occasional pocket water. Section 1B below the barriers was retained from the 1984 survey.

Sampling in 1985 included monitoring of juvenile anadromous fish and resident salmonid densities in seven sections during July 31-August 4. Additional observations on timing of steelhead fry emergence were made July 4, 1985, in conjunction with Lolo Creek sampling.

Juvenile rainbow-steelhead. Two groups of rainbow-steel head were observed in 1985 above the Eldorado Creek barriers, both the result of 1985 releases. Age 0 steel head, progeny from the 1985 adult outplants, were present in an 11.6 km reach above the barriers to Lunch Creek (Table 13). Residualized, adipose-clipped steel head from 1985 smolt releases were also observed in this reach. Below the barriers, rainbow-steel head parr were present in similar densities in 1984 and 1985 (Appendix A-2).

Outplanting adult steel head in 1985 provided a high level of seeding of fry in an 11.6 km reach of Eldorado Creek (Table 13). Downstream drift of steel head fry also partially seeded Eldorado Creek

Table 12. Sections sampled in Eldorado Creek, July 31 (above barriers) and August 4, 1985 (below barriers).

Location, section	% gradient	Section width(m)	Section area(m^2)	% Habitat Type		
				pool, run	riffle	pocket water
Above barriers						
1M	0.6	15.7	597	100.0	0	0
2M	0.5	6.4	510	100.0	0	0
1HG	1.6	7.5	758	13.3	26.7	60.0
1LG	0.6	11.6	1054	93.3	6.7	0
2HG *	1.3	9.3	889	86.7	13.3	0
2LG	1.0	6.3	539	86.7	13.3	0
Below barriers						
1B[a]	2.5	7.5	505	14.3	0	85.7

[a] Sampled shorter section than in 1984--turbidity was moderate following thunder storms and high flow.

Table 13. Density (number/100m^2) by age-group of rainbow-steelhead and chinook above and below barriers, Eldorado Creek, July 31 and August 4, 1985.

Location, section	Rainbow-steelhead				Chinook		Adipose-clipped steelhead[a]
	0	1	2	≥3	0	1+	
Above barriers							
TM	0	0	0	0	0	0	0
2M	0	0	0	0	0	0	0
IHG	51.8	0	0	0	0	0	2.1
1LG	13.5	0	0	0	0	0	0.9
2HG	54.6	0	0	0	0	0	2.4
2LG	126.7	0	0	0	0	0	0.7
Below barriers							
1B	18.6	2.6	2.6	0.2	0	0	0.2

[a] Residualized steelhead from 1985 smolt releases.

below the barriers and downstream portions of Lolo Creek (Table 14). The first opportunity to estimate the number of yearling steelhead produced within Eldorado Creek above the barriers (from a known number of adults) will be in 1986. The contribution to downstream areas by fish produced above Eldorado Creek barriers probably will not be estimable from the planned level of evaluation.

A portion of steelhead smolts released into Eldorado Creek in spring 1985 residualized. By late July, the reach between the barriers and Lunch Creek contained an estimated 1,549 ± 833 residualized steel head smolts or about 1.3$ of the number released in April. Because mortality and downstream drift could not be accounted for, 1.3% residualization is a conservative estimate.

Juvenile chinook. No juvenile chinook were observed in Eldorado Creek sections in 1984 or 1985 either above or below the barriers (Petrosky and Holubetz 1985) (Table 13).

Resident salmonids. Cutthroat trout was the only resident salmonid species identified upstream of the barriers in Eldorado Creek during surveys in 1983 (Fuller et al. 1984), 1984 (Petrosky and Holubetz 1985), and 1985 (Table 15). Cutthroat densities were slightly higher in 1985 than in 1984. Below the barriers in 1985, cutthroat and mountain whitefish were present in low densities.

Physical habitat. Except for determinations of section lengths, widths, gradients, and percentage habitat type (Table 12), physical habitat has not been measured in Eldorado Creek for these evaluations. In general, Eldorado Creek appeared to contain good rearing habitat for juvenile anadromous fish although sediment levels are high. Spawning habitat upstream from Lunch Creek appeared scarce. Physical habitat will be measured in the 1986 evaluation.

Future Evaluation and Recommendations

Future project evaluation for mitigation requires a determination on whether improved passage was actually attained and standing crop estimates for juvenile rainbow-steelhead and chinook at full seeding. Observations should be made at the barriers as adult steelhead and chinook begin to return from initial introductions. When adult chinook first return, an annual spawning ground survey should be initiated in Eldorado Creek.

Unbiased estimates of standing crops can be calculated from densities in stream sections with application of either a stratified random or systematic stratified sampling design (Scheaffer et al. 1979). Strata should include the reach from the barriers to Lunch Creek, the reach above Lunch Creek, and one reach for each tributary that is accessible to juvenile anadromous fish (i.e., Cedar Creek, Trout Creek, and Dollar Creek).

Table 14. Density (number/100m^2) by age-group of rainbow-steelhead, chinook, and cutthroat trout during July 1-4, 1985 in Eldorado Creek, compared to densities in Lolo Creek above and below the confluence.

Stream, location	Area sampled(m^2)	Rainbow-steelhead				Chinook		Cutthroat
		0	1	2	≥3	0	1+	≥1
Eldorado Creek								
Above barriers; near section 2M	180	0	0	0	0	0	0	1.7
Above barriers; Subsection 2HG	232	176.7	0	0	0.4[a]	0	0	9.5
Above barriers; Road 5119 bridge	111	495.6	0	0	0	0	0	6.3
Lolo Creek								
Above El dorado Creek (36 sections)	13,766	0.1	3.1	3.0	0.1	8.8	0.7	0.03
Below El dorado Creek (6 sections)	4,877	14.8	0.6	0.6	0.03	0.3	0.02	0

[a] Single fish, probably a residualized steel head smolt.

Table 15. Density (number/100m2) by age-group of cutthroat trout and whitefish, above and below barriers, Eldorado Creek, July 31 and August 4, 1985.

Location, section	Cutthroat	Whitefish	
	≥1	0	≥1
Above barriers			
1M	10.7	0	0
2M	12.9	0	0
1HG	7.5	0	0
1LG	5.0	0	0
2HG	8.8	0	0
1LG	5.4	0	0
Below barriers			
1B	0.4	0	0.2

A complete set of physical habitat measurements will not be essential to estimate benefits for th Eldorado Creek project. However, this data should be collected to compare fish population responses between streams as part of an overall, integrated data base.

Upper Lochsa River

The Lochsa River is formed by the confluence of Crooked Fork Creek and White Sand Creek (Fig. 10). Each major tributary is about 39 km long and drains about 60,000 hectares of the Bitterroot Mountains (Espinosa 1984). Crooked Fork Creek watershed is owned by USFS (77%) and Plum Creek Timber Company (23%). White Sand Creek watershed is owned primarily by USFS (98%); this tributary originates in the Selway-Bitterroot wilderness area. The two streams have similar channel gradients (1%) and flows (4.5-4.8 m^3/s, base; 85 m^3/s, peak). The project area includes USFS-owned portions of Crooked Fork Creek and White Sand Creek outside of the wilderness area.

Crooked Fork Creek and White Sand Creek are major producers of summer steelhead and spring chinook for the Lochsa River. Within their systems, they contain the bulk of the remaining high quality spawning and rearing habitat for anadromous fish on the Clearwater National Forest. The long-term ability to restore and maintain anadromous fish runs to the upper Lochsa River depends on maintenance and enhancement of spawning and rearing habitat in these two systems. Records of densities of juvenile rainbow-steel head and chinook for Crooked Fork Creek and White Sand Creek go back to 1975 when steel head run size was the lowest in recent history (Graham 1977, and Mabbott 1982). Existing juvenile density data from 1975-1984 was summarized in Petrosky and Holubetz (1985).

Nonanadromous salmonids in the upper Lochsa River system are rainbow trout, cutthroat trout, bull trout, brook trout, and mountain whitefish (Mallet 1974).

Extensive timber harvesting and road construction has occurred during the past two decades primarily in the lower half of Crooked Fork Creek watershed and its subdrainage, Brushy Fork Creek (Espinosa 1984). Only the lower 5 km of White Sand Creek drainage have been developed extensively. A series of seven major natural barriers blocked salmon passage and usually blocked steelhead passage to high-quality rearing habitat in upper Crooked Fork Creek. No migration barriers exist in White Sand Creek within the project area.

The USFS habitat surveys on Crooked Fork Creek in 1979 and White Sand Creek in 1971 suggested that some potential limiting factors to fish production were suboptimum levels of pool quality, bank cover, pool/riffle structure, and habitat diversity (Espinosa 1984). The surveys also suggested that suitable spawning habitat might be limiting

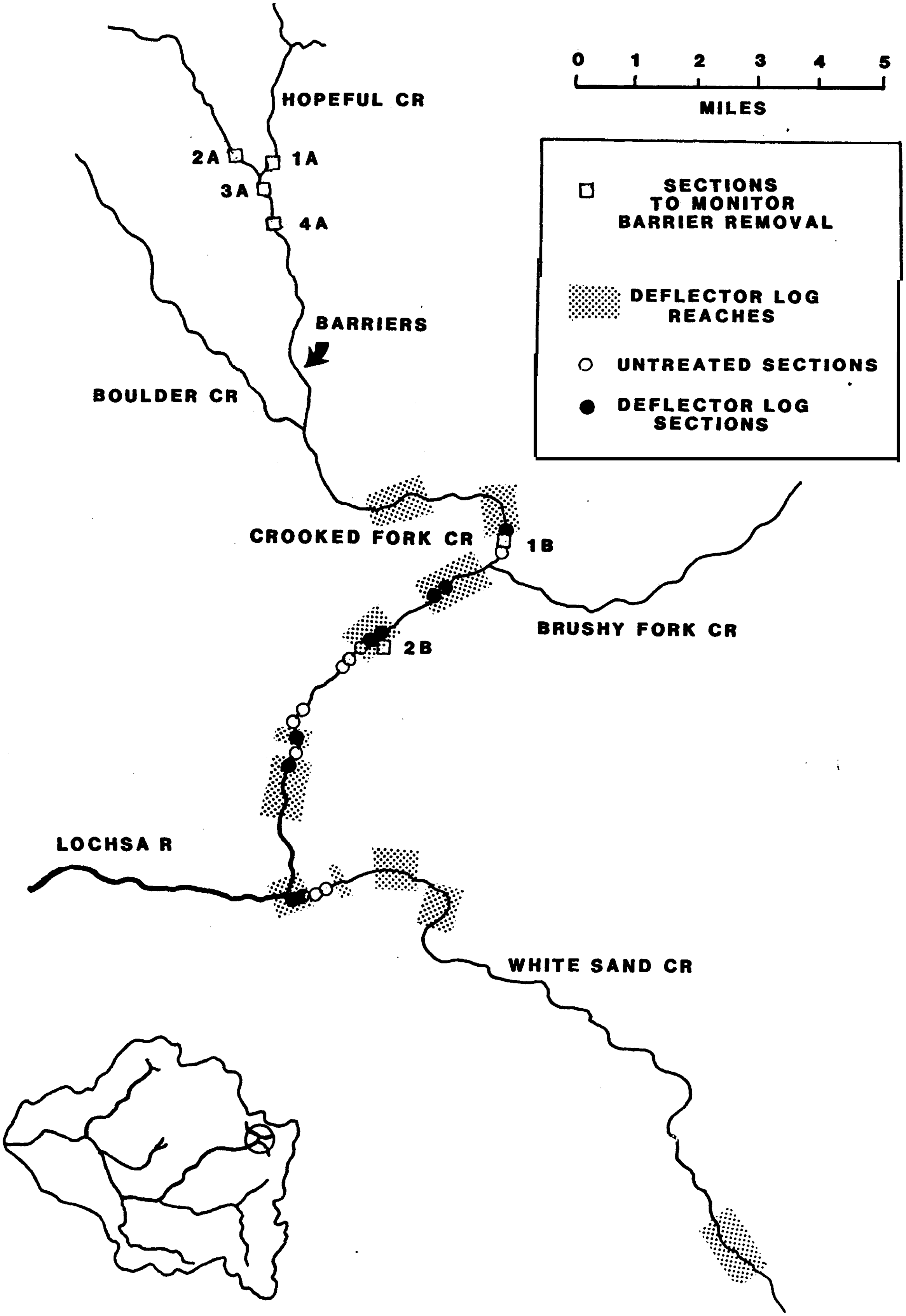

Figure 10. Location of 1983 instream habitat enhancement project and 1984-85 barrier removal project on the upper Lochsa and established monitoring sections.

in Crooked Fork Creek. in 1981, USFS fish abundance surveys on Crooked Fork Creek above the barriers found age 1 rainbow-steelhead present in low densities (1.5/100 m^2), evidence that a few adult steelhead passed the barriers in 1980 (R. Kramer, USFS, Powell Ranger District, personal communication),

Objectives of the instream Habitat Enhancement project in Crooked Fork Creek and White Sand Creek were: (1) increase rearing potential for juvenile steelhead and chinook, (2) increase pool frequency and quality, and (3) increase natural production of steel head and chinook consistent with IDFG (1985) anadromous Fish Management Plan for Subbasin CL-6.

Objectives of the Barrier Removal project on Crooked Fork Creek were (1) provide access for adult steelhead and chinook into spawning and rearing areas of upper Crooked Fork Creek; (2) if necessary, introduce populations of suitable stock into habitat made available by barrier removal; and (3) increase natural production of steelhead and chinook consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin a-6.

Anadromous Fish Management Considerations

A weir and acclimation pond will be constructed near the confluence of White Sand Creek and Crooked Fork to support smolt outplants and adult trapping for the Clearwater Hatchery. This program should return large numbers of spawning adults to this area, and the habitat of the upper Lochsa should be fully utilized in the future.

Prior to the fishway improvement at Lewiston Dam and reintroduction program that followed, the only known self-sustaining population of chinook salmon in the entire Clearwater River drainage was located in Crooked Fork. Obviously, the lower portions of Crooked Fork contain quality habitat for chinook salmon and steelhead trout but the upper portion of Crooked Fork above the series of barriers and Hopeful Creek contain even higher quality habitat.

Idaho Department of Fish and Game will stock the upper portion of Crooked Fork and White Sand Creek with appropriate races of spring chinook and steel head fry over the next several years to ensure that those production areas that have been made accessible by the Barrier Removal project will be brought into full production. Much of this area will have to be stocked by helicopter as there is limited road access.

Stocking records indicate that lower Crooked Fork Creek was previously stocked in the 1970s with steelhead fry (Clearwater "B") and spring chinook fry.

1983 Instream Habitat Enhancement

in 1983, USFS personnel installed 261 deflector log structures in Crooked Fork Creek and White Sand Creek by felling and cabling into place riparian conifers or by cabling existing organic debris. High water and an ice jam which moved through the project area in winter 1984 reduced effectiveness of the structures.

Maintenance and evaluation of the structures by USFS in 1984 indicated a failure rate of 20% after one year due to structures being swiveled onto the bank and breakage (Kramer and Espinosa 1985); 25% of the structures were actively scouring and 29% were suspended on rocks above the water during low flow in 1984. The estimated total pool habitat scoured by the structures was 1,452 m^2 (5.6 m^2 per structure installed).

1984-1985 Barrier Removal

The USFS personnel began a blasting project on natural barriers in upper Crooked Fork Creek in 1984 and completed the project in 1985 (Kramer, Oman, and Espinosa 1986). Natural barriers included several waterfalls and rock chutes on Crooked Fork Creek and a debris jam on the tributary Hopeful Creek.

Project Evaluation

Evaluation status. Final evaluations for mitigation purposes of both the Instream Structure project and the Barrier Removal project should be conducted at full seeding. Two levels of evaluation are planned for the projects. General monitoring of fish densities will be used to determine full-seeding levels. Benefits of the instream structure project can be determined from a comparison of anadromous fish densities in treated and control sections. Benefits of the Barrier Removal project can be determined from estimated standing crops of juvenile rainbow-steelhead and chinook above the barrier. Through 1985, monitoring sections have been established and sampled and an early evaluation of benefits of the instream Structure project was conducted in 1984.

The IDFG evaluation of effectiveness of instream structures in Crooked Fork Creek and White Sand Creek began in 1984, one year after structure installation. A total of nine sections with deflector logs and nine control sections were sampled in August 1984. We found no measurable increase in densities of rainbow-steelhead or chinook due to presence of the structures and little evidence of change in the summer rearing habitat (Petrosky and Holubetz 1985). Fish response to the structure applications can be reevaluated in the future at higher seeding levels if the remaining structures appear to have significantly altered the habitat through scour and deposition.

The IDFG evaluation of the Barrier Removal project on Crooked Fork Creek began in 1984 as a pretreatment assessment of anadromous and resident fish populations. Conclusions from the 1984 survey (Petrosky and Holubetz 1985) and earlier sampling by USFS (A. Espinosa, USFS, personal communication) were that the falls completely blocked passage of adult chinook and blocked adult steelhead passage in most years. Cutthroat trout dominated fish populations above the barriers.

The IDFG sampling in 1985 consisted of monitoring fish densities during July 9-11 in six Crooked Fork Creek sections, four above and two below the barriers (Table 16). Downstream sections were also sampled in White Sand Creek and the Lochsa River. Physical habitat variables were measured in the general monitoring sections of Crooked Fork Creek in 1985.

<u>Juvenile rainbow-steelhead</u>. Crooked Fork Creek below the barriers was severely under-seeded by rainbow-steelhead in 1985 (Table 17); no rainbow-steelhead were observed above the barriers. Densities in established monitoring sections below the barriers were lower in 1985 than in 1983 and 1984 (Appendix A-3).

Steelhead fry may be available for initial introductions into upper Crooked Fork Creek in 1986. Standing crops of age 0 and yearling steelhead upstream of the barriers which result from the introductions can be estimated in 1986 and 1987.

<u>Juvenile chinook</u>. Crooked Fork Creek below the barriers was severely under-seeded by age 0 chinook in 1985 (Table 17). Densities in Crooked Fork Creek declined in 1985 from levels in 1983 and 1984 (Appendix A-3).

Chinook fry will be available for initial introductions into upper Crooked Fork Creek in 1986. The standing crop of age 0 chinook above the barriers which results from the introductions can be estimated in 1986.

<u>Resident salmonids</u>. Above the Crooked Fork barriers, salmonid populations were dominated by cutthroat trout in 1985 (Table 18). Cutthroat were present above the barriers in similar densities in 1985 (4,9/100 m^2) as in 1984 (4.6/100 m^2). Bull trout were rare above and below the barriers. We observed whitefish only downstream of the barriers in both years.

<u>Physical habitat</u>. Aquatic habitat upstream of the barriers in Crooked Fork Creek is high quality and much of it is pristine. Depths and velocities were optimal for juvenile anadromous fish rearing (Bovee 1978), and the substrate contained only small amounts of deposited sand (Table 19).

Table 16. Sections sampled in Crooked Fork Creek, above and below barriers, and in downstream areas of the Lochsa River drainage July 9-11, 1985.

Location, section	% gradient	Section width(m)	Section area(m^2)	% Habitat Type pool, run	riffle	pocket water
Crooked Fork Above barriers						
1A	1.9	7.1	771	43.0	27.0	30.0
2A	2.4	4.7	446	50.0	30.0	20.0
3A	1.3	8.9	1953	57.0	43.0	0
4A	1.6	11.1	2458	40.0	50.0	10.0
Crooked Fork Below barriers						
1B	1.3	17.5	2998	48.0	52.0	0
28	1.4	20.4	3053	58.0	42.0	0
White Sand						
WS1	0.7	39.8	3980	100.0	0	0
Lochsa River						
LI	-	38.7	4833	80.0	20.0	0
L2		50.1	6057	100.0	0	0
L3		37.8	5786	100.0	0	0
L4		55.3	6188	100.0	0	0

Table 17. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in Crooked Fork Creek, above and below barriers, and in downstream areas of the Lochsa River drainage, July 9-11, 1985.

Location, section	Rainbow-steelhead				Chinook	
	0	1	2	≥3	0	1+
Crooked Fork Above barriers						
1A	0	0	0	0	0	0
2A	0	0	0	0	0	0
3A	0	0	0	0	0	0
4A	0	0	0	0	0	0
Crooked Fork Below barriers						
1B	1.4	0.1	0.5	0.2	0.4	0
2B	8.3	0.6	1.0	0.2	0.5	+
White Sand						
WS1	0	0.4	0.6	0.1	0.1	+
Lochsa River						
L1	2.6	0.2	0.5	0.2	0	0
L2	1.0	0.1	0.1	+	+	0
L3	0.9	0.3	0.4	+	0.1	+
L4	1.3	+	0.3	0.1	0	0

Table 18. Density (number/100m^2) by age-group of cutthroat trout, bull trout, whitefish, and hatchery rainbow trout (catchable-size) in Crooked Fork Creek, above and below barriers, and in downstream areas of the Lochsa River drainage, July 9-11, 1985.

Location, section	Cutthroat	Bull		Whitefish		Hatchery rainbow trout
	≥1	0	≥1	0	≥1	
Crooked Fork Above barriers						
1A	5.1	0	0	0	0	0
2A	8.5	0	0.2	0	0	0
3A	3.4	0	0	0	0	0
4A	2.4	0	0	0	0	0
Crooked Fork Below barriers						
1B	0.1	0	0	0	0.4	0
28	0.2	0	0	0	0.6	0
White Sand						
WS1	0.1	0	0	0	0.2	0
Lochsa River						
L1	0.1	0	0	0.2	0.4	0
L2	+	+	0	0	0.5	0
L3	0.1	0	0	0	1.2	0
L4	+	0	0	+	0.5	0.1

Table 19. Summary of physical habitat measurements (by percent) in the Crooked Fork Creek sections, July 9-10, 1985.

Location,	Depth(m)					Velocity(mps)					Substrate[a]				Embeddedness (%)				
section	<0.2	0.2- 0.4	0.5- 0.7	0.8- 1.0	>1.1	<0.3	0.3- 0.5	0.6- 0.8	0.9- 1.1	>1.2	S	G	R	B	<5	5- 25	25- 50	50- 75	>75
Above barriers																			
1A	26.7	66.7	6.7	0	0	46.7	40.0	10.0	3.3	0	7.2	24.3	35.8	32.7	93.3	3.3	3.3	0	0
2A	30.0	63.3	6.7	0	0	26.7	46.7	13.3	0	0	7.5	22.0	31.7	38.8	90.0	10.0	0	0	0
3A	16.7	73.3	10.0	0	0	50.0	16.7	20.0	10.0	3.3	11.8	18.3	34.0	35.8	73.3	26.7	0	0	0
4A	3.3	83.3	0	0	3.3	26.7	56.7	13.3	3.3	0	8.3	26.5	47.8	17.3	66.7	26.7	0	3.3	3.3
Below barriers																			
1B	0	55.6	33.3	11.1	0	18.5	29.6	37.0	0	14.8	2.2	23.3	43.9	30.6	96.3	3.7	0	0	0
2B	0	29.2	62.5	8.3	0	-	-	-	-	-	2.1	15.8	55.4	26.7	100.0	0	0	0	0

[a] S = sand; G = gravel; R = rubble; B = boulder.

Future Evaluation and Recommendations

Future evaluation and fish response to deflector log applications may be necessary depending on the longevity of the remaining structures. Differences in full-seeding densities of rainbow-steelhead and chinook between sections with and without structures can be used to estimate benefits for mitigation purposes. increased seeding levels in the upper Lochsa River will be aided by stocking and the development of a chinook rearing pond in the vicinity of Powell (IDFG 1985).

Observations should be made at the barriers as adult steel head and chinook begin to return from initial introductions. The existing spawning ground survey in Crooked Fork Creek should be extended into the reach above the barriers. Juvenile rainbow-steelhead and chinook densities above barriers in years without supplementation also can be used to infer successful passage.

Benefits of barrier removal can be determined for mitigation purposes from estimates of standing crops of juvenile anadromous fish at full seeding (Table 1). Annual monitoring of densities in established sections will help define full-seeding levels. Unbiased estimates of population totals can be calculated from densities in stream sections, using an increased number of sections in either a stratified random or systematic stratified sampling design (Scheaffer et al. 1979). Strata should include Crooked Fork Creek from the barriers to Hopeful Creek, Crooked Fork Creek above Hopeful Creek, and Hopeful Creek. Collection of physical habitat data will not be essential to evaluations of the Barrier Removal project. However, these data should be collected as part of an overall data base for comparison of fish population responses between streams.

SOUTH FORK CLEARWATER RIVER

Crooked River

Crooked River, 27 km long, enters the South Fork Clearwater River at river kilometer 95 (Fig. 11). The stream lies within the Nez Perce National Forest. The streambed was dredge mined for gold during the 1950s, and mining claims underlie much of the stream and surrounding area. The stream runs through two highly-degraded meadow reaches. Presently, the BPA-funded habitat enhancement project addresses problems only in the upper meadow (Reaches I and II).

Crooked River supports runs of summer steel head and spring chinook which were reestablished in the 1960s following removal of Harpster Dan on the South Fork Cleat-water River in 1962. Crooked River has potential to support much larger runs of steelhead and chinook than it does presently. Because of its high-quality water, habitat potential,

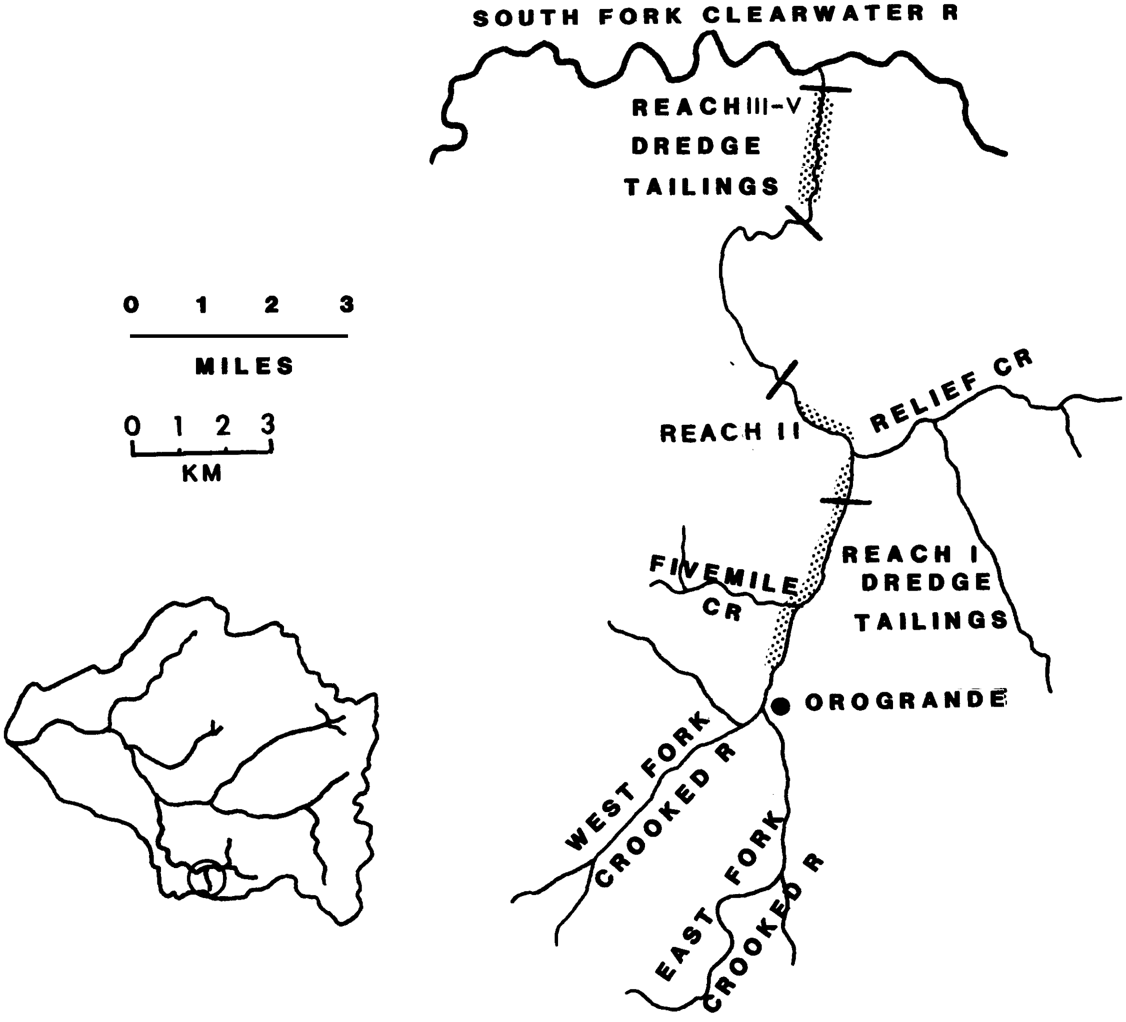

Figure 11. Location of 1984-85 habitat enhancement project on Crooked River.

and location in the South Fork drainage, IDFG (1985) has identified Crooked River as an important production stream in their Idaho Anadromous Fish Management Plan.

Salmonids identified in Crooked River in a 1983 survey of the two degraded meadas by USFWS in decreasing order of abundance were juvenile chinook, mountain whitefish, rainbow-steelhead, bull trout, and cutthroat trout (Fishery Assistance Office, USFWS, Ahsahka, Idaho, unpublished data). Nearly ail juvenile chinook and whitefish were found in the lower meadow.

Dredge mining for gold in the streambed severely degraded Crooked River during the 1950s. in the upper meadow (Reaches I and II), dredge tailing forced the stream to the outside of the meadow resulting in a relatively straight, high-gradient channel. in the lower meadow (Reaches III-V), tailings were piled perpendicular to the general stream course, forcing the stream into unnaturally long, slow meanders. Ground water flows through and around tailing piles in both meadows creating many of f-channel ponds and sloughs. During runoff, juvenile trout and salmon use some of these ponds and are trapped as flow recedes. Compounding problems in Reach I, a culvert at a road crossing had partially blocked adult steelhead passage at high flows, adult chinook passage at low flows, and juvenile steelhead and chinook passage at all flows (Stowell 1984a).

A BPA-funded habitat enhancement project was implemented in 1984 for Reach I, following planning stages in 1983. Objectives of the project were:

1. improve passage to the upper meadow by juvenile and adult steelhead and chinook;
2. increase carrying capacity of the stream in the upper meadow;
3. Connect of f-channel ponds to Crooked River to provide additional rearing habitat;
4. Gain information that can be used to rehabilitate other dredge-mined streams, such as Yankee Fork, Newsome Creek, and American River; and
5. increase natural product I on of steel head and chinook consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin a-4.

Anadromous Fish Management Considerations

After the Harpster Dam was removed and the fishways were improved at Lewiston Dam in the early 196Os, chinook salmon and steel head trout were released into Crooked River to reestablish the salmon and steelhead populations.

Summer steelhead (Clearwater "B") from Dworshak NFH have been released into Crooked River since 1969. Subsmolts were stocked in 1969, 1971, 1974, and 1981, smolts in 1984 and 1985, and adults in 1978 and 1985.

A total of 2,030 excess adult steelhead spawners (370 males, 1,363 females, and 297 not sexed) were released into Crooked River during April 24-May 2, 1985. These spawners produced large numbers of fry, and the majority of Crooked River was probably fully seeded with fry in 1985. A total of 42,235 steelhead smolts, all marked by an adipose clip, were released during April 29-May 1, 1985.

Chinook salmon fry have also been produced in an incubation channel at Orogrande and released into Crooked River in the past.

Management direction for Crooked River calls for a Smolt Release/Adult Recapture Satellite program that would support the new Clearwater Hatchery. In addition to this program, the weir to be constructed near the mouth of Crooked River will be used to monitor adult escapement into Crooked River and migration of juveniles out of Crooked River under the intensive evaluation studies. In 1986 and 1987, efforts will be made to fully seed portions of Crooked River to document full-seeding levels for salmon and steelhead parr in this environment.

Hatchery spawners, fry and fingerlings, will be stocked as needed in Crooked River in future years to assist in bringing the natural production of Crooked River to full capacity. Returns of smolt outplants to Crooked River will also add to spawning escapements and the ability to fully seed the natural production capacity.

1984-1985 Habitat Enhancement Project

Reach I. Enhancement activities in Reach I to date have consisted of replacing a barrier culvert with a bridge during September-October 1984, installation of instream structures (log weirs, boulder weirs and deflectors, instream organic debris, etc.) during 1984-1985, bank stabilization and revegetation with grass seed and shrubs in 1984-1985, and connection of an off-channel pond to the stream channel in 1984 (Hair and Stowell 1986).

Initial plans to lengthen the stream channel by reconstructing the channel through the tailings have not been carried out. Engineering feasibility and design studies in 1984 indicated that the channel changes as proposed would be expensive and would not substantially increase the channel length (J. Orsborne, Civil and Environmental Engineering, Washington State University, personal communications). The possibility of lengthening the stream channel in other locations of Reach I has been impeded by possible conflicts with mining claims. The engineering studies identified flood plain development as an alternative approach to channel reconstruction.

Reach II. Enhancement activity in 1985 consisted of instream structure placements, bank stabilization, riparian planting, and the connection of of f-channel ponds. Flood plain development of channelized areas was also accomplished in 1985 to allow for reduced scouring and increased deposition of fines during runoff to improve conditions for riparian revegetation.

Reaches III-V. No subprojects have been implemented in the lower meadow of Crooked River. There appears to be an excellent opportunity for connection of off-channel ponds in this area.

Project Evaluation

Evaluation status. Three basic levels of evaluation are planned for Crooked River: general monitoring; evaluations based on standing crops ; and an intensive study designed to determine relationships between spawner escapements, standing crops, and smolt yields. Through 1985, monitoring sections have been established and sampled and sampling approaches for standing crop evaluations have been established. The first posttreatment evaluation of the Crooked River project is planned for 1986. The intensive study will be initiated after the construction of an upstream and downstream migrant trapping facility.

In-channel and off-channel portions of the Crooked River project will require different evaluation approaches. Of f-channel pond developments can be evaluated as habitat additions (Petrosky and Holubetz 1985; Everest et al. 1984). in-channel enhancement requires establishment of control sections within the treated stream reaches (Table 20) to determine differences in rearing densities between treated and untreated sections. The replacement of the barrier culvert should be treated as a removal of a partial barrier; a fraction of the production potential upstream of the culvert site (based on unenhanced conditions) can be used as a mitigation benefit.

The IDFG evaluation of the Crooked River project began in 1984 as a pretreatment assessment of the work planned for 1984-1985 in Reach I. Permanent sections were established and sampled in portions of Reach I that were to be treated with structures, rechanneled, or left untreated (Fig. 12). Physical habitat conditions were measured before implementation by Intermountain Forest and Range Experiment Station (IFRES, USFS, Boise, Idaho) under subcontract to IDFG. Additional monitoring sections were also established downstream in Reaches III-V prior to formulation of definite enhancement plans.

Pretreatment fish monitoring during 1984 indicated low densities of anadromous fish in Reach I which was due to a combination of depressed spawner escapements, the partial barrier at the culvert, and degraded habitat conditions (Petrosky and Holubetz 1985). Anadromous fish densities downstream in Reaches III-V were higher and canparable to densities in nearby Red River.

Table 20. Status through 1985 of sampling for the experimental design anticipated for post-treatment evaluations of localized improvements in rearing, Crooked River project.

Reach, section	Treatment type[a]	Year enhanced	Years physical habitat sampled: control/pre-	Years physical habitat sampled: post-	Years fish population sampled: control/pre-	Years fish population sampled: post-
Reach I						
Control 1	C	-	84,85	-	84,85	-
Control 2	C	-	84,85	-	84	-
Rechannel A	U	-	84	-	84	-
Rechannel B	U	-	84	-	84,85	-
Sill log A	IS	84,85	-	-	84	85
Sill log B	IS	84,85	84	-	84	-
Boulder A	IS	84,85	84,85	-	84	-
Boulder B	IS	84,85	-	-	84	85
Reach II						
Control 1	C	-	85	-	85	
Control 2	C	-	-	-	-	
Treatment 1	IS,FP	85	85	-	85	
Treatment 2	IS,FP	85	-	-	-	
Reach III-V						
Control 1[b]	C	-	-	-	-	
Control 2[b]	C	-	-	-	-	
Treatment 1[b]	U	-	-	-	-	
Treatment 2[b]	U	-	-	-	-	

[a] C = control; IS = instream structure; FP = flood plain development; U = undetermined.

[b] Sections established in 1984 and 1985 probably can serve as controls or pre-treatments once specific enhancement plans are formulated.

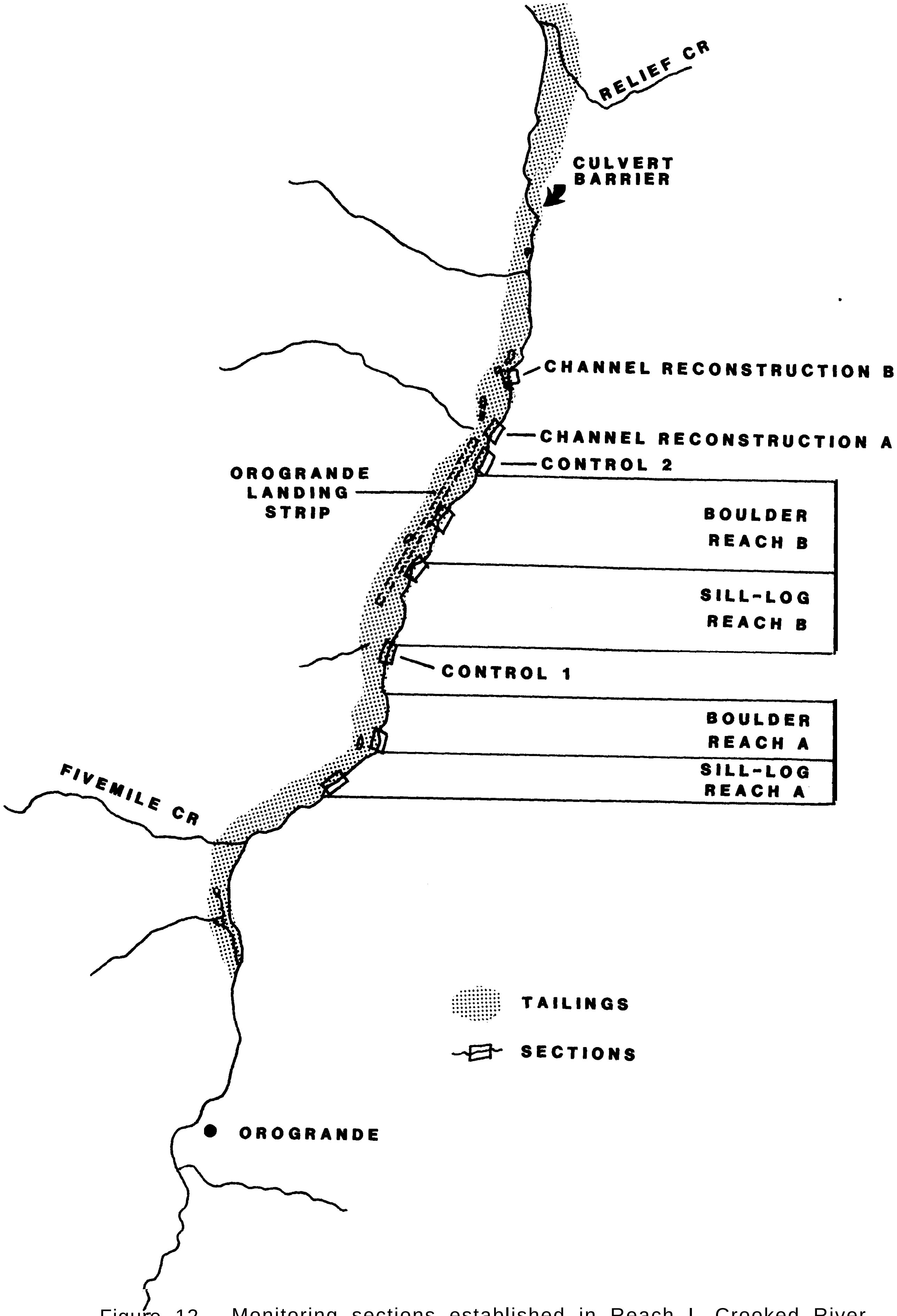

Figure 12. Monitoring sections established in Reach I, Crooked River.

Sampling in 1985 included monitoring of juvenile anadromous fish and resident fish densities in eight sections during summer (Table 21); observations of habitat use by juvenile fish in the fall and spring 1986; and observations of distributions of adult hatchery steelhead, adult chinook (natural origin), and redds. Physical habitat data were also collected in 1985.

Juvenile rainbow-steelhead. Densities of yearling and older rainbow-steelhead in July 1985 were relatively low (Table 22) and similar to densities in 1984 (Appendix A-4). Fry densities were much higher in 1985 (average, 401.6/100 m^2) than in 1984 (< 0.1/100 m^2) due primarily to the stocking of adult steelhead in 1985. Residualized steelhead smolts marked by adipose clips were also present in varying densities in 1985.

Posttreatment information on response of rainbow-steelhead to instream structures in Crooked River is limited to monitoring data on two treated and two untreated sections in Reach I in 1985 (Table 22). Steelhead fry densities averaged somewhat higher in sections with structures (average, 597/100 m^2) than in untreated sections (483/100 m^2). Although rainbow-steelhead parr were present in low densities in 1985, they did show some preference for sections with structures (1.7/100 m^2) over untreated sections (0.4/100 m^2). The posttreatment evaluations planned for Reaches I and II in 1986 will take advantage of yearling steelhead densities projected to be at or approaching carrying capacity.

Snorkeling observations in of f-channel ponds indicate that rainbow-steelhead in early life stages use this type of habitat at least through their first winter (Table 22).

Juvenile chinook. Densities of age 0 chinook in July 1985 averaged 52.8/100 m^2 (Table 22), a large increase from 1984 levels (Appendix A-4). Densities in Reach I increased from an average of 0.2/100 m^2 in 1984 to 16.8/100 m^2 in 1985 (Table 22), due partially to replacement of the barrier culvert with a bridge.

Response of juvenile chinook to instream structures in Reach I cannot be determined from the current monitoring data. Treated sections in 1985 appeared to contain a higher proportion of optimal rearing habitat in terms of depths and velocities, but much of this habitat was not occupied by chinook. Average densities in 1985 were similar in treated and control sections (18.0 and 15.6/100 m^2, respectively, Table 22). Releases of juvenile chinook into upper areas of Crooked River in 1986 will increase densities and facilitate posttreatment evaluations of the instream structures in Reaches I and II.

Development of off-channel ponds appear to have good potential to increase the capacity of Crooked River for chinook rearing. Age 0 chinook occupied these ponds during summer and fall 1985 (Table 23).

Table 21. Sections sampled in Crooked River, July 15-19, 1985.

				% Habitat Type		
Reach, section	% gradient	Section width(m)	Section area(m^2)	pool, run	riffle	pocket water
Reach I						
Control 1	1.4	10.9	993	24.6	75.4	0
Rechannel B[a]	1.6	9.5	581	34.4	65.6	0.
Sill log A		9.4	856			-
Boulder B	-	9.4	856	-		-
Reach II						
Control 1		11.4	1202	60.6	39.4	0
Treatment 1	-	9.2	754	66.7	33.3	0
Reach III-V						
Forced Meander 1	0.3	9.7	775	65.5	34.5	0
Forced Meander 2	0.3	12.0	1468	73.2	26.8	0

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[a] Control 2 was not sampled as planned because of disturbances by small suction dredge.

Table 22. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in Crooked River sections, July 15-19, 1985.

Reach, section	Years after treatment	Rainbow-steelhead				Chinook		Adipose clipped steelhead[a]
		0	1	2	>3	0	I+	
Reach I								
Control 1	0	414.4	0.2	0.3	0	9.7	0	1.5
Rechannel B	0	551.3	03	0	0	21.5	0	11.7
Sill log A	1	797.2	0.6	0.7	0.2	31.9	0	0.8
Boulder B	1	467.3	1.2	0.6	0.1	4.2	0.5	34.0
Reach II								
Control 1	0	340.8	1.8	0.7	0.1	90.2	0.1	0.4
Treatment 1	0	215.0	0.8	0.7	0	52.4	0.4	0.1
Reach III-V								
Forced Meander 1	0	241.7	0	0.4	0	81.9	3.1	0
Forced Meander 2	0	254.9	0	0.1	0	40.7	0.7	0

[a] Residualized steelheed from 1985 smolt releases.

Table 23. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in in-channel [Boulder B) and off-channel [pond) habitats, Reach 1, Crooked River, October 10, 1985 and April 18, 1988.

Mouth, section	Section area(m^2)	Rainbow-steelhead 0	Rainbow-steelhead 1	Rainbow-steelhead 2	Rainbow-steelhead >3	Chinook 0	Chinook I+	Adipose-clipped steelhead[a]
October								
Boulder B	956	0.4	0.7	0.4	0	0.6	0	12.1
Pond	180	156.9	0	0	0	6.7	D	0
Apri1								
Boulder B[b]								
Pond	160	-	17.2	0	0	-	0	5.0

[a] Represent residualized steelhead from smolt releases (October) and recently stocked smolts (Apri1).

[b] Extremely high density of smolts prevented effective density estimation by snorkeling.

Adults and redds. Adult steelhead released into Crooked River in 1985 held and spawned in both treated and untreated habitat of Crooked River. Many adults ascended small tributaries to spawn. Within Reach I of Crooked River, adult steelhead used sections that contained structures preferentially over untreated sections by a 4:1 ratio (Table 24).

Chinook spawning escapements Into the upper end of Crooked River have been too small to determine whether adult chinook prefer areas with structures. However, adult chinook and chinook redds have been associated with some of the structures.

Resident salmonids. Resident cutthroat trout, brook trout, bull trout, and mountain whitefish were observed in Crooked River sections in 1984 and 1985 (Table 25). In 1985, we observed 22 bull trout in one treated section in Reach I. Whitefish were most abundant downstream in Reach III.

Physical habitat. Detailed physical habitat measurements in sections of Reach I and IV are summarized in Appendix C and Petrosky and Holubetz (1985, Appendix C).

In general, pretreatment conditions in Reach I can be characterized by low pool to riffle ratios and predominantly rubble substrate. Pretreatment conditions in Reaches III-V can be characterized by high pool to riffle ratios and smaller substrate with higher embeddedness. Post-treatment habitat changes will be documented in future evaluations.

Future Evaluation and Recommendations

Future project evaluations for mitigation based on standing crops require estimates of increased rearing potential in the treated in-channel areas, an assessment of the importance of connected of f-channel ponds, and development of the factor which is needed to estimate benefits from removal of the partial barrier. The intensive study will provide a direct means to estimate smolt yields based on estimates of increased standing crops. The intensive study will also provide an opportunity to investigate survival rates between various life stages and times of year, seasonal habitat use and movements, and limiting factors of anadromous fish populations.

The approach to evaluate any future treatments in the lower reaches should be designed into the implementation plan. The intensive study must be integrated closely with the general evaluations in Crooked River and other project streams in the Clearwater drainage. Results of the intensive study should al so provide feedback to the general evaluations, including tests of assumptions inherent to sampling designs based on summer standing crops.

Table 24. Distribution of adult spawner steelhead on May 2, 1985 and live chinook and redds on September 2, 1985 in treated and untreated sections, Reach I, Crooked River.

Section	Years after treatment	Adult steelhead (May 2)	Adult chinook (September 2)	Chinook redds (September 2)
Control 1	0	8	0	0
Control 2	0	6	0	0
Sill log A	1	24	0	0
Sill log B	1	32	1	1
Boulder A	0[a]	0	0	0
Boulder B	1		0	0
Rechannel A	0	7	0	0
Rechannel B	0	12	0	0

[a] Treatment was primarily on banks (bank stabilization, seed, and mulch, etc.)--minimal habitat change instream.

Table 25. Density (number/100m^2) by age-group of cutthroat trout, brook trout, bull trout, whitefish, and hatchery rainbow trout [catchable-size] in Crooked River sections, July 15-19, 1916.

Reach, section	Years after treatment	Cutthroat	Brook		Bull		Whitefish		Hatchery rainbow trout
		>1	0	>1	0	>1	0	>1	
Reach I									
Control 1	0	0.3	0	0	0	0.2	0	0.7	0
Rechannel B	0	0	0	0	0	0	0.2	0	0
Sill Log A	1	1 .a	0	0	0	2.6	0.6	1.2	0
Boulder B	1	0	0	0.1	0	0	0.1	0.6	0.1
Reach II									
Control 1	0	0.2	0	0	0	0.1	0	2.2	0
Treatment 1	0	0.7	0	0	0	0	0	4.6	0
Reach III-V									
Forced Meander 1	0	0.4	0	0	0	0.4	30.2	11 .I	0
Forced Meander 2	0	0	0	0	0	0.4	10.3	5.7	0

Red River

The confluence of Red River with American River near Elk City forms the South Fork of the Clearwater River (Fig. 13). Ownership of the 31 km of Red River within the project area is about half private and half federal (Nez Perce National Forest). Man's activity has altered fish habitat in Red River. Reaches of the river have been dredged for gold and channelized. Logging and road construction have introduced sediment streamwide. Grazing in riparian zones has led to loss. of riparian cover, stream bank destabilization, and sedimentation.

Red River supports runs of summer steelhead and spring chinook. Anadromous runs were restored to Red River in the 1960s following removal of Harpster Dam in the South Fork of the Clearwater River in 1962. Chinook returns to Red River in recent years have been among the strongest in the state aided by the establishment of an adult trapping facility and juvenile rearing pond at Red River Ranger Station.

In addition to anadromous fish, Red River supports several native resident species, cutthroat trout, bull trout, mountain whitefish, northern squawfish, bridgelip sucker, longnose and speckled date, and sculpin (Torquemada and Platts 1984). Brook trout have also become established in the Red River drainage

The USFS project personnel identified five reaches with different characteristics in Red River (Fig. 13) and rated habitat with respect to opportunity for improvement (Stowell 1984b). Reaches rated highest with respect to potential improvement were II, IV, and V. Grazing on private land in Reaches I, III, and V has degraded riparian meadow habitat. Tailings from past dredge mining operations have channelized the stream in Reach IV. Sedimentation from logging, road construction, and grazing is excessive throughout all reaches.

Primary objectives of the BPA-funded habitat enhancement project for Red River were: (I) protect the riparian zone from continued grazing impacts through streamside fencing, (2) reverse the degradation of cover by reestablishing hardwood vegetation, (3) increase in-channel cover for fish through installation of instream structures, and (4) increase natural production of steelhead and chinook consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin a-4.

Secondary objectives were: (I) increase quantity and quality of spawning and rearing habitat for fish, and (2) provide examples of riparian area management techniques compatible with grazing of private pastures which may be utilized by other landowners in the future.

Anadromous Fish Management Considerations

After the Harpster Dam was removed from the South Fork of the Clearwater River, Red River was stocked with adult steelhead spawners that were taken from the fishways at Lewiston Dam. An incubation

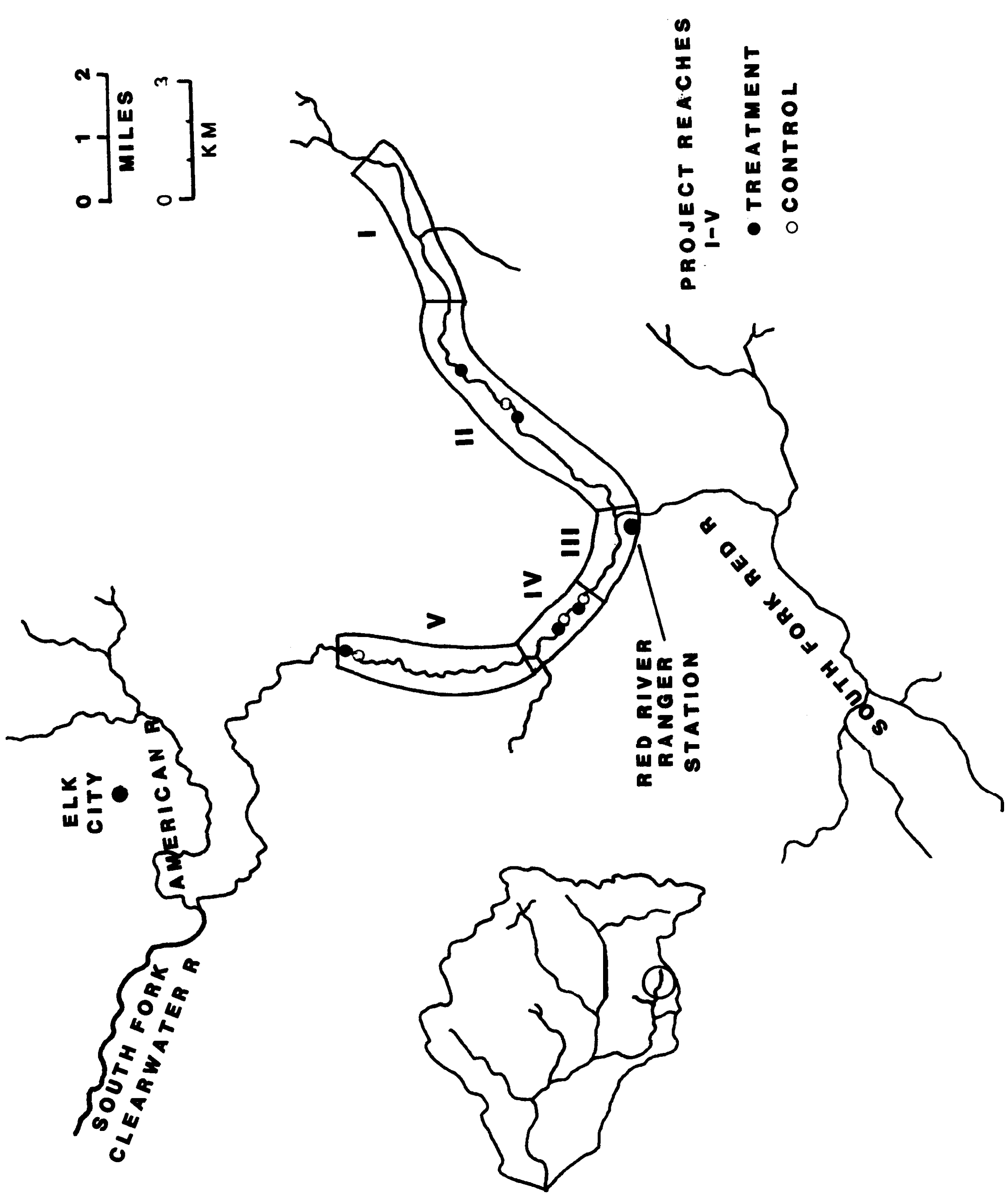

Figure 13. Location of 1983-85 habitat enhancement project and established monitoring sections on Red River.

channel located on the South Fork of Red River near the Red River Ranger Station was also used to reestablish steelhead populations. In the late 1970s, a rearing pond for spring chinook was constructed immediately downstream from the mouth of the South Fork of Red River. This pond has been very successful in rearing spring chinook smolts, and the returning adults have greatly increased the seeding of natural habitats in Red River over the last several years.

The habitat of Red River has been significantly degraded by mining, timbering, grazing, and roading. The importance of restoring this habitat will increase as additional anadromous fish management measures are implemented in Red River.

A new weir will be constructed in Red River near the Red River Ranger Station as a satellite facility for the Clearwater Hatchery. Large numbers of spring chinook and steelhead smolts will be outplanted in Red River upstream from the weir. When adult returns from this program start spawning in Red River, the natural production habitat capability will be fully realized.

Red River has been stocked with steelhead and spring chinook regularly from the mid-1960s to date.

1983-1985 Habitat Enhancement Project

Reach I. No major BPA-funded activities were planned for this reach. Some bank stabilization and revegetation work was done in 1984.

Reach II. Activities in 1984-1985 included placements of instream structures (boulder, rock and log weirs, deflectors, instream debris, and bank covers), bank stabilization and riparian revegetation (seeding, shrub plantings, etc.), and development of side channels for off-channel rearing (Hair and Stowell 1986).

Reach III. Activities on the private land in this reach have been relatively minor to date but could include riparian corridor fencing and revegetation. In 1984, a jackleg fence was constructed on USFS property and some instream structure and riparian revegetation work was accomplished.

Reach IV. The BPA-funded activities in 1983-1985 consisted primarily of installations of boulder clusters, deflectors, and miscellaneous structures and willow/dogwood plantings through the entire reach.

Reach V. As in Reach III, future work may include extensive riparian corridor fencing and revegetation on private land. To date, activities have been limited to bank shaping and revetments, revegetation, some instream structure installations, and construction of a jackleg fence on a USFS pasture.

Project Evaluation

Evaluation status. Evaluation of the Red River project will include the general monitoring level and evaluations based on standing crops. Through 1985, some of the monitoring sections have been established and sampled and sampling approaches have been identified for standing crop evaluations. The first post-treatment evaluation of the Red River project (instream structures, Reaches II and IV) is planned for 1986.

Localized improvements in rearing conditions from instream structure applications and riparian revegetation can be evaluated from comparisons of anadromous fish densities in treated and control sections arranged in a blocked (by reach) sampling design (Table 26). We expect more of a lag time in fish response to riparian revegetation than to the instream structures.

If streamside fencing and riparian revegetation develops into a large-scale treatment in Red River, important streamwide improvements in habitat could accrue. Any evaluation of streamwide increases in rearing potential would probably hinge on a measured habitat change (e.g., reduced sediment deposition) that could be attributed to the project and a habitat-fish response model. Comparable data in other Clearwater River tributaries will aid in development of such a model.

Evaluation of instream structure applications in Reach IV of Red River was begun in 1983 by the Intermountain Forest and Range Experiment Station (USFS, Boise, Idaho). One pretreatment and one control section were established to evaluate boulder placements; fish populations and physical habitat parameters were estimated in 1983 (Torquemada and Platts 1984). In 1984, IDFG began pretreatment fish monitoring and IFRES continued physical habitat measurements in Reach IV (Petrosky and Holubetz 1985).

Monitoring effort was expanded in 1985 (Table 27). Instream structure applications in Reach VI were monitored in one posttreatment, one pretreatment, and one control section. Establishment of sections to evaluate riparian revegetation in Reaches III and V has been delayed pending development of agreements or easements with private landowners. Physical habitat data were collected in 1985 for sections in Reach IV by IFRES (Appendix C).

Juvenile rainbow-steelhead. Densities of rainbow-steelhead parr in July 1985 were relatively low (Table 28) and down slightly from densities in 1983 and 1984 (Appendix A-5). Rainbow-steelhead fry densities in 1985 were higher downstream (Reaches IV and V) than upstream (Reach II) of the hatching channels at Red River Ranger Station.

Table 26. Status through 1985 of sampling for the experimental design anticipated for post-treatment evaluations of localized improvements in rearing, Red River project.

Reach, section	Treatment type[a]	Year enhanced	Years physical habitat sampled		Years fish population sampled	
			control/pre-	post-	control/pre-	post-
Reach II						
Control 1	C	-	85	-	85	-
Control 2	C	-	-	-	-	-
Treatment 1	IS	84	-	85	-	85
Treatment 2	IS	85	85	-	85	-
Reach III						
Control 1	C	-	-	-	-	-
Control 2	C	-	-	-	-	-
Treatment 1	BSR	-	-	-	-	-
Treatment 2	BSR	-	-	-	-	-
Reach IV						
Control 1	C	-	83,84,85	-	83,84,85	-
Control 2	C	-	83,84,85	-	83,84,85	-
Treatment 1	IS	-	83,84,85	-	83,84,85	-
Treatment 2	IS	84	83,84	85	83,84	85
Reach V						
Control 1	C				-	-
Control 2	C	-	85	-	85	-
Treatment 1	BSR	-	-	-	-	-
Treatment 2	BSR	84	-	(85)[b]	-	(85)[b]

[a] C= control; IS = instream structures; BSR = bank stabilization, riparian revegetation.

[b] No change in aquatic habitat from enhancement visible in 1996.

Table 27. Sections sampled in Red River, July 16-18, 1985.

				% Habitat Type		
Reach, section	% gradient	Section width(m)	Section area(m^2)	pool, run	riffle	pocket water
Reach II						
Control 1	-	10.1	830			
Treatment 1		9.5	952	-		-
Treatment 2		9.5	854			
Reach IV						
Control 1		14.4	2403	74.7	25.3	0
Control 2		13.0	1989	56.7	43.3	0
Treatment 1		13.1	2191	65.7	34.3	0
Treatment 2	-	14.5	2620	83.9	16.1	0
Reach V						
Control 2	-	13.0	517	-		
Treatment 2	-	13.3	927			

Table 28. Density (number/100m^2) by age group of rainbow-steelhead and chinook in Red River sections, July 16-18, 1985.

Reach, section	Years after treatment	Rainbow-steelhead				Chinook	
		0	1	2	≥ 3	0	1+
Reach II							
Control 1	0	3.5	0.2	0.7	0.1	39.9	0.2
Treatment 1	1	7.8	1.1	1.2	0.1	75.4	0.6
Treatment 2	0	0.8	2.4	1.4	0.1	41.1	0.9
Reach IV							
Control 1	0	39.0	0.2	+	+	63.1	1.2
Control 2	0	46.4	0.2	0.7	0.2	77.8	1.4
Treatment 1	0[a]	36.7	0	0.2	0.1	99.3	1.7
Treatment 2	1	41.4	0.3	0.5	0	60.2	0.5
Reach V							
Control 2	0	83.4	0.2	0.2	0	7.2	1.2
Treatment 2	1[b]	57.8	0.1	0.4	0	8.0	0.9

[a] Structures not in place by mid-July, 1985.

[b] No change in aquatic habitat from enhancement yet apparent in 1985.

Posttreatment information on response of rainbow-steel head to instream structures in Red River is limited to monitoring data f n two treated sections in Reaches II and IV in 1985 (Table 28). Post-treatment evaluations planned for 1986 will include samples from at least two treatments and two controls each in Reach II and Reach IV. Evaluations of riparian revegetation projects (Reaches III and V) will be phased into subsequent evaluations as specific implementation plans evolve.

Juvenile chinook. Densities of age 0 chinook in Red River were among the highest of any Idaho stream surveyed in 1985 (Appendix A-4). Densities were lower in the downstream, Reach V, than in upstream reaches (Table 28).

Posttreatment evaluations of chinook responses to in&ream structure applications in Reaches II and IV will be conducted in 1986. Determination of effects of riparian revegetation on chinook rearing will occur in later evaluations.

Resident Salmonids. Resident cutthroat trout, brook trout, and bull trout were present in Red River sections in 1985 at low densities (Table 29). Mountain whitefish were abundant throughout Red River.

Physical habitat. Physical habitat data for Reach IV is summarized in Torquemada and Platts (19841, Petrosky and Holubetz (1985, Appendix C), and Appendix C.

Future Evaluation and Recommendations

Future project evaluation for mitigation purposes requires an estimate of the difference in rearing potential between control sections and sections treated with structures and riparian revegetation. Sample size can be adjusted as necessary posttreatment (as in the Lolo Creek project). Side channel developments should probably be evaluated as habitat additions with the increment of anadromous fish reared in this habitat considered the basis for mitigation. If this increment appears large and plans exist elsewhere for extensive side channel developments, a mere intensive evaluation of this subproject may be warranted. Such investigation could be operated from the intensive study location at Crooked River.

SALMON RIVER

Panther Creek

Panther Creek, 69 km long, enters the Salmon River at river kilometer 327 near Shoup (Fig. 14). Panther Creek lies within the Salmon National Forest and drains a watershed of a bout 138,000 hectares. The watershed ranges in elevation from 1,000 to

Table 29. Density (number/100m^2) by age-group of cutthroat trout, brook trout, bull trout, whitefish, and hatchery rainbow trout (catchable-size) in Red River sections, July 16-19, 1985.

Reach, section	Years after treatment	Cutthroat	Brook		Bull		Whitefish		Hatchery rainbow trout
		>1	0	>1	0	>1	0	>1	
Reach II									
Control 1	0	0.2	0	0	0	0	0.7	1.0	0
Treatment 1	1	0	0	0.1	0	0.1	0.5	0.9	0
Treatment 2	0	0	0	0.3	0	0	0.1	1.3	0
Reach IV									
Control 1	0	0.2	0	0	0	+	15.3	1.7	0
Control 2	0	0.1	0	0	0	0	0.5	1.7	0
Treatment 1	0	0	0	+	0	+	1.7	2.1	0
Treatment 2	1	0.2	0	0	0	0	1.5	2.3	0
Reach V									
Control 2	0	0	0	0	0	0.2	3.9	4.3	0
Treatment 2	1	0	0	0	0	0	0.9	2.3	0.1

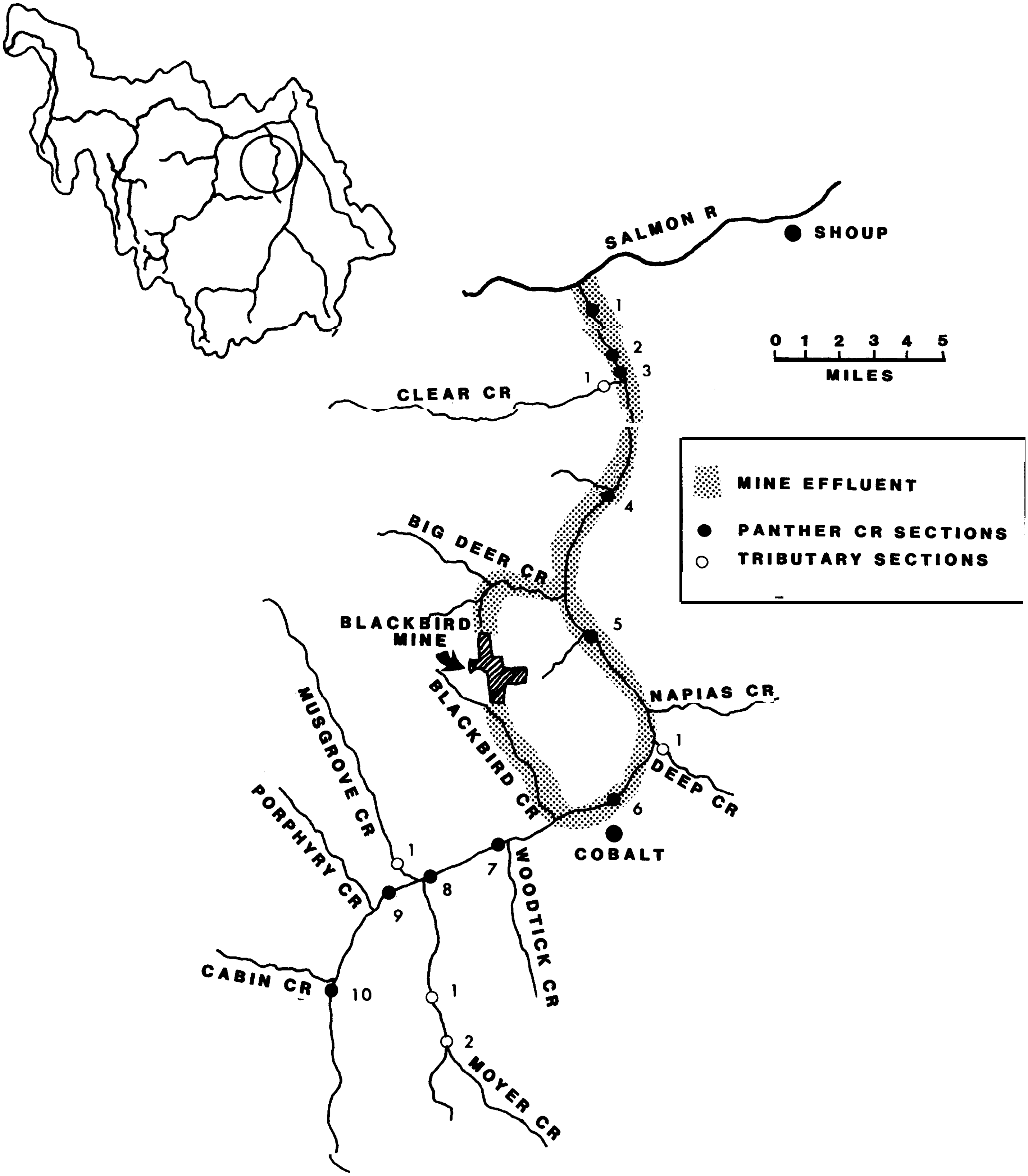

Figure 14. Location of Blackbird Mine, reaches of Panther Creek receiving effluent, and monitoring sections established in the Panther Creek drainage.

3,000 m and contains nearly 160 km of rearing streams. Cobalt and copper ore have been mined at Blackbird Mine near Cobalt. Access to rearing habitat has been blocked by effluent from the mining area which has entered Panther Creek via Blackbird Creek and Big Deer Creek since at least the early 1950s.

Panther Creek supported substantial runs of steelhead and chinook before being damaged by pollution from mining. As many as 2,000 chinook may have spawned in the drainage historically (Corley 1967). The last known spawning by chinook in Panther Creek occurred in 1962. However, an IDFG conservation officer observed a pair of adult chinook holding below Beaver Creek Bridge in 1983 (M. Reingold, IDFG, Salmon, Idaho, personal communication). Since 1979, IDFG has released adult spawner steelhead and steel head fry into Panther Creek upstream of Blackbird Creek confluence. Chinook fingerlings had been stocked in the Panther Creek drainage in the late 1970s.

In 1967, IDFG personnel electrofished four sections in Panther Creek between Prophyry Creek and Napias Creek and one section in Blackbird Creek (Corley 1967). Rainbow-steel head dominated the fish populations follwed by whitefish, brook trout, dace, and sculpin. No fish were found in Blackbird Creek or Panther Creek just downstream from Blackbird Creek confluence. Mallet (1974) also reported cutthroat trout, bull trout, and chinook in the drainage.

Effluents from the mining area have long affected fish populations in Panther Creek. These effluents resulted in acidic waters high in sediment and the heavy metals copper, cobalt, iron, manganese, lead, and zinc (Platts et al. 1979). Significant fish kills occurred in 1954 when acid was released from Blackbird Mine (Corley 19671, Between 1954 and 1967, numerous reports exist of black sediment deposition. Corley found no invertebrates in five benthos samples from Panther Creek just downstream from Blackbird Creek; in 1967 field experiments, both cutthroat trout eyed eggs and juvenile rainbow trout suffered increased short-term mortality downstream from Blackbird Creek compared to upstream locations.

Live-box tests conducted by IDFG in 1977 with juvenile steel head and in 1984 with juvenile chinook indicated acute toxicity effects in Panther Creek below Blackbird and Big Deer Creek effluent sources (M. Reingold, IDFG, personal communication). Further bioassays conducted in October 1985 by EPA also indicated acute toxicity of the effluent to juvenile steel head and chinook (D. McDonough, EPA, personal communication), Reiser (1986) provided a comprehensive summary of historic conditions, mining operations, and field studies which relate the effects of effluents to aquatic invertebrates and fish.

Objectives of the Panther Creek Habitat Enhancement project are: (1) develop a means to eliminate or control toxic discharges into Panther Creek, (2) restore anadromous fish populations in the Panther Creek drainage, and (3) increase natural production of steelhead and salmon consistent with IDFG (1985) anadromous Fish Management Plan for Subbasin SA-6.

Anadromous Fish Management Considerations

Idaho's Anadromous Fish Management Plan calls for rehabilitation of the mine pollution problem and restoration of the anadromous fish runs by 1990, Panther Creek is a large drainage, approximately 160 km of stream, and located in an especially-attractive area for both steelhead and chinook salmon fisheries.

Large numbers of juvenile steelhead have been stocked in the drainage in recent years. Only one significant stocking of chinook salmon has occurred, and that was 46,300 fingerlings in 1977. Stocking of steel head will continue in the future, and chinook salmon will be stocked when there is some assurance that the mining pollution problem will be restored.

At present, juvenile steelhead are moderately abundant and juvenile chinook salmon are extremely rare in Panther Creek.

1984-1985 Feasibility of Habitat Rehabilitation

A BPA contract was awarded to Bechtel National Incorporated in 1984 to develop feasible alternatives to controlling toxic discharges from the Blackbird Mine area. Specific phases of the contract Included: (1) data acquisition and review, (2) mine reclamation/effluent abatement alternatives, and (3) fishery habitat surveys.

Two major alternative abatement measures were identified in Phase II (Reiser 1986). Alternative I involved treating poor quality water in the mine area. Alternative II relied on passive measures to improve water quality.

Phase III consisted of detailed habitat surveys of the drainage and estimates of potential production of steelhead and chinook smolts and adults following control of toxic discharges. Economic analyses indicated in general that costs of the proposed abatement programs were of the same relative magnitude as economic benefits that would be realized through restoration of anadromous fish runs (Reiser 1986).

Project Evaluation

Evaluation status. Final evaluations for mitigation purposes of a pollution abatement program in the Panther Creek drainage can be based on the estimated standing crops of anadromous fish at full seeding. Because the toxic conditions eliminated anadromous runs (Reiser 1986), abatement measures can be given full credit for anadromous fish established in the drainage analogous to the removal of a complete passage barrier. General monitoring of fish densities in a small number of sections will be conducted annually to follow trends in seeding levels during the recovery.

In conjunction with the planned level of fish density monitoring, Reiser (1986) recommended a program of water quality monitoring, assessment of adult escapement, smolt outmigration, continued live-box testing, fish tissue analysis, and invertebrate sampling.

The IDFG evaluation of the Panther Creek project began in 1984 as a pretreatment survey of fish distributions and densities in the drainage. The IDFG established and sampled ten sections in Panther Creek and five sections In tributaries (Fig. 14). We documented in 1984 a general pattern of reduced densities of salmonids below Blackbird Creek, total absence of fish below Big Deer Creek, and a partial recovery of fish populations downstream of Clear Creek (Petrosky and Holubetz 1985). Outside the influence of Blackbird Mine effluents, rainbow-steel head densities were comparable to those in other Salmon River tributaries in 1984; chinook were virtually absent from the drainage.

The IDFG sampling in 1985 consisted of monitoring fish densities on August 28 in four of the established sections (Table 30), One section each was selected in reaches upstream of Blackbird Creek between Blackbird and Big Deer creeks and Big Deer and Clear creeks and downstream of Clear Creek.

juvenile rainbow-steelhead. Densities of rainbow-steel head parr were similar in 1984 and 1985 (Table 31, Appendix A-6). The same pattern of reduced densities In effluent-receiving water was observed both years. The only section sampled in 1985 that did not receive mine effluent supported a moderately high density of rainbow-steelhead parr ($6.4/100m^2$). Small numbers of residualized steelhead smolts were observed in lower Panther Creek in 1985.

Juvenile chinook. Chinook have not been reestablished in Panther Creek drainage through 1985 (Table 31, Appendix A-6).

Resident salmonids. Cutthroat trout, bull trout, brook trout, and mountain whitefish were observed in the Panther Creek drainage in 1985 (Table 32). Resident salmonids were rare in sections of Panther Creek that received effluent.

Physical habitat. Except for water quality problems from effluents from the Blackbird Mine, aquatic habitat in the drainage is in basically good condition. To estimate potent1 al smolt production, Reiser et al. (1986) quantitatively surveyed the drainage using the Instream Flow Incremental Methodology (IFIM, Bovee 1982; Milhouse, et al. 1984). The IFIM data does not mesh directly into the physical habitat data set being generated through IDFG general monitoring in other project areas.

Table 30. Sections sampled in Panther Creek drainage, August 28, 1985.

					% Habitat Type		
Location[a]	Stream, section	% gradient	Section width(m)	Section area(m^2)	pool, run	riffle	pocket water
A	Moyer Creek						
	MO1	2.4	6.7	1222			
B1,A2	Panther Creek						
	PC6	0.8	13.8	1381			
B1,B2	Panther Creek						
	PC4	1.2	24.6	2460			
B1,B2	Panther Creek						
	PC1	1.2	18.3	1629			

[a] A = above mine effluent; B1 = below Blackbird Creek; A2 = above Big Deer Creek; B2 = below Big Deer Creek.

Table 31. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in Panther Creek drainage sections, August 28, 1985.

Location[a]	Stream, section	Rainbow-steelhead				Chinook		Adipose-clipped steelhead[b]
		0	1	2	>3	0	I+	
A	Moyer Creek M01	1.2	2.0	3.4	1.0	0	0	0
B1,A2	Penther Creek PC6	0.5	0.4	0.5	0.1	0	0	0
B1,B2	Panther Creek PC4	0	+	0	0	0	0	0.1
B1,B2	Penther Creek PC1	0.2	0.1	0.4	0.2	0	0	0.4

[a] A = above mine effluent; B1 = below Blackbird Creek; A2 = above Big Deer Creek; B2 = below Big Deer Creek.

[b] Residualized steelhead from 1985 smolt releases.

Table 32. Density (number/100m^2) by age-group of cutthroat trout, bull trout, brook trout, whitefish, and hatchery rainbow trout (catchable-size) in Panther Creek drainage, August 28, 1985.

Location[a]	Stream, section	Cutthroat	Bull		Brook		Whitefish		Hatchery rainbow trout
		≥1	0	≥1	0	≥1	0	≥1	
A	Moyer Creek MO1	0	0	2.4	0	0.1	0	0	0
B1,A2	Panther Creek PC6	0.1	0	0.2	0	0	0	0.6	0
B1,B2	Panther Creek PC4	0	0	0	0	0	0	0	0.1
B1,B2	Panther Creak PC1	0	0	0	0	0	0	0	0.8

[a] A = above mine effluent; B = below Blackbird Creek; A2 = above Big Deer Creek; 82 = below Big Deer Creek.

Future Evaluation and Recommendations

Future project evaluation for mitigation should require documentation of improved water quality conditions and standing crop estimates for juvenile rainbow-steel head and chinook at full seeding. Except for the complexities of pollution abatement, the evaluation will be analogous to that of a complete barrier removal.

Unbiased estimates of standing crops can be calculated from densities in stream sections with application of either a stratified random or systematic stratified sampling design (Scheaffer et al. 1979). Major divisions in strata for Panther Creek should be at the confluences of Clear Creek, Big Deer Creek, and Blackbird Creek. General monitoring of densities, reestablishment of a chinook spawning ground survey, and water quality monitoring should be used to document impraved water quality and passage conditions and define full-seeding densities.

Any water quality monitoring program established in conjunction with this potential BPA project should be designed with special consideration given to the timing of upstream and downstream migrations of steel head and chinook. Physical habitat data in general fish density monitoring sections should be collected to complement IDFG data in other streams.

Lemhi River

The Lemhi River Is 951 km long and enters the Salmon River at river kilometer 1,240 at Salmon (Fig. 15). The Lemhi River flows through a high, alluvial flood plain between the Beaverhead and Lemhi Mountain Ranges. Water fertility in the main stem Lemhi River is higher than in most other anadromous production streams in Idaho (total dissolved solids, nearly 300 parts per million; Bjornn 1978). Water diversions to flood irrigate agricultural lands create occasional passage blocks for migration adult salmon and steel head primarily in the lower 14 km of river. Juvenile steelhead and chinook also can be delayed on downstream migrations during April and May when the irrigation season begins and before spring runoff.

Historically, summer steelhead, spring chinook, and possibly summer chinook spawned and reared in the Lemhi River and tributaries (Bjornn 1966). Construction in 1897 of a 2-m high diversion dam near the mouth of the Lemhi River and upstream irrigation diversions virtually eliminated steelhead and summer chinook; spring chinook were able to enter the river during spring runoff. The dam was breached in the 1920s. Major irrigation diversions were screened beginning in the late 1950s. Programs to reestablish steel head runs in the Lemhi River have been underway since 1962 with operation of an incubation channel

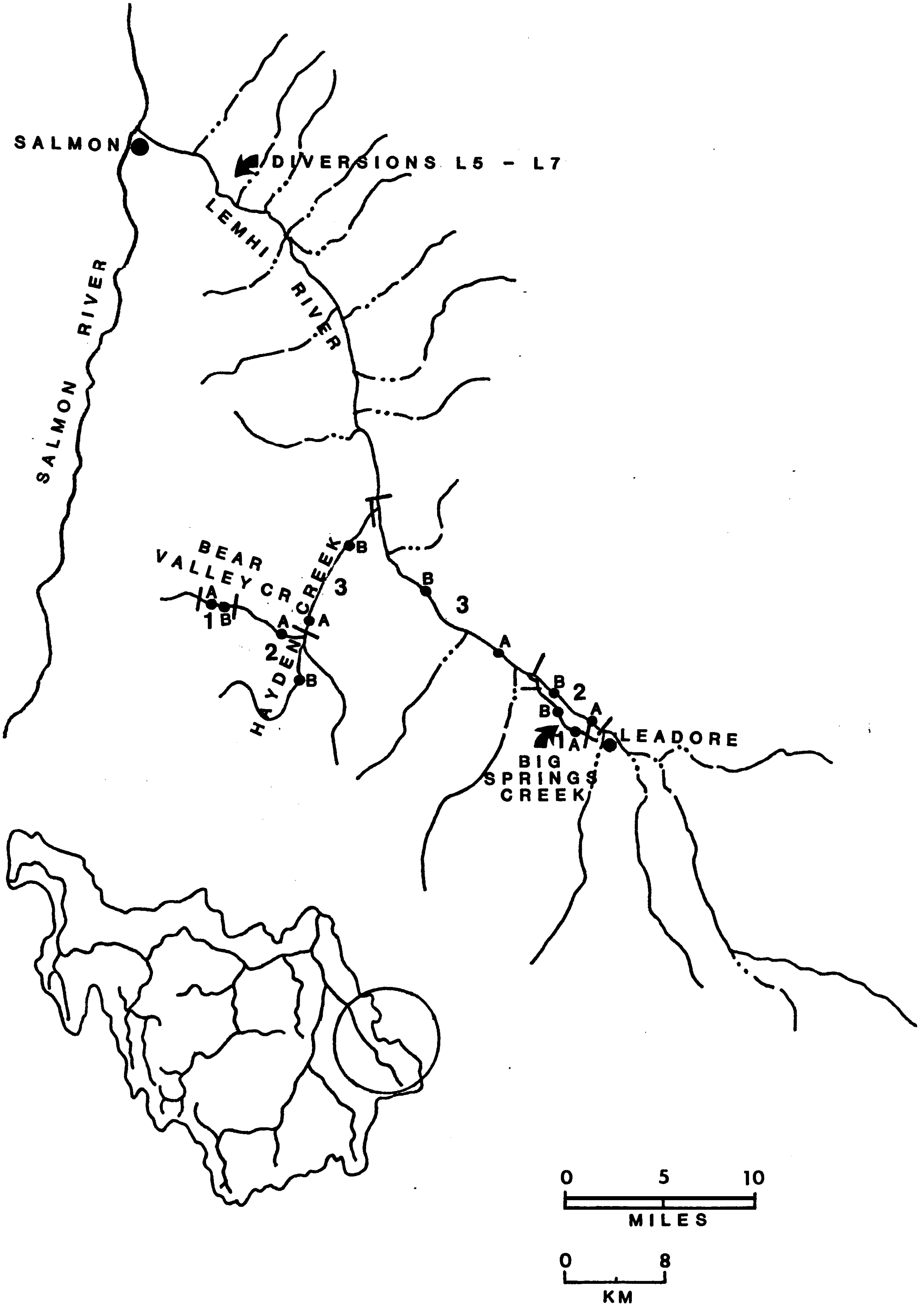

Figure 15. Location of major passage blocks at L5-L7 diversions and monitoring sections established in the Lemhi River drainage.

(1962-1967) and fry releases (1968-1974 and 1981-1985). Most of the Lemhi River drainage remains severely under-seeded by steelhead and spring chinook.

Resident salmonids in the Lemhi River drainage include resident rainbow trout, brook trout, cutthroat trout, bull trout, and mountain whitefish (Bjornn 1978; Horner 1978).

Dewatering of the Lemhi River occurs as a result of variable and complex interactions of the subbasin's hydrology, geology, and water use. Irrigation water Is diverted in more than 60 different location in the drainage (Ott 1985). During certain periods, appropriated water rights of irrigators exceed available stream flows in the Lemhi River. Complete dewatering occurs at times, especially in spring before snowmelt and in late summer.

Objectives of the Lemhi River Habitat Enhancement project are: (1) develop feasible means of solving passage problems for adult and juvenile anadromous fish, (2) restore anadromous fish runs in the Lemhi River, and (3) increase natural production of salmon and steel head consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin SA-7.

Anadromous Fish Management Considerations

Management plans for the Lemhi River involve some outplanting of hatchery fish and utilization of the very productive, natural habitat. Recent trends indicate that the natural production is increasing. The redd counts in 1985 showed a substantial increase in chinook salmon spawning escapement over the previous 5-year average.

The Lemhi River has been regularly stocked with chinook salmon and steelhead juveniles over the last 20 years.

If the flow problem can be resolved, an excellent sport fishery for salmon could be sustained in the Lemhi River.

1985 Feasibility Study for Habitat Improvement

A BPA contract was awarded to Ott Water Engineers Incorporated In 1985 to develop feasible alternatives to solve passage problems in the Lemhi River drainage. Specific phases of the project included: (1) problem definition, literature search, hydrologic analysis, and stream habitat survey; (2) development of enhancement alternatives; and (3) Benefit:Cost (B:C) analysis.

Nine enhancement alternatives were identified. These were flow concentration, fish screen improvement, groundwater augmentation, groundwater irrigation, water withdrawal reduction, return flow improvement, sprinkler irrigation, storage, and trap and haul (Ott 1986). The alternatives were narrowed into four feasible options which were combinations of flow concentrations through use of diversions, channelization and levees, and river flow augmentations through use of flood irrigation improvement or sprinkler irrigation. The feasibility phase also identified some potentially serious passage problems for steel head and chinook smolts during downstream migrations.

Benefit:Cost analyses performed in Phase III indicated low B:C ratios for any project (Ott 1986) partly because of: (1) high capital costs, (2) the estimated slow process of rebuilding the runs, and (3) estimates of passage delays and high mortality of smolts which were factored into the projections. The report recognized that fundamentally different analyses could show more attractive B:C ratios. The Fish and Wildlife program does not require positive B:C ratios for project implementation.

Project Evaluation

Evaluation status. Final evaluations for mitigation purposes of a passage improvement program on the Lemhi River can be based on estimated standing crops at full seeding and on a previous intensive study that developed relationships between steelhead and chinook spawning escapements and migrant yields in the upper Lemhi River (Bjornn 1978). Because current conditions allow some passage, a fraction of standing crops should be apportioned for the record of credit. This fraction should be developed based on the severity and frequency of the passage blocks before and after implementation. General monitoring of fish densities in a small number of sections will be conducted annually pending project implementation and to help define full-seeding levels.

The IDFG evaluation of the Lemhi River project began in 1985 as a pretreatment survey of fish distributions and densities in the upper Lemhi River and its major tributary, Hayden Creek; IDFG established and sampled 12 sections in the drainage June 25-27, 1985 (Fig. 15, Table 33). An additional site was sampled qualitatively below the L5 diversion, the vicinity of major passage blocks. Fish densities in main stem Lemhi River sections were determined by electrofishing (two-pass depletion estimates; Seber and LeCren 1967). Densities in Hayden Creek were estimated by snorkeling. We repeated the sampling in two Bear Valley Creek sections on August 18.

Juvenile rainbow-steelhead. Densities of rainbow-steelhead in the Lemhi River drainage varied considerably by location in 1985 (Table 34). Densities of yearlings in the upper Lemhi River and Big Springs Creek where steelhead fry have been stocked ranged to 41 fish/100 m^2, higher than in any Idaho stream surveyed in 1985 (Appendix A-7). Rainbow-steelhead densities were low In the Hayden

Table 33. Sections sampled in the Lemhi River drainage, June 25-27, 1985.

Stream-Reach, section	% gradient	Section width(m)	Section area(m^2)	% Habitat Type pool, run	riffle	pocket water
Big Springs Cr.-L1						
A[a]		8.6	847	-	-	-
B[a]		7.3	832	-	-	-
Lemhi R.-L2						
A		6.9	620	-	-	-
B	-	8.1	892	-	-	-
Lemhi R.-L3						
A		10.1	765	-	-	-
B		10.1	992	-	-	-
Hayden Cr.-H1						
A[b]	-	6.8	683	-	-	-
B[b]	-	6.8	704		-	-
Hayden Cr.-H2		5.5	495	-	-	-
B	0	8.9	757	-	-	-
Hayden Cr.-H3						
A		8.4	775	-	-	-
B	-	8.4	782	-	-	-

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[a] Big Springs Creek sections A and B were sampled previously in 1979-82, and numbered 3 and 8, respectively (Petrosky 1984).

[b] Located on Bear Valley Creek.

Table 34. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in the Lemhi River drainage, June 25-27, 1985.

Stream-reach, section	Rainbow-steelhead				Chinook	
	0[a]	1	2	≥3	0	1+
Big Springs Cr.-L1						
A	7.3	41.2	3.0	0.4	0.5	0
B	52.6	13.2	2.3	0.2	0.4	0
Lemhi R.-L2						
A	3.9	35.2	2.4	0.6	7.6	1.1
B	0.1	16.8	1.6	1.6	1.4	0.3
Lemhi R.-L3						
A	5.9	12.7	2.2	1.0	1.7	0
B	0	1.2	1.6	0.9	0.5	0
Hayden Cr.-H1						
A[b]	0	0	0.3	0	0	0
B[b]	0	0	0	1.0	0	0
Hayden Cr.-H2						
A[b]	0	0.2	0.4	0	0	0
B	0	0	0	0	14.4	0
Hayden Cr.-H3						
A	0	0	0.3	0.3	1.0	0
B	0	0.1	0.3	0.1	7.3	0

[a] Sampled prior to major period of emergence for natural rainbow-steelhead.

Creek and Bear Valley Creek sections (Tables 34 and 35). We observed no rainbow-steelhead in a qualitative electrofishing sample in the lower river near the L5 diversion.

Juvenile chinook. The drainage was severely under-seeded by chinook in 1985 (Table 34, Appendix A-7). No age 0 chinook were observed in the prime spawning and rearing habitat of Bear Valley Creek in either late June or August (Table 35). No chinook were observed near the L5 diversion in late June.

Resident salmonids. Resident salmonid populations vary by location in the Lemhi River drainage. Resident rainbow trout comprise the major portion of rainbow-steelhead in the upper Lemhi when steelhead escapements are low (Bjornn 1978; Horner 1978; and Petrosky 1984). The upper Lemhi River and Big Springs Creek support brook trout (Table 36). Hayden Creek and Bear Valley Creek support sizable populations of bull trout. Bull trout begin to move into the meadow of Bear Valley Creek (Sections 1A and 18) in late summer prior to spawning (Table 35). Whitefish are distributed throughout most of the Lemhi River drainage.

Physical habitat. Physical habitat data for Lemhi River drainage sections was not collected in 1985. Habitat classification of the drainage was accomplished in 1985 as part of the feasibility and inventory phase (Ott 1986). The 1985 habitat classification system used in the Lemhi River does not mesh directly into the data base being generated through IDFG general monitoring in other project areas.

Future Evaluation and Recommendations

Evaluation of any future BPA project to improve flows for passage will require estimates of standing crops at full seeding and development of a factor to account for pretreatment passage conditions. Estimated smolt yields for any Lemhi River project should be based on the standing crop estimates and the existing intensive study for the Lemhi River (Bjornn 1978).

East Fork Salmon River

The East Fork Salmon River, 51 km long, enters the Salmon River at river kilometer 540 (Fig. 16). The East Fork system is a major tributary to the upper Salmon River and contains about 150 km of spawning and rearing habitat for anadromous fish. Habitat problems in the drainage are related primarily to agricultural practices on private land in the lower East Fork and Herd Creek. Habitat in much of the upper drainage is very high quality.

Table 35. Density (number/100m^2) by sampling date in two sections of Bear Valley Creek, Lemhi River drainage, 1985.

Species,	Section 1A		Section 1B	
age-group	June 27	August 18	June 27	August 18
Rainbow-steelhead				
0	0	0	0	0
1	0	0	0	0
2	0.3	0	0	0.1
>3	0	0.3	1.0	0.6
Chinook				
0	0	0	0	0
1+	0	0	0	0.1
Cutthroat				
≥1	0	0.4	0.1	0.3
Bull				
0	0.1	0.6	0.1	0.4
≥1	0.1	2.3	2.6	8.1

Table 36. Density (number/100m^2) by age-group of cutthroat trout, bull trout, brook trout, and whitefish in Lemhi River drainage, June 25-27, 1985.

Stream-Reach, section	Cutthroat	Bull		Brook		Whitefish	
	≥1	0	≥1	0	≥1	0	>1
Big Springs Cr.-L1							
A	0	0	0	2.1	0.5	0	0.2
B	0	0	0	0	0.5	0.1	13.2
Lemhi R.-L2							
A	0	0	0	1.1	0.6	0	2.7
B	0	0	0	0	0	0	23.5
Lemhi R.-L3							
A	0	0	0	0	0.1	0.1	0
B	0	0	0	0	0	1.4	14.3
Hayden Cr.-H1							
A	0	0.1	0.1	0	0	0	0
B	0.1	0.1	2.6	0	0	0	0
Hayden Cr.-H2							
A	3.2	0	1.6	0	0	0	0
B	0.3	0.1	1.3	0	0	0	0.5
Hayden Cr.-H3							
A	0	0	0.5	0	0	0	0.4
B	0	0	0	0	0	0	0.5

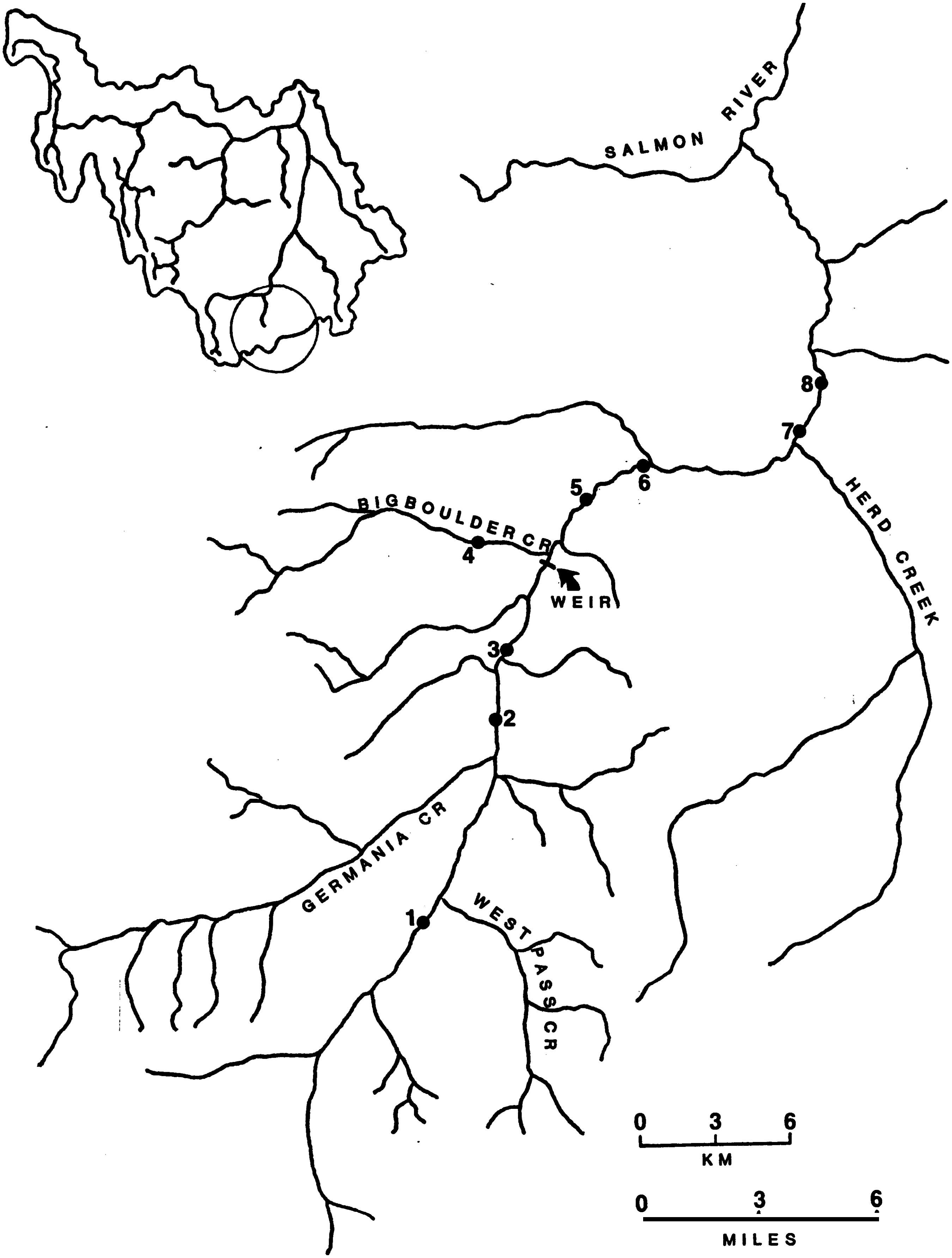

Figure 16. Location of IDFG monitoring sections established in the East Fork Salmon River drainage.

The East Fork Salmon River is a major producer of anadromous fish in the upper Salmon River. Summer steelhead, spring chinook, and summer chinook utilize the drainage for spawning and rearing. A weir to capture adult steelhead and salmon was constructed on the East Fork for Lower Snake River Compensation Plan programs.

Nonanadromous salmonids reported in the East Fork drainage include rainbow trout, cutthroat trout, bull trout, and mountain whitefish (Mallet 1974).

The East Fork Salmon River and tributary Herd Creek have been degraded by agricultural practices on private land. Habitat problems, including stream bank Instability and reduced riparian vegetation, are being defined through a BPA contract with the Shoshone-Bannock Tribe.

Objectives of the East Fork Salmon River Habitat Enhancement project are: (1) define and treat riparian and aquatic habitat problems which potentially limit anadromous fish production, and (2) increase natural production of steel head and salmon consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin SA-9.

Anadromous Fish Management Considerations

A weir, adult trap, and smolt acclimation facility have been constructed above the mouth of Big Boulder Creek and will serve as a satellite facility for the Sawtooth Hatchery. In 1984 and 198.5, the majority of spawners returning to this area has been used for brood stock for the Sawtooth Hatchery and the Magic Valley Hatchery. This situation has resulted in the upper portions of the East Fork Salmon River being severely under-seeded,

As adult return from smolt releases, spawning escapements and resultant seeding of the high quality natural production habitat in the upper East Fork should increase dramatically.

The East Fork is an important fishing area, as well as an important production area. Habitat enhancement in the lower reaches should increase adult holding capability and juvenile rearing capability.

Trends for chinook salmon spawning escapement In the last several years have improved slightly but are far below the levels required to fully seed the habitat. Group B steelhead have been stocked in the East Fork and steel head spawning escapements are increasing.

1985 Problem Identification

Habitat problems and project feasibility are being defined through a BPA contract by the Shoshone-Bannock Tribe. Through 1985, no BPA projects have been implemented.

Project Evaluation

Evaluation status. Evaluations for mitigation purposes of any habitat improvement project in the East Fork drainage should be based on measured changes in physical habitat and estimated increases in standing crops at full seeding. Until implementation of a BPA-funded habitat project, IDFG will conduct annual general monitoring of fish densities in a small number of sections to follow trends In seeding levels.

The IDFG evaluation of any East Fork Salmon River project began in 1985 as a pretreatment survey of fish distributions and densi ties in the drainage (exclusive of Herd Creek). The IDFG sampled eight sections during August 26-29, 1985, three sections above the weir, one in the tributary Big Boulder Creek, and four below the weir (Table 37). The Shoshone-Bannock Tribe also began fish density surveys in 1985 in conjunction with the problem identification phase.

Juvenile rainbow-steelhead. Densities of juvenile rainbow-steelhead in 1985 were higher below the weir than above (Table 38, Appendix A-8). Residualized steelhead smolts were locally abundant below the weir.

Juvenile chinook. The East Fork Salmon River was under-seeded by chinook in 1985. Densities of juvenile chinook were highly variable (Table 38, Appendix A-8); no juvenile chinook were observed upstream of the weir.

Resident salmonids. Cutthroat trout, bull trout, mountain whitefish, and catchable-size hatchery rainbow trout were observed in the drainage In 1985 (Table 39).

Future Evaluation and Recommendations

Specific evaluation approaches to BPA habitat projects in the East Fork drainage should be formulated during the development of implementation plans.

Upper Salmon River

The Salmon River, 660 km long, has its source in the Sawtooth Mountains within the Idaho Batholith, a region with highly erodible soils. The upper river above Stanley (Fig. 17) lies primarily within the Sawtooth National Recreation Area which was created in 1972 to assure the "preservation and protection of the natural, scenic, historic, pastoral, and fish and wildlife values." The upper river

Table 37. Sections sampled by IDFG in the East Fork of the Salmon River, August 26-29, 1985. Fish densities were also determined in Herd Creek and the East Fork in 1985 by the Shoshone-Bannock Tribe.

				% Habitat Type		
Reach, section	**% gradient**	**Section width(m)**	**Section area(m^2)**	**pool, run**	**riffle**	**pocket water**
Above weir						
1	1.5	7.6	758	0	0	100
2	2.0	15.7	1573	50.0	50.0	0
3	1.4	13.7	1372	33.3	66.7	0
Below weir						
4[a]	5.2	5.2	522	0	0	100
5	1.1	13.9	1387	61.1	38.9	0
6	1.0	13.5	1348	83.3	16.7	0
Below Herd Creek						
7	1.0	18.3	1826	73.3	26.7	0
8	0.8	11.9	1190	80.0	20.0	0

[a] Big Boulder Creek.

Table 38. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in the East Fork Salmon River, August 26-29, 1985.

Reach, section	Rainbow-steelhead 0	Rainbow-steelhead 1	Rainbow-steelhead 2	Rainbow-steelhead ≥3	Chinook 0	Chinook 1+	Adipose-clipped. Steelhead[a]
Above weir							
1	0	0.1	0.1	0.3	0	0	0
2	0.3	0.1	0.1	0	0	0	0
3	0	0	0	0	0	0	0
Below weir							
4	0.4	0.4	0.2	0.4	0	0	0
5	0.4	0.6	0.6	0.1	6.0	0.7	3.7
6	0.8	0.9	0.9	0.1	4.4	0	0.4
Below Herd Creek							
7	0.3	0.1	0.1	0.1	0.4	0	0.2
8	4.1	4.4	1.5	0.2	21.0	0	0

[a] Residualized steelhead from 1985 smolt release.

Table 39. Density (number/100m^2) by age-group of cutthroat trout, bull trout, brook trout, whitefish, and hatchery rainbow trout (catchable-size) in East Fork Salmon River, August 26-29, 1985.

Reach, section	Cutthroat	Bull		Brook		Whitefish		Hatchery rainbow trout
	≥1	0	≥1	0	≥1	0	≥1	
Above weir								
1	0	0	0	0	0	0	0.4	0
2	0	0	0.1	0	0	0	0.4	0.1
3	0	0	0	0	0	0	0.8	0.1
Below weir								
4	0.4	0	0	0	0	0	0	1.1
5	0	0	0.4	0	0	0.1	1.7	0
6	0	0	0.1	0	0	0	2.2	0
Below Herd Creek								
7	0.1	0	0.3	0	0	0.4	3.4	0
8	0	0	0.1	0	0	0.2	3.1	0

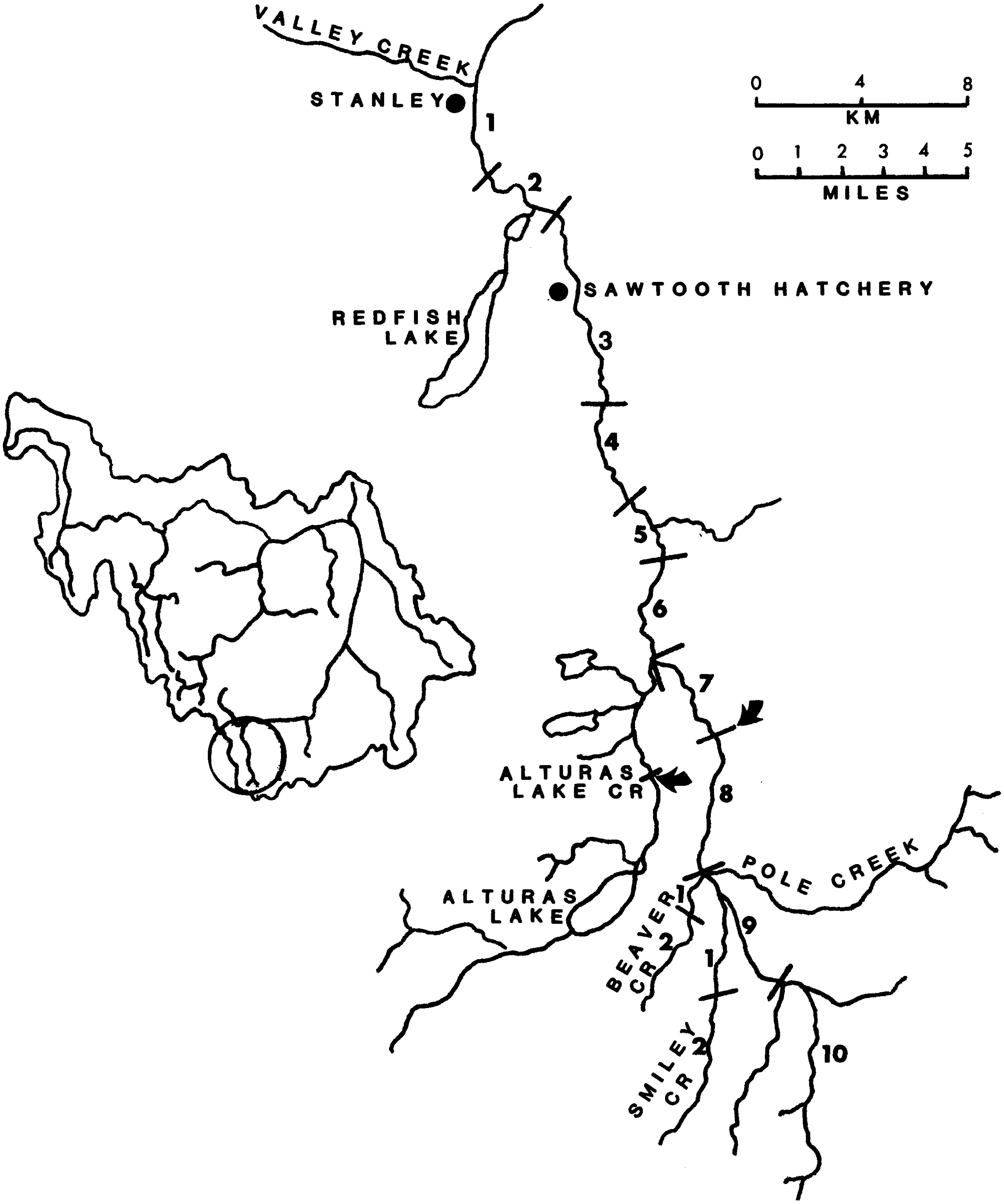

Figure 17. Location of passage blocks (arrows) at irrigation diversions in the upper Salmon River basin, and reaches established in 1985 to define habitat problems.

flaws through a relatively flat basin. Flow diversions for irrigation restrict anadromous fish use to parts of the basin, and grazing in riparian zones has degraded aquatic habitat.

The upper Salmon River system is a major production area for spring chinook salmon. The upper basin also produces summer steelhead. A remnant run of sockeye salmon returns to Redfish Lake. Anadromous fish runs to the upper Salmon River were reduced in the early 1900s by construction of Sunbean Dan downstream from Stanley. The dam, which was a barrier to anadromous fish at high flows, was breached in 1934. The upper Salmon River was not restocked extensively in the years immediately following the dam removal. Compensation for spring chinook in the Salmon River drainage led to recent construction of the Sawtooth Hatchery near Stanley under the Lower Snake River Compensation Pl an. A brood stock development program involving trapping of adults and release of smolts has been in operation since 1981 (Partridge 1984).

Native resident salmonids in the upper Salmon River drainage are rainbow trout, cutthroat trout, bull trout, and mountain whitefish (Mallet 1974). Nonnative brook trout have also become established.

An irrigation diversion on the Salmon River between the confluences of Alturas Lake Creek and Pole Creek dewaters the stream for about one-quarter mile during late summer In dry years. Passage for adult chinook is restricted during these years, and rearing habitat is reduced for juvenile steelhead and chinook. A ladder was constructed on the diversion structure in 1981. Informal arrangements had been made with a private caretaker to check the ladder and open it if adult chinook were beginning to concentrate in the dewatered area (M. Reingold, IDFG, Salmon, Idaho, personal communication).

The USFS is currently working on feasible solutions to passage restrictions for adult chinook at the irrigation diversion using BPA funds. Two possible alternatives are to purchase enough of the water right to assure passage during all years and/or construct a fishway channel to pass fish around the dewatered stream reach.

Definition of other aquatic and riparian degradation problems in the drainage, as well as in the Valley Creek, Marsh Creek, and Bear Valley Creek drainages, was Initiated In 1985 through a BPA-funded inventory conducted by OEA Research Incorporated. The IDFG conducted the associated fish density surveys in the Salmon River drainage. Treatment recommendations for Initiation of BPA projects will be developed based on the inventory data.

Objectives of the upper Salmon River BPA projects are (1) secure passage for anadromous fish at the water diversion; (2) if possible, improve instream flows downstream from the diversion; (3) define and treat riparian and aquatic habitat problems which potentially limit anadromous fish production; and (4) increase natural production of anadromous fish in the upper Salmon River consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin SA-11 l

Anadromous Fish Management Considerations

The upper reaches of the Salmon River contain unique and very high-quality natural production habitat. When the degradation problems associated with irrigation and cattle grazing are resolved, this large production area will be one of the most important areas in the Columbia River basin.

The Sawtooth Hatchery will accelerate the recovery of summer steelhead and spring chinook runs returning to the Stanley basin area. Steelhead runs are already responding to hatchery supplementation with spring chinook expected to greatly increase In the next two to three years. Surplus spawners, fry, and fingerlings will be released into the natural habitats of the upper Salmon River. This area has been chosen as an intensive study site to document in detail the relationship of parr production to smelt production, habitat factors that limit natural production, parr densities that represent full utilization of the production capability, spawning escapements required to achieve full seeding, and the best means to integrate hatchery and natural production.

1984-1985 Passage Improvement Project

Efforts to secure a solution to the irrigation dewatering problem have been underway since 1984 involving negotiations between a private landowner, USFS, and BPA. Proposed technical solutions to dewatering include water right purchases and installation of sprinkler irrigation to replace the existing practice of flood irrigation. In 1985, emphasis of the project was focused on quantification, valuation, and purchase of water rights that will meet instream flow requirements of the salmon resources (H. Forsgren, Sawtooth National Forest, personal communication). No project had been implemented through 1985.

1985 Habitat Problem Identification

An inventory to define habitat problems in the drainage, particularly those related to land use and sedimentation, was initiated in 1985 by OEA Research Incorporated under a BPA contract. The BPA-funded habitat project proposals will be formulated following the report on the inventory and treatment recommendations.

Project Evaluation

Evaluation status. Three basic levels of evaluation are planned for the upper Salmon River: general monitoring; evaluation based on standing crops; and an intensive study designed to determine relationships between spawner escapement, standing crops, and smolt yields. Through 1985, monitoring sections have been established and sampled, and sampling approaches for standing crop evaluations for passage improvements have been established. Sampling procedures for the intensive studies will be developed during 1986.

Different evaluation approaches are required for passage improvement and any future riparian/aquatic habitat improvement projects. Passage improvements at the irrigation diversion will be evaluated as the removal of a partial barrier to chinook. Standing crops of juvenile chinook produced above the diversion factored by the historical frequency of dewatering can be used for mitigation benefits (Petrosky and Holubetz 1985). Evaluation of any future habitat improvements can be based on measured physical habitat changes (improved instream flows, reduced sediment, etc.) and estimated increases in standing crops of steel head and chinook at full seeding. The intensive production studies planned in the upper Salmon River will provide direct estimates of smolt yields based on standing crops for both evaluation approaches. Construction and operation of an upstream and downstream migrant-trapping facility at the diversion in conjunction with the main facility at Sawtooth Hatchery would allow for partitioning smolt yields from different parts of the drainage.

The IDFG evaluation of the upper Salmon River habitat projects began in 1984 as a pretreatment assessment of the Passage Improvement project at the irrigation diversion. Six permanent sections were established and sampled in 1984, four above and two below the diversion.

Juvenile chinook densities in the upper Salmon River sections in 1984 were relatively high, ranging to 97 fish/100 m2 (Petrosky and HOlubetz 1985). Densities of juvenile rainbow-steelhead In the upper Salmon River in 1984 were low.

Sampling effort was increased in 1985 to Include complementary fish population data in the habitat problem-identification inventory. A total of 42 sections were sampled in the main stem Salmon River and tributaries Smiley Creek and Beaver Creek (Table 401, and an additional 10 sections were sampled in Pole Creek. Aquatic habitat variables were measured and fish densities were determined in the sections. The entire riparian corridor in low-gradient reaches was classified by vegetative community type and stream bank stability. Results and recommendations of the inventory phase will be reported separately by OEA Research Incorporated.

Juvenile rainbow-steelhead. The upper Salmon River continued to be under-seeded by steelhead in 1985 (Table 41). Densities of rainbow-steelhead parr showed an increase from 1984, however (Appendix A-9).

This low-gradient habitat may be most important to steelhead for spawning and early rearing and less important for rearing full-term smolts. We noted a general tendency for parr densities to be higher in the higher gradient reaches.

Table 40. Sections sampled in the upper Salmon River and tributaries Smiley Creek and Beaver Creek, August 13-22, 1985.

						% Habitat Type[c]		
Stream, section-reach	Section type[a]	Location[b]	% gradient	Section width(m)	Section area(m^2)	pool, run	riffle	pocket water
Salmon River								
10B	M	A	1.4	4.8	475	71.4	28.2	-
10A[d]	M	A	2.0	4.2	466	24.7	75.3	-
9B	M	A	1.5	7.0	700	11.4	BB .6	-
9A[d]	M	A	1.0	5.4	1044	20.9	78.1	-
8B[d]	M	A	1.5	10.7	1087	22.6	77.4	-
8A[d]	M	A	0.5	8.0	890	31.3	68.7	-
7B[d]	M	B	0.5	6.8	660	50.1	49.9	-
7A[d]	M	B	1.4	10.8	1080	8.5	90.5	-
6B	M	B	1.5	27.3	2733	5.7	94.3	-
6A	M	B	2.0	24.3	2484	24.9	75.1	-
5B	M	B	1.0	22.3	2232	21.8	78.2	-
5A	M	B	2.0	25.3	2528	16.2	83.8	-
4B	M	B	2.0	24.4	2439	25.5	74.5	-
4A	M	B	I .5	25.5	2548	22.1	77.8	-
3B	M	B	2.0	25.8	2575	27.2	72.8	-
3A	M	B	1 .I	23.3	2333	13.3	86.7	-
2B	M	B,W	2.5	32.2	3223	22.3	77.7	-
2A	H	B,W	2.7	39.8	3876	19.0	81.0	-
1B	M	B,W	2.5	36.2	3619	2.0	80.0	-
1A	H	B,W	2.6	32.8	3275	23.5	76.5	-
8SB	S	A	1.0	2.1	211	48.3	50.7	-
8SA	S	A	1.0	3.3	333	100.0	0	-
7SB	S	B	0.3	4 .I	411	62.5	37.5	
7SA	S	B	1.5	4.1	411	77.5	22.5	-
6SB	S	B	0.5	7.3	731	97.3	2.7	-
6SA	S	B	1.0	8.6	658	86.5	13.5	-
4SB	S	B	0.5	7.1	731	48.8	51.2	-
4SA	S	B	0.5	5.8	577	94.9	5.1	-
3SB	S	B	1.0	5.8	588	34.5	65.5	-
3SA	S	B	7.0	5.9	586	34.5	65.5	-
4BRB	BR	B	2.0	21.9	2166	33.9	66.1	-
4BRA	BR	B	2.0	36.9	3689	16.7	83.3	-
3BRB	BR	B	2.0	32.6	3257	36.1	63.8	-
3BRA	BR	B,W	2.0	23.7	2372	13.7	86.3	-
Smiley Creek								
2B	H	A	1.2	5.7	570	w .3	22.0	-
2A	M	A	1 .3	6.1	607	41.6	58.4	-
1B	M	A	2.1	7.2	724	47.2	52.8	-
1A	H	A	0.5	6.4	639	34.6	65.4	-

Table 40. Continued.

Stream, section-reach	Section type[a]	Location[b]	% gradient	Section width(m)	Section area(m^2)	% Habitat Type[c] pool, run	riffle	pocket water
Beaver Creek								
2B	M	A	1.2	6.4	645	69.9	30.1	-
2A	M	A	1.2	5.4	541	69.9	30.1	-
1B	M	A	2.0	5.1	536	30.9	69.1	-
1A	M	A	1.4	7.4	744	23.0	77.0	-

[a] M = main channel; S = side channel; BR = braided channel.

[b] A = above Salmon River irrigation diversion; B = below diversion; W = below Sawtooth Hatchery weir.

[c] Rated from "pool width and riffle width" across transects.

[d] Sections 10A, 9A, 8B, 7B, and 7A were initially numbered in 1984 as 1, 2, 3, 4, 5, and 6, respectively.

Table 41. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in the upper Salmon River and tributaries Smiley Creek and Beaver Creek, August 13-22, 1985.

Stream, reach-section	Section type[a]	Location[b]	Rainbow-steelhead				Chinook	
			0	1	2	>3	0	I+
Salmon River								
10B	M	A	1.5	0	0	0	0	3.2
10A[c]	M	A	13.7	4.3	6.4	0.2	7.1	1.8
9B	M	A	5.6	4.6	0.3	0	4.0	0
BA[c]	M	A	4.6	3.6	0.1	0	12.8	1.0
8B[c]	M	A	1.0	0.5	0	0.1	1.2	0.7
BA[c]	M	A	0	0.4	0	0	1.4	13.0
7B[c]	M	B	0.2	0.2	0.6	0	10.6	5.2
7A[c]	M	B	1.8	0.2	0.7	0.3	17.4	3.3
66	M	B	+	0	0	0	0.5	0.1
6A	M	B	0.4	0.1	0	0	0	0
5B	M	B	3.7	0.2	0.3	0.1	4.6	0
5A	M	B	2.4	0.5	0.3	0	4.0	0.1
46	M	B	2.4	1.2	0.3	+	9.7	0.3
4A	M	B	4.0	0.4	0	0.1	6.0	0.1
38	M	B	4.6	0.4	+	+	23.2	03
3A	M	B	2.6	0.5	0.6	+	25.0	0.2
26	M	B,W	3.2	1.0	1.0	0	2.2	0.4
2A	M	B,W	2.8	1.9	0.7	0	1.2	0.1
1B	M	B,W	1.1	0.2	0	0	0.1	0
1A	M	B,W	0.1	0	0	0	0	0
6SB	S	A	1.4	0	0	0	0.5	0
6SA	S	A	0	0	0	0	0	0
7SB	S	B	0.5	0	0	0	0	0
7SA	S	B	5.8	1.2	0.2	0	1.0	0
6SB	S	B	0	0	0	0	0.3	0
6SA	S	B	0.1	0	0	0	0.4	0
4SB	S	B	7.7	1.4	0.4	0	12.0	0
4SA	S	B	26.9	2.8	0.2	0	6.6	0.2
3SB	S	B	3.6	5.3	1.4	0	22.9	0
3SA	S	B	20.6	1.0	0.9	0	15.4	0.2
4BRB	BR	B	9.8	2.2	0.9	0	4.3	0.1
4BRA	BR	B	3.0	0.3	0.1	0	4.6	1.2
3BRB	BR	B	7.2	0.9	0.9	0.1	7.1	0.1
3BRA	BR	B,W	25.6	5.6	2.4	0.1	32.2	1.0
Smiley Creek								
28	M	A	0	0.3	0.2	0	3.3	0.3
2A	M	A	0	0	0	0	0	0
1B	M	A	0	0	0	0	0.2	0
1A	M	A	0	0	0	0	0	0.2

Table 41. Continued.

Stream, reach-section	Section type[a]	Location[b]	Rainbow-steelhead 0	1	2	≥3	Chinook 0	I+
Beaver Creek								
2B	M	A	0	0	0	0	0	0
2A	M	A	0	0	0	0	0	0
1B	M	A	0	0.2	0.2	0	0	0.2
1A	M	A	0	0.4	0.1	0	0.3	0.1

[a] M = main channel ; S = side channel; BR = braided channel.

[b] A = above irrigation diversion; B = below diversion; W = below Sawtooth Hatchery weir.

[c] Sections 10A, 9A, 8B, 8A, 7B, and 7A were initially numbered in 1994 as 1, 2, 3, 4, 5, end 6, respectively.

Juvenile chinook. The upper Salmon River was severely under-seeded by chinook in 1985 (Table 41). Spawntaking operations at Sawtooth Hatchery have reduced natural spawning escapements in 1982-1985. Juvenile chinook densities were lower in 1985 than in 1984 (Appendix A-91, reflecting the decrease in redd counts from 1983 to 1984. Chinook fry from Sawtooth Hatchery have not been available yet to reseed the upper end of the Salmon River.

Resident salmonids. Resident cutthroat trout, brook trout, bull trout, mountain whitefish, and catchable-size hatchery rainbow trout were present in the upper Salmon River sections in August 1985 (Table 42). Brook trout were abundant primarily in headwater areas; cutthroat trout were rare throughout the drainage.

Physical habitat. During summer 1985, the Salmon River was again dewatered below the diversion during the time of adult chinook migration.

Detailed aquatic habitat measurements, riparian corridor data, and results of simple hypothesis tests will be reported by OEA Research Incorporated. In general, riparian areas in the upper Salmon River drainage were found to be degraded locally by cattle grazing; instream physical habitat was less severely sedimented than in Bear Valley Creek and Elk Creek (Fig. 33).

Future Evaluation and Recommendations

Future project evaluations for mitigation of the Passage project requires estimates of stand1 ng crops of juvenile chinook at full seeding in the drainage upstream of the diversion and development of the factor to account for the frequency of passage blocks in the past. The intensive study in this area will provide the direct means to estimate smolt yields based on standing crop estimates. The intensive study must be integrated closely with the general evaluations in the upper Salmon River and other project streams. Results of the intensive study should also provide feedback to the general evaluations, including tests of assumptions inherent to sampling designs based on summer standing crops and measured changes in physical habitat.

Specific evaluation approaches to other potential BPA-funded habitat projects in the drainage should be formulated during the development of implementation plans.

Alturas Lake Creek

Alturas Lake Creek is a tributary to the upper Salmon River and originates at 2,730 m elevation in the Sawtooth National Recreation Area. From its source, the stream courses in a general northeasterly

Table 42. Density (number/100m^2) by age-group of cutthroat trout, brook trout, bull trout, whitefish, and hatchery rainbow trout (catchable-size) in the upper Salmon River and tributaries Smiley Creek and Beaver Creek, August 13-22, 1985.

Stream, reach-section	Section type[a]	Location[b]	Cutthroat	Brook		Bull		Whitefish		Hatchery rainbow trout
			≥1	0	≥1	0	≥1	0	≥1	
Salmon River										
10B	M	A	0	5.1	4.6	0	0	8.2	2.7	0
10A[c]	M	A	0	0	1.9	0	0	0	1.5	0
88	M	A	0	0	0.1	0	0.3	0.6	2.3	0
BA[c]	M	A	0	0.2	0.3	0	0	3.6	0.7	0
8B[c]	M	A	0	0	0	0	0	1.2	5.6	0
BA[c]	M	A	0	0	0	0	0	11.8	6.0	0
7B[c]	M	B	0	0	0.6	0	0	14.7	0	0
7A[c]	M	B	0	0	1.3	0	0.1	2.5	5.5	0.1
66	M	B	0	0	0.1	0	0	2.5	6.2	0
6A	M	B	0	0	0	0	0	3.6	7.6	0
5B	M	B	0	0	0	0	0	0.2	5.7	0
5A[d]	M	B	0	+	+	0	0	0.9	7.5	0
46	M	B	0	0	0.2	0	+	2.1	11.2	0
4A	M	B	0	+	+	0	0	4.5	2.2	0
38	M	B	f	0.3	0.1	0	0	36.4	6.9	0
3A	M	B	0	0	0	0	0	6.3	7.1	0
26	M	B,W	0.1	0	+	0	0	0.3	3.0	0.3
2A	M	B,W	0	0	0	0	0	0.3	1.3	0.1
1B	M	B,W	0	0	0	0	0	0.4	1.7	0
1A	M	B,W	0	0	0	0	0	0.1	2.5	0.5
8SB	S	A	0	1.4	0	0	0	0	1.9	0
8SA	S	A	0	0	0	0	0	0	0	0
7SB	S	B	0	0	0	0	0	0	0	0
7SA	S	B	0	0.2	0.5	0	0	3.2	0.2	0
6SB	S	B	0	0	0	0	0	0	0	0
6SB	S	B	0	0	0	0	0	15.4	0	0
4SB	S	B	0	15.0	2.2	0.1	0	5.9	0	0
4SA	S	B	0	0.3	0.9	0	0	4.0	0	0
3SB	S	B	0	0.7	1.0	0	0	4.4	0	0
3SA	S	B	0	0.5	0	0	0	0	0	0
4BRB	BR	B	0	0	0.3	0	+	1.1	2.7	+
4BRA	BR	B	0	+	0.1	0	0	4.1	1.4	0
3BRB	BR	B	+	0	+	0	0	1.7	2.6	0
3BRA	BR	B,W	0	0	0.1	0	+	1.8	2.8	0.5
Smiley Creek										
28	M	A	0	0	2.1	0	0	2.1	0	0
2A	M	A	0	2.8	6.6	0	0	3.5	0.2	0
1B	M	A	0	0	2.9	0	0	2.1	3.3	0
1A	M	A	0	0	1.1	0	0	1.4	0.6	0

Table 42. Continued.

Stream, reach-section	Section type[a]	Location[b]	Cutthroat	Brook		Bull		Whitefish		Hatchery rainbow trout
			>1	0	>1	0	>1	0	>1	
Beaver Creek										
2B	M	A	0	1.7	3.6	0	0.3	0	0	0
2A	M	A	0	0.7	2.2	0	0	0	0	0
1B	M	A	0	0.7	2.6	0	0	0	0	0
1A	M	A	0	0.5	0.6	0	0	0	0	0

[a] M = main channel; S = side channel; BR = braided channel.

[b] A = above irrigation diversion; B = below diversion W = below Sawtooth Hatchery weir.

[c] Sections 10A, 8A, 8B, 8A, 7B, and 7A were initially numbered in 1984 as 1, 2, 3, 4, 5, and 6, respectively.

[d] One juvenile kokanee also observed.

direction dropping 650 m in 25 km to its confluence with the Salmon River (Fig. 18). The stream passes through two natural lakes, Alturas Lake (339 hectares) and Perkins Lake (21 hectares), which receive moderate recreational use during the summer season. Below the lakes, four main tributaries and subsurface seepage enter the stream; above the lakes, only Alpine Creek contributes substantially to its volume. An irrigation diversion below the lakes completely dewaters the stream during most years, limiting use of the stream by anadromous fish.

Historically, spring chinook spawned and reared In Alturas Lake Creek above and below the lakes and in Alpine Creek up to its barrier 2.4 km upstream. Sane use of Alturas Lake Creek by summer steelhead also occurred. Sockeye salmon spawned in the upper drainage and reared in Alturas Lake.

Resident salmonids in Alturas Lake Creek are rainbow trout, cutthroat trout, bull trout, brook trout, and mountain whitefish (Mallet 1974); kokanee have been stocked In Alturas Lake.

Approximately 8 km upstream from the mouth of Alturas Lake Creek, an irrigation diversion dam (Fig. 18) usually diverts all flow after the first week of July. Most of the potential chinook spawning habitat and more than 80% of the suitable rearing habitat exists upstream from the diversion (H. Forsgren, Sawtooth National Forest, personal communication). The stream is dewatered for 2.6 km below this diversion during the largest part of the chinook spawning season. Vat Creek and subsurface flows do provide sufficient water to the lower portions of Alturas Lake Creek for fair spawning and rearing conditions in most years. In addition to reducing chinook and steelhead production potential, the diversion eliminated a sockeye run which probably exceed 4,500 in escapement.

The USFS investigated two approaches to resolve the Instream flow problem in Alturas Lake Creek (Forsgren 1984a). The first approach involved the construction of an outlet control structure on Alturas Lake to store spring runoff water for release into the creek during late summer and early fall to accommodate upstream migrating and spawning chinook. In conjunction with this structure, a fish screen and fish ladder would be necessary at the diversion. The second approach would be the acquisition of the water right or a portion of that right held on Alturas Lake Creek for instream flows.

Objectives of the project are (1) secure passage of adult chinook and sockeye into the upper stream, (2) improve instream flows downstream from the diversion, (3) restore production potential of Alturas Lake Creek for chinook and sockeye, and (4) increase natural production of anadromous fish, consistent with IDFG (1985) Anadromous Fish Management PI an for Subbasin SA-11.

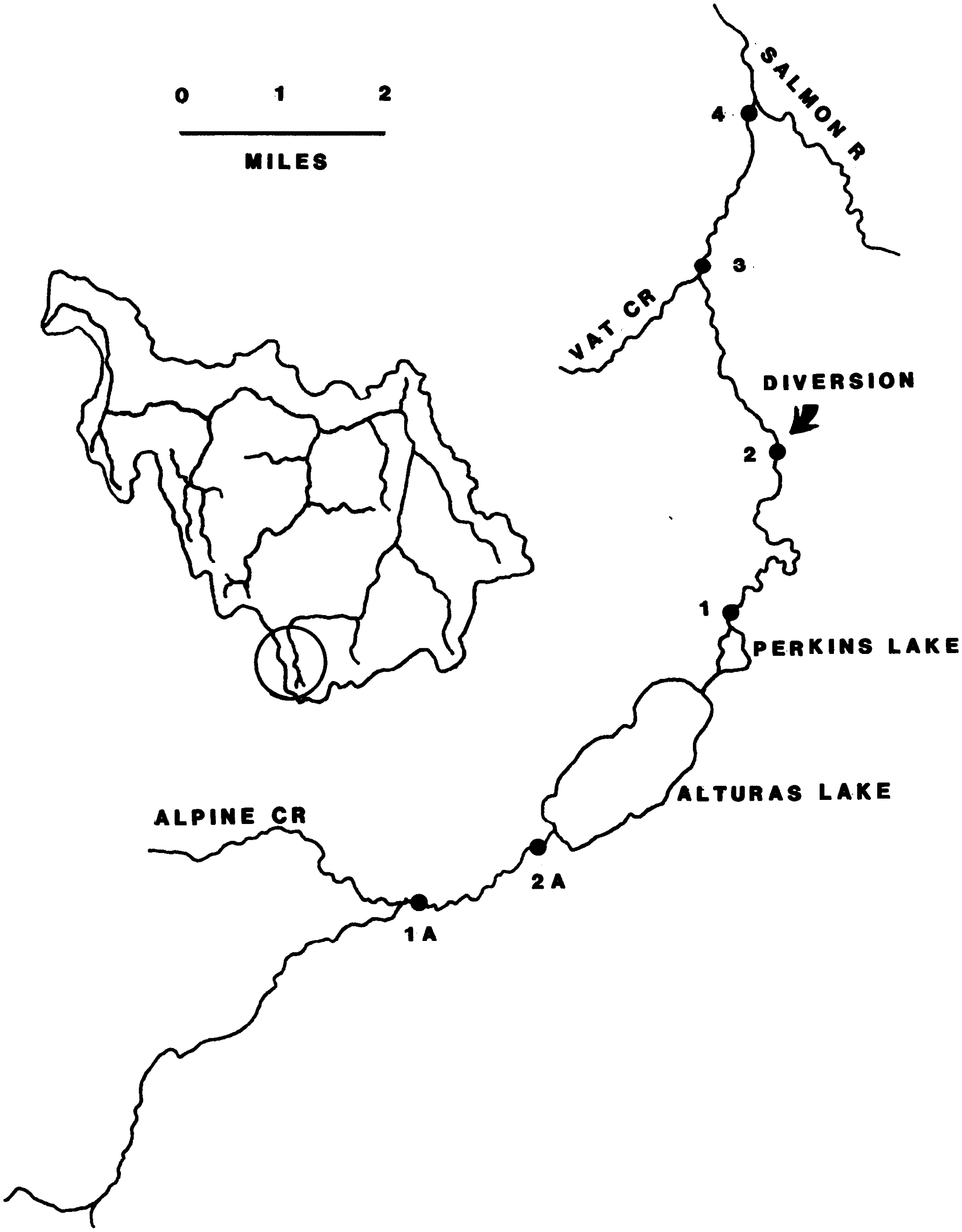

Figure 18. Location of passage block at irrigation diversion on Alturas Lake Creek and established monitoring sections.

Anadromous Fish Management Considerations

The many years of dewatering of the lower part of Alturas Lake Creek has totally eliminated the sockeye salmon runs and brought the chinook salmon and steelhead trout runs to near-extinction levels above the Breckenridge diversion. Trapping of adults for spawntaking at Sawtooth Hatchery has further depressed returns of adult salmon and steel head to the upper part of Alturas Lake Creek. There is concern that the unique population of chinook salmon that migrated through Alturas Lake and spawned and reared in the stream above Alturas Lake has been lost

No chinook salmon fry or fingerlings have been stocked in Alturas Lake Creek in recent years. Steelhead fry have been stocked below the lake periodically from 1978 to 1985, A suitable sockeye brook stock will have to be located for reestablishing sockeye salmon into Alturas Lake.

1983-l 985 Passage Improvement Project

Both the flow augmentation and water right purchase approaches to resolve conflicts between irrigation use and fishery needs have been investigated and deemed technically feasible (H. Forsgren, personal communication). in 1985, emphasis was placed on quantification, valuation, and purchase of the water rights that will meet instream flow requirements for salmon. No project had been implemented through 1985.

Project Evaluation

Evaluation status. Three basic levels of evaluation are planned for Alturas Lake Creek: general monitoring; evaluations based on standing crops; and an intensive study in the upper Salmon River drainage designed to determine relationships between spawning escapements, standing crops, and smolt yields. In 1985, monitoring sections were established and sampled and the sampling approach for standing crop evaluations in Alturas Lake Creek was established.

Passage improvement at the irrigation diversion will be evaluated as a removal of a barrier to adult chinook and sockeye (and possibly to juvenile steelhead). Mitigation benefits for chinook can be determined from standing crops of juveniles produced above the diversion. Evaluation of benefits for lake-rearing sockeye will require trapping of downstream migrants either at the Sawtooth Hatchery weir or at a weir constructed at the diversion structure. Improvements In instream flows associated with passage improvements can be evaluated in affected reaches from estimated increases in standing crops of juvenile chinook and steelhead at full seeding. The intensive production studies planned in the upper Salmon River will provide direct estimates of smolt yields based on standing crops of chinook and steelhead. Construction and operation of an upstream and downstream migrant trapping facility at the Alturas Lake Creek diversion would allow for partitioning of smolt yields from different parts of the upper Salmon River drainage.

The IDFG evaluation of the Alturas Lake Creek project began in 1984 as a pretreatment assessment of the passage improvement project at the irrigation diversion. Six permanent sections were established and sampled In 1984, two above the lakes, two below the lakes and above the diversion, and two below the diversion.

Juvenile chinook densities in 1984 varied considerably by location averaging about 2 fish/100 m^2 in sections above the diversion and 47 fish/100 m^2 below the diversion (Petrosky and Holubetz 1985). The remnant status of chinook above Alturas Lake will be of special concern if these fish are unique genetically. Rainbow-steelhead densities in 1984 were low throughout most of Alturas Lake Creek.

Sampling efforts in 1985 were maintained at the general monitoring level. We estimated densities in two sections above Alturas Lake and 1 section below the diversion in August 1985 (Table 43).

juvenile rainbow-steelhead. Alturas Lake Creek was under-seeded by steelhead in 1984 and 1985 (Table 44, Appendix A-10). Rainbow-steelhead were rare in the reach above Alturas Lake.

Juvenile chinook. Densities of age 0 chinook decreased from 1985 to 1985 (Table 44, Appendix A-10) due to a decrease in number of adult chinook allowed to pass the Sawtooth Hatchery weir. No age 0 chinook and a single precocious yearling were observed in two sections above Alturas Lake in 1985. The single salmon redd counted above the lake In 1985 Spawning Ground Survey (M. Reingold, IDFG, personal communication) was In the same location that we observed a large bull trout redd.

Resident salmonids. Brook trout, bull trout, and mountain whitefish were observed In Alturas Lake Creek in 1985 (Table 45). Brook trout were most abundant In the vicinity of Vat Creek (Section 3) where groundwater enters the stream. No cutthroat trout were observed in Alturas Lake Creek in 1984 or 1985.

Future Evaluation and Recommendations

Future evaluations for mitigation of the Passage project requires standing crop estimates of juvenile steelhead and chinook at full seeding upstream of the diversion and in the dewatered reach below the diversion. All sockeye and most chinook produced In this area should

Table 43. Sections sampled in Alturas Lake Creek, August 21, 1985,

					% Habitat Type[b]		
Section	Location[a]	% gradient	Section width(m)	Section area(m^2)	pool, run	riffle	pocket water
1A	A, L	-	7.6	759	66.7	33.3	0
1B	A, L		7.3	732	85.2	14.8	0
3	B		8.2	1597	71.7	28.3	0

[a] A = above irrigation diversion; B = below diversion; L = above Alturas Lake.

[b] 1984 survey data.

Table 44. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in Alturas Lake Creek, August 21, 1985.

		Rainbow-steelhead				**Chinook**	
Section	**Location**[a]	**0**	**1**	**2**	**≥3**	**0**	**1+**
1A	A,L	0.5	0.1	0	0	0	0.3
1B	A,L	0	0	0	0	0	0
3	B	6.7	0.7	0.1	+	12.5	1.8

[a] A= above irrigation diversion; B = below diversion; L = above Alturas Lake.

Table 45. Density (number/100m^2) by age-group of brook trout, bull trout, and whitefish in Alturas Lake Creek, August 21, 1985.

Section	Location[a]	Brook		Bull		Whitefish	
		0	≥1	0	≥1	0	≥1
1A	A,L	0.7	1.1	0.1	0.5	0	0.1
1B	A,L	0.1	2.5	0	0	0	0
3	B	3.9	9.1	0	0	0.6	0

[a] A = above irrigation diversion; B = below diversion; L = above Alturas Lake.

be counted as mitigation benefits. An undetermined fraction of the steelhead produced could be considered mitigation. An intensive study in the upper Salmon River will provide the direct means to estimate smolt yields of chinook and steelhead based on standing crop estimates. Numbers of sockeye smolts and adults could be estimated directly at the Sawtooth Hatchery weir or a weir designed into the diversion structure. The intensive study should be integrated closely with the general evaluations in the upper Salmon River and other project streams.

Pole Creek

Pole Creek, 14 km long, enters the Salmon River near its headwaters at river kilometer 631 (Fig. 19). Pole Creek lies entirely within the Sawtooth National Recreation Area. The stream in its lower 5 km below an irrigation diversion flows through private, irrigated land. Habitat for spawning and rearing of anadromous fish is high quality. However, irrigation withdrawals before 1982 had dewatered the mouth of the stream and partially dewatered the lower 5 km during summer.

Summer steelhead and spring chinook were essentially eliminated from Pole Creek above the irrigation withdrawals. After anadromous fish runs are restored, Pole Creek should be an important producer of steel head and chinook for the upper Salmon River drainage. Aquatic habitat surveys by IDFG and USFS suggest that the 5 km of stream immediately above the diversion could support about 560 steelhead spawners and 940 chinook spawners (Forsgren 1984b).

Resident salmonids in Pole Creek include rainbow trout, brook trout, bull trout, and mountain whitefish.

The abstracted water rights in Pole Creek (65.6 cfs) exceeded the total instream flow throughout most of the irrigation season before 1982 (Forsgren 1984b). irrigation water was withdrawn from seven points along the stream, leaving the mouth of Pole Creek dewatered. In 1982, the mode of irrigation was changed from "flood" to "overhead sprinkler." The new irrigation system requires only 12-18 cfs drawn from one point and leaves enough water instream to reestablish steel head and chinook in Pole Creek. Screening of juvenile steel head and chinook from the new single diversion was an important part of anadromous fish restoration in Pole Creek. Preliminary estimates suggested that about 25% of all juvenile steelhead and chinook could die in an unscreened diversion network (Forsgren 1984b). With support of IDFG, the Sawtooth National Forest entered into an agreement with BPA in 1983 to screen the Pole Creek diversion. The USFS contracted IDFG to design, construct, and install the screen.

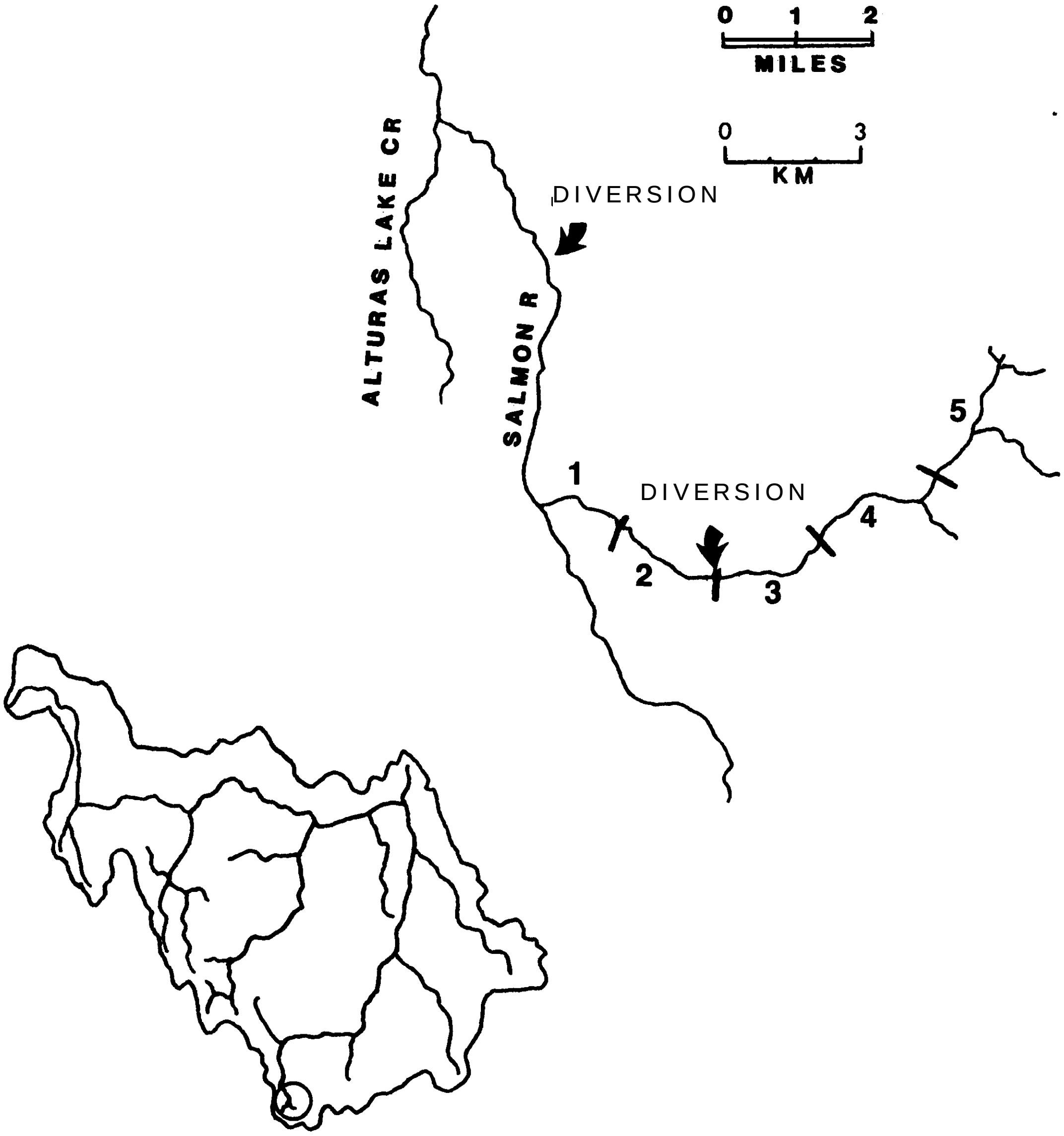

Figure 19. Location of 1983 screening project at irrigation diversion on Pole Creek and reaches established in 1985 to define habitat problems.

Definition of other aquatic and riparian degradation problems in the upper Salmon River (including Pole Creek) and In the Valley Creek, Marsh Creek, and Bear Valley Creek drainages was initiated In 1985 through a BPA-funded inventory conducted by OEA Research Incorporated. Treatment recommendations for initiation of BPA projects will be developed based on the inventory data.

Objectives of the Pole Creek BPA projects are: (1) reestablish steel head and chinook runs to Pole Creek, (2) screen downstream migrating juvenile steelhead and chinook from the Irrigation diversion, (3) define and treat riparian and aquatic habitat problems which potentially limit anadromous fish production, and (4) increase natural production of anadromous fish in Pole Creek consistent with IDFG (1985) Idaho Anadromous Fish Management Plan for Subbasin M-1 1.

Anadromous Fish Management Considerations

Since this project was implemented, no Increase In salmon production has occurred In the Pole Creek drainage upstream from the diversion. The spawntaking operation at Sawtooth Hatchery has reduced the number of adult salmon returning to the Pole Creek vicinity. In addition, 1985 summer flows were low and the Busterback diversion completely dewatered a portion of the Salmon River. These conditions prevented the small number of adults that were released at Sawtooth weir from reaching headwater streams like Pole Creek.

In the early summer of 1985, steelhead fry from Sawtooth Hatchery was stocked in the upper part of Pole Creek. No chinook fry or fingerlings have been stocked in Pale Creek in recent years. Chinook fry should be stocked in Pole Creek above the diversion at the earliest possible date.

1983 Screening Project

During summer 1983, IDFG engineering personnel surveyed the diversion site and designed the screen. A single-rotary drum screen powered by a paddle wheel was designed for use beginning with the 1984 Irrigation season. The IDFG completed concrete work and backfilling during September 1983; the screen was first installed and operated during the 1984 irrigation season.

1985 Habitat Problem Identification

An inventory to define habitat problems in the drainage, particularly those related to land use and sedimentation, was Initiated In 1985 by OEA Research Incorporated under BPA contract. The

BPA-funded habitat project proposals will be formulated following the report on the inventory and treatment recommendations.

Project Evaluation

Evaluation status. Three basic levels of evaluation are planned for Pole Creek: general monitoring; evaluations based on standing crops; and an intensive study in the upper Salmon River drainage designed to determine relationships between spawner escapements, standing crops, and smolt yields. Through 1985, monitoring sections have been established and sampled, and sampling approaches for standing crop evaluations for the screening project have been established.

Benefits to steel head and chinook from the Pale Creek Screening project can be estimated as some fraction of their standing crops at full seeding upstream of the diversion screen. This fraction could be determined as either the fraction of the total flow withdrawn (about 25%) or from mark-recapture experiments. Construction and operation of an upstream and downstream migrant trapping facility at the Pole Creek diversion would facilitate these mark-recapture experiments, as well as allow for partitioning of smelt yields from different parts of the upper Salmon River drainage. Evaluation of any future habitat improvements can be based on measured physical habitat changes (e.g., sediment reduction) and estimated increases in standing crops of juvenile steelhead and chinook at full seeding.

The IDFG evaluation of the Pole Creek habitat projects began in 1984 as a posttreatment assessment of the screening project. Four permanent monitoring sections were established and sampled in 1984, two above and two below the diversion screen.

The diversion dam was an impediment to upstream passage of adult chinook and juvenile chinook and steelhead in 1984 and probably 1983 (Petrosky and Holubetz 1985). No juvenile anadromous fish were observed above the diversion during 1984 fish density monitoring; whereas, juvenile chinook were abundant immediately downstream of the diversion. Upstream passage conditions for adult chinook at the diversion were good in August 1985; however, no adults were observed in Pole Creek that year.

Sampling effort was increased in 1985 to include complementary fish population data in the habitat problem-identification inventory of the upper Salmon and upper Middle Fork Salmon rivers. Ten sections were sampled in Pole Creek In conjunction with this Inventory (Table 46). Aquatic and riparian data and treatment recommendations will be reported separately by OEA Research Incorporated.

Juvenile rainbow-steelhead. Pole Creek was under-seeded by steelhead In 1984 and 1985 (Appendix A-l 1). The IDFG introduced steelhead fry Into Pole Creek In 1985, which resulted in moderate to

Table 46. Sections sampled in Pole Creek, August 13-16, 1985.

Section	Location[a]	% gradient	Section width(m)	Section area(m^2)	% Habitat Type[b] pool, run	riffle	pocket water
5B	A	2.0	2.7	267	27.0	73.0	-
5A	A	2.7	4.4	443	13.1	86.9	-
4B	A	0.5	6.1	553	33.7	66.3	-
4A	A	2.3	5.3	515	21.7	78.3	-
3B[c]	A	1.0	4.7	442	31.4	68.6	-
3A[c]	A	2.0	4.0	403	41.0	59.0	-
2B[c]	B	1.2	4.2	372	46.2	53.8	-
2A[c]	B	1.0	4.5	402	28.1	71.9	-
1B	B	1.5	7.1	765	26.1	73.9	-
1A	B	1.5	5.6	466	31.1	68.9	-

[a] A = above irrigation diversion and screen; B = below diversion and screen.

[b] Rated from "pool width and riffle width" across transects.

[c] Sections 3B, 3A, 2B, and 2A were initially numbered in 1984 as 1, 2, 3, and 4, respectively.

high fry densities in Reaches II, III, and IV (Table 47). Continued releases will be necessary to restore steel head production in Pole Creek.

Juvenile chinook. No age 0 chinook were observed in Pole Creek in 1985 (Table 47). Moderate densities of age 0 chinook had been observed below the diversion screen in 1984 (Appendix A-l 1). Chinook fry should be introduced into upper Pole Creek as allowed by fish availability.

Resident salmonids. Resident brook trout, bull trout, and mountain whitefish were observed in Pal e Creek in 1985 (Table 48). No cutthroat trout were seen in 1984 or 1985.

Physical habitat. The major habitat problem identified in the inventory of Pole Creek was severe bank erosion caused by sprinkler irrigation wheels crossing the stream and cattle use in the downstream reach. Detailed physical habitat measurements, riparian corridor information, and results of simple hypothesis tests will be reported by OEA Research Incorporated.

Future Evaluation and Recommendations

Future evaluation of the Pole Creek Screening project for mitigation requires a standing crop estimate of juvenile steelhead and chinook at full seeding upstream of the diversion screen and an estimate of the fraction of migrants diverted successfully by the screen. An intensive study in the upper Salmon River with weirs below Pole Creek will provide a direct means to estimate smolt yields from standing crop estimates. The intensive study should be integrated closely with the general evaluation work that has already been accomplished.

Specific evaluation approaches to other potential habitat projects, such as in lower Pole Creek, should be formulated during the development of implementation plans.

Valley Creek

Valley Creek, 34 km long, enters the Salmon River near the headwaters at river kilometer 598 (Fig. 20). The Valley Creek drainage lies primarily within the Sawtooth National Recreation Area with its headwaters in the Challis National Forest. Anadromous fish habitat has been degraded in portions of the drainage from activities such as grazing in riparian zones and irrigation withdrawals.

Table 47. Density (number/100m^2) by age-group of rainbow-steel head and chinook in Pole Creek, August 13-16, 1985.

Section	Location[a]	Rainbow-steelhead				Chinook	
		0	1	2	≥3	0	1+
5B	A	0	0	0	0	0	0
5A	A	0	0	0	0	0	0
4B	A	12.3	0.2	0	0	0	0
4A	A	13.2	5.6	0.2	0	0	0
3B[b]	A	159.3	0	0	0	0	0
3A[b]	A	79.6	0	0	0	0	0
2B[b]	B	18.8	0	0	0	0	0
2A[b]	B	0	2.5	0.5	0.2	0	0.2
1B	B	0	0	0	0.1	0	0.1
1A	B	0	0.2	0.2	0	0	0

[a] A= above irrigation diversion and screen; B = below diversion and screen.

[b] Sections 3B, 3A, 2B, and 2A were initially numbered in 1984 as 1, 2, 3, and 4, respectively.

Table 48. Density (number/100m^2) by age-group of brook trout, bull trout, and whitefish in Pole Creek, August 13-16, 1985.

Section	Location[a]	Brook		Bull		Whitefish	
		0	≥1	0	≥1	0	≥1
5B	A	0	0	0	0	0	0
5A	A	0	0	0	0	0	0
48	A	0	0	0	0	0	0
4A	A	0.4	2.3	0.6	0.2	0	0
3Bb	A	0.2	0	0	0	0	0
3Ab	A	0.5	0.5	0	0	3.0	0
2Bb	B	0.3	0	0	0	3.2	0
2Ab	B	0	0	0	0	0	0.2
18	B	0	0.3	0	0.1	0	1.4
1A	B	0	0.9	0	0	0	0.9

[a] A= above irrigation diversion and screen; B = below diversion and screen.

[b] Sections 3B, 3A, 2B, and 2A were initially numbered in 1984 as 1, 2, 3, and 4, respectively.

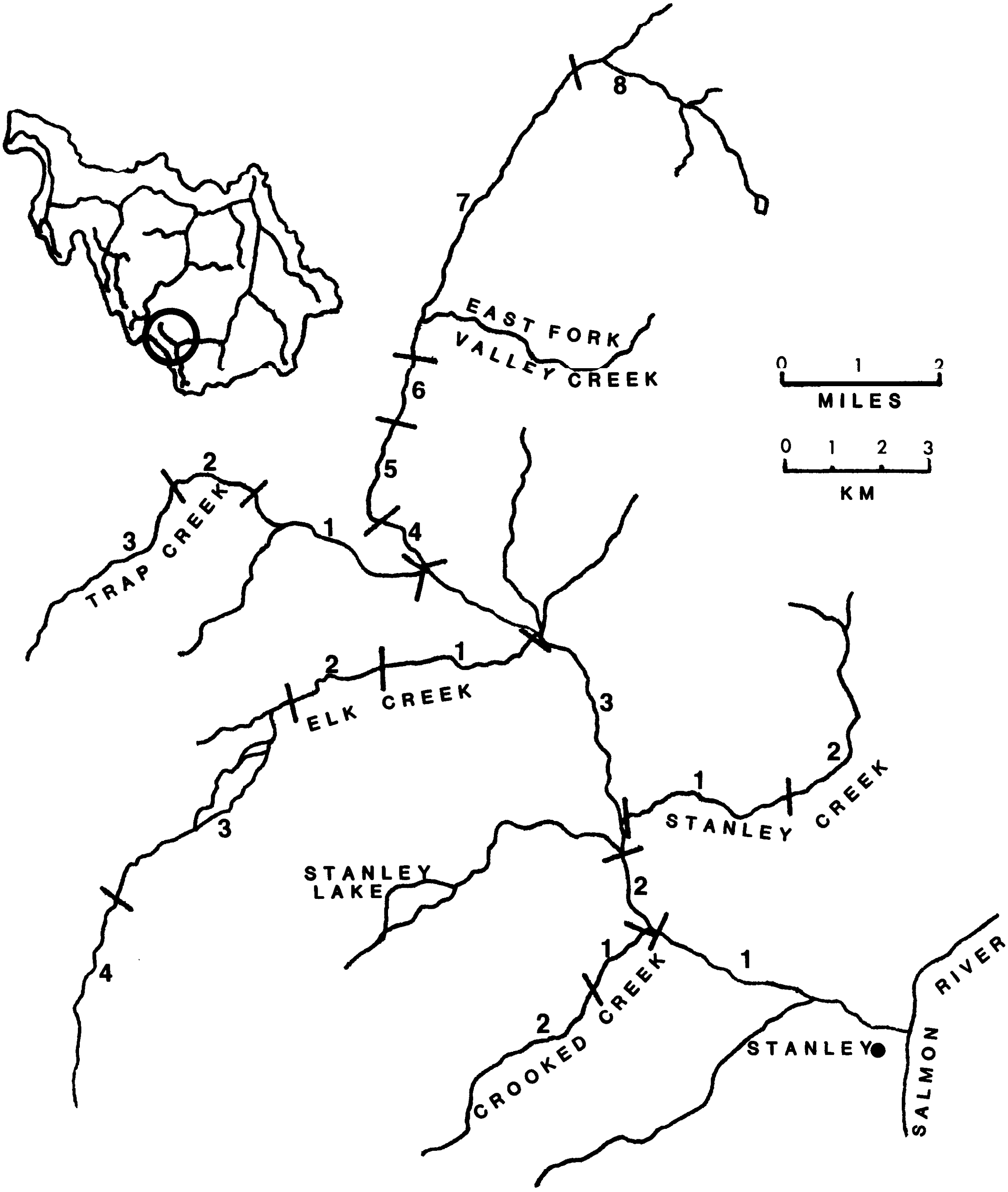

Figure 20. Location of reaches established in 1985 to define habitat problems in the Valley Creek drainage.

The Valley Creek system is a major production area for spring and summer chinook and summer steel head. Anadromous fish runs to Valley Creek were reduced in the early 1900s by construction of Sunbeam Dam downstream from Stanley. The dam, which was a barrier to anadromous fish at high flows, was breached in 1934. Efforts are underway to restore a sockeye run to Stanley Lake.

Native resident salmonids in the Valley Creek drainage are rainbow trout, cutthroat trout, bull trout, and mountain whitefish (Mallet 1974). Nonnative brook trout have al so become established.

Definition of aquatic and riparian degradation problems in the drainage and, al so, upper Salmon River, Marsh Creek and Bear Valley creek drainages was Initiated In 1985 through a BP&funded Inventory conducted by OEA Research Incorporated. The IDFG conducted the associated fish density surveys in the Valley Creek drainage. Treatment recommendations for initiation of BPA projects will be developed based on the Inventory data.

Objectives of the BPA inventory in the Valley Creek drainage are: (1) define and treat riparian and aquatic habitat problems which potentially limit anadromous fish production, and (2) increase natural production of anadromous fish in the Valley Creek drainage consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin SA-11.

Anadromous Fish Management Considerations

Valley creek will be supplemented with hatchery steel head and chinook salmon from Sawtooth Hatchery in those years that the habitat is under-seeded by natural spawning. Portions of the Valley Creek drainage have badly degraded aquatic habitat. The Sawtooth NRA is implementing projects to improve those degraded conditions.

In the last several years, both fingerling and smolt steelhead have been stocked in Valley Creek No surplus chinook salmon have been available to stock In Valley Creek.

The chinook salmon run this past year was at a very low level. With the first returns to Sawtooth Hatchery occurring in the next two to three years, the prospects for restoring chinook salmon production in Valley Creek are very good.

1985 Habitat Problem Identification

An inventory to define habitat problems in the drainage, particularly those related to land use and sedimentation, was initiated In 1985 by OEA Research Incorporated under BPA contract. The

BPA-funded habitat project proposals will be formulated following the report on the Inventory and treatment recommendations.

Project Evaluation

Evaluation status. Two basic levels of evaluation will be used on any BPA habitat projects implemented in the valley creek drainage: general monitoring and standing crop evaluations. Through 1985, monitoring sections had been established and sampled pretreatment (Table 49). Pending development of BPA projects in the drainage, IDFG will continue to monitor density trends in the drainage in a small number of sections (Appendix A-12).

Juvenile rainbow-steelhead. The Valley Creek drainage was under-seeded by steel head in August 1985 (Table 50). Densities of juvenile rainbow-steelhead in Valley creek drainage were generally similar to those In the upper Salmon River drainage (Table 41).

Juvenile chinook. The drainage was under-seeded by chinook in 1985 (Table 50). However, compared to many other depressed stocks in Idaho, main stem Valley Creek supported a relatively good population of juveniles in 1985 oven without past supplementation. The spawning escapement to Valley Creek in 1985 declined to a very low level.

Resident salmonids. Resident cutthroat trout, brook trout, bull trout, mountain whitefish, and catchable-size hatchery rainbow trout were present in the Valley Creek drainage (Table 51). Brook trout were abundant primarily in headwater areas; cutthroat trout and bull trout were rare throughout the drainage.

Physical habitat. Results and recommendations from the aquatic/riparian habitat inventory will be reported by OEA Research Incorporated. In general, riparian areas in the Valley Creek drainage were found to be degraded locally by cattle grazing. Instream physical habitat was less severely sedimented than in Bear Valley Creek and Elk Creek (Fig. 33).

Future Evaluation and Recommendations

Specific evaluation approaches to any BPA habitat project in the Valley creek drainage should be formulated during the development of implementation plans.

Table 49. Sections sampled in Valley Creek and tributaries Trap Creek, Elk Creek, Stanley Creek, and Crooked Creek, August 14-30, 1985.

Stream, reach-section	Section type[a]	% gradient	Section width(m)	Section area(m^2)	% Habitat Type[b] pool, run	riffle	pocket water
Valley Creek							
8B	M	2.0	4.9		20.6	79.4	-
8A	M	1.5	4.6		56.2	43.7	-
78	M	1.5	6.3	633	32.2	67.6	-
7A	M	1.2	6.4	620	45.4	54.6	-
68	M	1.6	7.0	900	13.3	86.7	-
6A	M	1.5	5.9	525	33.4	66.6	-
56	M	1.5	7.1	629	44.6	55.2	-
5A	M	1.0	7.3	935	31.9	68.1	-
46	M	0.5	7.9	703	40.1	59.9	-
4A	M	1.0	5.5	546	56.6	41.2	-
38	M	1.0	7.3	814	31.8	66.2	-
3A	M	2.0	11.2	3316	22.4	77.6	-
28	M	1.0	27.6	2736	39.6	60.4	-
2A	M	1.0	19.7	2203	18.4	81.6	-
1B	M	1.5	16.7	1336	22.2	77.6	-
IA	M	2.0	16.2	2241	25.3	74.7	-
3SB	S	0.5	2.1	214	100.0	0	-
3SA	S	1.0	4.4	433	59.2	40.6	-
358	S	0.5	7.3	722	96.6	3.4	-
1SA	S	0.5	5.9	592	100.0	0	-
Trap Creek							
38	M	1.0	6.4	638	69.7	30.3	-
3A	M	1.0	3.6	373	56.9	43.1	-
28	M	3.0	3.9	310	27.4	72.6	-
2A	M	1.5	3.6	313	21.6	79.4	-
1B	M	1.0	4.3	464	79.7	20.3	-
1A	M	0.5	5.2	423	98.1	1.9	-
Elk Creek							
4B	M	1.6	5.6	546	33.2	66.6	-
4A	M	1.9	6.4	662	50.7	49.3	-
36	M	1.6	5.2	515	65.9	34.1	-
3A	M	1.5	7.4	736	66.5	33.5	-
2B	M	3.0	7.4	674	20.3	79.7	-
2A	M	2.0	6.2	585	23.0	77.0	-
1B	M	1.5	5.2	511	15.5	64.5	-
1A	M	2.0	6.2	640	12.3	67.7	-
3SB	S	0.6	2.0	238	72.7	27.3	-
3SA	S	1.0	2.1	209	47.1	52.9	-

Table 49. Continued.

Stream, reach-section	Section type[a]	% gradient	Section width(m)	Section area(m^2)	% Habitat Type[b] pool, run	riffle	pocket water
Stanley Creek							
2B	M	0.2	3.4	205	95.1	2.4	-
2A	M	0.5	3.2	328	94.3	5.7	-
1B	M	0.5	2.7	362	87.0	13.0	-
1A	M	0.5	3.0	267	93.2	6.6	-
Crooked Creek							
28	M	1.0	3.3		43.7	56.3	-
2A	M	2.6	3.1	307	19.6	60.4	-
1B	M	1.6	3.5		30.3	69.7	-
1A	M	1.5	393	333	22.3	77.7	-

[a] M = main channel; S = side channel.

[b] Rated from "pool width and riffle width" across transects.

Table 50. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in Valley Creek and tributaries, August 14-30, 1985.

Stream, reach-section	Section type[a]	Rainbow-steelhead				Chinook	
		0	1	2	≥ 3	0	1+
Valley Creek							
8B	M	-	-		0		-
8A	M	0	0	0	0		
7B	M	0	0	0	0	5.1	0.3
7A	M	0	0	0	0	27.8	1.3
6B	M	0	0.2	0	0	5.4	1.4
6A	M	0	0.6	0.2	0	11.6	1.3
5B	M	0	0.2	0	0	10.6	1.3
5A	M	4.6	2.8	0.8	0.4	6.7	0
4B	M	5.3	1.0	0.3	0	17.2	0.1
4A	M	23.9	2.7	0.6	0	15.2	0.2
3B	M	12.8	2.1	0.4	0.1	38.6	0.5
3A	M	8.3	1.8	1.6	0.1	45.5	2.8
2B	M	3.6	0.8	0.4	0.2	8.2	0.1
2A	M	1.6	1.3	1.0	+	4.6	0.1
1B	M	3.6	1.0	0.2	0.1	15.1	1.2
1A	M	3.0	0.2	+	0.2	4.7	0
3SB	S	1.9	0	0	0	20.6	0
3SA	S	3.5	0.7	0.2	0	22.4	0
1SB	S	0	0	0	0	5.7	0
1SA	S	0	0.2	0	0	0	0
Trap Creek							
3B	M	0	0	0	0	0	0
3A	M	0	0	0	0	0	0
2B	M	0	0	0	0	0	0
2A	M	0	0	0	0	0	0
1B	M	0	0	0	0	0	0
1A	M	0	1.0	0	0	0	0
Elk Creek							
4B	M	0.4	0	0	0	29.5	0
4A	M	0	0	0	0	5.4	0
3B	M	0.4	0	0	0	15.9	0
3A	M	0	0	0	0	0.1	0
2B	M	1.9	1.3	0.9	0.3	6.8	0.4
2A	M	1.2	1.0	1.4	0	11.5	1.0
1B	M	0.8	0.6	0	0	32.5	0.2
1A	M	0.3	1.2	0.3	0	25.9	0.6
3SB	S	10.5	0	0	0	0	0
3SA	S	0	0	0	0	10.5	0

Table 50. Continued.

Stream, reach-section	Section type[a]	Rainbow-steelhead 0	Rainbow-steelhead 1	Rainbow-steelhead 2	Rainbow-steelhead ≥3	Chinook 0	Chinook 1+
Stanley Creek							
28	M	0	0	0	0	0	0
2A	M	0	0	0	0	0	0
1B	M	26.3	4.0	1.2	0	3.7	0
1A	M	6.7	4.1	0.8	0	3.4	0
Crooked Creek							
28	M						
2A	M	0	0	0	0	0	0
1B	M						
1A	M	0	0	0.3	0	0.6	0

[a] M = main channel; S = side channel.

Table 51. Density (number/100m^2) by age-group of cutthroat trout, brook trout, bull trout, whitefish, and hatchery rainbow trout (catchable-size) in Valley Creek and tributaries, August 14-30, 1985.

Reach, section	Section type[a]	Cutthroat	Brook		Bull		Whitefish		Hatchery rainbow trout
		≥1	0	≥1	0	≥1	0	≥1	
Valley Creek									
8B	M	-		-					
8A	M					0	0	0	
7B	M	0	0.3	7.4	0	0	0	0	0
7A	M	0	0.2	3.9	0	0.2	1.8	3.1	0
6B	M	0	0	2.4	0	0	1.4	0.4	0.1
6A	M	0	0	1.1	0	0	3.6	0.2	0.6
5B	M	0	0	1.1	0	0	0.6	0.5	0
5A	M	0	0	0.2	0	0	0.5	0.4	0.6
4B	M	0	0	0.8	0	0	0.7	0	0
4A	M	0	0	2.0	0	0.2	0	0	0
3B	M	0	0	1.1	0	0	0.9	1.1	0
3A	M	0	0	1.0	0	0.2	1.7	1.4	0
2B	M	0	0	0.1	0	0.1	1.0	1.7	0.2
2A	M	0	0.1	0.2	0	0	0.9	1.7	0
1B	M	0	0	0.1	0	0	1.0	7.0	0
1A	M	0	0	+	0	0	0.7	0.5	0
3SB	S	0	0.5	1.4	0	0	0	0	0
3SA	S	0	0.7	2.8	0	0	1.6	0.2	0
1SB	S	0	0.1	0.4	0	0	3.3	0	0
1SA	S	0	0	0	0	0	0	0	0
Trap Creek									
3B	M	0	4.1	0.5	0	0	0	0	0
3A	M	0	1.9	0	0	0	0	0	0
2B	M	0	0	0.6	0	0	0	0	0
2A	M	0	0.6	4.8	0	0	0	0	0
1B	M	0	1.0	4.8	0	0	0	0	0
1A	M	0	4.3	1.9	0	0	0	0	0
Elk Creek									
4B	M	0	0.2	1.5	0	0	0	0	0
4A	M	0.2	0	1.8	0	0	0	0	0
3B	M	0	4.5	7.2	0	0	3.3	0.2	0
3A	M	0	1.4	5.6	0	0	0	0	0
2B	M	0	0	2.2	0	0	0.1	0.4	0
2A	M	0	0	1.0	0	0	0.3	3.1	0
1B	M	0	0	2.5	0	0	0.4	1.0	0
1A	M	0.2	0	2.5	0	0	2.8	0.5	0
3SB	S	0	0	0	0	0	0	0	0
3SA	S	0	1.4	10.0	0	0	4.3	0	0

Table 51. Continued.

Reach, section	Section type[a]	Cutthroat ≥1	Brook 0	Brook ≥1	Bull 0	Bull ≥1	Whitefish 0	Whitefish ≥1	Hatchery rainbow trout
Stanley Creek									
2B	M	0	4.4	8.8	0	0	0	0	0
2A	M	0	0.6	5.0	0	0	0	0	0
1B	M	0	3.0	6.1	0	0	0	0	0
1A	M	0	1.1	12.4	0	0	0	0	0
Crooked Creek									
2B	M		0						
2A	M	0	0	0	0	0	0	0	0
1B	M								0
1A	M	0	0	1.5	0	0.3	0	0	0

[a] M = main channel; S = side channel.

MIDDLE FORK SALMON RIVER

Bear Valley Creek

Bear Valley Creek, 60 km long, and Marsh Creek form the Middle Fork Salmon River (Fig. 21). Both streams flow from high, flat basins in the Idaho Batholith, a mountainous region with unstable, sandy soils. Bear Valley Creek lies within the Boise National Forest and is an important traditional fishing area for the Shoshone-Bannock Tribe. Bear Valley Creek has been severely degraded by sedimentation from dredge mining and heavy livestock use.

Bear Valley Creek supported a sizable run of spring chinook before the mid-1970s. Summer steelhead also spawned and reared in this meadow stream. Production of both species is currently depressed by low escapement and degraded habitat.

Resident salmonids in Bear Valley Creek Include rainbow trout, cutthroat trout, bull trout , mountain whitefish (Mallet 19741, and brook trout.

During 1955-1959, dredge mining for placer deposits in upper Bear Valley Creek (Fig. 21) induced catastrophic sedimentation of important chinook spawning and rearing areas. The stream was diverted around the mining area through canals dug into the depositional bottom lands. instability of canals resulted in canal breaching and channel scouring. In 1969, the major canal system was filled In, and the stream was allowed to find its own channel. Sediment from the dredge mining area continues to enter Bear Valley Creek and degrade aquatic habitat downstream. Platts (1968) estimated that extensive, heavy livestock use of the meadow could be as large a source or larger of sedimentation to the stream.

The Shoshone-Bannock Tribe (SBT) undertook a BPA-funded project in 1984 to reduce the “point-source” sedimentation from the mining area. To better define the other sedimentation problems on Bear Valley Creek and other upper basin streams of the Middle Fork and main stem Salmon River, a BPA-funded inventory was initiated in 1985. The SBT and IDFG conducted fish density surveys in Bear Valley Creek in conjunction with the inventory.

Objectives of BPA projects in Bear Valley Creek are: (1) develop and implement feasible means to reduce "point-source" sedimentation from the mining area, (2) define and treat riparian and aquatic habitat problems which potentially limit anadromous fish populations, and (3) restore wild chinook and steelhead runs in Bear Valley Creek consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin SA-5.

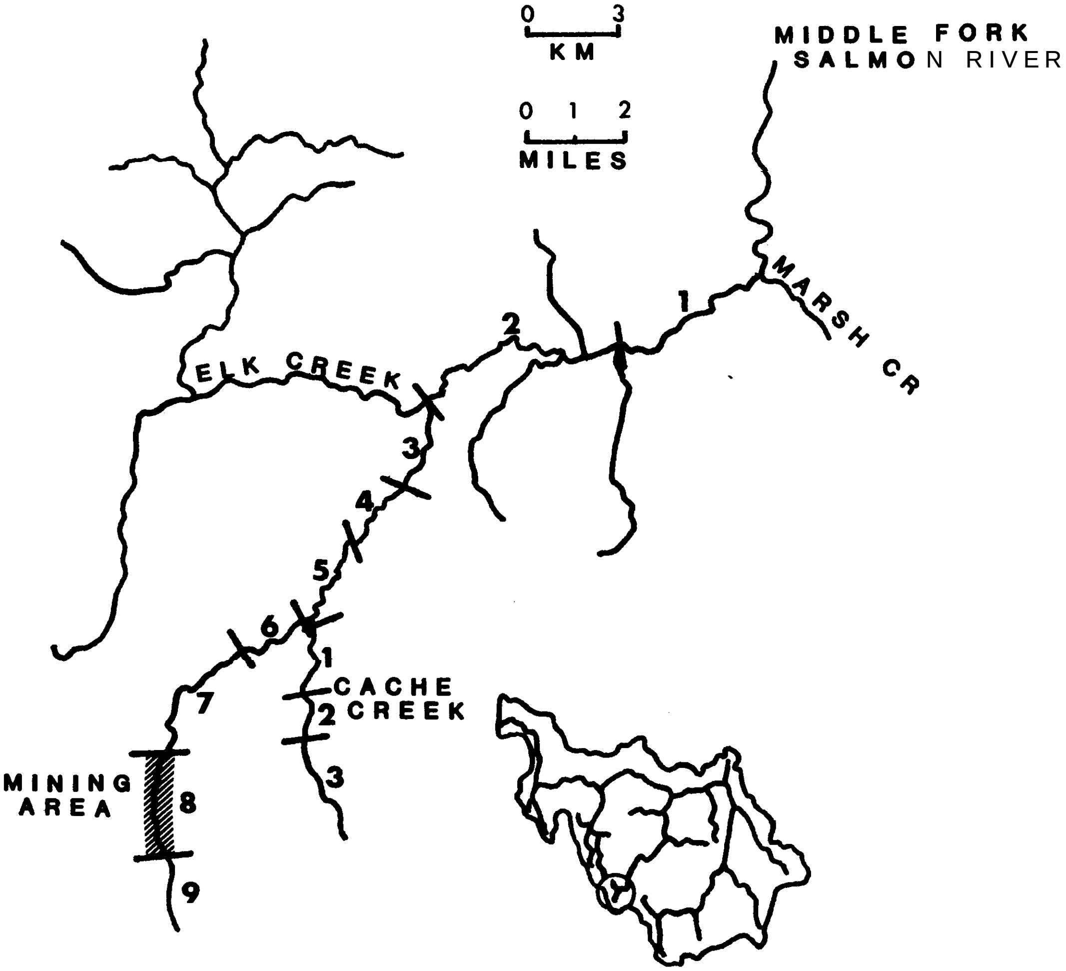

Figure 21. Location of mining area on Bear Valley Creek and reaches established in 1985 to define habitat problems in the drainage (excluding Elk Creek).

Anadromous Fish Management Considerations

Bear Valley Creek is one of the most important spawning and rearing areas for chinook salmon in the Middle Fork Salmon River drainage. The wild populations of chinook salmon and steel head that are produced in Bear Valley Creek are at very low levels of abundance. Although most wild populations of chinook salmon and steelhead are improving, the numbers of fish returning to Bear Valley Creek have remained at very low levels. Much of the habitat In the low-gradient meadow areas has been heavily sedimented. Mining and grazing have aggravated the situation by adding sediment to a high level of natural sediment.

A gradual rebuilding of anadromous fish runs will occur in this area, and any habitat improvement will accelerate the recovery of these important wild populations of salmon and steel head.

No stocking of hatchery salmon or steelhead has occurred in the past and Idaho's anadromous fish plan calls for exclusively managing the indigenous wild stocks in this drainage.

1985 "Point-Source" Sediment Reduction

The Shoshone-Bannock Tribe through BPA contract Initiated a sediment-reduction project in the privately-owned mining area. The SBT contracted J.M. Montgomery to begin stream bank stabilization/sediment-reduction work in the mining area in late summer 1985, following the planning and engineering feasibility phase in 1984-1985 (Konopacky et al. 1985). The implementation phase will continue in 1986.

1985 Habitat Problem Identification

An Inventory to define other habitat problems in the drainage, particularly those related to land use and "nonpoint-source" sedimentation, was initiated In 1985 by OEA Research Incorporated under a BPA contract. The BPA-funded habitat project proposals to address "nonpoint-source" problems will be formulated following the report on the inventory and treatment recommendations.

Project Evaluation

Evaluation status. Two basic levels of evaluation are planned for Bear Valley Creek: general monitoring and evaluations based on standing crops and measured habitat change. Through 1985, monitoring sections have been established, and sampling approaches for standing crop evaluations of “point-source" sediment reductions have been established by the Shoshone-Bannock Tribe (Konopacky et al. 1985).

Evaluations for other BPA projects in Bear Valley Creek require close coordination between IDFG and SBT which have overlapping evaluation responsibilities in the stream. Methodologies developed by IDFG and SBT are similar but not entirely compatible. The major advantage of the SBT approach is that the high degree of replication will provide more precise estimates within Bear Valley Creek of the amount of "point-source" sediment-reduction and fish population trends. The major advantage of the IDFG approach is compatibility with data in other stream systems and with USFS historical data (Platts, Nelson, and Torquemada 1986). To better link these data bases, sections established in the 1985 habitat problem-identification Inventory overlapped those established in 1984 by SBT.

In 1984, sampling in Bear Valley Creek consisted of pretreatment evaluations of “point-source" sediment reduction by SBT and density monitoring by IDFG (Petrosky and Holubetz 1985). Densities of chinook and rainbow-steelhead were low in 1984 compared to densities in nearby anadromous fish production streams.

A total of 24 sections were established in Bear Valley Creek and the tributary Cashe Creek In 1985 as part of the habitat problem-identification inventory of the upper Salmon and upper Middle Fork Salmon Rivers (Table 52). Aquatic habitat variables were measured and fish densities were determined in the sections. The entire riparian corridor in low-gradient reaches was inventoried. Results and recommendations of the inventory phase will be reported separately by OEA Research Incorporated.

Juvenile rainbow-steelhead. Except for moderate numbers of fry, rainbow-steelhead were extremely rare in Bear Valley Creek in 1985 (Table 531, as well as in 1984 (Appendix A-13). The low densities contrast with the general increasing trend since 1980 in wild steel head populations in the Middle Fork Salmon River (Reingold 1981; Thurow 1982, 1983, and 1985; and Reingold, unpublished data).

Juvenile chinook. Chinook densities were low in 1985 (Table 53) and showed a slight decrease from 1984 levels (Appendi x A-1 3). Densities age 0 chinook in Bear Valley Creek correlate directly with the previous year’s redd counts during the period 1976-1985 (Table 54, Fig. 22). Based on this relationship and the increased redd count in 1985, we expect that densities will increase slightly in 1986.

Resident salmonids. Resident salmonids observed in Bear Valley Creek were cutthroat trout, brook trout, bull trout, and mountain whitefish (Table 55). Brook trout were abundant only in headwater sections; cutthroat trout and bull trout were rare.

Table 52. Sections sampled on Beer Valley Creek end tributary Cache Creek, July 22-August 15, 1995.

Stream, reach-section	Section type[e]	Collector[b]	% gradient	Section width(m)	Section area(m^2)	% Habitat Type[c] pool, run	riffle	pocket water
Bear Valley Creek								
9A[d]	M	SBT	2.0	1.7	65	34.1	65.9	-
9B[d]	M	SST	2.0	2.0	24	53.2	46.6	-
7A	M	SBT	1.5	8.6	172	75.3	24.7	-
78	M	SBT	1.5	5.7	139	75.4	24.6	-
BA	M	SBT	1.0	8.8	934	82.2	17.6	-
BB	M	SBT	1.0	12.3	586	50.4	49.6	-
5A	H	SBT	1.0	10.6	536	40.2	59.8	-
5B	M	SBT	1.0	14.8	851	25.3	74.7	-
4A	M		1.0	12.6		37.0	63.0	-
48	M	SBT	1.5	14.2	389	41.0	59.0	-
3A	M	SBT	1.0	12.7	210	30.7	69.3	-
38	M		1.5	14.4		35.4	64.6	-
2A[e]	M	IDFG	1.0	27.2	4894	34.7	65.3	-
2B[e]	M	IDFG	0.5	22.6	4136	42.1	57.9	
1A	M	SBT	2.5	21.9	2445	11.3	86.7	-
1B	M	SBT	2.5	16.9	1663	19.6	90.4	-
5SA	S	-	**0**	4.2		100.0	**0**	-
5SB	9		**0**	6.6		100.0	**0**	-
2SA	S	SBT	**0**	8.6	2264	100.0	**0**	-
258	S	SBT	**0**	9.8	923	100.0	**0**	-
Cache Creek								
3A	M	IDFG	2.0	9.3	760	87.4	12.6	-
38	M	IDFG	1.5	5.7	459	94.1	5.9	-
1A	M	IDFG	2.0	5.7	662	37.1	62.9	-
1B	M	IDFG	2.0	4.7	572	49.2	50.8	-

[a] M = main channel; S = side channel.

[b] SBT= Shoshone-Bannock Tribe; IDFG = Idaho Department of Fish and Game.

[c] Rated from "pool width and riffle width" across transects.

[d] Above mining area.

[e] Sections 2A and 28 were initially numbered in 1994 as 4 and 5.

Table 53. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in Bear Valley Creek and tributary Cache Creek, July 22-August 15, 1985. Densities per pool area observed by Shoshone-Bannock Tribal biologists (SBT) are transformed by the proportion of pool area in each section.

Stream reach-section	Section type[a]	Collector	Rainbow-steelhead 0	1	2	>3	Chinook 0	1+
Bear Valley Creek								
9A[b]	M	SBT	0	0	0	0	7.7	0
9B[b]	M	SBT	4.1	0	0	0	0	0
7A	M	SBT	8.1	0	0	0	1.7	0
78	M	SBT	6.5	0.7	0	0	6.5	0.7
6A	M	SBT	2.1	0	0	0	0.4	0
68	M	SBT	0.7	0	0	0	0.3	0
5A	M	SBT	0	0	0	0	0.2	0.2
5B	M	SBT	0.6	0	0	0	0	0
4A	M			0		0	0	
48	M	SBT	0.5	0	0	0	0.5	0
3A	M	SBT	6.2	0	0	0	1.0	0.5
38	M			0	-			
2A	M	IDFG	20.9	0.1	0	0	1.9	0
28	M	IDFG	1.5	0	0	0	0	0
1A	M	SBT	0.7	0	0	0	0.2	0
18	M	SBT	0.5	0.1	0	0	0.4	0
5SA	S	-	-	0	111	-	-	0
5SB	S					-		0
2SA	S	SB;	0.4	0	0	0	0.1	0
293	S	SBT	0.8	0	0	0	0.2	0
Cache Creek								
3A	M	IDFG	0	0	0	0	0	0
38	M	IDFG	0	0	0	0	0	0
1A	M	IDFG	1.7	0.9	0.6	0	1.7	0.2
1B	M	IDFG	3.0	0.5	0.4	0	15.6	1.2

[a] M = main channel; S = side channel.

[b] Above mining area.

Table 54. Summary of age 0 chinook densities and adult redd counts, Beer Valley Creek, 1976-85.

Year density estimated	Redd count previous year: Actual count	Redd count previous year: % of 1960-69 average	Mean number of age 0 chinook/100m^2	Source of density data
1976	275	44.9	9.2	Platts, Nelson, & Torquemada (1986)
1977	76	15.9	1.9	Platts, Nelson, & Torquemada (1986)
1979	129	28.9	4.0	Platts, Nelson, & Torquemada (1986)
1979	184	39.4	14.7	Platts, Nelson, & Torquemada (1996)
1990	69	14.4	0.8	Platts, Nelson, & Torquemada (1986)
1984	56	11.7	2.4	Petrosky and Holubetz (1985)
1965	55	11.5	1.3	Table 53.
1986	134	28.0		

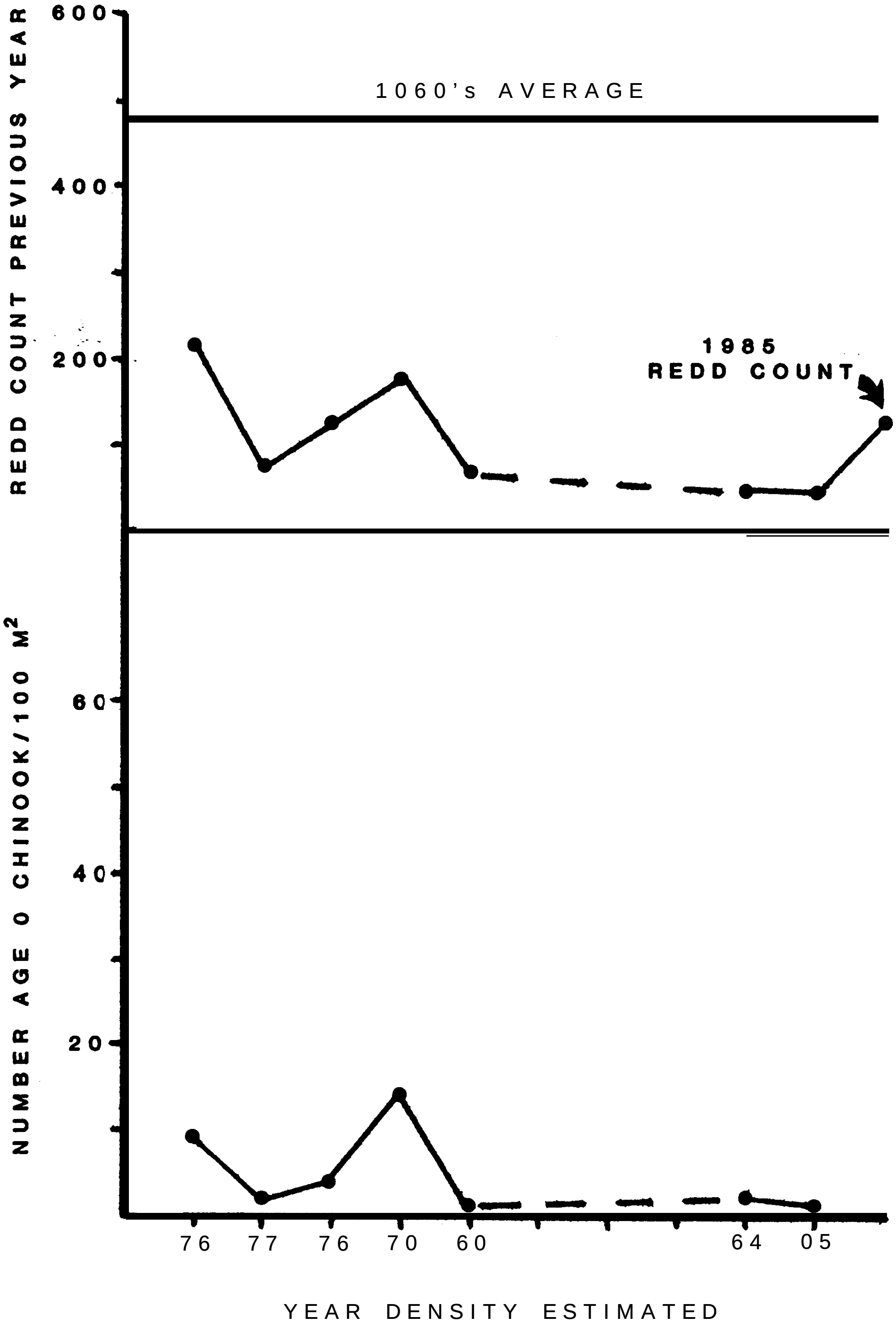

Figure 22. Relationship of juvenile chinook density to the previous year's redd count, Bear Valley Creek, 1976-85.

Table 55. Density (number/100m^2) by age-group of cutthroat trout, brook trout, bull trout, and whitefish in Bear Valley Creek and tributary Cache Creek, July 22-August 15, 1985. Densities per pool area observed by Shoshone-Bannock Tribal biologists (SBT) are transformed by the proportion of pool area in each section.

Reach, section	Section type[a]	Collector	Cutthroat	Brook		Bull		Whitefish	
			≥1	0	≥1	0	≥1	0	≥1
Bear Valley Creek									
9A[b]	M	SBT	0	1.5	3.0	0	0	0	57.0
9B[b]	M	SBT	0	0	0	0	0	16.7	0
7A	M	SBT	0	1.2	0.6	0	0	8.7	0
7B	M	SBT	0	0.6	1.2	0	0	0	0
6A	M	SBT	0	1.5	0.5	0	0	2.3	0
6B	M	SBT	0	7.8	0.5	0	0	3.2	0
5A	M	SBT	0	0	0	0	0	0	0
5B	M	SBT	0	0	0	0	0	4.0	0
4A	M			-			-		-
4B	M	SB;	0	0	0	0	0	2.6	0
3A	M	SBT	0	0	0	0	0	2.4	0
3B	M				-				
2A	M	IDFG	0	0	+	0	0	2.5	+
2B	M	IDFG	+	0	+	0	0	7.3	0.2
1A	M	SBT	+	0	0	0	0.4	0.4	2.0
1B	M	SBT	0	0	0	0	0	1.3	2.5
5SA	S	-	-						
5SB	S	-	-	-	-	-	-	-	-
2SA	S	SBT	0.1	0	0	0	0	0.2	0.4
2SB	S	SBT	0.1	0	0	0	0	0.1	2.5
Cache Creek									
3A	M	IDFG	0	0	0.8	0	0	0	0
3B	M	IDFG	0	0	0	0	0	0	0.2
1A	M	IDFG	0	0.2	3.2	0	0	0.9	0.3
1B	M	IDFG	0	0	0.5	0	0	1.2	0.2

[a] M = main channel; S = side channel.

[b] Above mining area.

Physical habitat. Detailed physical habitat measurements, riparian corridor information, and results of simple hypothesis tests will be reported by OEA Research Incorporated. In general, riparian areas in Bear Valley Creek were found to be degraded by cattle grazing. The problem of instream deposition of granitic sands in the Bear Valley Creek drainage (including Elk Creek) was worse than in any other major stream system inventoried in 1985 (Fig. 33).

Future Evaluation and Recommendations

Future evaluation of the "Point-Source" Sediment-Reduction project requires standing crop estimates, documentation of the degree of sediment reduction, and the development of an empirical sediment, fish-response model to separate effects of seeding levels from effects of habitat change. The established SBT sampling design should be used posttreatment especially to document sediment. reduction. Sediment fish-response relationships developed from 1985 inventories in the Middle Fork and Salmon River drainages (see Results and Discussion) should be developed and refined as seeding levels increase, and the two approaches should be linked together. This will require continued general monitoring of fish densities as spawning escapements increase.

Specific evaluation approaches to other BPA habitat projects in Bear Valley Creek should be formulated during the development of implementation plans.

Elk Creek

Elk Creek, 35 km long, is the largest tributary to Bear Valley Creek (Fig. 23). Sedimentation in Elk Creek has been increased above natural levels by logging and livestock grazing and mass erosion in the Bearskin Creek watershed.

Elk Creek, like Bear Valley Creek, supported a substantial run of spring chinook before the mid-1970s. Summer steelhead also spawned and reared in Elk Creek. Currently, both species are at a depressed level.

Resident salmonids in Elk Creek are rainbow trout, cutthroat trout, bull trout, mountain whitefish (Mallet 19741, and brook trout.

Aquatic habitat in much of the Elk Creek drainage is degraded. Bearskin Creek and lower Elk Creek have been most affected by sedimentation (Konopacky 1984). Stream banks have collapsed in reaches where livestock graze the riparian zones.

Definition of aquatic and riparian degradation problems in the Elk Creek drainage, as well as in the Bear Valley Creek, Marsh Creek, Valley Creek, and upper Salmon River drainages, was initiated in 1985

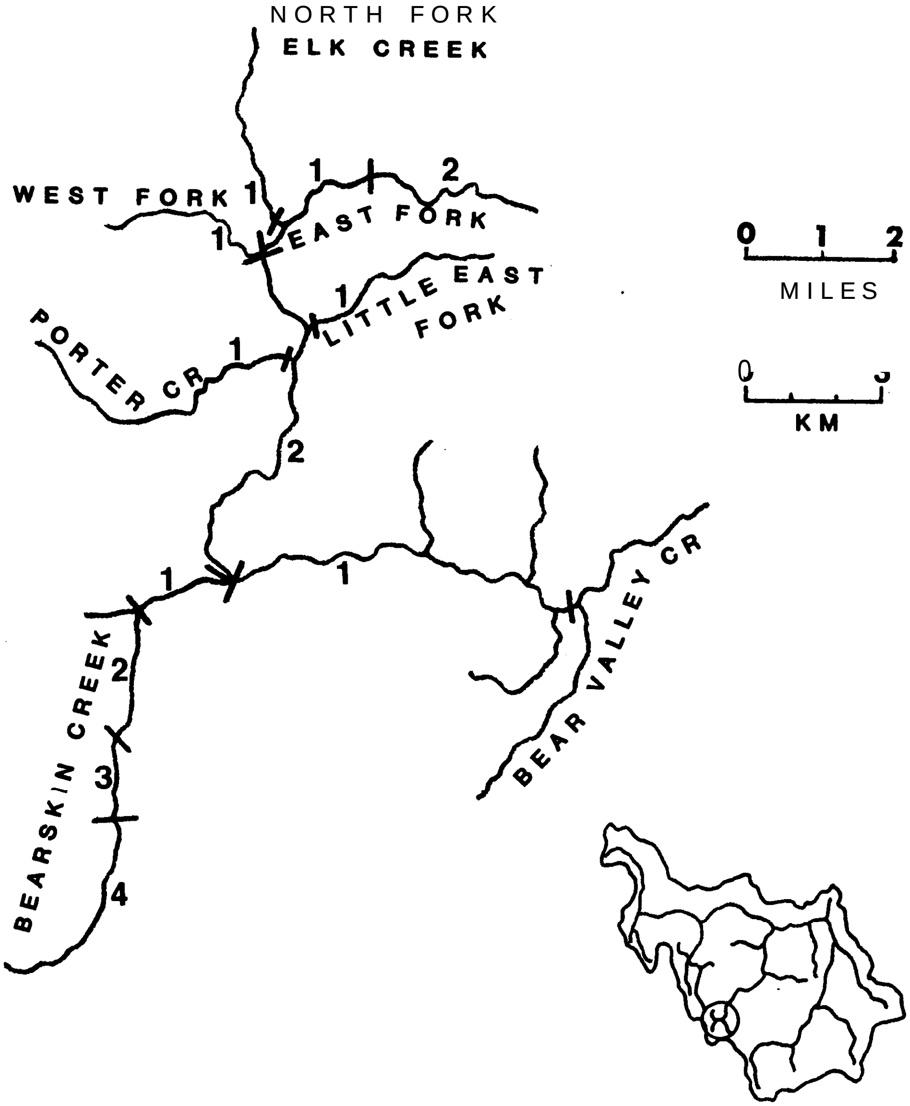

Figure 23. Location of reaches established in 1985 to define habitat problems in the Elk Creek drainage.

through a BPA-funded Inventory conducted by OEA Research Incorporated. The IDFG conducted the fish density survey in conjunction with the habitat inventory. Treatment recommendations for Initiation of BPA projects will be developed based on the Inventory data.

Objectives of the BPA inventory in Elk Creek drainage are: (1) define and treat riparian and aquatic habitat problems which potentially limit anadromous fish production, and (2) restore wild chinook and steelhead runs in Elk Creek consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin SA-5.

Anadromous Fish Management Considerations

Idaho's Anadromous Fish Management Plan specified that this stream will be managed exclusively for wild salmon and steelhead runs. Elk Creek is the major tributary of Bear Valley Creek and is an extremely important spawning and rearing area for chinook salmon. Sediment bed load has increased dramatically in the last 15 to 20 years and has degraded the quality of the aquatic habitat. At this time, the salmon and steel head populations in Elk Creek are at very low levels.

Idaho Department of Fish and Game will continue to pursue improved survival rates for adult and juvenile migrants in the Columbia River while simultaneously working closely with the US Forest Service, Shoshone-Bannock Tribe, and grazing permittees to restore the productivity of Elk Creek for juvenile salmon and steelhead rearing.

Tribal fisheries in Bear Valley Creek and Elk Creek are dependent on restoration of the wild stocks of salmon and steelhead.

1985 Habitat Problem Identification

An inventory to define habitat problems in the Elk Creek drainage, particularly those related to land use and sedimentation, was initiated In 1985 by OEA Research Incorporated under a BPA contract. Habitat project proposals will be formulated following the report on the inventory and treatment recommendations.

Project Evaluation

Evaluation status. Two basic levels of evaluation are planned for any BPA habitat projects implemented in the Elk Creek drainage: general monitoring and evaluations based on standing crops and measured habitat change. Through 1985, monitoring sections have been established and sampled pretreatment (Table 56). Pending development

Table 56. Sections sampled in Elk Creek and tributaries, August 5-7, 1985.

Stream, reach-section	Section type[a]	% gradient	Section width(m)	Section area(m^2)	% Habitat Type[b] pool, run		
					pool, run	riffle	pocket water
Elk Creek							
2A[c]	M	2.0	9.5	1951	72.0	28.0	-
28	M	1.0	9.9	1292	22.8	77.2	-
1A[b]	M	2.0	13.4	1291	81.3	19.7	-
1B[c]	M	1.5	13.6	3066	62.4	37.6	-
2SA	S	0.2	2.7	239	100.0	0	-
2SB	S	0	3.3	464	100.0	0	-
1SA	S	0.5	6.4	616	100.0	0	-
1SB	S	0	5.4	902	100.0	0	-
North Fork Elk Creek							
?A	M	2.0	2.3	249	72.1	27.9	-
1B	M	1.5	2.7		99.7	10.3	-
East Fork Elk Creek							
2A	M	2.5	3.9		65.7	14.3	-
28	M	2.5	3.4		40.7	59.3	-
1A	M	2.0	3.6	354	66.6	33.4	-
1B	M	2.0	3.9	351	64.8	35.2	-
West Fork Elk Creek							
1A	M	1.5	3.4	340	91 .9	8.1	-
18	M	2.0	3.6	402	75.8	24.8	-
Little East Fork Elk Creek							
1A	M	1.0	2.9	192	59.6	40.4	-
1B	H	1.0	2.9	247	79.9	21.1	-
Porter Creek							
IA	M	1.5	3.1	289	92.6	17.4	-
1B	M	1.5	4.7	409	66.6	31.4	-
Bearskin Creek							
4A	M	2.5	2.7	263	47.8	52.2	-
4B	M	1.0	2.6	284	30.7	69.3	-
3A	M	1.0	3.8	366	44.9	55.1	-
38	M	1.0	5.0	617	100.0	0	-
2A	M	0.5	4.8	356	100.0	0	-
2B	M	1.0	5.1	452	14.1	65.9	-
1A	M	1.0	5.6	526	77.4	28.6	-
1B	M	1.0	6.5	687	15.9	94 .1	-

[a] M = main channel; S = side channel.

[b] Rated from "pool width and riffle width" across transects.

[c] Sections 2A and 1B were initially numbered in 1984 as 1 and 2, respectively.

of BPA projects, IDFG will continue to monitor fish densities and habitat conditions in a small number of sections in Elk Creek (Appendix A-14). Given the severity of sedimentation problems and status of wild anadromous fish in Elk Creek, IDFG will place high priority on initiation of restorative habitat projects in the drainage.

The IDFG evaluation of potential BPA projects in Elk Creek began in 1984 as pretreatment monitoring of anadromous fish densities in two sections. Densities of both steel head an chinook were very low in 1984 (Petrosky and Holubetz 1985).

A total of 28 sections were established in the Elk Creek drainage in 1985 as part of the habitat problem identification inventory of the upper Salmon and upper Middle Fork Salmon rivers (Table 56). Aquatic habitat variables were measured and fish densities determined in the sections; the entire riparian corridor of low-gradient reaches was inventoried. Results and recommendations of the Inventory phase will be reported separately by OEA Research Incorporated.

Juvenile rainbow-steelhead. Elk Creek was under-seeded by steelhead in 1985 (Table 57) l Densities of both age 0 and yearling rainbow-steelhead were generally high in Elk Creek than in the rest of the Bear Valley Creek drainage (Table 53).

Juvenile chinook. Elk Creek was under-seeded by chinook In 1985 (Table 57). Age 0 chinook densities were similarly low in Elk Creek and Bear Valley Creek. Juvenile chinook densities in Elk Creek correlate directly with the previous year's redd count during the period 1972-1985 (Table 58, Fig. 24). Spawning escapements and juvenile densities appear to be well below the capacity of the &-earn.

Resident salmonids. Brook trout, bull trout, and mountain whitefish were observed in the Elk Creek drainage in 1985 (Table 59). A single cutthroat trout was observed during the 1984 survey (Petrosky and Holubetz 1985).

Physical habitat. Detailed physical habitat measurements, riparian corridor information, and results of simple hypothesis tests will be reported by OEA Research Incorporated. In general, riparian areas in Elk Creek were found to be degraded by cattle grazing. The problem of instream deposition of granitic sands in the Elk Creek and Bear Valley Creek drainages was worse than in any other major stream system inventoried in 1985 (Fig. 33).

Future Evaluation and Recommendations

Specific evaluation approaches to BPA habitat projects in the Elk Creek drainage should be formulated during the development of implementation plans. Because Elk Creek is so badly degraded from

Table 57. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in Elk Creek and tributaries, August 5-7, 1985.

Stream, reach-section	Section type[a]	Rainbow-steelhead				Chinook	
		0	1	2	≥3	0	1+
Elk Creek							
2A	M	19.0	0	0	0	0.5	0
28	M	13.2	0.9	0.2	0	6.1	0.6
1A	M	24.7	0.3	0.1	0	2.8	0
18	M	9.9	1.3	0.1	+	1.0	0.4
2SA	S	9.6	0	0	0	0.4	0
2SB	S	0	0	0	0	3.0	0
1SA	S	2.0	0.2	0	0	4.5	0.5
1SB	S	0	0	0	0	0	0
North Fork Elk Creek							
1A	M	1.3	0.8	0	0	0	0.4
1B	M					0	0
East Fork Elk Creek							
2A	M	0	-	0	0		
28	M					0	0
1A	M	35.3	0.6	0	0.3	0	0
18	M	11.7	0.3	0	0	0.9	0
West Fork Elk Creek							
1A	M	27.9	0	0	0	0.3	0
1B	M	8.5	1.5	0	0	0.5	0
Little East Fork Elk Creek							
1A	M	21.9	0	0	0	1.0	0
1B	M	6.9	0.8	0	0	0.8	0
Porter Creek							
1A	M	19.8	1.4	0	0	2.1	4.2
1B	M	18.9	0	0	0	1.2	0.2
Bearskin Creek							
4A	M	0	0	0	0	0	0
4B	M	0	0.4	0	0	0	0
3A	M	10.1	0.8	0	0	4.9	0.3
3B	M	0	0	0	0	0	0
2A	M	2.2	0.3	0.3	0	1.4	1.1
2B	M	0	0	0	0	0.2	0
1A	M	0	0	0	0	0	0
1B	M	0	0	0	0	0.2	0

[a] M = main channel; S = side channel.

Table 58. Sunmary of age 0 chinook densities and adult redd counts, Elk Creek, 1872-1885.

Year density estimated	Redd count previous year Actual count	Redd count previous year % of 1960-69 average	Mean number of age 0 chinook/100m^2	Source of density data
1872	173	41.1	26.1	Stuehrenberg [1875]
1973	212	50.4	27.0	Stuehrenberg [1875]
1975	108	25.7	10.0	Sekulich [1880]
1978	208	48.4	18.1	Konopacky [unpublished data]
1981	8	1.8	1.3	Bjornn [unpublished data]
1984	38	8.0	4.1	Petrosky and Holubetz [1985]
1985	27	6.4	2.6	Table 57.
1986	28	6.7		

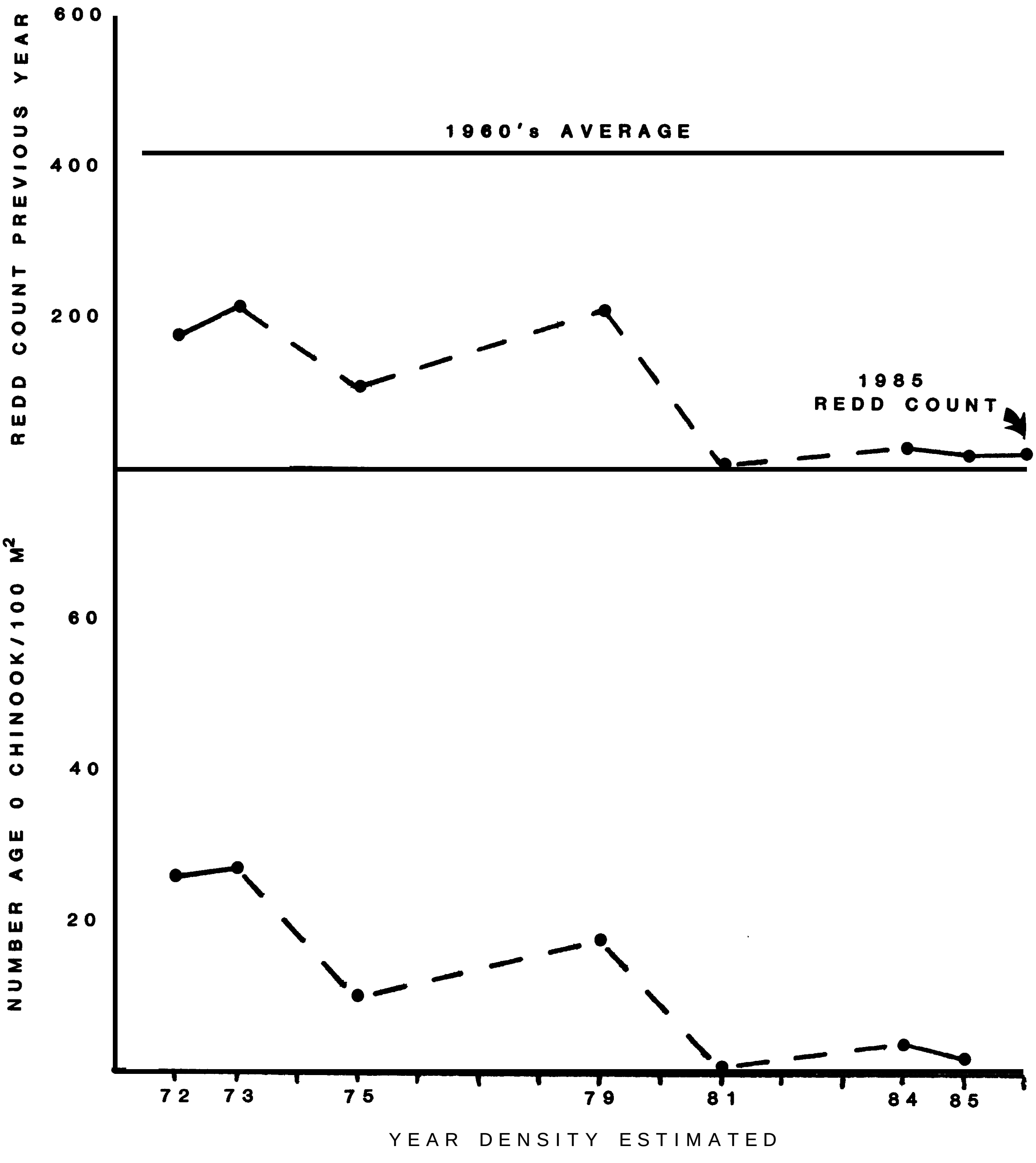

Figure 24. Relationship of juvenile chinook density to the previous year's redd count, Elk Creek, 1972-1985.

Table 59. Density (number/100m^2) by age-group of cutthroat trout, brook trout, bull trout, and whitefish in Elk Creek and tributaries, August 5-7, 1985.

Stream, reach-section	Section type[a]	Cutthroat	Brook		Bull		Whitefish	
		>1	0	>1	0	>1	0	>1
Elk Creek								
2A	M	0	0.1	0	0	0.1	2.7	1.6
28	M	0	0	0	0	0	4.6	0.3
1A	M	0	0.2	0.1	0	0	7.2	0.4
1B	M	0	0.1	0.3	0	0	8.8	0.6
2SA	S	0	0	0	0	0	0	0
2SB	S	0	0	0	0	0	0	0
1SA	S	0	0	0	0	0	5.0	0
1SB	S	0	0	0	0	0	20.6	0
North Fork Elk Creek								
1A	M	0	0	0	0	0.4	0	1.3
1B	M	-	-	-	-		-	-
East Fork Elk Creek								
2A	M	-				-		
2B	M	-	-	-	-	ll		-
1A	M	0	0	0	0	0	0	0
1B	M	0	0	0	0	0	1.7	0
West Fork Elk Creek								
1A	M	0	0.3	0	0	0	0.6	0
1B	M	0	0	0.2	0	0	0.7	0
Little East Fork Elk Creek								
1A	M	0	0.5	0	0	0	1.6	0
1B	M	0	1.2	0	0	0	0.4	0
Porter Creek								
1A	M	0	0.3	0	0	0	6.2	0
1B	M	0	2.2	0	0	0	5.1	0
Bearskin Creek								
4A	M	0	0	0	0.4	1.9	0	0
48	M	0	0	0	0.4	0	0	0
3A	M	0	0	0	0	0.3	0	0
3B	M	0	0.2	0	0	0	0	0
2A	M	0	0	0	0	0	0	0
2B	M	0	0.2	0	0	0	0	0
1A	M	0	0.6	0	0	0	0	0
1B	M	0	0	0	0	0	1.6	0

[a] M = main channel; S = side channel.

nonpoint sources, both the proposed projects and subsequent evaluations should address these problems on a streamwide basis.

Marsh Creek

Marsh Creek is 23 km long and rises from springs in a relatively flat, high-elevation basin within the Challis National Forest. Important tributaries include Knapp Creek, Cape Horn Creek, and Beaver Creek (Fig. 25). The confluence of Marsh Creek with Bear Valley Creek forms the Middle Fork Salmon River which historically is the most important producer of anadromous fish in Idaho. Aquatic habitat in meadow reaches of Marsh Creek while in better condition than that in the Bear Valley Creek drainage has been degraded by livestock grazing in riparian areas.

Marsh Creek is most important as a production stream for spring chinook and, also, produces summer steelhead. Production of both species is currently depressed by low spawning escapements.

Nonanadromous salmonids In Marsh Creek drainage include resident rainbow trout, cutthroat trout, bull trout, mountain whitefish (Mallet 19741, and brook trout.

Livestock grazing in riparian zones has degraded aquatic habitat throughout much of the meadow habitat of Marsh Creek and sane tributaries. Stream banks have become unstable, and sediment loads have increased due to grazing.

Definition of aquatic and riparian degradation problems in the Marsh Creek drainage, as well as in the Bear Valley Creek and upper Salmon River drainages, was initiated in 1985 through a BPA-funded Inventory conducted by OEA Research Incorporated. The IDFG conducted the fish density survey in conjunction with the habitat inventory. Treatment recommendations for initiation of BPA projects will be developed based on the inventory data.

Object Ives of the BPA inventory in Marsh Creek drainage are: (1) define and treat riparian and aquatic habitat problems which potentially limit anadromous fish production, and (2) restore wild chinook and steelhead runs in Marsh Creek consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin SA-5.

Anadromous Fish Management Considerations

Marsh Creek is one of the most important spawning and rearing streams in the Middle Fork drainage. This stream is a nursery area for fry and fingerling that rear in the Middle Fork. The importance of keeping Marsh Creek aquatic habitat in the best possible condition

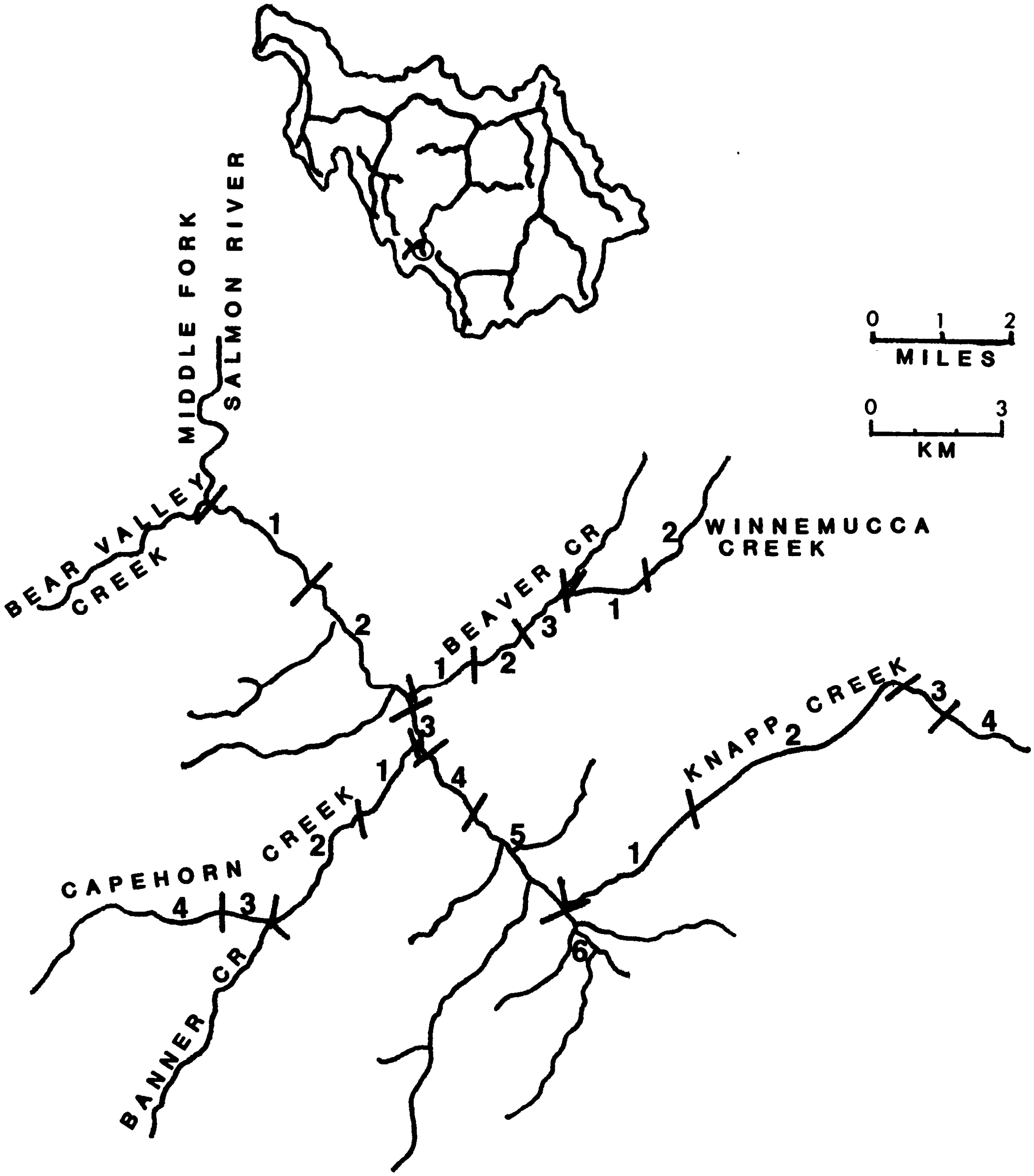

Figure 25. Location of reaches established in 1985 to define habitat problems in the Marsh Creek drainage.

cannot be over-stressed. Damage to riparian zones by livestock grazing in the past has reduced the production capability of parts of this stream; however, a major proportion of Marsh Creek and its tributaries are excellent salmon and steelhead habitat.

This drainage and other tributaries of the Middle Fork Salmon River are managed for wild fish. Idaho's Anadromous Fish Management Plan places priority consideration of wild stocks of salmon and steelhead. Restoration of these wild fish populations is important to meeting the needs of treaty fisheries in Marsh Creek and the lower Columbia River.

Marsh Creek is one of the few streams in the state that has had some juvenile production studies accomplished on it. Juvenile production data can be correlated with spawning escapement data over the last several years and examination of that data shows that juvenile production is dependent upon adult spawning escapements. Marsh Creek will be a good place to monitor impacts of future management.

1985 Habitat Problem Identification

An Inventory to define habitat problems in the Marsh Creek drainage, particularly those related to land use and sedimentation, was Initiated in 1985 by OEA Research Incorporated under a BPA contract. Habitat project proposals will be formulated following the report on the Inventory and treatment recommendations.

Project Evaluation

Evaluation status. Two basic levels of evaluation are planned for any BPA habitat projects implemented in the Marsh Creek drainage: general monitoring and evaluations based on standing crops and measured habitat change. Through 1985, monitoring sections have been established and sampled pretreatment (Table 60). Pending development of BPA projects, IDFG will continue to monitor fish densities and habitat conditions in a small number of sections in the Marsh Creek drainage (Appendix A-15).

The IDFG evaluation of potential BPA projects in Marsh Creek began in 1984 as pretreatment monitoring of anadromous fish densities in a single section (Petrosky and Holubetz 1985). The number of general monitoring sections in the drainage has since been expanded to 11.

A total of 42 sections was established in the Marsh Creek drainage in 1985 as part of the habitat problem-identification inventory of the upper Salmon and upper Middle Fork Salmon rivers (Table 60). Aquatic habitat variables were measured and fish densities determined in the sections; the entire riparian corridor of low-gradient reaches was inventoried. Results and recommendations of the inventory phase will be reported separately by OEA Research Incorporated.

Table 60. Sections sampled in Marsh Creek and tributaries, August 7-23, 1985.

Stream, reach-section	Section type[a]	% gradient	Section width(m)	Section area(m^2)	% Habitat Type[b] pool, run	riffle	pocket water
Marah Creek							
6B	M	0.5	1.7	146	81.3	8.7	-
6A	M	1.5	5.4	567	48.3	51.7	-
5B	M	1.5	10.7	663	54.4	45.6	-
5A	M	1.5	11.2	1148	26.5	73.5	-
4B[c]	M	1.0	6.6	1808	36.8	61.2	-
4A	M	1.5	8.6	848	40.8	56.8	-
3B	M	1.5	8.8	821	41.8	58.1	-
3A	M	1.5	20.3	2067	8.3	90.7	-
2B	M	2.5	22.7	21428	24.8	75.4	-
2A	M	2.5	13.5	1682	21.1	78.8	-
1B	M	2.5	17.7	1913	7.1	82.8	
1A	M	2.0	20.4	2004	19.6	80.4	-
5SB	S	1.0	5.1	430	76.0	22.0	-
5SA	S	0	4.5	403	100.0	0	-
4SB	S	0	1.3	117	100.0	0	-
4SA	S	0.5	4.6	461	100.0	0	-
Knapp Creek							
4B	M	1.5	4.4	363	47.1	54.8	-
4A	M	1.0	5.3	826	65.1	34.8	-
3B	M	2.0	5.0		38.8	68.1	-
3A	M	2.0	5.7		42.8	57.1	-
2B	M	1.0	5.7	685	42.0	58.0	-
2A	M	1.0	7.6	764	42.8	57.1	-
1B	M	1.5	5.1	506	63.1	36.8	-
1A	M	1.1	5.7	572	45.0	55.0	-
Cape Horn Creek							
4B	M	2.0	3.4	265	21.3	76.1	-
4A	M	2.0	4.2	293	32.7	67.3	-
3B	M	1.5	3.8	382	32.4	67.6	-
3A	M	1.0	5.4	433	45.6	54.4	-
2B	M	1.0	7.5	643	21.4	76.6	-
2A	M	1.5	6.6	663	16.0	84.0	-
1B	M	1.5	8.5	688	17.5	82.5	-
1A	M	1.5	7.5	532	25.5	74.5	-

Table 60. Continued.

Stream, reach-section	Section type[a]	% gradient	Section width(m)	Section area(m^2)	% Habitat Type[b] pool, run	riffle	pocket water
Winnemucca Creek							
26	M	2.0	4.3	371	58.7	41.3	-
2A	M	1.5	5.2	333	78.8	23.2	-
18	M	1.5	5.7	455	48.3	51.7	-
IA	M	1.5	4.8	455	80.2	39.8	
Beaver Crask							
38	M	1.0	10.0	1003	48.5	51.5	-
3A	M	1.5	12.8	1362	18.3	61.7	-
26	M	1.5	17.0	1560	42.8	57.1	-
2A	M	1.5	12.4	1203	47.7	52.3	-
18	M	1.0	13.3	1601	44.6	55.4	-
IA	M	1.5	15.6	1560	28.4	71.6	-

[a] M = main channel; S = aide channel.

[b] Rated from “pool width and riffle width” across transects.

[c] Section 46 was initially numbered in 1884 as 1.

Juvenile rainbow-steelhead. The Marsh Creek drainage was under-seeded by steelhead in 1985 (Table 61). However, densities of wild rainbow-steel head parr were higher than in the adjacent Bear Valley Creek drainage and comparable to densities in supplemented streams in the Valley Creek and upper Salmon River drainages.

Juvenile chinook. Marsh Creek drainage was under-seeded by chinook in 1985 (Table 611, but densities of age 0 chinook exceeded those in the adjacent Bear Valley Creek drainage. During the period 1972-1985, age 0 chinook densities have carrel ated strongly with the adult spawning escapements the previous year (Table 62, Fig. 26). The lowest mean density in 1981 (11.6/100 m^2 followed the lowest redd count on record; the highest mean density in 1974 (57,4/100 m^2 followed the highest redd count on record since the mid-1960s.

The high positive correlation (r = 0.91) between juvenile densities and redd counts through this period suggests that summer carrying capacity of the meadow habitat was at least 57/100 m^2. From stocking experiments in the Marsh Creek tributary Cape Horn Creek, Sekulich (1980) set the upper limit of chinook carrying capacity during summer at about 120/100 m^2. Most juvenile chinook (and steelhead) leave the upper meadow of Marsh Creek to winter downstream. Counts of age 0 chinook emigrants at a weir located just upstream of the mouth of Cape Horn Creek also correlate positively to redd counts and to summer densities (T. Bjornn, Idaho Cooperative Fishery and Wildlife Research Unit, University of Idaho, Moscow, Idaho, personal communications).

Resident salmonids. Cutthroat trout, brook trout, bull trout, and mountain whitefish were observed in the drainage in 1985 (Table 63). Brook trout were observed primarily in headwater reaches; cutthroat trout were mainly in the canyon reaches near the Middle Fork Salmon River. Bull trout were scarce throughout most of the drainage.

Physical habitat. Results and recommendations from the aquatic/riparian habitat inventory will be reported by OEA Research Incorporated. In general, stream banks In reaches of Marsh Creek that were grazed by cattle were found to be very unstable. Deposition of sediment Instream was less severe In a relative sense than In the Bear Valley Creek/Elk Creek drainage (Fig. 33).

Future Evaluation and Recommendations

Specific evaluation approaches to BPA habitat projects in the Marsh Creek drainage should be formulated during the development of Implementation plans.

Sulphur Creek

Sulphur Creek is 31 km long and enters the Middle Fork Salmon River 151 km from the mouth (Fig. 27). Sulphur Creek lies entirely within

Table 61. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in Marsh Creek and tributaries, August 7-22, 1985.

Stream, reach-section	Section type[a]	Rainbow-steelhead				Chinook	
		0	1	2	≥3	0	1+
Marsh Creek							
6B	M	0	0	0	0	0	0
6A	M	1.2	0	0	0	9.7	1.8
5B	M	6.5	0	0	0	26.7	0.5
5A	M	13.1	0.4	0.1	0	35.7	0.8
4B	M	18.1	1.0	0.2	0.1	22.2	0.1
4A	M	7.3	0.4	0.1	0	25.1	0.1
3B	M	6.4	0.9	0.2	0	10.3	0.3
3A	M	15.8	1.2	1.4	0.2	14.1	0.6
2B	M	5.6	2.8	1.2	0	9.9	0.2
2A	M	4.0	2.7	1.4	0.1	5.6	0.2
1B	M	3.2	0.5	1.0	0.1	10.6	0.1
1A	M	0.1	0.8	0.6	0.2	5.4	+
5SB	S	1.9	0	0	0	34.6	0.5
5SA	S	3.5	0	0	0	10.4	0
4SB	S	13.7	0	0	0	0.1	0
4SA	S	6.7	0	0	0	0	0
Knapp Creek							
48	M	0	0.3	0.3	0	0	0
4A	M	0	0	0	0	0	0
3B	M	-	-		-	-	-
3A	M	-		1			
28	M	0.6	0.3	0.3	0	0.4	0
2A	M	0	0.1	0	0	0.1	0
1B	M	2.8	5.9	0.4	0	20.8	1.4
1A	M	3.8	0.5	0.2	0.4	23.6	0.2
Cape Horn Creek							
48	M	0	0	0.4	0	0	0
4A	M	0	0	0	0	0	0
38	M	0	0	0.5	0.2	0	0
3A	M	0	0.2	0.5	0	0	0
28	M	0	0	0.2	0	49.0	0.8
2A	M	0	0	0	0	10.7	0.1
1B	M	0.2	0	0.1	0	34.7	1.6
1A	M	1.1	0	0	0	25.2	1.3

Table 61. Continued.

Stream, reach-section	Section type[a]	Rainbow-steelhead				Chinook	
		0	1	2	≥3	0	1+
Winnemucca Creek							
28	M	8.6	0.3	0	0	0	0
2A	M	6.3	0	0	0	0	0
1B	M	2.6	0.9	0.4	0.2	0	0
1A	M	3.3	1.1	0	0	0	0.2
Beaver Creek							
3B	M	0.3	0.8	0.4	0	10.8	0.2
3A	M	8.8	0.9	0.4	0	7.1	0.3
28	M	1.4	0.4	0.4	0	21.7	0.3
2A	M	1.2	1.1	0.3	0	21.7	0.5
1B	M	4.4	1.1	0.5	0	27.4	0.2
1A	M	1.6	1.0	0.3	0	12.9	0.1

[a] M = main channel; S = side channel.

Table 62. Summary of age 0 chinook densities and adult redd counts, Marsh Creek and Knapp Creek, 1972-1985. Densities estimated for Marsh Creek between Beaver Creek and Knapp Creek. Densities estimated for Knapp Creek from mouth to Guard station.

Year density estimated	Redd count previous year Actual count	 % of 1960-69 average	Mean number of age 0 chinook/100m^2	Source of density data
1972	234	87.3	31.7	Stuehrenberg (1975)
1974	351	131.0	57.4	Sekulich (1980)
1975	155	57.9	31.6	Sekulich (1980)
1976	139	51.9	49.7	Sekulich (1980)
1979	154	57.5	39.9	Konopecky (unpublished data]
1981	7	2.6	11.6	Bjornn, (unpublished data)
1983	38	14.2	21.9	USFWS data [Petrosky and Holubetz 1986]
1984	19	7.1	17.9	Petrosky and Holubetz (1985)
1985	36	13.4	20.9	Table 61.
1986	78	29.1		

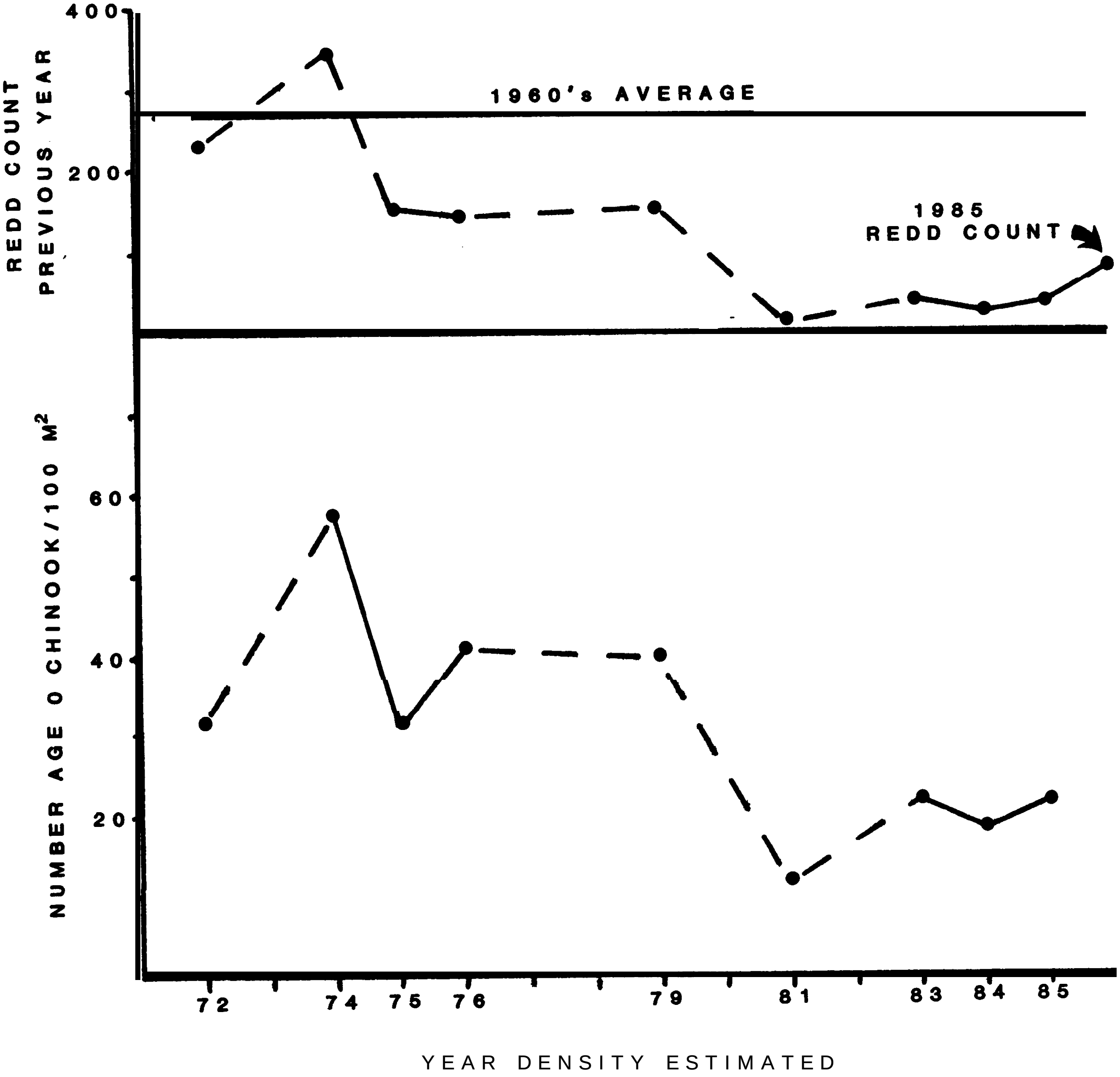

Figure 26. Relationship of juvenile chinook density to the previous year's redd count, Marsh and Knapp creeks, 1972-85.

Table 63. Density (number/100m^2) by age-group of cutthroat trout, brook trout, bull trout, and whitefish in Marsh Creek and tributaries, August 7-22, 1985.

Stream, reach-section	Section type[a]	Cutthroat	Brook		Bull		Whitefish	
		≥1	0	≥1	0	≥1	0	≥1
Marsh Creek								
6B	M	0	11.5	12.8	0	0	0	0
6A	M	0	11.6	18.7	0	0	0	0
58	M	0	2.0	2.9	0	0	1.7	0.3
5A	M	0	1.0	2.0	0	0	3.3	1.1
48	M	0.1	5.1	1.6	0	0.1	8.8	1.5
4A	M	0	0.1	0.4	0	0	5.2	0.5
38	M	0	0	0	0	0	1.2	0.5
3A	M	0	+	0.2	0	+	+	2.4
28	M	0.1	0	0.1	0	0	+	1.2
2A	M	0.2	0	0.1	0	0	0.1	2.1
1B	M	0.4	0	0.1	0	0	1.0	2.5
1A	M	0.4	0	0	0	0	1.5	3.9
5SB	S	0	37.9	0.2	0	0	0.2	0
5SA	S	0	0	0.5	0	0	0	0
4SB	S	0	3.4	0.9	0	0	0	0
4SA	S	0	0	0	0	0	0	0
Knapp Creek								
4B	M	0	0	1.1	0	0	0	0
4A	M	0	0.2	0.8	0	0	0	0
3B	M					I	-	-
3A	M	-						-
2B	M	0	0.1	4.4	0	0	0	0
2A	M	0	0	2.5	0	0	0	0
1B	M	0	0.4	5.9	0	0	0	0
1A	M	0	0.2	6.8	0	0.5	0	0
Cape Horn Creek								
4B	M	0	0	0	0.4	1.9	0	0
4A	M	0	0	0	0	2.4	0	0
38	M	0	0	0.3	0	1.0	0	0
3A	M	0	0	0	0	0.2	0	0.2
28	M	0	0	0	0	0	0	0
2A	M	0	0	0.1	0	0	0	0
1B	M	0	0	0.7	0	0	0	0
1A	M	0	0	0	0	0	0	0

Table 63. Continued.

Stream, reach-section	Section type[a]	Cutthroat	Brook		Bull		Whitefish	
		≥1	0	≥1	0	≥1	0	≥1
Winnemucca Creek								
2B	M	0	0	0.3	0	0	0	0
2A	M	0	0	0	0	0	0	0
1B	M	0	0	0	0	0.2	0	0
1A	M	0	0	0.4	0	0	0	0
Beaver Creek								
3B	M	0	0	0.1	0	0.2	0	0
3A	M	0	0	0.1	0	0	0	0.1
28	M	0	0.1	1.1	0	0.8	0.1	0
2A	M	0	0.2	1.2	0	0.4	0.3	0.1
1B	M	0	0.3	1.1	0	0	0	0.2
1A	M	0	0.1	0	0	0	0	0.1

[a] M = main channel; S = side channel.

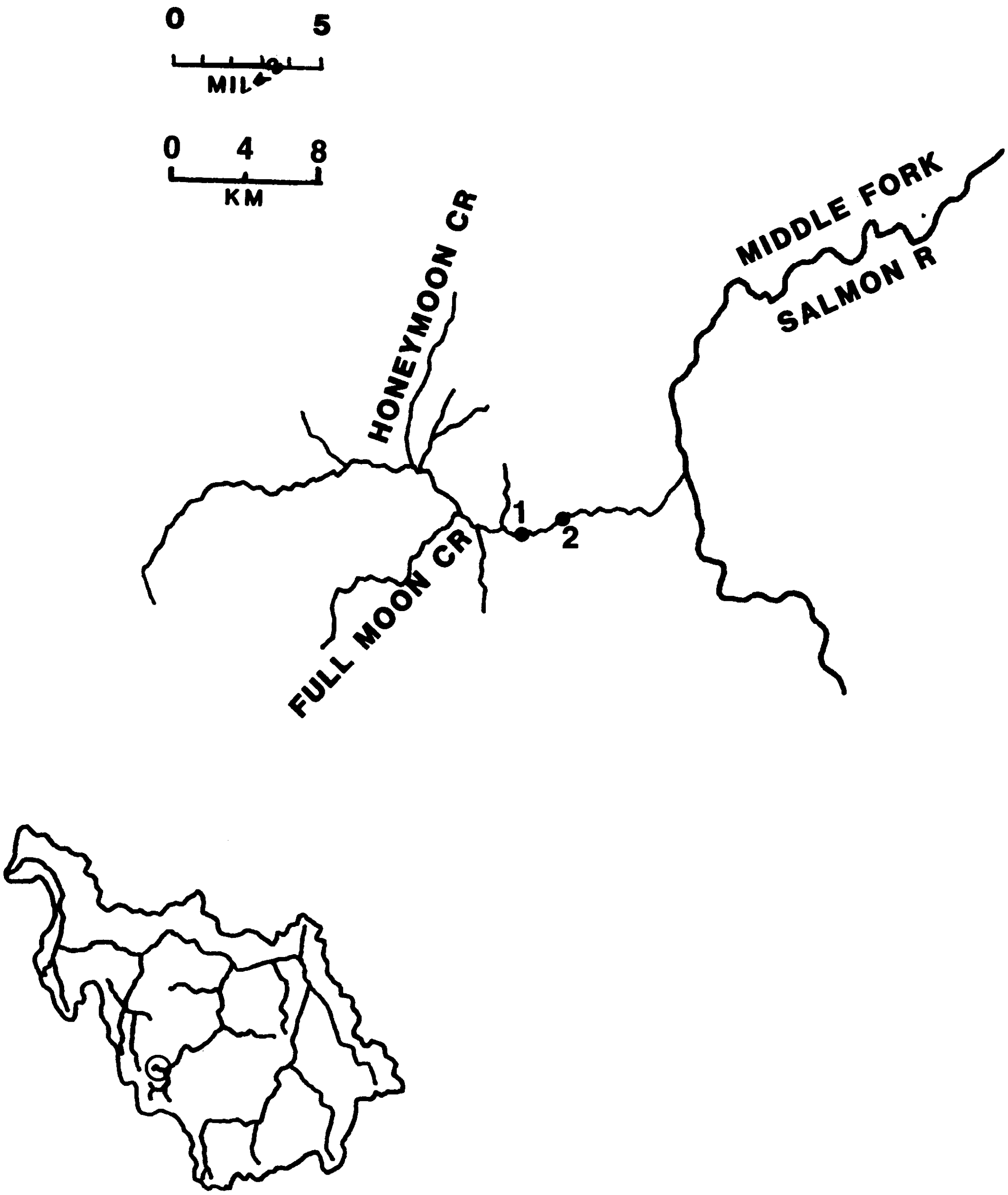

Figure 27. Location of established monitoring sections in the control stream Sulphur Creek.

the Frank Church River of No Return Wilderness Area and is accessible only by trail or by an airstrip at Parker Ranch. Most of the meadow habitat in Sulphur Creek is essentially pristine.

Spring chinook and summer steelhead runs in Sulphur Creek have gone through the same declines seen in other Idaho streams; in the reach established to count chinook redds, no redds or adult chinook were seen in 1984. The depressed anadromous fish populations in Sulphur Creek reflect the escapement problems associated with migration mortality on the Columbia and lower Snake rivers and overfishing more clearly than in streams with obvious habitat problems.

Nonanadromous salmonids reported in Sulphur Creek are rainbow trout, cutthroat trout, and mountain whitefish (Mallet 1974). Apparently, brook trout have not become established.

No BPA-funded projects are slated for Sulphur Creek. However, its high-quality habitat and the established chinook spawning ground counts make Sulphur Creek a good "control" stream for comparison with other degraded Middle Fork and upper Salmon River tributary streams which will have BPA projects.

Objectives of BPA surveys in Sulphur Creek are: (1) expand the data base into pristine habitat to help determine fish responses to measured habitat changes in BPA project areas, and (2) monitor anadromous fish populations through a period of restoration of wild runs.

Anadromous Fish Management Considerations

Sulphur Creek is exclusively managed for wild populations of chinook salmon and steelhead. Although the chinook population at this time is at a very low level, the spawning escapements and densities of chinook parr have steadily increased over the last several years, similar to populations of wild chinook in Middle Fork Salmon River tributaries other than Bear Valley Creek and Elk Creek.

Both riparian and aquatic habitats are in excellent condition in this moderate-to-low gradient stream. By comparing response of increasing escapements in this stream to response observed in similar streams that have been degraded by grazing and timber management, considerable insight should be gained on the relative impact of the factors that are adversely affecting anadromous fish production.

Project Evaluation

Evaluation status. Habitat and fish population data from Sulphur Creek will be incorporated as a set of control sections into the data base for BPA projects in the upper Middle Fork and upper Salmon rivers. The data will be used at the general monitoring level and at evaluation levels which require estimation of fish responses based on measured physical habitat changes. Through 1985, two monitoring sections had been established and sampled (Table 64, Appendix A-16).

The IDFG established a single section in Sulphur Creek in 1984. No rainbow-steelhead were observed that year, and chinook densities were low (Petrosky and Holubetz 1985). An additional monitoring section was added in 1985.

The IDFG will collect riparian corridor and aquatic habitat data throughout Sulphur Creek in 1986 in a manner compatible with the 1985 problem-identification inventory of the upper Middle Fork and upper Salmon rivers. Tentatively, five reaches will be defined with two aquatic sections in each reach; the entire riparian corridor of low-gradient reaches will be inventoried. Fish densities will be estimated for each defined section in 1986.

Juvenile rainbow-steelhead. Sulphur Creek was under-seeded by steelhead in 1985 (Table 65). NO rainbow-steelhead were observed in the 1984 survey (Appendix A-16)

Juvenile chinook. Sulphur Creek was also under-seeded by chinook in 1985 (Table 65). Density in Section 1 doubled from the 1984 level (Appendix A-16).

Resident salmonids. Cutthroat trout and juvenile mountain whitefish were the only resident salmonids observed in Sulphur Creek in 1985 (Table 66).

Physical habitat. Habitat in Sulphur Creek is essentially pristine. The established sections are low gradient (0.600.8%) and the substrate surface contained about 30% granitic sand (Table 67). A greater variety of stream gradients will be incorporated into the 1986 survey which will better define natural levels of sediment deposition in Sulphur Creek for comparison with the Bear Valley Creek, Elk Creek, Marsh Creek, Valley Creek, and upper Salmon River drainages.

Future Evaluation and Recommendations

Fish population and habitat data collection should be continued in Sulphur Creek, which has undisturbed habitat, to allow for the future interpretation of population trends and measured habitat changes in streams in the upper Middle Fork and Salmon rivers that will have BPA projects. The habitat data should be fully compatible with data from the 1985 habitat inventory and problem identification and include measurements of stream bank stability and vegetative community typing in the riparian corridor.

Table 64. Sections sampled in Sulphur Creek, July 25, 1985.

Section	% gradient	Section width(m)	Section area(m2)	% Habitat Type pool, run	riffle	pocket water
1	0.6	10.7	2146	71.4	28.6	0
2	0.8	10.8	1604	70.0	29.2	0

Table 65. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in Sulphur Creek, July 25, 1985.

	Rainbow-steelhead				Chinook	
Section	0	1	2	≥ 3	0	I+
1	16.2	0.8	0.2	0	18.1	0.4
2	1.4	0	0	0	0.1	0

Table 66. Density (number/100m^2) by age-group of cutthroat trout, bull trout, and whitefish in Sulphur Creek, July 25, 1985.

	Cutthroat	Bull		Whitefish	
Section	≥1	0	≥1	0	≥1
1	0	0	0	1.7	0
2	0.2	0	0	0.8	0

Table 67. Summary of physical habitat measurements (by percent) in Sulphur Creek section, July 25, 1985.

	Depth(m)					Velocity(mps)					Substrate[a]				Embeddedness (%)				
		0.2-	0.5-	0.8-			0.3-	0.6-	0.9-							5-	25-	50-	
Section	<0.2	0.4	0.7	1.0	>1.1	<0.3	0.5	0.8	1.1	>1.2	S	G	R	B	<5	25	50	75	>75
1	14.3	61.9	14.3	9.5	0	90.5	9.5	0	0	0	30.5	54.8	14.8	0	38.1	14.3	0	19.0	19.0
2	8.3	41.7	25.0	16.7	8.3	79.2	20.8	0	0	0	31.2	48.8	20.0	0	45.8	16.7	8.3	8.3	20.8

[a] S = sand; G = gravel; R = rubble, B = boulder.

Camas Creek

Camas Creek, 61 km long, is a major tributary to the Middle Fork Salmon River entering the Middle Fork 56 km above its mouth (Fig. 28). Compared to the infertile upper Middle Fork and Salmon River tributaries of the batholith, Camas Creek is moderately productive in terms of water chemistry. Camas Creek in its lower 19 km flows through a steep canyon; the stream in the upper section has less gradient and more meanders. Road access is limited to Meyer's Cove in the upper section. Past agricultural practices at Meyer's Cove have degraded and destabilized aquatic habitat. Presently, this area is managed by USFS.

Camas Creek supported sizable summer steel head and chinook runs before the 1970s. Gebhards (1959) estimated that the potential capacity of the stream exceeded 5,200 chinook females. Both steel head and chinook spawn and rear in the main stem and tributaries. The stream at Meyer’s Cove is an important spawning area for both species.

Resident salmonids in Camas Creek include rainbow trout, cutthroat trout, bull trout, and mountain whitefish (Mallet 1974).

Habitat quality of Camas Creek at Meyer's Cove has been reduced by past land management and the influence of runoff events. Intensive agricultural use, including crop production, livestock grazing, and irrigation, has negatively influenced channel stability. Natural flow events compounded and further intensified unstable conditions (May and Rose 1986).

The Camas Creek project was in the feasibility and planning phase in 1984-1985. Objectives of the project are (1) improve riparian and instream conditions to increase spawning and rearing potential for steel head and chinook, and (2) restore wild steelhead and chinook runs In Camas Creek consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin SAT5.

Anadromous Fish Management Considerations

Camas Creek, as other tributaries of the Middle Fork Salmon River, is being managed exclusively for the production of wild salmon and steelhead. Camas Creek is a productive stream that has historically produced large numbers of salmon and steel head. Portions of the stream have been severely degraded by overgrazing, mining, dams, and channel relocation. Periodically, rock and debris barriers have partially blocked access into the upper portions of the drainage. Camas Creek is considered to be one of the more important spawning and rearing streams in the Middle Fork Salmon River drainage.

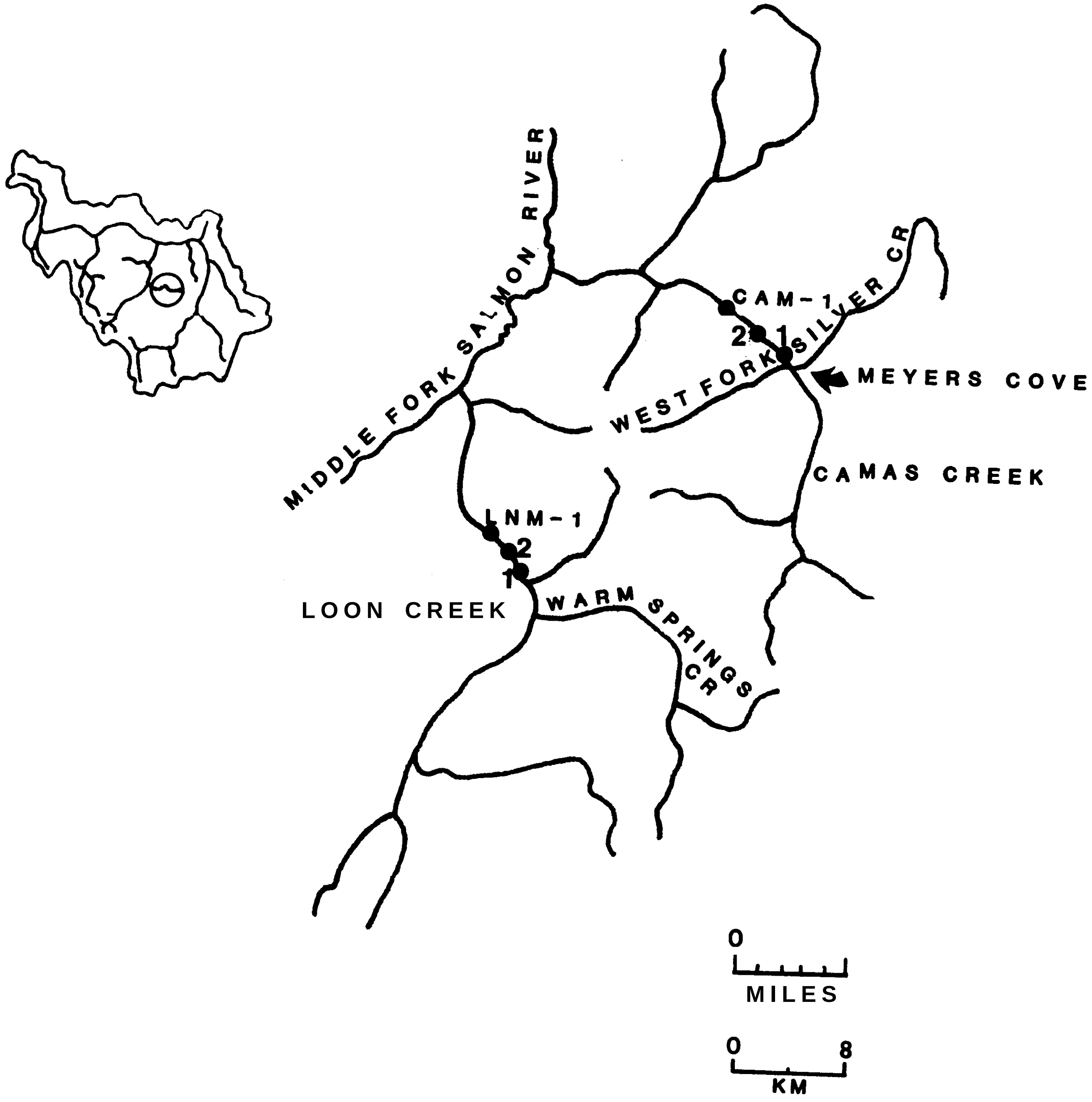

Figure 28. Location of the Meyers Cove habitat enhancement project and established monitoring sections on Camas Creek and the control stream Loon Creek.

Spawning ground counts have been conducted in Camas Creek and illustrate the decline of salmon and steelhead production in this stream over the years. The decline of Camas Creek fish runs is primarily due to the losses of migrants at main stem dams on the Columbia and Snake rivers and overfishing in the Columbia River and Pacific Ocean.

1984-1985 Project Feasibility and Design

Through 1985, the Camas Creek project was in a feasibility and design phase (May and Rose 1986). This relatively small-scale project will be jointly funded by BPA and USFS and enhance the degraded portion of an otherwise high-quality stream. Enhancement activities will include fencing of riparian zones, revegetation, seeding, bank stabilization, and a small number of boulder placements.

Project Evaluation

Evaluation status. Two basic levels of evaluation are planned for the Camas Creek project: general monitoring and evaluations based on standing crops and measured habitat change. Through 1985, monitoring sections have been established and sampled pretreatment (Table 68).

The IDFG evaluation of the BPA project in Camas Creek began in 1984 as pretreatment monitoring of anadromous fish densities in two sections (Petrosky and Holubetz 1985). Camas Creek was under-seeded by steelhead and chinook in 1984.

In 1985, we added one monitoring section in Camas Creek and a set of three monitoring sections in a similar but pristine control stream (Loon Creek). Loon Creek was added into the monitoring because we expect the benefits of the Camas Creek project to be subtle and difficult to separate from the effects of increasing escapements. Habitat conditions in Loon Creek are expected to remain "constant," while habitat in Camas Creek improves. One monitoring section each in Camas Creek (CAM-1) and Loon Creek (LNM-1) had been sampled previously by Thurow (1985).

Juvenile rainbow-steelhead. Both the project area in Camas Creek and Loon Creek were under-seeded by steel head in 1985 (Table 69). Fry densities were moderately high; however, and Section CAM-1 supported a density of 16.8 parr/100 m^2. Densities of rainbow-steel head fry have increased substantially in Camas Creek since 1983 (Petrosky and Holubetz 1985).

Table 68, Sections sampled in Camas Creek and Loon Creek (control stream), August 28-30, 1985.

Stream, section	% gradient	Section width(m)	Section area(m^2)	% Habitat Type pool, run	riffle	pocket water
Camas Creek						
1	1.1	18.0	3948	66.7	33.3	0
2	1.0	14.7	1468	100.0	0	0
CAM-1	1.5	10.6	382	16.7	16.7	66.7
Loon Creek						
1		16.1	645	-		
2	0.9	13.9	1738	-	I	-
LNM-1	1.4	18.4	606			-

Table 69. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in Camas Creek and Loon Creek (control stream), August 28-30, 1985.

Stream, section	Rainbow-steelhead				Chinook	
	0	1	2	>3	0	1+
Camas Creek						
1	17.2	1.6	0.3	+	3.0	0
2	20.1	0.9	0	0.1	3.6	0
CAM-1	6.3	7.9	3.7	5.2	2.1	0.3
Loon Creek						
1	15.8	1.7	0	0	3.3	0
2	7.1	1.4	0	0	3.3	0.1
LNM-1	21.3	0.2	0	0	1.7	0

Juvenile chinook. Densities of age 0 chinook were uniformly low in Camas Creek and Loon Creek sections in 1985 (Table 69). Spawning escapements in both streams remain at about 10% of the 1960-1969 average.

Resident salmonids. Cutthroat trout, bull trout, and mountain whitefish were observed in Camas Creek and Loon Creek in 1985 (Table 70). Thurow (1985) considered Loon Creek to be one of the major production areas of cutthroat trout for the middle Fork Salmon River. Unlike most Middle Fork Salmon River tributaries, Camas Creek has an abundant population of resident rainbow trout.

Physical habitat. Physical habitat has not been measured in the monitoring sections through 1985. Habitat in Loon Creek and Camas Creek appears quite similar except for riparian and stream bank degradation that has occurred in Camas Creek.

Future Evaluation and Recommendations

Future evaluation of the Camas Creek project requires documentation of habitat change and the development of a habitat-fish response model to detect subtle effects. Monitoring of control sections in Loon Creek will be very important in the separation of effects of habitat change in Camas Creek from the trend of increased spawning escapement and juvenile fish densities.

Sampling of habitat in the Meyer's Cove area of Camas Creek and in Loon Creek in an increased number of sections should be accomplished in 1987 before effects of the Riparian Revegetation project begin to alter aquatic habitat.

SOUTH FORK SALMON RIVER

Main Stem South Fork Salmon River

The South Fork Salmon River is a major tributary which enters the Salmon River at river kilometer 214 (Fig. 29). The South Fork Salmon River contains about 300 km of stream available to anadromous fish in a 3,300-km^2 watershed. The fragile, steep slopes of the watershed are primarily granitic bedrock. Mass erosion in the South Fork drainage began to occur during the 1950s following soil disturbances from logging and road construction (Platts and Megahan 1975). Major storm events in 1962, 1964, and 1965 accelerated erosion rates tremendously, particularly from logging roads.

Table 70. Density (number/100m^2) by age-group of cutthroat trout, bull trout, and mountain whitefish in Camas Creek and Loon Creek (control stream), August 28-30, 1985.

Stream, section	Cutthroat	Bull		Whitefish	
	≥1	0	≥1	0	≥1
Camas Creek					
1	0	0	+	1.0	0.5
2	0.1	0	0	0.3	0.4
CAM-1	0.3	0	0	0.3	0.8
Loon meek					
1	0.3	0	0	0	3.1
2	0.6	0	0	2.6	1.6
LNM-1	0.3	0	0	0	1.5

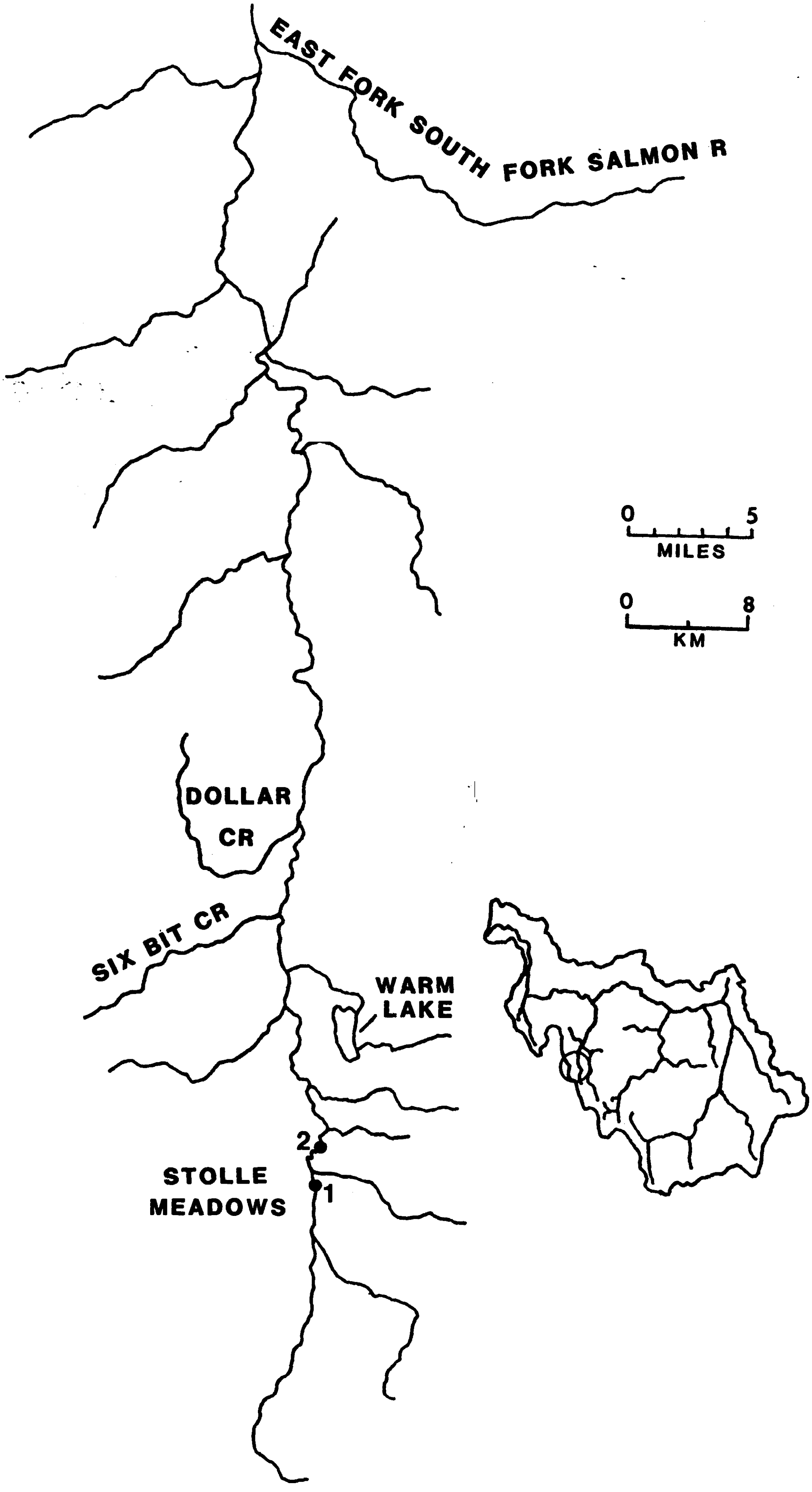

Figure 29. Location of passage projects on Six Bit Creek and Dollar Creek and established monitoring sections on the upper South Fork Salmon River.

Erosion severely affected runs of summer steelhead and summer chinook in the South Fork Salmon River (Platts and Partridge 1978). The summer chinook run, historically Idaho's largest salmon run, began to decline before migration mortality at Columbia and Snake River dams reduced other stocks in the 1970s (Fig. 30). During the early 1970s (1971, 1972, and 19741, when escapements were only about 20% of earlier levels, age 0 chinook densities in South Fork tributaries ranged from about 1 to 40/100 m^2 (Platts and Partridge 1978). A further reduction in adult chinook returns occurred in 1974 which paralleled declines in other Idaho production streams. Since 1980, IDFG has trapped adult chinook for spawntaking and reared juveniles at McCall Hatchery for their release back into the South Fork as smolts. Sockeye salmon reportedly once used the drainage but have not been seen during extensive spawning ground surveys since 1955 (Mallet 1974).

Nonanadromous salmonids native to the South Fork Salmon River drainage include cutthroat trout, bull trout, and mountain whitefish (Platts and Megahan 1975). Brook trout have become established widely throughout the drainage.

Habitat conditions in the South Fork Salmon River improved moderately since sediment production from surface erosion declined and sediment was transported from the system (Platts and Megahan 1975). Largely responsible for the decreasing erosion rates was a moratorium placed on logging and road construction in the mid-1960s. However, another mass erosion event occurred in 1984.

No BPA-funded habitat enhancement project is planned currently for the main stem South Fork Salmon River. The established spawning ground surveys for summer chinook, a management direction which includes supplementation of summer chinook, and ongoing USFS studies of sedimentation make the upper portions of the South Fork a good "control" stream from which to compare success of summer chinook introductions into upper Johnson Creek.

A relatively small-scale BPA project is planned for 1986 on Dollar Creek and Six Bit Creek. Natural debris jams which block passage of adult steel head will be selectively treated to improve passage. The barrier removals may also aid adult chinook passage; however, neither tributary is considered to be prime chinook habitat.

Objectives of BPA surveys and barrier removal projects in the South Fork Salmon River drainage are: (1) establish a control set of data in the Stolle Meadows vicinity to aid evaluation of success of summer chinook introductions into Johnson Creek, (2) improve passage conditions for adult wild steelhead in tributaries, and (3) restore wild steelhead and natural summer chinook runs in the South Fork Salmon River drainage consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin SA-3.

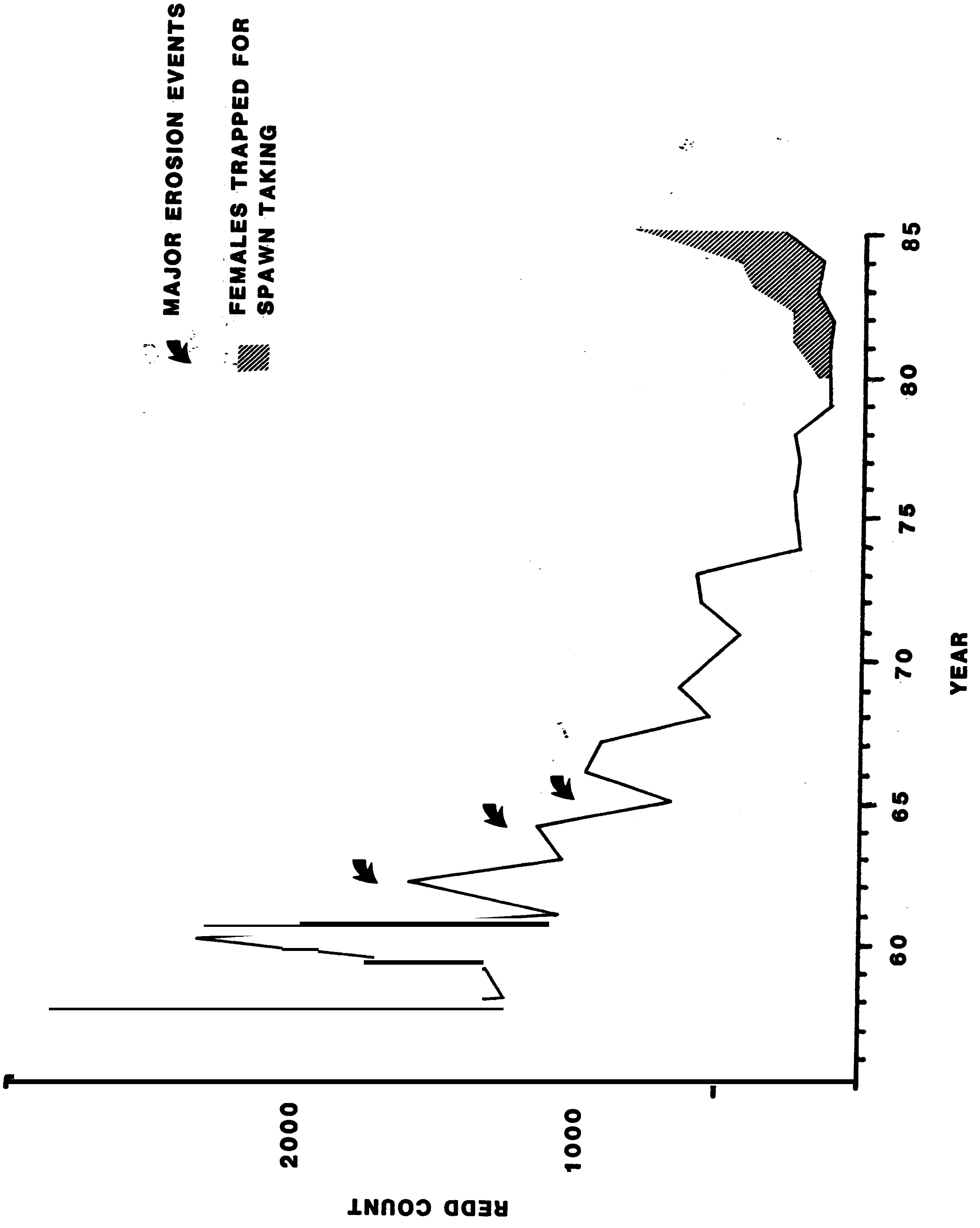

Figure 30. Major erosion events and summer chinook redd counts in established trend area, South Fork Salmon River, 1957-85.

Anadromous Fish Management Considerations

The South Fork Salmon River is being managed for wild populations of steelhead and a combination of hatchery and natural summer chinook salmon. The restoration of the aquatic habitat is the primary consideration in this highly sedimented stream. Land management constraints have been implemented to aid the restoration of this stream. The South Fork Salmon River is the most important summer chinook salmon stream in Idaho.

The BPA habitat enhancement will play a minor role in this stream. Return of adults from smolt releases from McCall Hatchery to the upper portion of the drainage should bring the natural production habitat to full seeding in the very near future. Sane fishing opportunities for salmon may be possible in the next several years in this stream.

The majority of the salmon production occurs in the main stem of the South Fork with significant steelhead production occurring in both the main stem and tributaries.

The BPA habitat enhancement will not be considered in lieu of responsible land management that will allow the aquatic habitat to recover to a productive state.

1984-1985 Passage Project Feasibility

Debris jams which potentially block passage of adult steel head and chinook to the tributaries Dollar Creek, Six Bit Creek, and Curtis Creek were inventoried in 1984-1985 and plans were developed to selectively modify barriers on Dollar Creek and Six Bit Creek (D. Newberry, USFS Cascade Ranger District, personal communication). The projects were delayed in 1984 by environmental concerns over stored sediment which could be released if a major debris removal occurred. Projects were delayed in 1985 by work restrictions and lack of crew during an extended period of high fire danger.

Project Evaluation

Evaluation status. Habitat and fish population data from Stolle Meadows sections will be collected to complement evaluation of summer chinook introductions into upper Johnson Creek. Two levels of evaluation are planned for **tr** passage projects: general monitoring and an evaluation based on standing crops. Because the debris jams are probably only partial barriers to steelhead, a fraction of standing crops at full seeding should be used to estimate project benefits. This fraction will be developed based on pretreatment surveys in 1986. Through 1985, only the monitoring sections in Stolle Meadows have been established and sampled (Table 71, Appendix A-18).

The IDFG established a single monitoring section In the Stolle Meadows area of the South Fork Salmon River in 1984; an additional monitoring section was added in 1985. General monitoring sections will be added in 1986 in Dollar Creek and Six Bit Creek.

Juvenile rainbow-steelhead. The upper South Fork Salmon River was under-seeded by wild steelhead in 1984 and 1985 (Table 72, Appendix A-18). The low rainbow-steel head densities in the upper South Fork were similar to those recorded in meadow habitat in upper Johnson Creek in 1984-1985.

Juvenile chinook. Densities of age 0 chinook in the upper South Fork varied considerably between 1984 and 1985 (Table 72, Appendix A-18). The high density in Section 1 in 1985 (75/100 m2) partially reflected the release of 50,000 fry (149 fish/pound) into Stolle Meadows on July 5. Large numbers of these fish were not represented in Section 2, about 2 km downstream.

Resident Salmonids. Brook trout, bull trout, and mountain whitefish were observed in the South Fork sections in 1985 (Table 73).

Physical habitat. Through 1985, the complete set of habitat variables has not been measured in South Fork monitoring sections.

Future Evaluation and Recommendations

Future project evaluation for South Fork tributary barrier removals requires a determination of whether improved passage was actually attained and standing crop estimates at full seeding of juvenile steel head and chinook. Because these are fairly small projects on small tributaries, evaluation of monitoring should be kept at a low level. Improvements in passage to adults can be monitored indirectly through juvenile density trends. Estimates of standing crops should be based on a stratified sampling design at full seeding.

Monitoring sections in Stolle Meadows should continue to be sampled annually to aid evaluation of the Johnson Creek project. Summer chinook densities in Stolle Meadows will be at full seeding sooner than in Johnson Creek because the management direction in the main stem South Fork is for continued supplementation of chinook.

Johnson Creek

Johnson Creek is 51 km long and enters the East Fork of the South Fork Salmon River from the mouth (Fig. 31). Johnson Creek flows through the Idaho batholith. The steep slopes of the watershed are

Table 71. Sections sampled in upper South Fork Salmon River at Stolle Meadows, July 22, 1985.

Section	% gradient	Section width(m)	Section area(m^2)	% Habitat Type pool, run	riffle	pocket water
1	-	9.6	1765	61.9	38.1	0
2	-	12.0	1565	86.7	13.3	0

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Table 72. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in upper South Fork Salmon River at Stolle Meadows, July 22, 1985.

Section	Rainbow-steelhead				Chinook	
	0	1	2	$\geq$3	0	I+
1	5.0	0.6	0.3	0.2	75.0	0.5
2	8.2	0	0	0	7.5	0

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Table 73. Density (number/100m^2) by age-group of cutthroat trout, brook trout, bull trout, and mountain whitefish in upper South Fork Salmon River at Stolle Meadows, July 22, 1985.

	Cutthroat	Brook		Bull		Whitefish	
Section	≥1	0	≥1	0	≥1	0	≥1
1	0	0	0.2	0	0.2	2.2	1.3
2	0	0	0	0	0	0.4	0

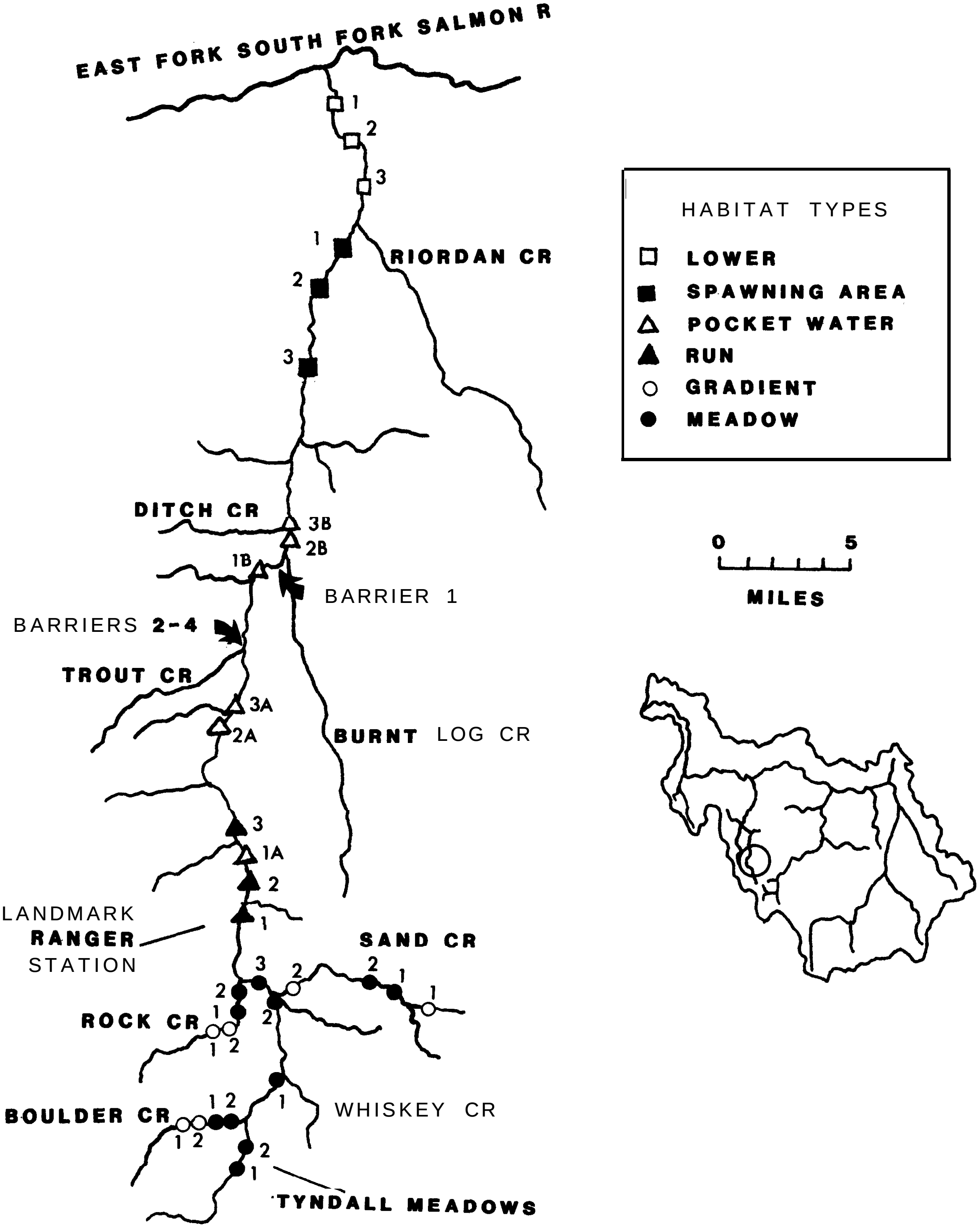

Figure 31. Location of 1984-85 barrier removal project on Johnson Creek and established monitoring sections.

extremely vulnerable to erosion from land-disturbing activities. HOwever, the Johnson Creek watershed has been less disturbed than many other parts of the South Fork Salmon River drainage. Gradient in the lower 45 km of Johnson Creek alternates between moderate and steep. The headwaters is In a flat, high-elevation basin containing about 32 km of moderate-to-high quality spawning and rearing habitat. A series of three barriers downstream from the mouth of Trout Creek and another barrier between Halfway Creek and Ditch Creek prevented adult chinook from seeding this habitat in most years. All barriers were caused by natural rock slides combined with high stream gradient and consisted of large boulders that had fallen into the stream.

Johnson Creek supports runs of summer steelhead and summer chinook. Adult steelhead apparently can pass these barriers during most flows but the upper basin produces few juvenile steelhead. Adult chinook are blocked from the upper drainage during low flows of late summer. In most years, chinook spawning and rearing is restricted to the lower end of Johnson Creek. Known passage by adult chinook to the upper meadow prior to the project consists of seine samples of juvenile chinook near Rock Creek In 1976 and observations of a single chinook redd near Rock Creek in 1983 and five chinook redds in the upper meadow in 1960 (Petrosky and Holubetz 1985). A sheepherder also reported that salmon were very numerous in Sand Creek in the early 1930s.

Resident salmonids of Johnson Creek Include rainbow trout, bull trout, brook trout, and mountain whitefish (Mallet 1974) and cutthroat trout. Brook trout dominate the fish community in the upper meadow.

The upper basin of Johnson week has received less development than many other South Fork Salmon River watersheds. Roads follow the entire main stem of Johnson Creek and sane of the upper tributaries (e.g., Sand Creek, Whiskey Creek, and lower Rock Creek). Livestock grazing has degraded riparian habitat in parts of the upper basin. Sedimentation is high in parts of the upper basin.

Objectives of the BPA-funded project in Johnson Creek are: (1) modify the natural barriers to allow passage by adult chinook into the upper basin, (2) establish summer chinook in habitat made available by the barrier removal project, (3) improve passage conditions for wild steelhead, (4) increase natural production of anadromous fish consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin SA-3.

Anadromous Fish Management Considerations

Johnson Creek produces wild summer chinook salmon and steel head trout in the lower reaches and with the completion of the barrier removal project will produce wild salmon and steelhead in the upper portions of the drainage. South Fork stock of summer chinook is being used to establish the chinook population in upper Johnson Creek. The Johnson Creek stock of wild steel head will be used to build steelhead populations in upper Johnson Creek.

Sediment levels are high in the lower gradient areas of upper Johnson Creek. Land management activity should be directed to minimize the addition of sediment to the Johnson Creek system. With the exception of the sediment problem, Johnson Creek contains a diversity of high quality habitats and will produce large numbers of salmon and steelhead at full seeding.

The Barrier Removal project is being designed to accommodate passage of summer chinook salmon at moderate-to-low flows. The Improvement will not accommodate passage of salmon at high flows. Sane improvement in passage conditions for adult wild steel head will also occur as a result of this project.

Chinook salmon and steelhead redd counts in the lower part of Johnson Creek have shown an improving trend in recent years.

1984-1985 Barrier Removal Project

The Johnson Creek Barrier Removal project was planned for late August or September 1984. Problems with completing the environmental assessment delayed IDFG action on the project until October 1984.

During October 1984, IDFG personnel and a consulting fisheries engineer modif led the barriers. individual rocks were selectively drilled and blasted to create lower over-pours, deeper jumping pools, and escape avenues above the falls (Fisher 1984). Ice and snow during this period caused some of the 1984 work to be extremely difficult.

The planned work on barrier removal was completed in 1985. The barriers appeared passable to adult chinook at low flows in late summer 1985, and Welsh (personal communication) reported a single false redd in the Landmark vicinity.

The barriers should be observed at several flow conditions in 1986 before concluding that passage is assured.

Project Evaluation

Evaluation status. Two basic levels of evaluation are planned for the Johnson Creek Barrier Removal project: general monitoring and evaluations based on standing crops. Through 1985, monitoring sections have been established and sampled. The standing crop evaluations are underway to determine success of summer chinook Introductions Into the drainage above the barriers. This portion of the evaluation is being conducted by T. Welsh (Cooperative Fish and Wildlife Research Unit, University of Idaho) through IDFG subcontract (Table 74).

Because the barriers were essentially a complete block to adult chinook passage, the entire standing crop of juvenile chinook above the barriers at full seeding can be used to determine benefits for mitigation. Benefits from downstream drift of juvenile chinook into the canyon below the barriers may also be definable in Johnson Creek. In the 1984 pretreatment survey, we observed no juvenile chinook or substantial accumulations of spawning gravel in the area from the barriers down to Ditch Creek vicinity; seeding of this rearing habitat in the future will likely depend on the contribution of chinook fry originating above the barriers. We anticipate no definable mitigation benefit for steel head from the project because adult steelhead could pass before project implementation.

The IDFG evaluation of the Johnson Creek project began in 1984 as a pretreatment survey of fish distribution and density in the drainage above and belaw the barriers. Rainbow-steel head were present in moderate densities in pocket water habitat above and below the barriers (Petrosky and Holubetz 1985). Juvenile chinook were present only in the lower third of Johnson Creek during the pretreatment survey.

Juvenile rainbow-steelhead. Johnson Creek was under-seeded by steelhead. Rainbow-steelhead parr were present in low densities in the upper meadow in 1984 and 1985 (Table 75, Appendix A-19).

Juvenile chinook. No age 0 chinook were observed above the barriers either in 1984 or in 1985 prior to fish introductions (T. Welsh, personal communication). The first introductions of juvenile summer chinook (South Fork Salmon River stock, M&al I Hatchery) into upper Johnson Creek occurred in 1985. The small number released (25,000) resulted in the low densities observed in monitoring sections (Table 75). A combination of a late release date (August 2-3 and large size at release (87 fish/pound)) were probably major factors in the high degree of dispersal observed (T. Welsh, personal communication).

Resident salmonids. The upper Johnson Creek drainage supports a sizable brook trout population. No other resident Salmonids were observed above the barriers in 1985 (Table 76). In 1984 a few bull trout and cutthroat trout were also observed; mountain whitefish were present only below the barriers (Petrosky and Holubetz 1985).

Physical habitat. Physical habitat variables were measured in all sections in 1984, but the data set did not include measurements of gradient. Deposition of sand in upper Johnson Creek varied considerably by location (Petrosky and Holubetz 1985). Percent substrate composition as sand was highest in sections in Tyndall Meadows (average 82.5%) and Boulder Creek (63.1%), intermediate in the

Table 74. Sections sampled in Johnson Creek and tributaries Rock Creek and Sand Creek, August 3-10, 1985.

Stream section	Location[a]	% gradient	Section width(m)	Section area(m^2)	% Habitat Type[b] pool, run	riffle	pocket water
Johnson Creek							
Meadow 1	A	-	7.3	668	70.0	30.0	0
Meadow 2	A	-	6.9	630	90.0	10.0	0
Meadow 3	A	-	8.7	1582	73.3	26.7	0
Run 1	A	-	12.2	1557	90.5	0	9.5
PW1A	A	-	17.4	1589	0	0	100.0
Run 3	A	-	16.1	688	93.3	6.7	0
Rock Creek							
Meadow 1	A	-	4.1	373	100.0	0	0
Sand Creek							
Meadow 2	A	-	4.4	398	100.0	0	0

[a] A = above barriers.

[b] 1984 data.

Table 75. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in Johnson Creek and tributaries, August 3-10, 1985.

Stream section	Location[a]	Rainbow-steelhead 0	1	2	≥ 3	Chinook 0	1+
Johnson Creek							
Meadow 1	A	0	0	0	0	2.8	0
Meadow 2	A	0	0	0	0	0.3	0
Meadow 3	A	0	0	0	0	1.6	0
Run 1	A	0	0.1	0	0	1.4	0
PW1A	A	0	0.2	0	0	0.8	0
Run 3	A	0	0.2	0	0	0.4	0
Rock Creek							
Meadow 1	A	0	0	0	0	4.0	0
Sand Creek							
Meadow 2	A	0	0	0	0	8.0	0

[a] A = above barriers.

Table 76. Density (number/100m^2) by age-group of cutthroat trout, brook trout, bull trout, and whitefish in Johnson Creek and tributaries, August 3-10, 1985.

Stream, section	Location[a]	Cutthroat	Brook		Bull		Whitefish	
		≥1	0	≥1	0	≥1	0	≥1
Johnson Creek								
Meadow 1	A	0	0	5.3	0	0	0	0
Meadow 2	A	0	1.1	6.2	0	0	0	0
Meadow 3	A	0	0.8	2.8	0	0	0	0
Run 1	A	0	0.1	0.4	0	0	0	0
PW1A	A	0	0	0.1	0	0	0	0
Run 3	A	0	0.1	0.4	0	0	0	0
Rock Creek								
Meadow 1	A	0	63.8	18.8	0	0	0	0
Sand Creek								
Meadow 2	A	0	0.5	1.0	0	0	0	0

[a] A = above barriers.

reach from Boulder Creek to Landmark (35.8%)) and lowest in sections in Rock Creek (28.9%) and Sand Creek (25.1%). Gradient in the sections will be measured in 1986 to make substrate composition data comparable to data in other stream systems.

Future Evaluation and Recommendations

The barriers should be examined at various flow levels to determine If additional work is necessary to provide safe passage.

Future project evaluation for mitigation requires a determination of whether improved passage was actually attained and standing crop estimates of juvenile summer chinook at full seeding. Observations should be made at the barriers as adult chinook begin to return from initial introductions. When adult chinook first return, an annual spawning ground survey should be initiated above the barriers.

Unbiased estimates of standing crops can be calculated from densities in stream sections with application of either a stratified, random or systematic stratified sampling design (Scheaffer et al. 1979). Strata should be those same reaches defined in 1984 for Johnson Creek and upper tributaries. The pocket water reach below the barriers should be included to help define extra benefits of downstream rearing habitat made available to juvenile chinook by allowing adults access to upstream spawning habitat,

A complete set of physical habitat measurements will not be necessary to estimate benefits for the Johnson Creek barrier project. However, these data should be collected as part of an overall data base for comparison of fish population responses between streams.

LITTLE SALMON RIVER

Boulder Creek

Boulder Creek, 26 km long, enters the Little Salmon River at river kilometer 16 (Fig. 32). About 6 km above the mouth of Boulder Creek, a 2.7-m high, natural rock fall usually blocked upstream passage by adult chinook.

Boulder Creek presently supports spawning and rearing of summer steel head and spring chinook. Steelhead apparently could pass the falls; but prior to barrier removal, chinook could not pass the falls every year. Habitat in the 20 km above the barrier is moderately high quality and should support considerable numbers of juvenile chinook.

Nonanadromous salmonids present In Boulder Creek include rainbow trout, bull trout, brook trout, and mountain whitefish (Mallet 1974).

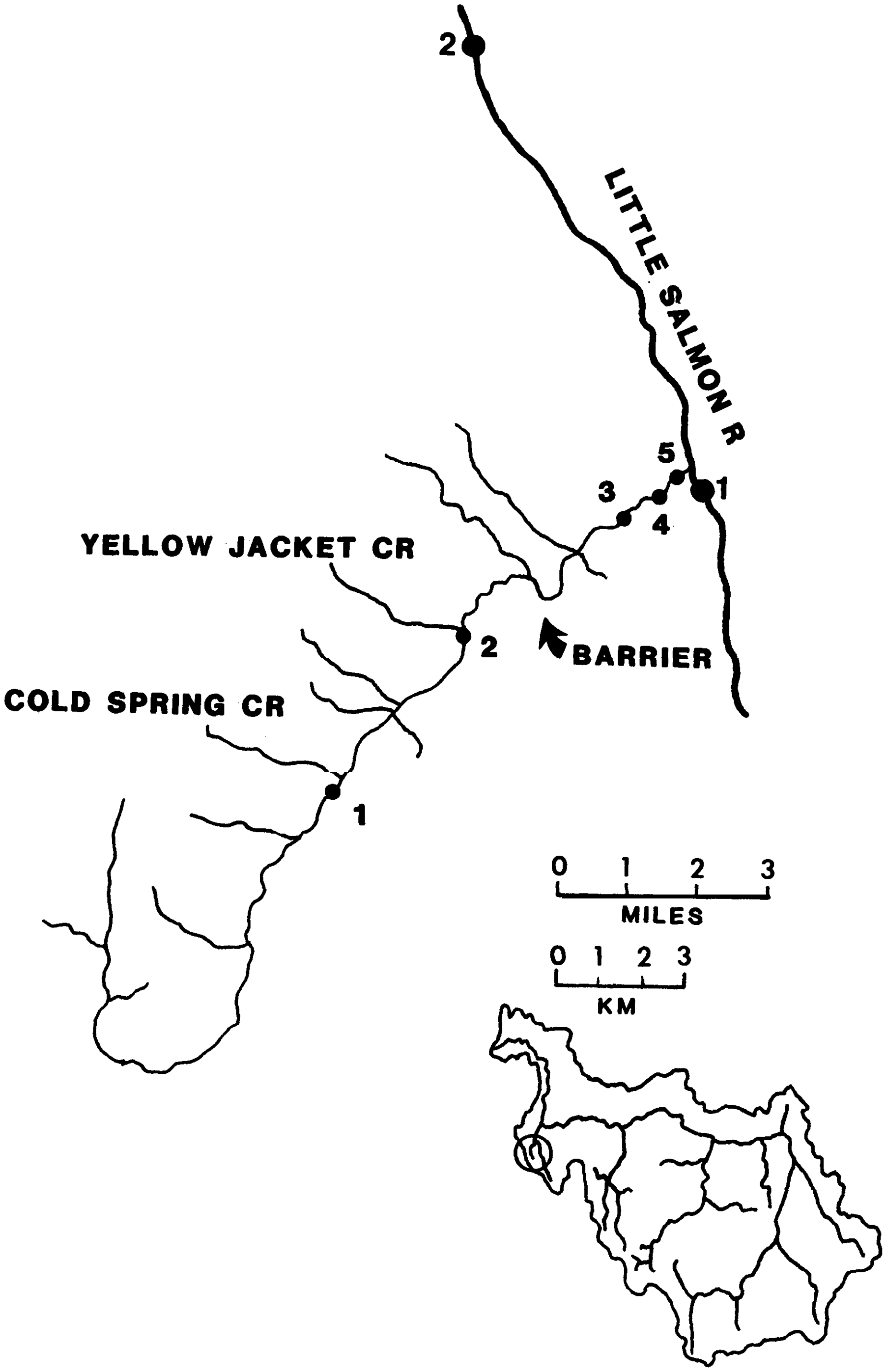

Figure 32. Location of 1985 barrier removal project on Boulder Creek and established monitoring sections.

A BPA-funded project was implemented in 1985 to modify the falls to al passage of adult chinook under all flow condi This IDFG project used expl to lower the height of the falls by removing portions of the solid granite sill to provide a "stair stepping" of two drops of about 1.2 to 1.5 m with adequate jumping pools below each drop.

Objectives of the project are: (1) provide assured access for chinook to the upper 20 km of Boulder Creek, (2) introduce spring chinook of suitable stock above the barriers, and (3) increase natural production of chinook consistent with IDFG (1985) Anadromous Fish Management Plan for Subbasin SA-1.

Anadromous Fish Management Considerations

Boulder Creek is a high-gradient stream that has some simliarity to Rapid River. Sane degradation of the watershed has occurred from logging and roading. A major diversion (Yantis Ditch) in the upper part of the watershed diverts all of the flow at that point from Boulder Creek drainage into the Weiser River drainage during part of the summer low-flow period. Despite the habitat problems, Boulder Creek has a good potential for salmon and steelhead rearing.

With modification of the waterfall to allow upstream passage of adult salmon in every year, the upper portion of the drainage should contribute significant Increases in the chinook salmon production. Sane straying of Rapid River adults has been noted in previous years. Also, steelhead smolts that were stocked in the Little Salmon River near the mouth of Hazard Creek ascended Boulder Creek as far upstream as the barrier and resided in Boulder Creek in large numbers throughout the summer. Chinook fry from Rapid River Hatchery will be stocked in the upper portion of Boulder Creek over the next several years to establish the population of chinook salmon above the barrier.

1985 Barrier Removal Project

In September 1985, IDFG engineering and fisheries personnel began the blasting project on the Boulder Creek barrier. The rock sill on the left bank was lowered about 1 m, and a jumping pool was created at the new sill. Rock debris partially filled the lower Jumping pool. This debris was expected to flush out during spring runoff.

The barrier may be passable to adult chinook at this time but requires further observation at high and low flows.

Project Evaluation

Evaluation status. Two basic levels of evaluation are planned for the Boulder Creek Barrier Removal project: general monitoring and evaluations based on standing crops. Through 1985, monitoring sections have been established and sampled (Table 77) and the sampling approach for standing crop evaluations has been established. The first post-treatment standing crop estimate for spring chinook is planned for 1986, following releases of fry upstream of the barrier.

Based on the assessment that the falls usually blocked all adult chinook passage, the entire standing crop of juvenile chinook above the barriers at full seeding can be used to determine mitigation benefits. We anticipate no definable mitigation benefit for steelhead from the project because adult steelhead could pass before project implementation.

The IDFG evaluation of the Boulder Creek project began in 1984 as a pretreatment survey of fish distribution and density above and below the barriers. Rainbow-steelhead were present In moderate densities above and below the barrier; juvenile chinook were present only below the barrier in 1984 at low densities (Petrosky and Holubetz 1985).

Juvenile rainbow-steelhead. Boulder Creek supported moderately high densities of rainbow-steelhead juveniles in 1984 and 1985, both above and below the barrier (Table 78, Appendix A-20). Residualized steelhead smolts (all adipose clipped) were probably present below the barriers. No attempt was made to visually separate these fish from naturally produced rainbow-steelhead.

Juvenile chinook. We observed three age 0 chinook above the barrier in 1985 (Table 781, evidence that very few adult chinook passed the barrier in 1984 before project implementation. Boulder Creek below the barrier supported low densities of chinook in 1984 and 1985 (Appendix A-20); this high-gradient area is not considered to be prime chinook habitat.

Resident Salmonids. Brook trout, bull trout, mountain whitefish, and catchable-size, hatchery rainbow trout were observed in Boulder Creek and the Little Salmon River sections in 1985 (Table 79). Brook trout were observed only in Section I in a low-gradient meadow reach. Whitefish were present only below the barrier.

Physical habitat. Physical habitat variables have not been measured in Boulder Creek monitoring sections through 1985. These data will be collected in future years.

An irrigation diversion, Yantis Ditch, 14 km above the barrier is unscreened and could reduce survival of migrants from upper Boulder Creek.

Table 77. Sections sampled in Boulder Creek and Little Salmon River, July 24-25, 1985.

Stream section	Location[a]	% gradient	Section width(m)	Section area(m^2)	% Habitat Type pool, run	riffle	pocket water
Boulder Creek							
1	A	1.2	8.0	723			
2	A	2.8	8.3	867			
3	B	4.2	12.5	1029	0	0	100.0
5	B	3.3	8.7	874	11.1	11.1	77.0
Little Salmon							
1	B	1.4	18.9	1550	22.2	0	77.8
2	B	2.1	13.2	2233	55.6	0	44.4

[a] A = above barrier; B = beta barrier.

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Table 78. Density (number/100m^2) by age-group of rainbow-steelhead and chinook in Boulder Creek and Little Salmon River, July 24-25, 1985.

Stream, section	Location[a]	Rainbow-steelhead[b]				Chinook	
		0	1	2	>3	0	1+
Boulder Creek							
1	A	0.7	3.2	0.4	0.1	0.4	.0
2	A	0.2	2.9	3.2	1.4	0	0
3	B	13.4	7.9	3.5	1.9	3.9	0
5	B	9.3	7.6	7.0	2.3	4.2	0.1
Little Salmon River							
1	B	6.4	4.8	6.8	1.6	0.1	0
2	B	13.5	4.3	4.3	1.4	1.3	0.5

[a] A = above barrier; B = below barrier.

[b] Residualized smolts were probably present in Boulder Creek sections 3 and 5 and Little Salmon River sections, and included in estimated densities of natural rainbow steelhead.

Table 79. Density (number/100m^2) by age-group of brook trout, bull trout, mountain whitefish, and hatchery rainbow trout (catchable-size), Boulder Creek and Little Salmon River, July 24-25, 1985.

Stream, section	Location[a]	Brook		Bull		Whitefish		Hatchery rainbow trout
		0	≥1	0	≥1	0	≥1	
Boulder Creek								
1	A	21.2	6.1	0	0.1	0	0	0
2	A	0	0	0	0.5	0	0	0
3	B	0	0	0	0	0	0.7	0
5	B	0	0	0	0	0	0.6	0.3
Little Salmon River								
1	B	0	0	0	0	0	0.2	0.1
2	B	0	0	0	+	0.1	0.7	0.2

[a] A = above barrier; B = below barrier.

Future Evaluation and Recommendations

Future evaluation for mitigation requires a determination of whether improved passage was attained and an estimate of standing crops of juvenile spring chinook at full seeding. Observations should be made at the barriers, especially as adult ch begin to return from f introductions. When adult chinook first return, an annual spawning ground survey should be initiated in Boulder Creek.

Unbiased estimates of standing crops can be calculated from densities in steam sections with application of either a stratified, random or systematic stratified sampling design (Scheaffer et al. 1979). Strata should be divided in the vicinity of Yantis Ditch.

A complete set of physical habitat measurements will not be essential to estimate benefits for the Boulder Creek project. However, this data should be collected as part of an overall data base for comparison of fish population responses between streams.

Potential for migrant fish losses into Yantis Ditch should be assessed; and If appropriate, the diversion should be screened.

RESULTS AND DISCUSSION

Project Evaluations

Success of the entire Fish and Wildlife program will be determined ultimately by the restoration of runs that are affected by hydropower operation, particularly the runs of depressed upriver stocks. Successful on-site mitigation to increase passage survival at main stem Columbia and Snake River dams is essential to success of off-site mitigation projects, including the habitat enhancement actions listed in Measure 704(d).

During the period of run restoration, most anadromous populations in Idaho will exhibit a wide range of seeding levels. The current under-seeded conditions and the expected trend for increasing steel head and salmon escapements as main stem passage conditions improve preclude a simple "before and after" comparison of populations to estimate benefits from habitat projects.

The IDFG general evaluation approach relies heavily on monitoring populations' trends to define full-seeding levels and separation of those parts of "final" densities or standing crops due to specific enhancement activities (Petrosky and Holubetz 1985). Intensive production studies relating spawning escapements, standing crops of juveniles, and smolt yields (e.g., Bjornn 1978) will be integrated with the survey approach of the general evaluations. A common data base will be required to apply results from a small number of intensive studies across a broad range of habitats and stocks.

In 1984-1985, IDFG project evaluations focused primarily on collection of pretreatment habitat and fish population data and establishment of trend-monitoring sections and evaluation approaches. Posttreatment evaluations of instream structure projects were conducted In the upper Lochsa River in 1984 and Lolo Creek in 1985, both at less-than-full seeding conditions. Posttreatment evaluations in 1986 will be conducted primarily in areas above barriers that were supplemented by excess hatchery adults or fry (Eldorado Creek, Crooked Fork Creek, Johnson Creek, and Boulder Creek) and Crooked River and Red River, which will also be at high seeding levels. Also in 1986, IDFG will begin two intensive production studies in the upper Salmon River and Crooked River.

General Monitoring and Evaluation

In 1984-1985, IDFG developed a short list of physical habitat variables based on Platts et al. (19831, that we intend to measure in every general monitoring section. We kept the variable list short so that at least some comparable data could be collected in every project stream without the data collection process becoming cumbersome and costly. Consistency built into the habitat data base will facilitate between stream comparisons and modeling of fish populations relative to habitat or habitat change. Other habitat variables required to specifically evaluate individual projects can be added easily to this core set of data. The physical habitat data base will be computerized beginning in 1986.

Densities of anadromous and resident fish in sections of project streams were estimated primarily by snorkeling techniques in 1984-1985. Where turbidity limited usefulness of snorkeling techniques in the Lemhi River sections, abundance was estimated by electrofishing (230-volt direct current) using a two-catch removal method (Seber and LeCren 1967). Snorkeling techniques have been used extensively in Idaho and the Northwest (e.g., Pal lard and Bjornn 1973; Johnson 1985; Thurow 1985) but seldom compared to more conventional methods of population estimation (Northcote and Wilkie 1963; Schill and Griffith 1984). In 1986, IDFG plans to begin to calibrate density estimates conducted by snorkeling with estimates conducted by electrofishing in streams of water clarity, conductivity, width, and gradient and varying anadromous fish densities. The fish population data base will be computerized beginning in 1986.

The basic biological parameters of general monitoring and general evaluations are anadromous fish densities and standing crops, respectively (BPA 1985). Stratified sampling of densities within defined stream reaches will be used in most evaluations to help control statistical variation. Except for projects that add new increments of habitat (e.g., barrier removal), standing crop estimates must be partioned to determine mitigation benefits.

General density monitoring, The major objectives of the general monitoring phase are to determine population trends of juvenile steel head and salmon and to help define full-seeding levels (Petrosky and Holubetz 1985). Project evaluations can be carried out at full seeding or when deemed appropriate as determined by population trend data.

The IDFG established density trend monitoring sections in every BPA project stream and in a few "control" streams (e.g., Sulphur Creek, Loon Creek, South Fork Salmon River). Fish densities will be estimated annually in these sections (Appendix A). This monitoring program will be integrated with a separate IDFG fisheries management program which will monitor juvenile fish population trends in other key anadromous fish production streams. Together these two programs will provide representative trend data for all of Idaho's salmon and steel head production.

Secondary information will also be obtained during general monitoring of juvenile anadromous fish densities. Trends in resident salmonid populations can be followed as habitat projects are implemented and as anadromous populations rebuild. Trend data are al so being collected on numbers of adult chinook observed in established sect1 on (Appendix B). These adult trend data will complement redd count and juvenile density trends. However, these data will have to be used with caution because we frequently sample juvenile populations before adult chinook ascend stream in mid- to late July into the project areas.

Evaluation of habitat additions. Additions of new increments of habitat will provide some of the largest mitigation benefits (increased smolt-yield and adult production) often at low costs. Conceptually, habitat additions are also the easiest to evaluate. These projects include removal of natural barriers (e.g., Eldorado Creek and Johnson Creek), flow improvements for adult passage (e.g., upper Salmon River and Alturas Lake Creek), development of off-channel ponds and side channels (Crooked River), and control of pollution that blocks anadromous fish runs (Panther Creek). Where large increments of habitat are put into production, relatively few assumptions will be necessary to estimate benefits.

Standing crops of juvenile, anadromous fish at full seeding can be used as the basis for determining mitigation benefits. Stratified sampling will be used to estimate standing crops with reaches (strata) defined by major physical habitat features (low-gradient meadow reach versus high-gradient canyon reach). In cases of removal of a partial barrier, some fraction of standing crops can be used for mitigation.

The fractions will be developed for individual projects based on knowledge or estimates of the frequency of blockage, dewatering, etc. Yield of smolts and adults from the projects can be estimated by factoring the standing crops credited to the project by appropriate survival rates to the smolt stage. Estimates of survival rates will be developed at the intensive study sites.

Evaluation of localized habitat improvement. Habitat improvement projects should be credited with any detectable increase in standing crops over the pretreatment potential. Low seeding levels at the time of project implementation complicate the analyses.

The primary effect of many BPA habitat projects will be a localized increase in carrying capacity. For these projects designed to improve local rearing habitat (e.g., instream structures, sane types of riparian revegetation, flood-plain development), IDFG began in 1984 to reserve untreated (control) sections within project reaches. As juvenile populations increase and as local effects of the treatments "mature," the differences in densities between treatments and controls can be estimated using analysis of variance. Both the evaluation approach and initial rationale for these projects assume that quantity and quality of rearing habitat is likely the major limiting factor. Mass balance analyses of quantity of spawning and rearing habitat in Fish Creek, Oregon, and in Panther Creek tend to support this assumption (Everest and Sedell 1984; Reiser 1986).

A major thrust of the intensive production studies in addition to developing applicable survival rate and smolt yield factors should be investigations Into limiting factors of anadromous fish populations. Results of the applied research could help guide future habitat enhancement projects and the general project evaluations.

Evaluation of streamwide improvement. Detection of subtle, streamwide effects from sane types of projects, Including sediment reduction from nonpoint sources, will be difficult without the development and application of habitat model s. In the Idaho batholith, deposition of granitic sand is widely recognized as a major factor that potentially limits salmonid populations (Platts and Megahan 1975; Bjornn, et al. 1977; Konopacky 1984). Fish response curves to fine sediments in spawning and rearing areas are being developed and refined for the South Fork Salmon River (Stowell et al. 1983). Draw backs to general use of the present sediment model for BPA project evaluations include the model's reliance on laboratory experiments to simulate natural conditions and the need to calibrate the model to local conditions.

An alternative approach to extrapolating benefits from the sediment model is to develop empirical sediment fish population relationships for project streams and statistically interpolate mean responses based on measured habitat change for specific projects. Fish density and aquatic habitat data collected in the 1985 problem-identification inventory of the upper Salmon/Middle Fork Salmon River tributary show promise in this regard.

In 1985, deposition of large and fine sediment (0.8-5.0 mm and < 0.8 mm, respectively) at a given gradient was clearly worse in the Bear Valley Creek/Elk Creek drainage than in the Marsh Creek, Valley Creek, and upper Salmon River drainages (Fig. 33). Comparable unpublished data for substrate embeddedness and sediment deposition summarized within depth and velocity criteria indicate the same general patter (C. Hunter, OEA Research Incorporated, Helena, Montana, personal communication).

Densities of age 0 chinook in these aquatic sections were inversely related to deposition of sand (Fig. 34) even at the low seeding levels of 1985. Based on maximum densities observed in 1985, the critical sediment deposition level appears to be in the range of 35-40%; based on 1985 median densities, any increase in sediment above natural levels appears to be critical. Rainbow-steel head parr densities were also inversely related to sediment deposition (unpublished data). Similar empirical relationships were arrived at independently by Thurow and Burns (1986) for the South Fork Salmon River drainage.

The precision of the relationship in Fig. 34 potentially could be increased in several ways. The aquatic habitat data set was constructed in a manner that allows for development of surrogate variables, some of which may define more precisely the degree of sediment deposition (e. g., percent large + fine sediment, partitioned within specific ranges of depth and velocity). Covariats, such as stream gradient or width, could also be used in model development to account for some of the variation. However, we believe that lack of precision was largely the result of low seeding - much of the high-quality habitat in small tributaries was virtually unoccupied in 1985. Development of the model at full seeding conditions would better define the true shape and slope of the relationship.

Annual monitoring of densities through a period of increasing seeding levels may provide another means to separate streamwide effects, including those from sediment reduction. Consistent, long-term trend data is lacking for most BPA project streams but will be accumulated through IDFG evaluation/monitoring (Appendix A). Some density trend data currently are available for wild spring chinook in Marsh Creek, Elk Creek (Table 62 and 58), and similar streams except for the degree of sediment deposition (Fig. 35).

Chinook densities in 1985 in Marsh Creek and Elk Creek were inversely related to deposition of granitic sand (Fig. 36). Although the combined relationship showed low densities in sections with high sediment deposition (primarily Elk Creek), and higher densities in sections with less sediment (primarily Marsh Creek), the relationships within each of the streams was weak. This might imply sediment effects occur primarily streamwide or may be an artifact of low seeding. Compared to mean redd counts in the 1960s, Marsh Creek and Elk Creek spawning escapement for the brood year (1984) were 13% and 6% of predam levels, respectively (Tables 62 and 58).

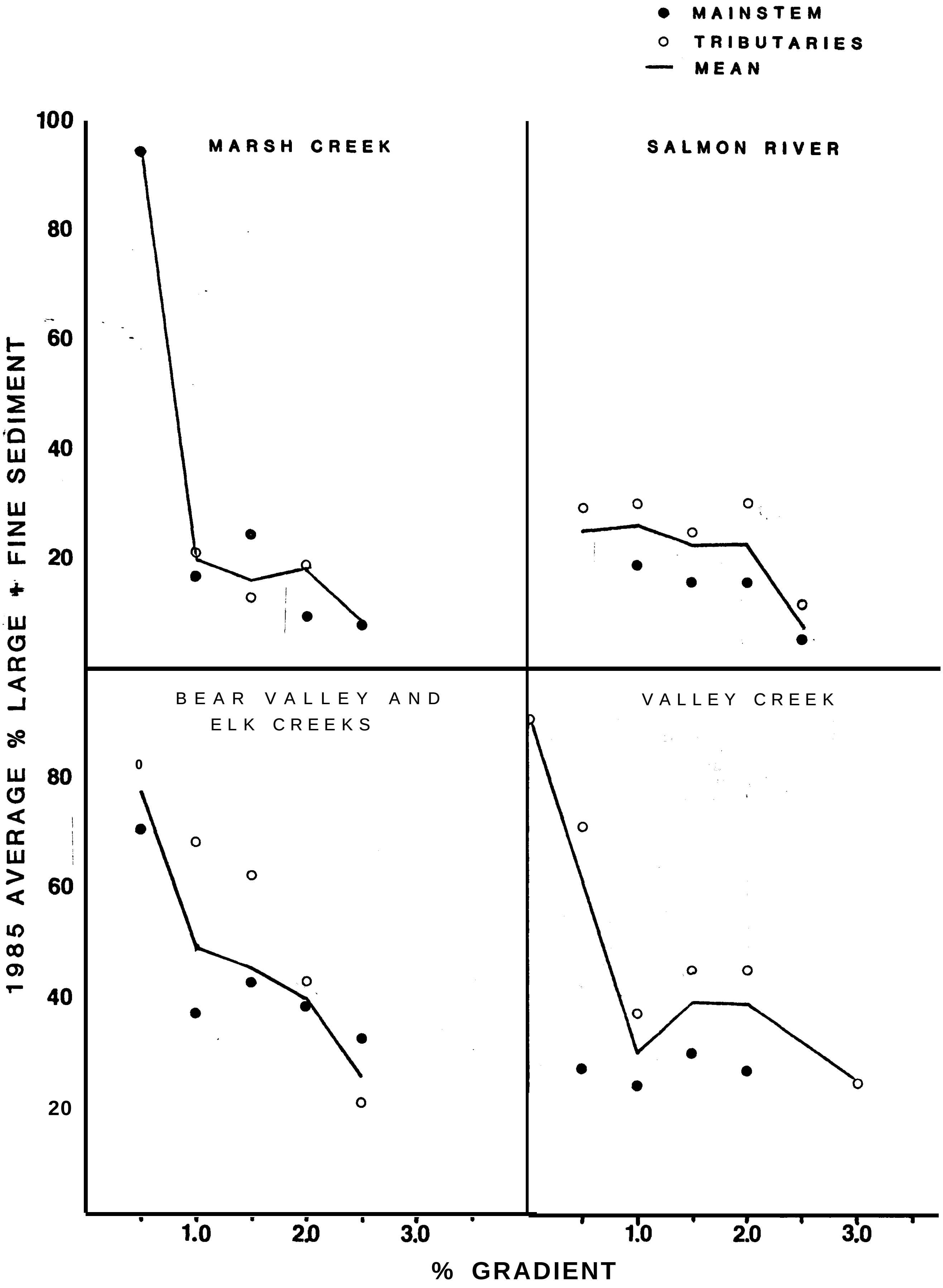

Figure 33. Relationship of sediment deposition and stream gradient in Marsh Creek, Bear Valley/Elk Creek, upper Salmon River, and Valley Creek drainages, July-August, -1985.

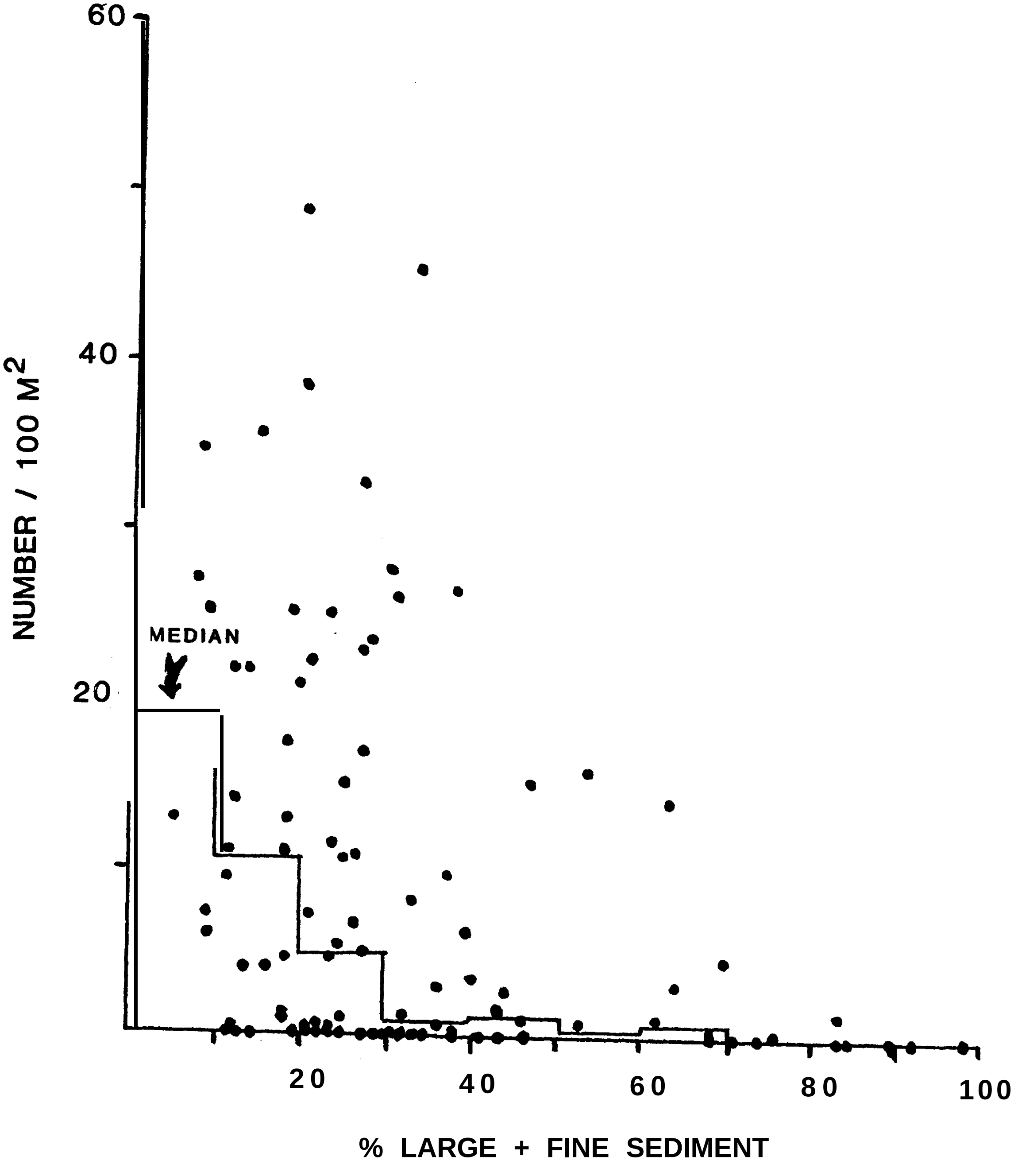

Figure 34. Relationship of juvenile chinook density to sediment deposition in a stream section in Marsh Creek, Bear Valley/ Elk Creek, upper Salmon River, and Valley Creek drainages July-August, 1985. All areas were underseeded in 1985.

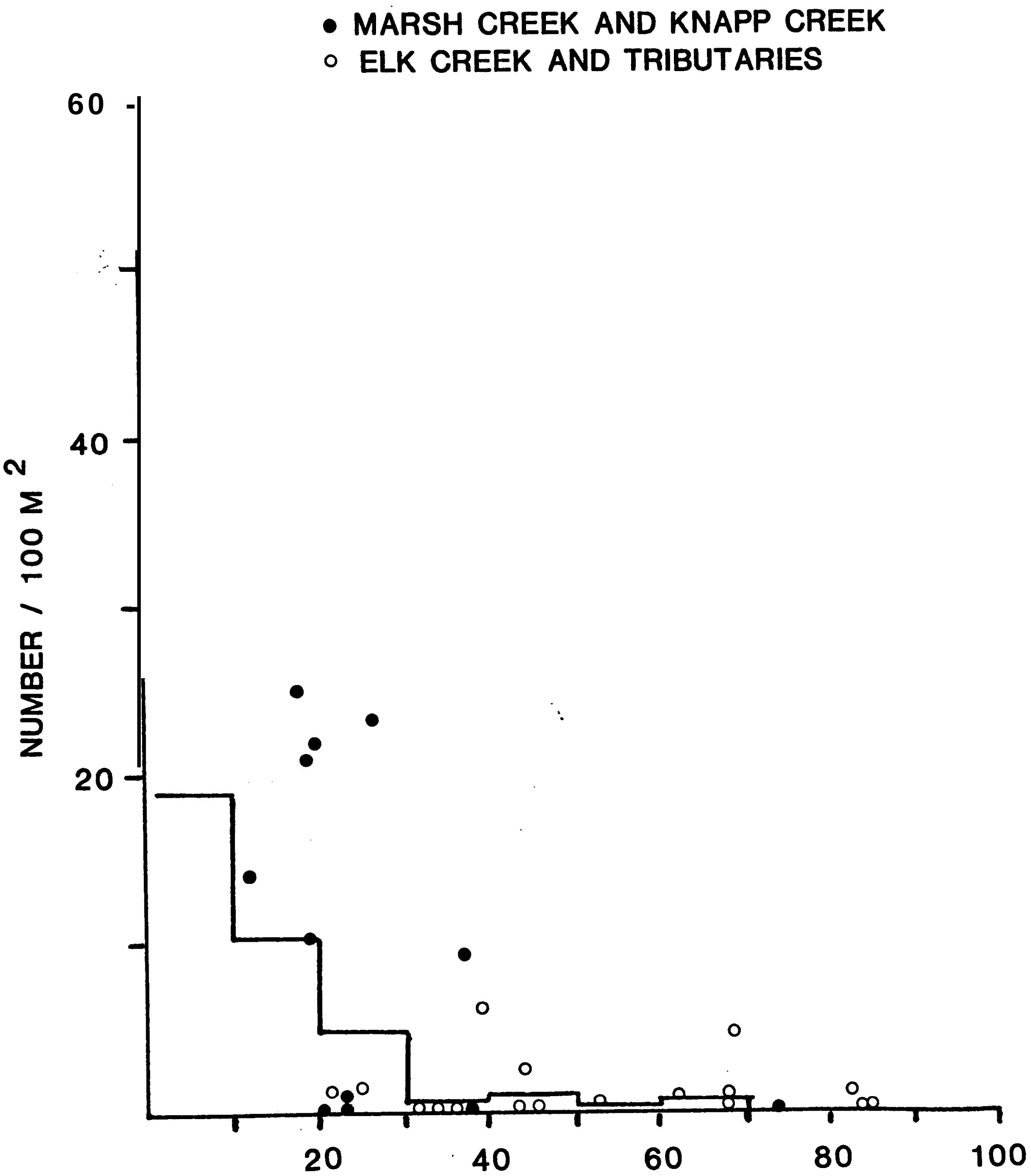

Figure 35. Relationship of juvenile chinook density to sediment deposition in Marsh and Knapp creeks and Elk Creek drainage, July-August, 1985. The median for all streams inventoried is represented by a solid line.

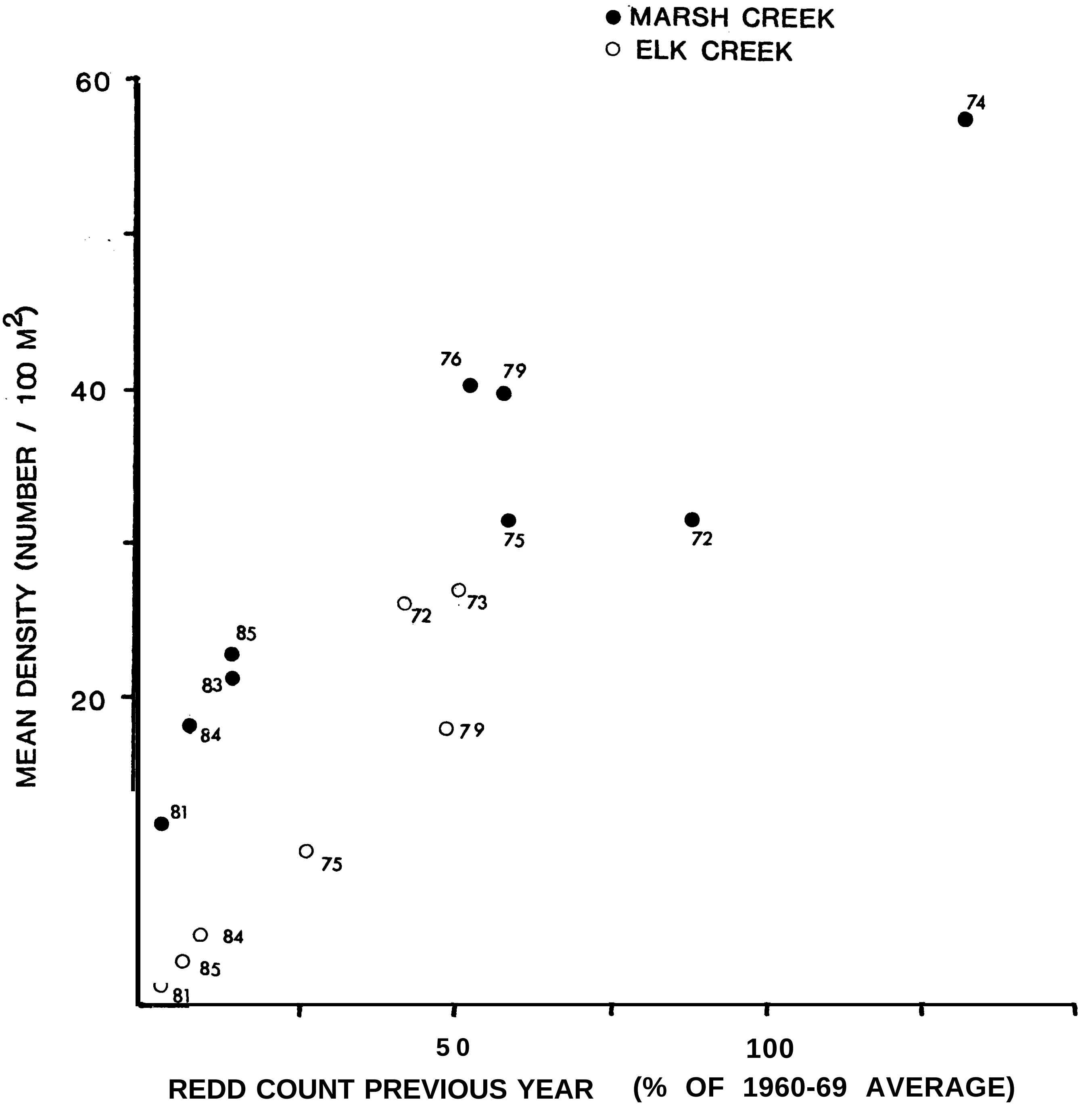

Figure 36. Relationship of juvenile chinook density to the previous year's redd count in Marsh Creek and Elk Creek. Redd counts are standardized as a percent of the pre-dam (1960-69) average.

During the period 1972-1985, chinook densities in both streams were directly related to the respective redd count the previous year (Fig. 36). However, Elk Creek appears to produce juvenile chinook less efficiently for a given standardized redd count. Data for Bear Valley Creek (Table 54), which contains a similar amount of deposited sand as Elk Creek, plot along a line similar to the Elk Creek data (Fig. 37).

Hypothetically, a family of reproduction-efficiency curves could be derived for chinook production streams in the batholith based on consistent, long-term juvenile density monitoring data and redd counts. Information contained in Fig. 33-37 further suggests that the curves may be separable based on estimated sediment deposition. More sophisticated modeling efforts will be required as chinook and steelhead populations rebuild to define streamwide benefits from sediment-reduction projects.

Intensive Studies

The IDFG will initiate two intensive studies in the upper Salmon River and Crooked River beginning in 1986, Other agencies and tribes will also initiate these long-term studies within Idaho and the rest of the Columbia basin. Basic biological information that is needed for evaluation of the Fish and Wildlife program will be gathered in a number of areas, including productivity of stocks in different habitats, spawning escapements required to fully seed the habitat, survival rates through life stages, parr-smolt relationships, and the success and best means of supplementation.

Intensive studies of survival, production, and yield in a few streams should al so provide further insight into the questions of whether spawning or rearing habitat is limiting, as well as define the relative importance of summer and winter rearing habitat. Currently in Idaho, general evaluations have focused on summer low-flew conditions. Conditions during summer are important but may or may not be the factors that limit anadromous fish populations. In the Lemhi River system, Idaho, the amount of suitable winter habitat influenced the migration of juvenile steel head from upstream areas (Bjornn 1978). However, these migrants found suitable winter habitat elsewhere in the Lemhi River where they remained an additional year before migrating seaward as smolts. Juvenile chinook in high-elevation streams in Idaho typically migrate from summer rearing areas and winter downstream before emigrating as smolts. The relative importance of summer and winter carrying capacity may ultimately be determined by seasonal estimates of survival rates which should be possible at most intensive study locations.

Development of a Mitigation Record

No final determination of mitigation credit for any Idaho habitat enhancement project has been attainable to date. It was not possible

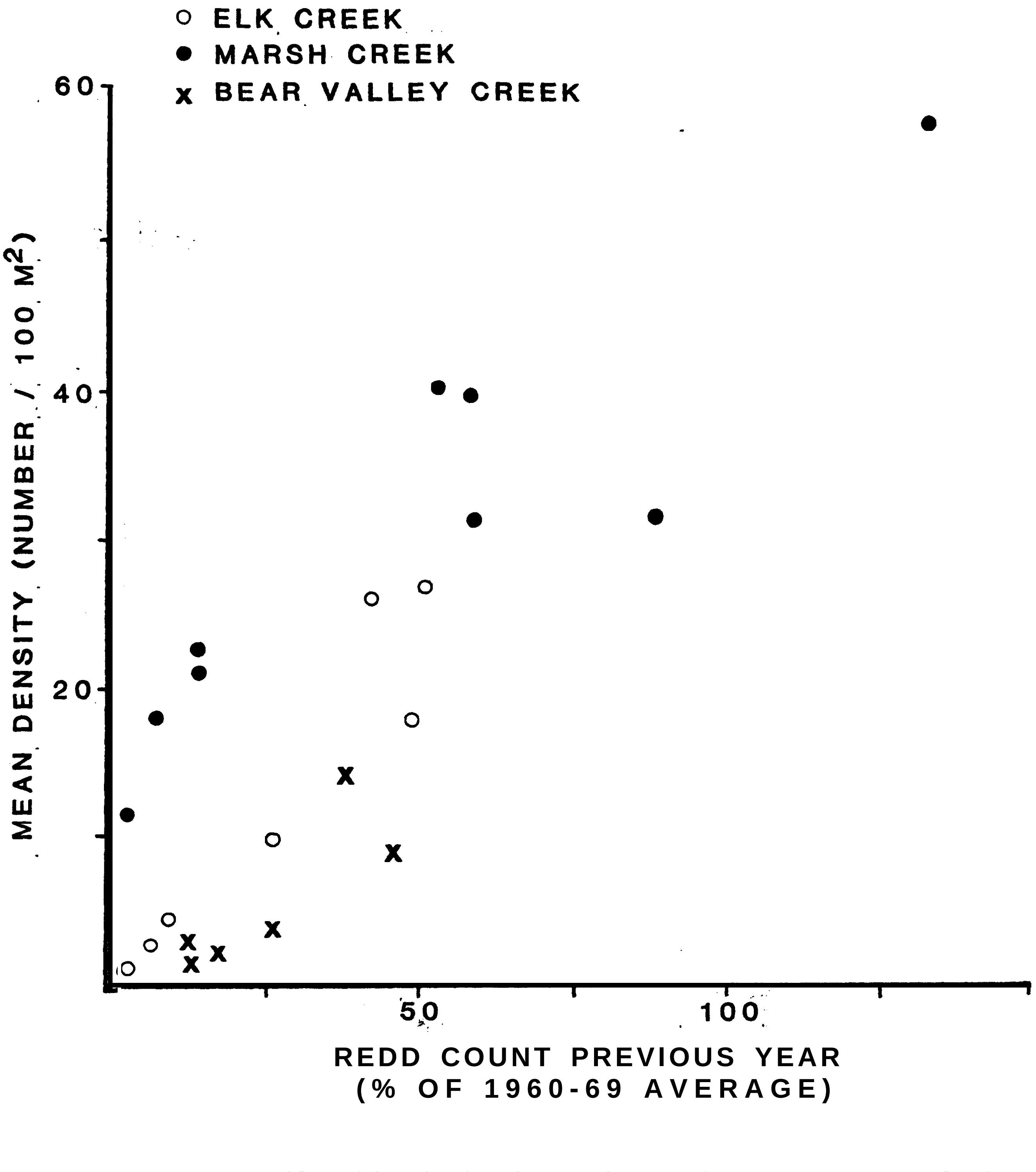

Figure 37. Juvenile chinook density and spawning escapement relationships for three Idaho batholith streams, 1972-85.

to observe full-seeding conditions at any of the projects in 1985, and definition of full seeding for the various types of habitat has not been made. In addition, a mitigation record based on increased smelt yield cannot be developed until the intensive studies define appropriate conversion rates to transform measured and estimated parr responses to estimated smolt production increases.

After these two major questions are answered for the appropr habitat and fish populations, this evaluation project will move from the pretreatment and monitoring phases to the post-treatment phase to document the full mitigation value of each habitat project.

Conclusions

Definition of suspected, limiting factors should be part of every project proposal. Determination of which habitat factors are limiting smolt production will be another product of the intensive evaluation studies. This knowledge can be used to increase the effectiveness of future habitat enhancement projects.

Intended benefits will not be realized if a habitat enhancement project is aimed at improving a habitat character that is not limiting product1 on capacity of the affected stream.

The evaluation work should be accomplished in the most cost-effective manner and should generally be accomplished in a standard manner irrespective of where the enhancement project is located.

The BPA should direct all project sponsors to submit proposals that display projected benefits (increased smolt/adult production) In a standard manner and should direct project evaluators to display estimated benefits (smolts/adults) in a standard format.

Whenever possible, controls should be established to complement the pretreatment and posttreament data collection.

The primary measurement for effectiveness of habitat enhancement measures should be increased smolt production.

A data collection system that would assimilate physical habitat data, juvenile density data, and spawning escapement data from all sources (fish and wildlife agencies, tribes, land management agencies, and private entities) Into a common data base should be implemented for the entire Columbia River basin. This data base would better serve fisheries managers, land managers, and planners than the presently-uncoordinated, fragmented data collection process.

On some projects, a disproportionate amount of funding is being dedicated to preliminary investigations with implementation of the habitat project being unduly delayed.

Parr production at full-seeding levels should be documented for some typical Idaho anadromous fish habitats at the earliest opportunity.

The smolt and adult production estimates at full seeding will be used to measure the effectiveness of many measures of the Fish and Wildlife program. Some examples are listed below:

Enhancement of natural production habitat
Supplementation of natural production
Changes in harvest management
Determining optimum spawning escapement goals
Determining subbasin production goals

Annual evaluation reports should be written for each state, and those reports should contain the Information needed to guide the future direction of habitat enhancement implemented under the Fish and Wildlife program.

Annual evaluation reports should display the project expenditures in the following format to Illustrate the relative cost of evaluation in relation to implementation cost and preliminary/feasibility cost:

IDAHO ANADROMOUS FISH HABITAT ENHANCEMENT SUMMARY
POLE CREEK PROJECT

Year	Preliminary/ Feasibility activity amount	Implementation amount	Evaluation amount	Total amount
1983	$0	$12,000	$ 0	$12,000
1984	0	0	600	600
1985	0	0	300	300
Cumulative to date	$0	$12,000	$900	$12,900

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Richard L. Granstrand, Fishery Research Biologist and Bruce C. Roberts provided enthusiastic field support during 1985.

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Corinne Barlow, Bonnie Mulligan, and Irma Johnson assisted in typing the report.

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Appendices

Appendix A

Table A-1. Annual trends in density (numbers 100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Lolo Creek. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Treatment[a]	Section	83	84	85	86	87	88
Rainbow-steelhead								
Age > 1	IS	8303	/	4.4	3.6			
	C	RUN 1U		3.9	2.5			
	C	RUN 7U		-	6.9			
	IS	8360		5.4	6.3			
	IS	DS 6		- /	1.0			
	C	RUN 6D		2.5	0.4			
		Mean		4.0	3.4			
Chinook								
Age 0	IS	8303	/	6.3	25.2			
	C	RUN 1U		0	7.1			
	C	RUN 7U		-	0.2			
	IS	8360	/	0.9	0.6			
	IS	DS 6		- /	0.7			
	C	RUN 6D		0				
		Mean		1.8	5.6			

[a] IS = Instream structure; C = control.

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Table A-2. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Eldorado Creek. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); elevation years are indicated by shading.

Species, Age	Location[a]	Section	83	84	85	86	87	88
Rainbow-steelhead								
age $\geq$ 1	AU	2M	-	- /	0			
	AL	1HG	-	0 /	0			
	AL	2LG	-	0 /	0			
	B	1B	-	5.1	5.3			
		Mean		1.7	1.3			
Chinook								
age 0	AU	2M	-	- /	0			
	AL	1HG	-	0 /	0			
	AL	2LG	-	0 /	0			
	B	1B	-	0	0			
		Mean		0	0			

[a] AU = Above barriers, upper meadow; AL = above barriers, lower meadow; B = below barriers.

Table A-3. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Crooked Fork Creek. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); elevation years are indicated by shading.

Species, Age	Location[a]	Section	83	84	85	86	87	88
Rainbow-steelhead								
age ≥ 1	A	1A	-	0	0 /			
	A	2A	-	0.1	0 /			
	A	3A	-	0	0 /			
	A	4A	-	0	0 /			
	B	1B	5.3	5.3	0.8			
	B	2B	4.8	5.0	1.8			
		Mean	1.7[b]	1.7	0.4			
Chinook								
age 0	A	1A	-	0	0 /			
	A	2A	-	0	0 /			
	A	3A	-	0	0 /			
	A	4A	-	0	0 /			
	B	1B	4.3	2.9	0.4			
	B	2B	8.6	3.8	0.5			
		Mean	2.2[b]	1.1	0.2			

[a] A = above barriers; B = below barriers.

[b] Densities above barriers assumed to be zero.

Table A-4. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Crooked Fork Creek. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); elevation years are indicated by shading.

Species, Age	Reach, Treatment[a]	Section	83	84	85	86	87	88
Rainbow-steelhead								
age > 1	I,IS	Sill log A		0.2 /	1.5			
	I,C	Control 1		0.7	0.5			
	II,IS	Treatment 1			1.5 /			
	II,C	Control 1			2.6			
	IV,U	Semi-natural	1.2	3.1				
	IV,U	Meander 1			0.4			
	IV,U	Meander 2	0.2	0.7	0.1			
		Mean	0.7	1.2	1.1			
Chinook								
age 0	I,IS	Sill log A		0 /	31.9			
	I,C	Control 1		0	9.7			
	II,IS	Treatment 1			52.4 /			
	II,C	Control 1			90.2			
	IV,U	Semi-natural	19.5	32.2				
	IV,U	Meander 1			91.9			
	IV,U	Meander 2	4.2	3.8	40.7			
		Mean	11.8	9.0	52.8			

[a] Roman numerals = reach; IS = instream structure; C = control; U = undetermined treatment.

Table A-5. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Red River. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); elevation years are indicated by shading.

Species, Age	Reach, Treatment[a]	Section	83	84	85	86	87	88
Rainbow-steelhead								
age $\geq$ 1	II,IS	Treatment 1		– /	2.3			
	II,C	Control 1		–	1.1			
	IV,C	Control 1		1.9	0.3			
	IV,IS	Treatment 1		2.2	0.4			
	IV,C	Control 2	3.9	2.7	1.1			
	IV,IS	Treatment 2	1.8	1.6 /	0.8			
	V,C	Control 2		–	0.4			
	V,BSR	Treatment 2		– /	0.5			
		Mean	2.8	2.1	0.9			
Chinook								
age 0	II,IS	Treatment 1		– /	75.4			
	II,C	Control 1		–	39.9			
	IV,C	Control 1		16.9	63.1			
	IV,IS	Treatment 1		35.7	99.3			
	IV,C	Control 2	11.7	9.8	77.8			
	IV,IS	Treatment 2	15.1	17.0 /	60.2			
	V,C	Control 2	–	–	7.2			
	V,BSR	Treatment 2	–	– /	8.0			
		Mean	13.4	19.8	53.9			

[a] IS = instream structure; C = control; BSR = bank stabilization, riparian revegetation.

Table A-6. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Panther Creek. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Location[a]	Section	83	84[b]	85[b]	86	87	88
Rainbow-steelhead								
age ≥ 1	A	MD1	-	4.3	8.4			
	A	PC9	-	7.1	-			
	B1, A2	PC6	-	1.1	1.0			
	B1, B2	PC4	-	0	+			
	B1, B2	PC1	-	1.0	0.7			
		Mean	-	2.7	2.0			
Chinook								
age 0	A	MD1	-	0	0			
	A	PC9	-	0	-			
	B1, A2	PC6	-	+	0			
	B1, B2	PC4	-	0	0			
	B1, B2	PC1	-	0	0			
		Mean	-	+	0			

[a] A = above mine effluent; B1 = below Blackbird Creek; A2 = above Big Deer Creek; B2 = below Big Deer Creek.

[b] Engineering feasibility, habitat assessment only.

Table A-7 Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Lemhi River. Sections are arranged sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Location[a]	Section	83	84	85[b]	86	87	88
Rainbow-steelhead								
age ≥ 1	Big Springs Cr.	LEM-1A	-	-	44.8			
	Lemhi R.	LEM-2B	-	-	20.0			
	Lemhi R.	LEM-3A	-	-	15.9			
	Bear Valley Cr.	HC-1B	-	-	1.0			
	Hayden Cr.	HC-2B	-	-	0			
	Hayden Cr.	HC-3B	-	-	0.5			
		Mean	-	-	13.7			
Chinook								
age 0	Big Springs Cr.	LEM-1A	-	-	0.5			
	Lemhi R.	LEM-2B	-	-	1.4			
	Lemhi R.	LEM-3A	-	-	1.7			
	Bear Valley Cr.	HC-1B	-	-	0			
	Hayden Cr.	HC-2B	-	-	14.4			
	Hayden Cr.	HC-3B	-	-	7.3			
		Mean	-	-	4.2			

[a] All sections located above dewatered area.

[b] Engineering feasibility, habitat assessment only.

Table A-8. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, East Fork Salmon River. Sections are arranged sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Location[a]	Section	83	84	85[b]	86	87	88
Rainbow-steelhead								
age $\geq$ 1	AW	2	-	-	0.2			
	AW	3	-	-	0			
	BW	5	-	-	1.2			
	BW	8	-	-	6.2			
		Mean	-	-	1.9			
Chinook								
age 0	AW	2	-	-	0			
	AW	3	-	-	0			
	BW	5	-	-	6.0			
	BW	8	-	-	21.0			
		Mean	-	-	5.2			

[a] AW = above East Fork weir; BW = below weir.

[b] Pre-treatment evaluations by Shoshone-Bannock Tribe.

Table A-9. Annual trends in density (number/100m²) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, upper Salmon River. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Location[a]	Section[b]	83	84	85	86	87	88
Rainbow-steelhead								
age > 1	AD	10A	-	0	5.1			
	AD	9A	-	0.2	3.9			
	AD	8B	-	0	0.6			
	AD	8A	-	1.9	0.4			
	BD	7B	-	0.2	0.9			
	BD	7A	-	1.4	1.2			
	BD	6A	-	-	0.1			
	BW	3BRA	-	-	8.2			
	BW	2B	-	-	2.0			
		Mean	-	0.6	2.5			
Chinook								
age 0	AD	10A	-	28.1	7.1			
	AD	9A	-	53.2	12.8			
	AD	8B	-	12.9	1.2			
	AD	8A	-	97.4	1.4			
	BD	7B	-	94.7	10.6			
	BD	7A	-	41.2	17.4			
	BD	6A	-	-	0			
	BW	3BRA	-	-	32.2			
	BW	2B	-	-	2.2			
		Mean	-	54.6	9.4			

---

[a] AD = Above irrigation diversion; BD = below diversion; BW = below Sawtooth Hatchery weir.

[b] Sections 10A, 9A, 8B, 8A, and 7A were initially numbered in 1984 as 1, 2, 3, 4, 5, and 6, respectively.

Table A-10. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Alturas Lake Creek. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Location[a]	Section	83	84	85	86	87	88
Rainbow-steelhead								
age ≥ 1	A, L	1A	-	0	0.1			
	A, L	2A	-	0	0			
	A	2	-	0.5	-			
	B	3	-	0.5	0.8			
		Mean	-	0.2	0.3			
Chinook								
age 0	A, L	1A	-	0.1	0			
	A, L	2A	-	1.2	0			
	A	2	-	6.8	-			
	B	3	-	81.9	12.5			
		Mean	-	22.5	4.2			

[a] A = above irrigation diversion; B = below diversion; L = above Alturas Lake.

Table A-11. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Pole Creek. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Location[a]	Section[b]	83	84	85[c]	86	87	88
Rainbow-steelhead								
age ≥ 1	A	3B	-	/ 0	0			
	A	3A	-	/ 0	0			
	B	2B	-	0	0			
	B	2A	-	0.8	3.2			
		Mean	-	0.2	0.8			
Chinook								
age 0	A	3B	-	/ 0	0			
	A	3A	-	/ 0	0			
	B	2B	-	45.2	0			
	B	2A	-	15.5	0			
		Mean	-	15.2	0			

[a] A = above irrigation diversion screen; B = below irrigation diversion screen.

[b] Sections 3B, 3A, 2B, and 2A were initially numbered in 1984 as 1, 2, 3, and 4, respectively.

[c] Habitat inventory and problem identification; not an evaluation of BPA screening project.

Table A-12. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Valley Creek. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Location[a]	Section	83	84	85[a]	86	87	88
Rainbow-steelhead								
age ≥ 1	-	7A	-	-	0			
	-	3B	-	-	2.6			
	-	3A	-	-	3.5			
	-	1B	-	-	1.2			
		Mean	-	-	1.8			
Chinook								
age 0	-	7A	-	-	27.8			
	-	3B	-	-	38.6			
	-	3A	-	-	45.5			
	-	1B	-	-	15.1			
		Mean	-	-	31.8			

[a] Habitat inventory and problem identification.

Table A-13. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Bear Valley Creek. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Location[a]	Section[b]	83	84[c]	85[c,d]	86	87	88
Rainbow-steelhead								
age $\geq$ 1	AM	9B	-	0	0			
	BM	5A	-	0	0 /			
	BM	3A	-	0.2	0 /			
	BE	2A	-	+	0.1 /			
	BE	2B	-	+	0 /			
	BE	1A	-	1.1	0 /			
		Mean	-	0.2	+			
Chinook								
age 0	AM	9B	-	5.9	0			
	BM	5A	-	5.4	0.2 /			
	BM	3A	-	2.0	1.0 /			
	BE	2A	-	4.7	1.9 /			
	BE	2B	-	1.3	0 /			
	BE	1A	-	3.2	0.2 /			
		Mean		3.8	0.6			

[a] AM = above mining area; BM = below mining area; BE = below mining area and Elk Creek.

[b] Sections 2A and 2B were initially numbered by IDFG in 1984 as sections 4 and 5; all other sections established by Shoshone-Bannock Tribe.

[c] Pre-treatment evaluations by Shoshone-Bannock Tribes.

[d] Habitat inventory and problem identification.

Table A-14. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Elk Creek. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Location[a]	Section[b]	83	84	85[c]	86	87	88
Rainbow-steelhead								
age ≥ 1	A	2A	-	0	0			
	A	2B	-	-	1.1			
	B	1A	-	-	0.4			
	B	1B	-	+	1.4			
		Mean	-	+	0.7			
Chinook								
age 0	A	2A	-	0.5	0.5			
	A	2B	-	-	6.1			
	B	1A	-	-	2.8			
	B	1B	-	7.7	1.0			
		Mean	-	4.1	2.6			

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[a] A = above Bearskin Creek confluence; B = below Bearskin Creek.

[b] Sections 2A and 1B were initially numbered in 1984 as 1 and 2, respectively.

[c] Habitat inventory and problem identification.

Table A-15. Annual trends in density (number/100m²) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Marsh Creek drainage. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Location, habitat[a]	Section[b]	83	84	85[c]	86	87	88
Rainbow-steelhead								
age ≥ 1	KN,M	2A	-	-	0.1			
	KN,M	1A	0.2	-	1.0			
	MA,M	6A	0.4	-	0			
	MA,M	5A	-	-	0.4			
	MA,M	4B	1.3	1.0	1.3			
	CH,M	2B	-	-	0.2			
	CH,M	1A	-	-	0			
	BV,M	3B	-	-	1.2			
	BV,M	1A	-	-	1.4			
	MA,C	1B	-	-	1.5			
	MA,C	1A	-	-	1.7			
		Mean	0.6	1.0	0.8			
Chinook								
age 0	KN,M	2A	-		0.1			
	KN,M	1A	16.9		23.6			
	MA,M	6A	25.9		9.7			
	MA,M	5A	-		35.7			
	MA,M	4B	21.6	17.8	22.2			
	CH,M	2B	-		48.0			
	CH,M	1A	-		25.0			
	BV,M	3B	-		10.8			
	BV,M	1A	-		12.9			
	MA,C	1B	-		10.6			
	MA,C	1A	-		5.4			
		Mean	21.5	17.8	18.7			

[a] Locations: KN = Knapp Creek; MA = Marsh Creek; CH = Capehorn Creek; BV = Beaver Creek—Habitat: M = Meadow; C = Canyon.

[b] Section 4B, Marsh Creek was initially numbered in 1984 as 1.

[c] Habitat inventory and problem identification.

Table A-16. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Sulphur Creek. (Sulphur Creek is being monitored as a pristine control stream to help evaluate projects implemented in tributaries of the Middle Fork and upper Salmon Rivers.)

Species, Age	Section	83	84	85	86	87	88
Rainbow-steelhead							
age $\geq$ 1	1	-	0	1.0			
	2	-	-	0			
	Mean		0	0.5			
Chinook							
age 0	1	-	9.2	18.1			
	2	-	-	0.1			
	Mean	-	9.2	9.1			

Table A-17. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Camas Creek and Loon Creek (control stream). Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Location, habitat[a]	Section	83	84	85	86	87	88
Rainbow-steelhead	C,DM	1	0.4	0.8	1.9			
age ≥ 1	C,DM	2	-	2.5	1.0			
	C,C	CAM-1	-	-	16.8			
	L,PM	1	-	-	1.7			
	L,PM	2	-	-	1.4			
	L,C	LNM-1	-	-	0.2			
		Mean	0.4	1.6	3.8			
Chinook								
age 0	C,DM	1	2.5	0.8	3.0			
	C,DM	2	-	1.3	3.6			
	C,C	CAM-1	-	-	2.1			
	L,PM	1	-	-	3.3			
	L,PM	2	-	-	3.3			
	L,C	LNM-1	-	-	1.7			
		Mean	2.5	1.0	2.8			

[a] Stream: C = Camas Creek, L = Loon Creek—habitat: DM = degraded meadow; C = Canyon; PM = pristine meadow.

Table A-18. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, South Fork Salmon River. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Stream	Section	83	84	85	86	87	88
Rainbow-steelhead age ≥ 1	South Fork	Stolle-1	-	0.2	1.1			
	South Fork	Stolle-2	-	-	0			
	Dollar Creak	1						
	Six Bit Creek	1						
		Mean	-	0.2	0.6			
Chinook age 0	South Fork	Stolle-1	-	14.6	75.0			
	South Fork	Stolle-2	-	-	7.5			
	Dollar Creak	1						
	Six Bit Creek	1						
		Mean	-	14.6	41.2			

Table A-19. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Johnson Creek and tributaries. Sections are listed sequentially, upstream to downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Stream habitat[a]	Section	83	84[b]	85[c]	86	87	88
Rainbow-steelhead								
age ≥ 1	J,MA	M1		0.6 /	0			
	J,MA	M2		0.2 /	0			
	J,MA	M3		0.8 /	0			
	S,MA	M2		0 /	0			
	R,MA	M1		0 /	0			
	J,CA	PW1A		0.5 /	0.2			
	J,CA	PW3A		8.1 /	-			
	J,CB	PW3B		3.1	-			
		Mean		1.7	+			
Chinook								
age 0	J,MA	M1		0 /	2.8			
	J,MA	M2		0 /	0.3			
	J,MA	M3		0 /	1.6			
	S,MA	M2		0 /	8.0			
	R,MA	M1		0 /	4.0			
	J,CA	PW1A		0 /	0.8			
	J,CA	PW3A		0 /	-			
	J,CB	PW3B		0	-			
		Mean		0	2.8			

---

[a] Stream J = Johnson Creek; S = Sand Creek; R = Rock Creek—habitat: MA = meadow above barriers; CA = canyon above barriers; CB = canyon below barriers.

[b] Pre-treatment survey.

[c] Success of chinook introductions evaluated through subcontract.

Table A-20. Annual trends in density (number/100m^2) of yearling-and-older rainbow-steelhead and age 0 chinook in established monitoring sections, Boulder Creek and Little Salmon River. Sections are listed sequentially, upstream and downstream. Time of implementation is indicated by a slash (/); evaluation years are indicated by shading.

Species, Age	Stream	Location[a]	Section	83	84	85	86	87	88
Rainbow-steelhead									
age ≥ 1	Boulder Cr.	A	1	-	6.3	3.7 /			
	Boulder Cr.	A	2	-	2.7	7.5 /			
	Boulder Cr.	B	3	-	8.1	13.3			
	Boulder Cr.	B	5	-	4.9	16.8			
	Little Salmon R.	B	1	-		13.2			
	Little Salmon R.	B	2	-		10.1			
			Mean	-	5.5	10.8			
Chinook									
age 0	Boulder Cr.	A	1	-	0	0.4 /			
	Boulder Cr.	A	2	-	0	0 /			
	Boulder Cr.	B	3	-	2.5	3.9			
	Boulder Cr.	B	5	-	1.8	4.2			
	Little Salmon R.	B	1	-	-	0.1			
	Little Salmon R.	B	2	-	-	1.3			
			Mean	-	1.1	1.7			

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[a] A = above Boulder Creek barrier; B = below barriers.

Appendix B

Table B-1. Number of adult chinook observed in established BPA monitoring sections, by subbasin, 1984-1985. Counts above barriers [denoted by *] are excluded from subbasin means. [Adult counts made before July 25 may not be representative.]

Subbasin	Stream	Section	Year 84	85	86	87	88	89
CL-3	Lolo Creek	8303	0	2				
		Run 1U	0	0				
		Run 7U		0				
		8360	0	0				
		DS6		1				
		Run 6D	0	0				
	[Sample period]		[7/10-13]	[9/3-5]				
	Eldorado Creek	2M		0*				
		1HG	0*	0*				
		2LG	0*	0*				
		IB	0	0				
	[Sample period]		[7/9-13]	[7/31-8/4]				
	Subbasin Mean		0	0.4				
CL-4	Crooked River	I Sill log A	0	0				
		I Control 1	0	0				
		II Treatment 1		0				
		II Control 1		0				
		IV Seminatural	0					
		IV Meander 1		0				
		IV Meander 2	0	0				
	[Sample period]		[7/16-19]	[7/15-19]				
	Red River	II Treatment 1		0				
		II Control 1		0				
		IV Control 1	0	0				
		IV Treatment 1	3	2				
		IV Control 2	0	0				
		IV Treatment 2	1	1				
		V Control 2	-	0				
		V Treatment 2	-	0				
	[Sample period]		[7/18-8/7]	[7/16-18]				
	Subbasin mean		0.5	0.2				

Table B-1. Continued.

			Year					
Subbasin	Stream	Section	84	85	86	87	88	89
CL-6	Crooked Fork Creek	1A	0*	0*				
		2A	0*	0*				
		3A	0*	0*				
		4A	0*	0*				
		1B	0	2				
		2B	0	0				
	(Sample period)		(8/8-9)	(7/9)				
	Subbasin mean		0	1.0				
SA-1	Boulder Creek	1	0*	0*				
		2	0*	0*				
		3	0	1				
		5	0	0				
	(Sample period)		(8/28)	(7/24-25)				
	Little Salmon River	1	-	0				
		2	-	0				
	(Sample period)		-	(7/24)				
	Subbasin mean		-	0.2				
SA-3	South Fork Salmon River	Stolle 1	3	2				
		Stolle 2	-	2				
	(Sample period)		(8/29)	(7/22)				
	Johnson Creek	M1	0*	0*				
		M3	0*	0*				
		PW3A	0*					
		PW3B	0					
	(Sample period)		(7/25-26)	(8/3-10)				
	Rock Creek	M1	0*	0*				
	(Sample period)		(7/26-27)	(8/3-10)				
	Sand Creek	M2	0*	0*				
	(Sample period)		(7/27)	(8/3-10)				
	Subbasin mean		1.5	2.0				

Table B-1. Continued.

			Year					
Subbasin	Stream	Section	84	85	86	87	88	89
SA-5	Bear Valley Cr. Creek	9B	0	0				
		5A	0	0				
		3A	0	0				
		2A	0	0				
		2B	0	0				
		1A	0	0				
	(Sample period)		(7/31)	(7/22-23)				
	Elk Creek	2A	0	0				
		2B	-	0				
		1A	-	0				
		1B	0	1				
	(Sample period)		(8/1)	(8/5-7)				
	Marsh Creek	6A		0				
		5A		0				
		4B	0	2				
		1B	-	0				
		1A	-	1				
	(Sample period)		(8/21)	(8/8-22)				
	Knapp Creek	2A	-	0				
		1A	-	0				
	(Sample period)			(8/12-15)				
	Cape Horn Creek	2B	-	4				
		1A	-	0				
	(Sample period)			(8/7-9)				
	Beaver Creek	3B	-	0				
		1A	-	1				
	(Sample period)			(8/15)				
	Sulphur Creek	1	0	2				
		2	-	2				
	(Sample period)		(7/24)	(7/25)				
	Camas Creek	1	4	1				
		3	0	1				
		CAM1	-	0				
	(Sample period)		(8/16)	(8/28)				

Table B-1 . Continued.

Subbasin	Stream	Section	Year					
			84	85	86	87	88	89
	Loon Creek	1	-	1				
		2	-	3				
		LNM1	-	0				
	[Sample period]			[8/30]				
	Subbasin mean		0.3	0.7				
SA-6	Panther Creek	PC9	0*					
		PC6	0*	0*				
		PC4	0*	0*				
		PC1	0*	0*				
	(Sample period)		[8/15-17]	[8/28]				
	Moyer Creek	M01	0*	0*				
	(Sample period)		[8/16]	[8/28]				
	Subbasin mean		-	-				
SA-7	Lemhi River	LEM-1A	-	0				
		LEM-2B	-	0				
		LEM-3B	-	0				
	(Sample period)			[6/25-26]				
	Hayden Creek	HO-1B	-	0				
		HO-2B	-	0				
		HO-3B	-	0				
	(Sample period)			[6/27]				
	Subbasin mean			0				
SA-9	East Fork Salmon River	2	-	0				
		3	-	0				
		5	-	5				
		8	-	0				
	[Sample period]		-	[8/26-29]				
	Subbasin mean		-	1.2				

Table B-1. Continued.

			Year					
Subbasin	**Stream**	**Section**	**84**	**85**	**86**	**87**	**88**	**89**
SA-11	Upper Salmon River	10A	0	D				
		9A	0	0				
		8B	0	D				
		8A	0	4				
		78	0	0				
		7A	1	0				
		6A	-	0				
		3BRA	-	9				
		2B		1				
	(Sample period)		[8/20-21]	[8/14-22]				
	Alturas Lake Creek	1A	0	0				
		2A	0	0				
		2	D					
		3	1					
	(Sample period)		[8/18-19]	[8/21]				
	Pole Creek	38	0	0				
		3A	0	0				
		28	0	0				
		2A	0	0				
	[Sample period)		[8/18]	[8/13-16]				
	Valley Creek	7A		0				
		3B		1				
		3A		4				
		1B		4				
	(Sample period)			[8/14-30]				
	Subbasin mean		**0.1**	**1.2**				

Appendix C

EVALUATION OF FISH HABITAT ENHANCEMENT PROJECTS IN CROOKED RIVER, RED RIVER, AND BEAR VALLEY CREEK

Progress Report II

to

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Idaho Department of Fish and Game

William S. Platts
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Richard Torquemada

Intermountain Forest and Range Experiment Station
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TABLE OF CONTENTS

ABSTRACT

As part of an ongoing research project to evaluate the response of stream rehabilitation and Bonneville Power Administration (BPA) funded enhancement projects on anadromous and resident salmonids in Central and Northern Idaho, aquatic habitat, riparian condition, and fish populations were evaluated in three Northern and Central Idaho streams. Data was collected and analyzed for the second consecutive year on a total of 12 sites; 8 on Crooked River, 2 on Red River, and 2 on Bear Valley Creek. 1985 was the first year of post-treatment monitoring on the majority of study sites, and represents the first information available to evaluate the effectiveness of these enhancement efforts.

INTRODUCTION

To improve stocks of anadromous fish within the Columbia Basin, and in accordance with the Congressional mandate to protect, mitigate and enhance fish populations impacted by dams and the development of hydroelectric power in the Pacific Northwest (Pacific Northwest Electric Power Planning and Conservation Act of 1980), a number of stream enhancement projects are planned, or are being constructed in the National Forests of Idaho. These activities are supervised by the Idaho Dept. of Fish and Game and funded by the Bonneville Power Administration (BPA), with the overall goal of increasing numbers of anadromous salmonids through stream rehabilitation and enhancement. However, meaningful enhancement efforts must be accompanied by careful description of habitat conditions not only before enhancement activities, but in the years following enhancement activity, so that effective rehabilitation efforts can be documented and unsuccessful ones identified. In an era of diminishing budgets, the management of anadromous fisheries must be cost-effective.

The stream habitat enhancement efforts within the areas of this study fall into four major categories: (1) Instream structures designed to increase cover and or poll-riffle ratio, and thereby increase summer and winter rearing capacity (e.g. k-dams, boulders, and check dams); (2) Instream structures designed to increase stream velocity so that fine sediments are flushed from the substrate (e.g. log deflectors and wing dams); (3) Rerouting of channelized stream systems to provide sinuosity, diverse habitat and approximate pre-development conditions; and (4) Reclamation of streambanks through riparian planting, construction of gabions and stabilization of banks through the use of log and rock materials.

This report covers rehabilitation efforts on three Idaho streams, all historically major producers of anadromous salmonids. Each stream system has suffered from one or more impacts associated with consumptive land uses, and are presently well below their collective carrying capacities. Red River, has been impacted by major inputs of sediment into the stream system. Clearcutting, road construction and grazing are considered the source of fine sediments. Crooked River was drastically altered by gold seekers in the 1950's, who channelized the stream by dredging. Bear Valley Creek has also been altered through extensive dredge mining and grazing activity. Figure 1 depicts the general location of each stream in relation to major Idaho rivers.

STUDY AREA

Red River

Red River is a major tributary of the South Fork Clear-water River (Figure Z), and is located entirely within the Nezperce National Forest. Land use activities including dredging and subsequent channelization, logging, road construction, and livestock grazing have lead to loss of riparian vegetation, streambank destabilization, channel alteration and excessive inputs of fine sediments.

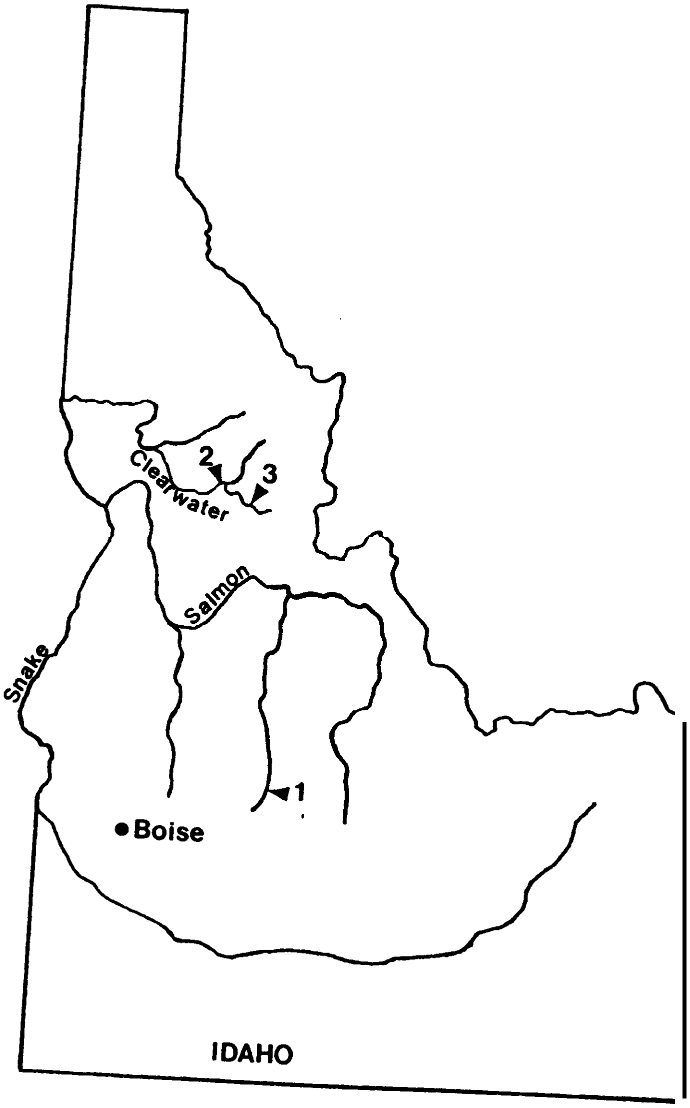

Figure 1. General location of the study streams in relation to the major river systems of Idaho. 1)-Bear Valley Creek, 2)-Crooked River, 3)-Red River.

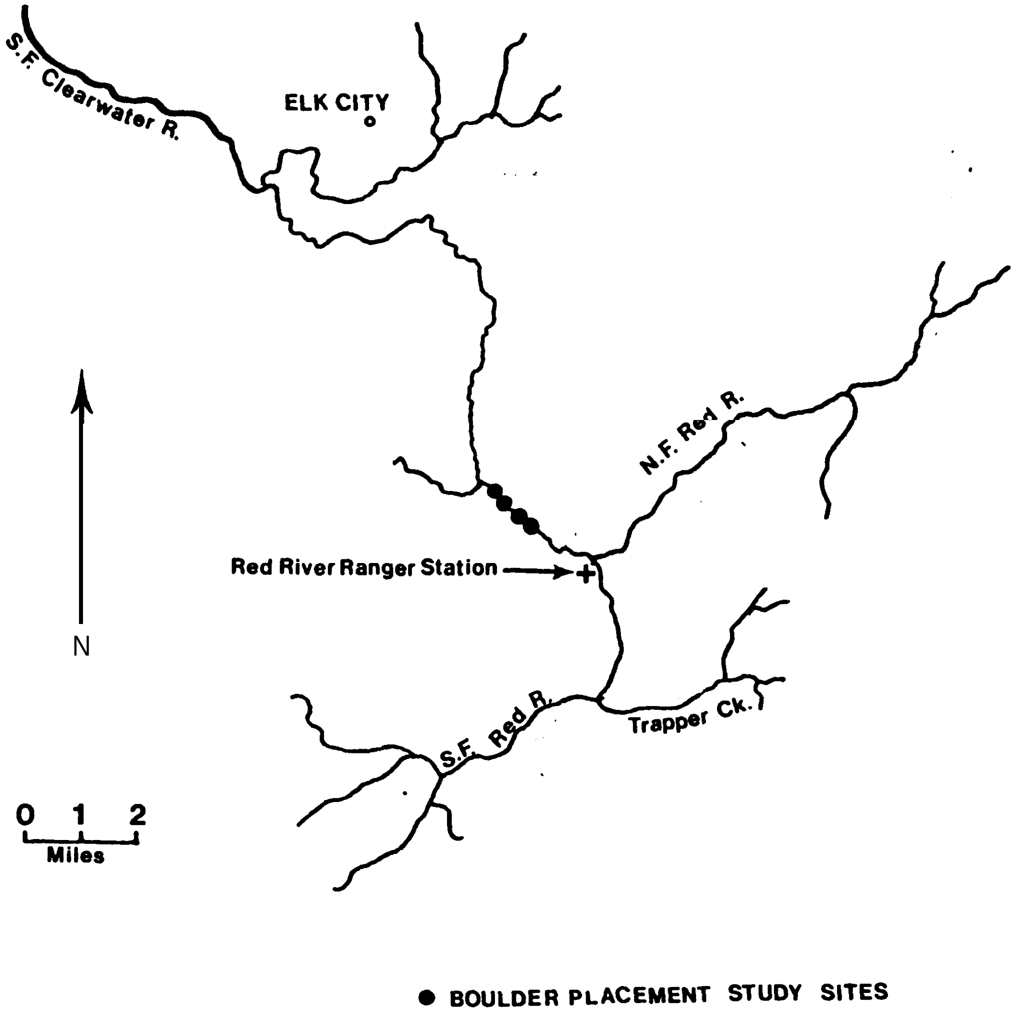

Figure 2. Location of the Red River study sites.

The watershed area covers approximately 36 956 hectares and is heavily timbered primarily by Douglas-fir and lodgepole pine. Climate consists of severe winters, with summers characterized by hot days and cool nights. Precipitation is variable ranging from 63.5 cm below 1500 m to 114 cm above 1820 m. Snowfall represents 85 percent of the precipitation and total runoff. Peak stream discharge occurs during the May snowmelt period.

Red River currently supports runs of summer steelhead trout and spring chinook salmon. Chinook salmon runs into Red River have been among the strongest in the state, aided by a juvenile rearing facility at the Red River Ranger Station, which releases between 40,000 and 350,000 chinook smolt annually (Idaho Fish and Game, 1985).

Crooked River

Crooked River, also located entirely within the Nezperce National Forest, is 27 kilometers long and enters the South Fork Clearwater River at river kilometer 94 (Figure 3). Crooked river presently supports small runs of summer steelhead and spring chinook, which were reestablished upon the removal of Harpster Dam on the South Fork Clearwater River in 1956. Because of its high quality water, potential habitat quality, and location, the Idaho Dept. of Fish and Game (1984) has identified Crooked River as an important production stream in their Anadromous Fish Management Plan.

Dredge mining for gold in the 1950's severely degraded Crooked River resulting in dredge pilings up to 9 meters tall, unnatural forced meander patterns in the lower reaches, and straight, channelized, high gradient channels in the upper reaches. Dredging patterns have created a series of dredge pools, some with excellent fish cover. These pools, already provide some wildlife habitat, and also may be of value to juvenile salmonids. Such protected habitats offer cover, protection from predation and slightly higher water temperatures.

Bear Valley Creek

Bear Valley Creek, 55-kilometers long, joins with Marsh Creek to form the Middle Fork Salmon River. Located entirely within the Boise Nation Forest (Figure 4), Bear Valley Creek has its source in the weakly glaciated granitic uplands of the southern Idaho Batholith. A structural depression within the batholith, Bear Valley has been filled with alluvium eroded from the surrounding uplands resulting in a low-gradient stream with a high meander ratio.

Because of excellent water quality, low channel gradient, and in combination with abundant rubble and gravel channel substrates, Bear Valley has historically supported large runs of chinook salmon and summer steelhead trout. Spawning ground surveys in 1962-1975 indicate an average of 37 percent of all chinook spawning areas occurred in the upper Middle Fork-Bear Valley-Marsh Creek areas (Idaho Fish and Game, 1985). However, redd counts have shown a continual decrease since 1955 indicating continuing habitat degradation.

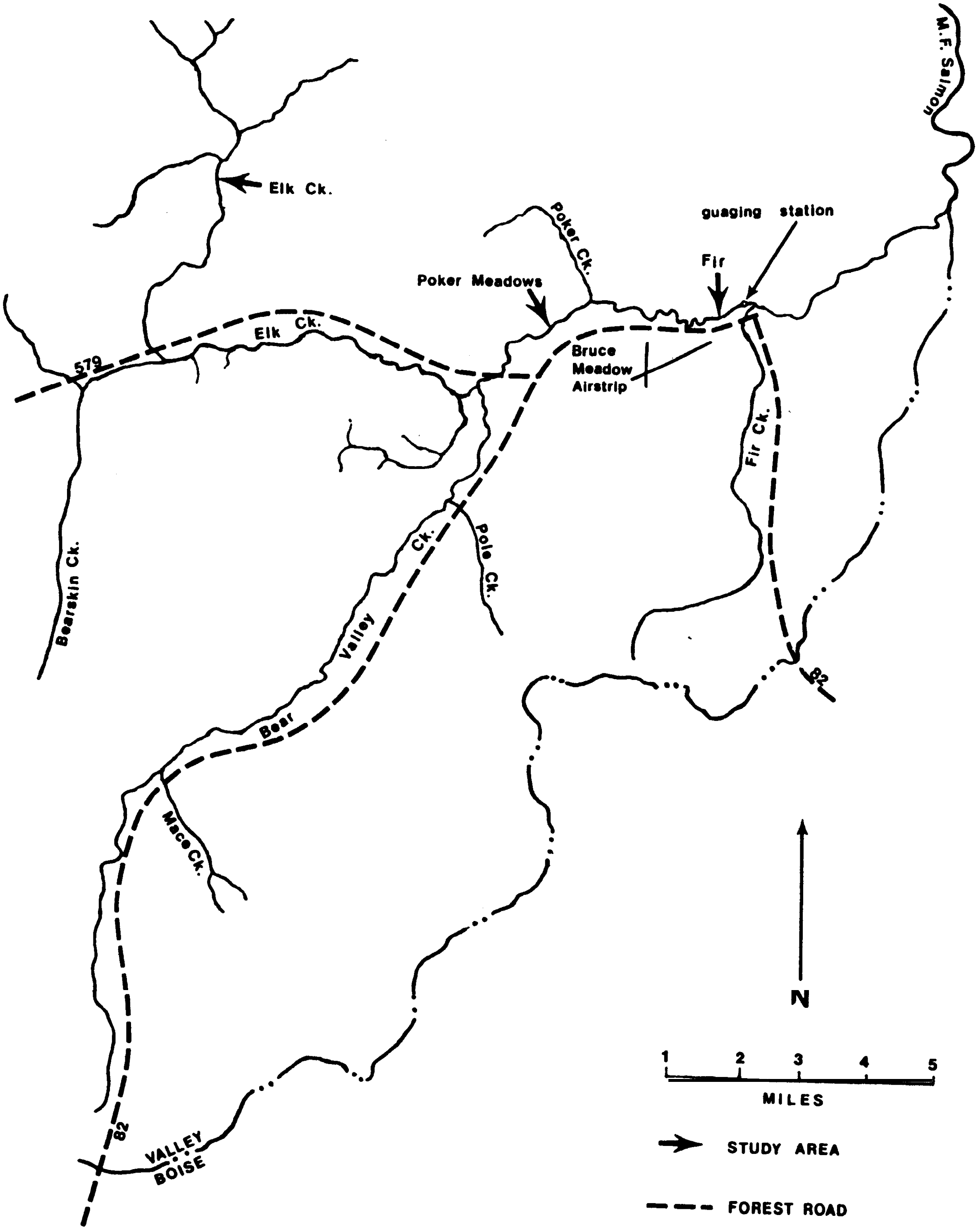

Figure 4. Location of the Bear Valley Creek study sites.

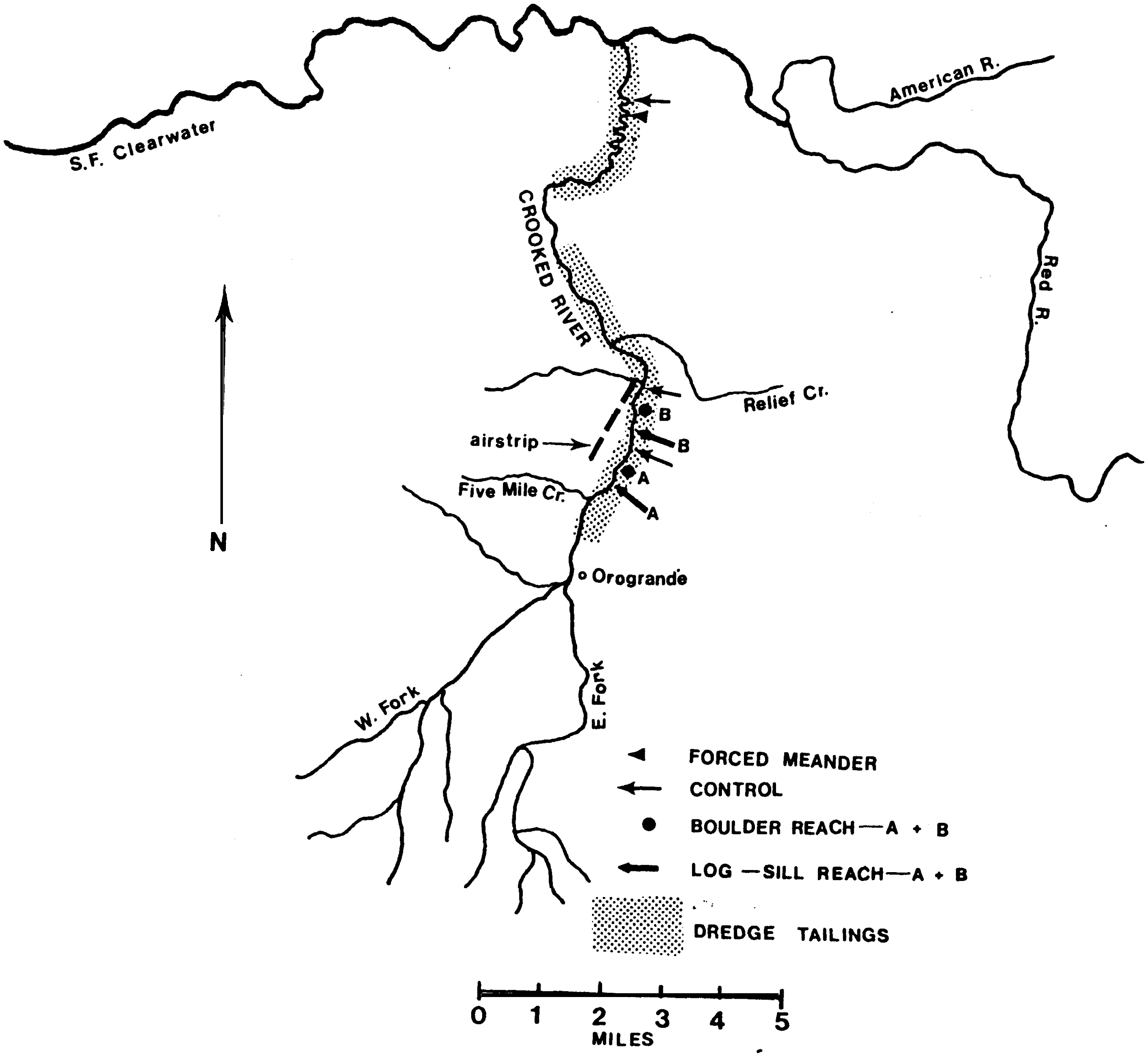

Figure 3. Location of the Crooked River study sites designated by the Idaho Fish & Game.

Sediment loading and streambank instability are the primary concern in Bear Valley Creek. Dredge mining on 900 acres of formerly public land along upper Bear Valley Creek began in 1955 and ended in 1959. To facilitate mining, Bear Valley Creek was channelized through a canal system. In 1969, the existing system of channels was filled and Bear Valley was allowed to form its own course. Today, upper Bear Valley is characterized by banks formed from unstable dredge deposits, and heavy deposits of fine sediments. Rates of bank erosion are high, and prime spawning substrates are often covered by fine sediments. Additionally, many pools that provide cover for holding and or rearing of salmonids have been partially filled with fine sediments.

METHODS

The study was designed to test the effectiveness of a variety of stream improvement techniques. Physical measurements of aquatic and riparian habitat conditions were conducted using transect sampling methodology described by Platts and others (1983) and Ray and Megahan (1979). Study site size varied with size of stream, and general locations were selected by a team of federal and state biologists to encompass specific treatment areas and budgetary restraints). The following are brief summaries of the designs of each area. Further information can be found in Idaho Fish & Game (1985) and Torquemada and Platts (1983).

The Red River evaluations consist of two study areas located approximately 5 and 6.4 kilometers downstream of the Red River Ranger Station. At each area an upriver control and downstream treatment area of equal size was systematically stratified with 60 sample transects. The lower study area was extended 10 transects in 1985 to accommodate for an error in boulder placement at the lower treatment area. Data collection was staggered between areas to allow alternate year sampling of the two areas. The 1985 field season represents the first post-treatment evaluation of the lower Red River area.

On Crooked River, a variety of treatments, including boulders, log-sill structures, k-dams, and channel reconstruction were put into effect throughout the treatment sections (Figure 3). Each treatment section was compared with an adjacent control reach. Both treatment and control reaches were 91.4 meters in length and delineated by permanent transects placed at 3.05 meter intervals so that habitat condition could be measured as needed.

In 1984, two study sites on Bear Valley Creek were established at Poker Meadows and near the confluence of Fir Creek (Figure 4) and represent controls for BPA-funded enhancement projects which began in the fall of 1985. Rehabilitation efforts here will be directed toward bank stabilization, riparian regeneration and the reduction of fine sediments.

Habitat condition was documented in all three areas using the intensive transect method of Platts et al. (1983). A list of habitat variables measured for each stream is given in Table 1. Fish population

Table 1.--List of aquatic habitat variable measured during 1985 at Red and Crooked Rivers, Bear Valley Creek.

Variable	Study Area Bear[1] Valley	 Crooked River	 Red[3] River
Geomorphic/Aquatic			
Stream width/depth	X	X	X
Pool quantity/quality	X	X	X
Riffle quality	X	X	X
Substrate	X	X	X
Embeddedness	X	X	X
Instream vegetation	X	X	X
Bank angle	X	X	X
Streamshore depth and undercuts	X	X	X
Riparian			
Habitat type	X	X	X
Streambank stability	X	X	X
Overhanging vegetation	X	X	X
Streambank alteration	X	X	X
Hydraulic Geometry			
Stream profile		X	X
Gradient		X	X
Velocity/flow		X	X
Biological			
Fish population estimates		X[4]	

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[1] 2 sites: Poker Meadows and Fir Creek

[2] 4 sites: Boulder A, Sill Log Control, Forced Meanders 1 and 2

[3] 2 sites: Control on rehabilitation site

[4] All fish population data collected by Idaho Fish and Game Department using snorkel survey technique.

Table 2.--Results of Stream geomorphology and riparian analysis for Bear Valley Creek, Idaho study sites, Idaho, 1985.

Variable	Poker Meadows			Fir Creek		
	$\bar{x}$ 1/	S.D. 2/	C.I. 3/	$\bar{x}$ 1/	S.D.	C.I.
Water Column						
Stream width (feet)	9716	11.439	93.5-101.7	102.8	7.4	100.2-105.4
Stream depth (feet)	0.7	2.0	0.0-1.4	1.1	1.4	0.6-1.6
Riffle width (percent)	37.7	17.5	31.4-44.0	3.2	5.8	1.2-5.2
Pool width (percent)	62.3	17.5	56.0-68.6	96.8	5.8	94.8-98.8
Pool feature 4/	5.1	0.4	4.9-5.3	5.0	0.0	
Pool rating 4/	2.9	1.1	2.2-3.6	4.0	0.0	-
Streambanks						
Bank angle (degrees)	107.0	42.6	91.7-122.3	78.4	31.9	67.0-89.8
Bank undercut (feet)	0.33	0.3	.22-.44	0.4	0.2	.31-.49
Bank water depth (feet)	0.26	0.3	.17-.37	0.24	0.18	0.18-.30
Vegetative use (percent)	5.5	8.9	2.3-8.7	2.3	2.9	1.2-3.4
Channel						
% fines (4.75-0.88mm)	3.8	4.5	2.2-5.4	23.0	7.5	21.3-25.7
% fines >.88mm	12.5	10.5	8.8-16.2	22.1	8.5	19.1-25.1
% gravel	45.5	30.9	34.4-56.6	38.1	15.2	32.6-43.6
% rubble	38.2	27.1	28.5-47.9	14.9	10.3	11.2-18.6
% boulder	0.4	0.2	.33-.47	1.7	1.8	1.0-2.4
Substrate embeddedness	51.3	24.1	42.7-59.9	73.2	10.7	69.4-77.0
Instream veg. cover (feet)	11.3	14.5	6.1-16.5	61.4	8.5	58.4-66.4
Riparian						
Habitat type 4/	13.1	5.0	11.3-14.9	16.3	2.8	15.3-17.3
Bank cover stability 4/	54.7	26.7	45.1-64.3	87.4	8.7	84.3-90.5
Stream cover 4/	1.7	0.6	1.5-1.7	2.3	0.5	2.1-2.5
Bank alteration (natural)	41.5	24.5	32.8-50.2	15.8	6.9	13.3-18.3
Bank alteration (artificial)	8.5	8.6	5.4-11.6			
Vegetative overhang (feet)	0.3	0.46	0.1-0.5	0.24	0.3	.13-.35

1/ $\bar{x}$ - Arithmetic mean
2/ S.D. = Standard deviation
3/ C.I. = 95 percent confidence interval
4/ **Categorical data, see Appendix A.**

census was conducted in Crooked River by the Idaho Dept. of Fish and Game using the snorkel survey method. Transects were established at 3.05 meter intervals, measured midstream with each perpendicular to stream flow, and were refenced to metal stakes on each bank. All habitat variables were measured along these transects for comparison with succeeding years. Detailed descriptions of the procedures used in this study can be found in Platts et al (1983), Ray and Megahan (1979), and Torquemada and Platts (1985).

Habitat condition variables were analyzed statistically using an IBM PC with SYSTAT^{c} software. Basic statistics ($\bar{x}$, S_D), were calculated as well as 95% confidence intervals. Data was further analyzed using paired t-tests (Sokal and Rohlf, 1973). Tables of categorical data are given in Appendix A.

RESULTS

Bear Valley-Fir Creek

In 1985, at the Fir Creek study site stream width decreased while water column depth increased over 1984 conditions (Table 2). Bank angles averaged 78 degrees, representing a 25% decrease over 1984 measurements. This overall trend toward acuteness, is a critical measure of habitat quality, and should be reflected by increases in rearing capacity. However, continued monitoring of site conditions must be documented annually before definite trends can be stated.

Bear Valley Creek channel substrate composition at the Fir Creek site was dominated by a high percentage of fine sediments (55.1%). This can be attributed to the large percentage of pools (96.8%) and the high rates of sediment transport. This large continuous deposition of sediments has not significantly changed from 1984, and does not coincide well with the increase in substrate embeddedness between 1984 and 1985. Another analysis period will be needed to isolate observer area, if It exists. In 1985 substrate embeddedness averaged 73.2% at the Fir Creek site. Possibly the embeddedness reflects the volume of introduced sediments to Bear Valley Creek and the severity of the problem. Complete results for the Fir Creek and Poker Meadow sites are given in Table 2.

Bear Valley-Poker Meadows

In contrast to the Fir Creek site, the Poker Meadow site was characterized by less stream width and water column depth, and a more balanced pool-riffle ratio (6:4). Bank angle averaged 107 degrees, and bank undercut was less (Table 2). Streambank alteration averaged 50%, with 83% of this alteration attributed to artificial causes, including damage induced by livestock grazing.

Substrate composition did not change significantly from 1984. Fine sediments averaged 16.3% in 1985, as compared to 13.4% in 1984. Similarly, embeddedness levels remained high in 1985, averaging 51.3%. This is especially significant, when the amount of gravel and rubble substrates in the study site (83.7%) are considered. Substrates of these size classes are of primary concern to biologists wishing to provide for optimum spawning habitat.

Unfortunately as fine sediments increase, the spawning success decreases. It will be interesting to determine if the overall fishery habitat condition in Bear Valley Creek are improved through reductions in fine sediments, increases in stream bank stability, and improvements in riparian condition and composition as the stream enhancement efforts are put into effect.

Lower Red River

Analysis of aquatic habitat condition revealed several significant differences in habitat quality following stream enhancement at the lower Red River study site (Table 3). Placement of instream structures, primarily boulder clusters and cabled tree deflectors, appear to have improved habitat condition from a standpoint of providing pool habitat. Significant differences were found between treatment and control sites in several areas. Stream depth, percent pool width, bank water depth, and pool quality improved in the treatment site as compared to the control site.

Channel materials changed significantly between sites, as might be expected. Increases in fine sediments were evident in the treatment section, and were probably associated with the increased pool-riffle (reduced velocity) ratio causing higher depositional processes. The riparian habitat variables exhibited no significant changes. Results of the hydraulic geometry analysis are given in Table 4.

Although the initial trends in pool formation and quality appear promising, it remains to be seen if anadromous salmonids respond favorably to these habitat alterations. Annual monitoring of stream geomorphology as well as fish population trends are necessary to ascertain the effectiveness of stream rehabilitation efforts. Economically, this will allow the cost-effectiveness of in-stream structures as compared to changes in carrying capacity they provide to be evaluated.

Crooked River

Originally six study sites were established on Crooked River to test a number of enhancement techniques. The original upper sites Boulder Reach A; Sill Log Control, Log Sill B; Channel Control, Rechannel B 6 A) were designed to test the effects of treatment with instream-structures. While the lower two (channel reconstruction A & B) were designed to test how proposed rechannelization affects habitat quality. In 1985, two additional study sections were added to the lower reaches of Crooked River. Here the river has been channelized by past dredge mining into unnatural, slow, forced meanders. By cutting through selected meanders, biologists hope to restore the channel and fishery habitat to a semblance of its former condition.

Table 3.--Results of pre/post treatment stream geomorphology and riparian analysis for the Lower Red River study site, Idaho, 1985.

	Control			**Treatment**			
Variable	$\bar{x}$[1]	**S.D.**[2]	**C.I.**[3]	$\bar{x}$[1]	**S.D.**	**C.I**	**Significance**
Water Column							
Stream width (feet)	37.5	8.3	35.8-39.2	41.8	9.2	39.9-43.7	N.S.
Stream depth (feet)	0.74	0.3	0.68-0.80	0.92	0.4	0.83-1.01	.003*
Riffle width (percent)	43.3	37.1	35.7-50.9	16.1	22.1	11.6-20.6	.001**
Pool width (percent)	56.7	37.1	49.1-64.3	83.9	22.1	79.4-88.4	.001**
Pool feature	5.4	0.8	5.2-5.6	5.5	0.8	5.3-5.7	N.S.
Pool quality rating	2.2	1.1	2.0-2.4	3.0	1.0	2.8-3.2	.001**
Streambanks							
Bank angle (degrees)	135.6	26.7	130.2-141.0	131.7	24.9	126.6-136.8	N.S.
Bank undercut (feet)	0.06	0.14	0.03-0.09	0.09	0.19	.05-. 13	N.S.
Bank water depth (feet)	0.03	0.1	0.01-0.05	0.08	0.2	.04-.12	l 012*
Channel							
% fines $\leq$.83mm	2.9	2.7	2.4-3.4	4.8	5.3	3.7-5.9	.009*
% fines .84-4.75m	6.7	5.6	5.5-7.9	14.1	12.8	11.5-16.7	.001**
% gravel	12.4	9.2	10.6-14.2	37.4	18.9	33.6-41.2	.001**
% rubble	70.2	9.9	68.2-72.2	39.2	20.4	35.0-43.4	.001**
% boulder	7.7	8.2	6.0-9.4	4.4	5.6	3.3-5.5	.003*
Embeddedness	58.9	9.3	57.0-60.8	62.8	15.5	59.6-66.0	N.S.
Instream veg. cover (feet)	0.43	0.7	0.29-0.57	0.49	0.7	0.35-0.63	N.S.
Riparian							
Habitat type	8.8	1.7	8.4-9.2	8.7	1.8	8.3-9.1	N.S.
Bank cover stability	70.2	16.1	66.9-73.5	63.0	14.8	60.0-66.0	.004*
Stream cover	1.85	0.4	1.76-1.94	1.87	0.3	1.81-1.93	N.S.
Bank alteration	65.6	6.2	64.3-66.9	65.2	7.2	63.7-66.7	N.S.
Vegetative overhang (feet)	0.26	0.36	0.19-0.33	0.3	0.3	.23-.37	N.S.

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[1] $\bar{x}$ - Arithmetic mean

[2] **S.D.** = Standard deviation

[3] **C.I.** = 95 percent confidence interval

Table 4.—Results of hydraulic geometry for Lower Red River rehabilitation study site, June, 1984 and July, 1985.

Year	Width (ft)			Depth (ft)			Area (ft^2)			Velocity (ft/sec)			Flow (ft^3/sec)			Mannings (N)			Gradient (%)		
	$\bar{x}$ 1/	S.D. 2/	C.I. 3/	$\bar{x}$	S.D.	C.I.	$\bar{x}$	S.D.	C.I.	$\bar{x}$	S.D.	C.I.	$\bar{x}$	S.D.	C.I.	$\bar{x}$ 1/	S.D. 2/	C.I. 3/	$\bar{x}$	S.D.	C.I.
1984	41.8	4.0	39.3-44.4	1.3	.3	1.1-1.5	54.8	11.48	47.5-62.1	1.4	.4	1.1-1.6	71.7	11.7	63.6-78.5	.08	.03	.6-1.0	.35	.09	.3-.4
1985	39.9	3.3	37.8-42.0	1.1	.25	0.9-1.2	41.8	9.0	36.9-46.6	.98	.3	0.8-1.2	39.0	3.3	36.9-41.1	.07	0	0.05-.09	.23	.11	.2-.3

1/ $\bar{x}$ - Arithmetic mean
2/ S.D. - Standard deviation
3/ C.I. - 95% confidence intervals

After consultation with Idaho Fish and Game personnel, we were directed to postpone evaluation of treatments in the upper Crooked River area until all enhancement work in the area has been completed. We anticipate a more thorough evaluation of these treatments in 1986.

Initial pre-treatment conditions between the new forced meander sites were fairly uniform (Table 5). Highly significant ($p<.05$) differences during the pretreatment period were found between sites in pool quality, channel substrate composition of fine sediments, streamside vegetative cover ratings, and vegetative overhang. Bank angles, habitat type, and instream vegetation were also significantly ($p<.10$) different between sites. Annual evaluation of the forced meander sites will reveal any structural changes in stream geomorphology and fishery habitat condition between sites in subsequent years that may result from enhancement efforts.

The remaining Crooked River study sites (channel control and log-sill control) complete the sites sampled in 1985. Paired data was not collected in 1985 for these sites. Thus, statistical comparisons were not made. However, several trends are evident in the control sites (Table 5). Both sites lack appreciable pool quantity and quality. This is a legacy of gold dredging activities which channelized Crooked River into a straight, narrow channel, lacking any appreciable structure that forms pools. As a result velocities are rapid, with freshets causing aggradation of fines sediments within the channel. Absence of fine sediments are evident at both control sites, as well as low embeddedness ratings.

Bank angles average 136 degrees in the two control sites. Little improvement (acuteness) in the upper Crooked River can be expected in bank angles, mainly because the left bank has been formed by dredge pilings that are up to 20 feet tall. These tailings will continue to negatively impact bank undercut, bank water depth, as well as bank angles. Results of the hydraulic geometry analysis are presented in Table 6.

Fish Population

Results of the 1985 fish snorkel survey by personnel of the Idaho Dept. of Fish & Game on the Crooked River study sites are given in Table 7. Unfortunately, due to the activities of a suction dredge mine operation, the department was unable to survey the Channel Control area. Additionally, Rechannel B was still untreated at the time of survey. Survey results show steelhead trout populations are fairly high throughout Crooked River. High numbers of age 0+ steelhead trout were found in Sill Log A. High numbers were also evident in rechannel B, which although untreated, contains some quality pool habitat. Numbers of age 0+ chinook also were highest in those study sites with superior pool habitat (Table 7). The relatively low number of age l+ chinook can be attributed to out-migration of smolts. Resident and anadromous salmonid populations can be expected to increase in number, as pool volume, pool quality and diversity of cover improves.

Table 5.--Results of Stream geomorphology and Riparian analysis for the Crooked River Study Sites, Idaho, 1985.

	Forced Meander #1			Forced Meander #2				Channel Control			Sill Log Control		
Variable	$\bar{x}$[1]	S.D.[2]	C.I.[3]	$\bar{x}$	S.D.	C.I.	Sig.[5]	$\bar{x}$	S.D.	C.I.	$\bar{x}$	S.D.	C.I.
Water column													
Stream width (ft)	31.8	20.6	25.6-38.0	39.5	14.1	35.9-43.1	N.S.	a5.5	8.8	12.9-18.1	28.2	5.3	26.6-29.8
Stream depth (ft)	1.2	0.8	0.6-1.0	1.2	0.55	1.0-1.4	N.S.	0.3	0.8	0.1-0.5	0.5	2.1	0.0-l. 1
Riffle width (%)	34.5	29.2	25.8-43.2	26.8	28.6	19.4-34.2	N.S.	77.0	15.8	72.3-81.7	78.7	20.1	72.8-84.6
Pool width (%)	65.5	29.2	56.8-74.2	73.2	28.6	65.7-80.5	N.S.	23.0	15.8	18.3-27.7	21.3	20.1	16.4-27.2
Pool feature[4]	5.5	0.8	5.4-5.6	5.3	0.7	5.1-5.5	N.S.	5.1	1.6	4.6-5.6	4.7	1.7	4.2-5.2
Pool rating[4]	2.9	1.5	2.5-3.3	3.5	1.3	3.2-3.8	<.001**	1.7	1.1	1.4-2.0	1.2	.9	1.0-1.4
Streambanks													
Bank angle (degrees)	145.8	25.8	138.1-153.5	127.7	26.7	117.9-137.5	.04*	128.0	41.2	111.5-146.5	144.1	16.9	139.0-149.
Bank undercut (ft)	0.04	0.11	0.01-0.07	0.10	0.18	0.04-0. 16	N.S.	0.18	0.4	0.01-0.35	0.0	0.0	-
Bank water depth (ft)	0.03	0.11	0.00-0.06	0.05	0.11	0.07-0.15	N.S.	0.05	0.11	0.00-.09	0.0	0.0	-
Channel													
% fines 1.88mm	3.3	5.6	1.6--5.0	6.3	11.8	5.8-6.8	N.S.	15.8	10.7	12.6-19.0	1.7	2.5	1.0-2.4
% fines (4.75-0.88mm)	5.5	9.5	2.7-8.3	13.6	7.9	12.4-14.8	<.001**	5.4	3.9	4.2-6.6	1.6	2.6	0.8-2.4
% Gravel	38.5	12.1	34.9-42.1	36.9	11.0	35.2-38.6	N.S.	4.6	3.3	4.0-5.2	12.7	9.9	9.8-15.6
% Rubble	48.4	16.2	43.6-53.2	40.0	7.7	38.8-41.2	N.S.	67.8	11.5	64.4-71.2	68.9	14.3	64.6-73.2
% Boulder	4.3	7.4	2.1-6.5	3.0	1.1	2.8-3.2	N.S.	6.4	4.7	5.0-7.8	14.9	9.5	12.1-17.7
Substrate embeddeness	36.9	23.3	29.9-43.9	44.8	26.2	40.8-48.8	N.S.	18.7	10.4	15.6-21.8	23.4	10.8	20.1-26.7
Instream veg. cover (ft)	0.07	0.36	0.0-.18	0.5	1.3	0.3-0.7	.04*	15.5	8.8	12.9-18.1	0.4	1.0	0.1-0. 7
Riparian													
Habitat type[4]	7.9	1.1	7.6-8.2	8.7	2.2	7.9-9.5	.04*	9.5	2.2	8.6-10.4	10.5	3.0	9.6-11.4
Bank cover stability[4]	52.7	16.9	47.6-57.8	60.7	16.2	54.8-66.6	N.S.	63.3	23.1	53.5-73.1	72.9	19.6	67.0-78.8
-[4]	- -	0.48	1.2-1.4	1.9	0.3	1.8-2.0	<.001**	1.8	0.5	1.6-2.0	1.7	0.8	1.5-1.9
Bank alteration	76.3	8.8	73.7-78.9	71.7	6.9	69.2-74.2	N.S.	65.7	13.6	59.9-71.5	61.8	19.6	55.9-67.7
Vegetative overhang (%)	0.03	0.11	0.0-0.06	0.13	0.2	.05-0.21	<.001**	0.4	0.9	0.0-0.8	0.16	0.22	0.10-0.22

[1] $\bar{x}$ - Arithmetic mean [2] S.D. - standard deviation [3] C.I. - 95% confidence interval [4] Categorical data, see Appendix A

[5] Sig. significance at 95% level N.S. - non significant * - ($p \leq .10$) significant ** - ($p \leq .05$) highly significant

Table 6.--Results of hydraulic geometry for the Crooked River Idaho sites 1985.

Site	Width (ft)			Depth (ft)			Area (ft^2)			Velocity (ft/sec)			Flow (ft^3/sec)			Mannings N)			Gradient (%)		
	$\bar{x}$[1]	S.D.[2]	C.I.[3]	$\bar{x}$	S.D.	C.I.	$\bar{x}$	S.D.	C.I.	$\bar{x}$	S.D.	C.I.	$\bar{x}$[1]	S.D.[2]	C.I.[3]	$\bar{x}$	S.D.	C.I.	$\bar{x}$	S.D.	C.I.
Boulder Reach A	28.91	3.29	21.7-36.1	0.7	.05	.6-.8	20.1	0.9	18.1-21.9	2.0	0.3	1.3-2.7	40.8	4.9	29.9-51.7	.06	.01	.04-.08	1.1	0	-
Sill Log Control	26.2	8.9	6.7-45.4	.54	.09	.34-.74	14.2	4.9	3.4-25.0	1.63	.53	0.4-2.8	21.5	3.9	12.9-30.1	.07	.02	.03-1.1	1.1	.26	0.5-1.7
Channel Control	32.5	2.8	26.3-38.7	.46	.12	0.2-.72	14.8	2.8	8.6-2.1	1.25	.27	.66-1.84	18.2	2.7	12.3-24.1	.09	.03	.03-.15	1.62	.01	1.60-1.64
Forced Meander #1	47.7	18.8	6.4-89.0	1.68	.75	.03-3.3	83.2	50.1	27.0-193.4	.64	.48	0.0-1.64	35.1	6.1	21.7-48.5	.30	.24	0.0-.83	.29	0	-
Forced Meander #1	34.9	19.5	17.3-52.5	1.7	1.2	0.6-2.8	74.7	36.0	0-153.5	1.1	0.4	0.0-3.1	33.0	12.6	21.6-44.4	1.1	2.43	0.0-3.3	.3	0	-

[1] $\bar{x}$ - Arithmetic mean
[2] S.D. - Standard deviation
[3] C.I. - 95% confidence intervals

Table 7.--Number of fish per 100m^2 for the Crooked River, Idaho study sites, Idaho, as determined by Snorkel survey, 1985 (Data collected by Idaho Fish and Game Department).

Site (surface area)	Chinook 0+	Chinook 1+	Steelhead 0+	Steelhead l+	Cutthroat	Brook	Bull	Whitefish
Boulder B (856m^2)	4.2	.46	487.3	35.8/34.0*	0	.11	0	.70
Sill Log A (856m^2)	31.9	0	707.2	1.52/.81*	1.28	0	2.57	1.17
Forced Meander #l (775m^2)	91.8	3.1	241.7	.38/O*	1.93	0	.38	32.6
Rechannel B (581m^2)	21.5	0	551.3	12.01/11.7*	0	0	0	.17
Control 1	9.7	0	414.4	1.0/1.5*	.30	0	.20	.60

* Number of fish counted that exhibited adipose clips, indicating natural/hatchery origin of steelhead.

RECOMMENDATIONS

This report documents habitat condition in Crooked River and Red River following rehabilitation and enhancement efforts. Initial conditions were documented at the Forced Meander sites at Crooked River. Rechannelization of the Forced Meander site is expected in 1986. The Bear Valley sites were surveyed for the second consecutive year. Recommendations for 1986 are as follows:

1. Continue to evaluate all the Crooked River study sites to determine the effectiveness of rehabilitation and enhancement project.
2. Evaluate Forced Meander sites on Crooked River to ascertain the effects of rechannelization.
3. Evaluate both Red River sites for another year so as to document fishery habitat condition under normal flow regimes, as runoff in 1985 was not representative of average conditions.
4. Continue evaluating the Bear Valley study sites to determine if there are short-term changes from the 1985 treatment efforts.
5. Establish study sites in Bear Valley Creek as needed to evaluate on-site treatments that may occur in proposed future work.
6. Evaluate economic viability of the stream enhancement projects.

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APPENDIX A: Tables used to measure categorical-type habitat variables (from Platts and others 1983).

Table A-l.--Key to pool quality rating.

		Pool Rating
1A	If the pool maximum diameter is within 10% of the average stream width of the study site[1]	Go to 2
1B	If the maximum pool diameter exceeds the average stream width of the study site by 10% or more	Go to 3
1C	If the maximum pool diameter is less than the average stream width of the study site by 10% or more	Go to 4
2A	If the pool is less than 2 feet in depth	Go to 5
2B	If the pool is more than 2 feet in depth	Go to 3
3A	If the pool is over 3 feet in depth or the pool is over 2 feet in depth and has abundant fish cover[2]	Rate 5
3B	If the pool is less than 2 feet in depth, or if the pool is between 2 and 3 feet and the pool lacks fish cover	Rate 4
4A	If the pool is over 2 feet with intermediate or better cover	Rate 3
4B	If the pool is less than 2 feet in depth but pool cover for fish is intermediate or better	Rate 2
4C	If the pool is less than 2 feet in depth and pool cover is classified as exposed	Rate 1
5A	If the pool has intermediate to abundant cover	Rate 3
5B	If the pool has exposed cover conditions	Rate 2

---

[1] A study area is the entire 1200-foot stream reach.

[2] (a) If cover is rated abundant, the pool has excellent in-stream cover and the perimeter has a fish cover.
(b) If cover is rated intermediate, the pool has moderate in-stream cover and one-half of the pool perimeter has fish cover.
(c) If the cover is rated exposed, the pool has poor in-stream cover and less than one-fourth of the pool perimeter has fish cover,

Table A-2--Embeddedness rating for channel materials (gravel, rubble, and boulder).

Rating	Rating Description
5	The gravel, rubble, and boulder particles have less than 5 percent of their perimeter (surface) covered by fine sediment,
4	The gravel, rubble, and boulder particles have between 5 to 25 percent of their perimeter (surface) covered by fine sediment.
3	The gravel, rubble, and boulder particles have between 25 and 50 percent of their perimeter (surface) covered by fine sediment.
2	The gravel, rubble, and boulder particles have between 50 and 75 percent of their perimeter (surface) covered by fine sediment.
1	The gravel, rubble, and boulder particles have over 75 percent of their perimeter (surface) covered by fine sediment.

Surface area incorporates the entire substrate particle. The underside and edge of the substrate especially provide the bulk of habitat for most aquatic insects.

Table A-3.--Streamside cover rating.

Rating	Streambank Cover
4 (tree)	The dominant vegetation influencing the streamside and/or water environment is of tree form.
3 (brush)	The dominant vegetation influencing the streamside and/or water environment is brush.
2 (grass)	The dominant vegetation influencing the streamside and/or water environment is grass or grasslike.
1 (exposed)	Over 50 percent of the streambanks have no vegetation and the dominant material is soil, rock, bridge materials, road materials, culverts, mine tailings, etc.

Table A-4.--Streamside cover as it relates to maintaining stability.

Rating	Environment Conditions
4 (Excellent)	Over 80 percent of the streambank surfaces covered by vegetation in vigorous condition or by boulder and rubble. These materials prevent water flows from eroding the streambanks.
3 (Good)	50 to 79 percent of the streambank surfaces are covered by vegetation or by gravel or larger material. These materials significantly buffer the banks allowing only minor damage.
2 (Fair)	25 to 49 percent of the streambank surfaces are covered by vegetation or by gravel or larger material. The streambank cover has some but only limited ability to inhibit erosion.
1 (Poor)	Less than 25 percent of the streambank surfaces are covered by vegetation or by gravel or larger materials. This cover provides little or no control over erosion and such banks are usually damaged each year by high water flows.

Table 5.--Classification of stream substrate channel materials by particle size.

Particle diameter size		Sediment classification
Millimeters	Inches	
304.8 and over	12 and over	Boulder
76.1 to 304.7	3 to 11.9	Rubble
4.75 to 76.0	0.19 to 2.9	Gravel
0.83 to 4.74	0.033 to 0.18	Coarse sediment
0.83 or less	0.033 and less	Fine sediment (sandy)

Table A-6.--Streamside habitat type rating.

	Streambank Material			Streambank Material	
Rating	Dominant	Subdominant	Rating	Dominant	Subdominant
1	fines	fines	13	boulder	tree
2	fines	gravel	13	boulder	sod
2	fines	grass	13	boulder	brush
2	fine6	rubble	12	root	fines
3	fine6	boulder	13	root	gravel
3	fines	root*	12	root	grass
3	fines	tree**	13	root	rubble
3	fines	sod***	13	root	boulder
3	fines	brush	13	root	root
4	gravel	fines	14	root	tree
5	gravel	gravel	13	root	sod
6	gravel	grass	14	root	brush
6	gravel	rubble	12	tree	fines
7	gravel	boulder	13	tree	gravel
8	gravel	root	13	tree	grass
8	gravel	tree	13	tree	rubble
7	gravel	sod	13	tree	boulder
8	gravel	brush	14	tree	root
8	grass	fines	14	tree	tree
9	grass	gravel	14	tree	sod
9	grass	grass	14	tree	brush
9	grass	rubble	12	sod	fines
9	grass	boulder	13	sod	gravel
11	grass	root	14	sod	grass
12	grass	tree	15	sod	rubble
13	grass	sod	16	sod	boulder
17	grass	brush	18	sod	root
8	rubble	fines	18	sod	tree
9	rubble	gravel	17	sod	sod
9	rubble	grass	19	sod	brush
10	rubble	rubble	17	brush	fines
10	rubble	boulder	20	brush	gravel
11	rubble	root	20	brush	grass
11	rubble	tree	21	brush	rubble
11	rubble	sod	22	brush	boulder
12	rubble	brush	23	brush	root
11	boulder	fines	23	brush	tree
12	boulder	gravel	24	brush	sod
12	boulder	grass	23	brush	brush
12	boulder	rubble			
12	boulder	boulder			
13	boulder	root			

* Should include only substantial roots, e.e. brush or tree roots.

** Downfall logs included.

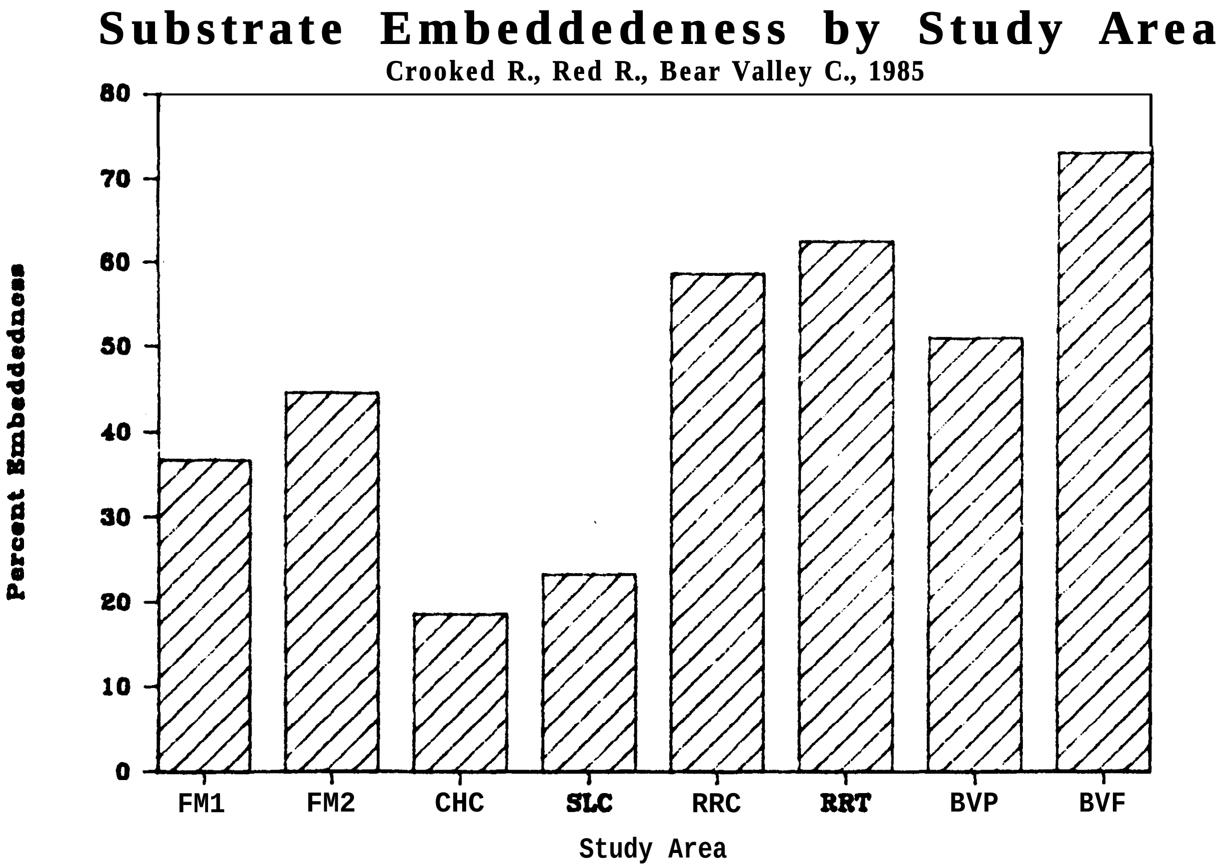
*** Sod has an extensive root mass and is more stable than grass or grass tufts.

Table A-7.--Streambank soil alteration rating.

Rating	Description
100% to 76%	Streambanks intercepted by the transect line are severely altered. Less than 25% of the streambank is in a stable condition. Over 75% of the streambank is false, broken down or eroding. A bank previously altered is now classified as a false bank that has gained some stability, and cover is still rated as altered. Alteration is rated as natural, artificial or a combination of both.
75% to 51%	Streambanks are receiving major alteration along the transect line. Less than 50% of the streambank is in a stable condition. Over 50% of the streambank is false, broken down, or eroding. A false bank that may have gained stability and cover is still rated as altered. Alteration is rated as natural, artificial or a combination of both.
SO% to 25%	Streambanks are receiving only moderate alteration along the transect line. At least 50% of the streambank is in a natural stable condition. Less than 50% of the streambank is false, broken down, or eroding. False banks are rated as altered. Alteration is rated as natural, artificial or a combination of both.
24% to 1%	Streambanks are stable but receiving some light alteration along the transect line. Less than 25% of the streambank is receiving any kind of stress and if stress is being received, it is very light. Less than 25% of the streambank is false, broken down, or eroding. Alteration is rated as natural, artificial or a combination of both.
0%	Streambanks are stable and receiving no alteration from water flows, animal use, or other factors.

Appendix B: Substrate composition and embeddedness for Bear Valley, Crooked River, and Red River stream enhancement study sites, 1985.

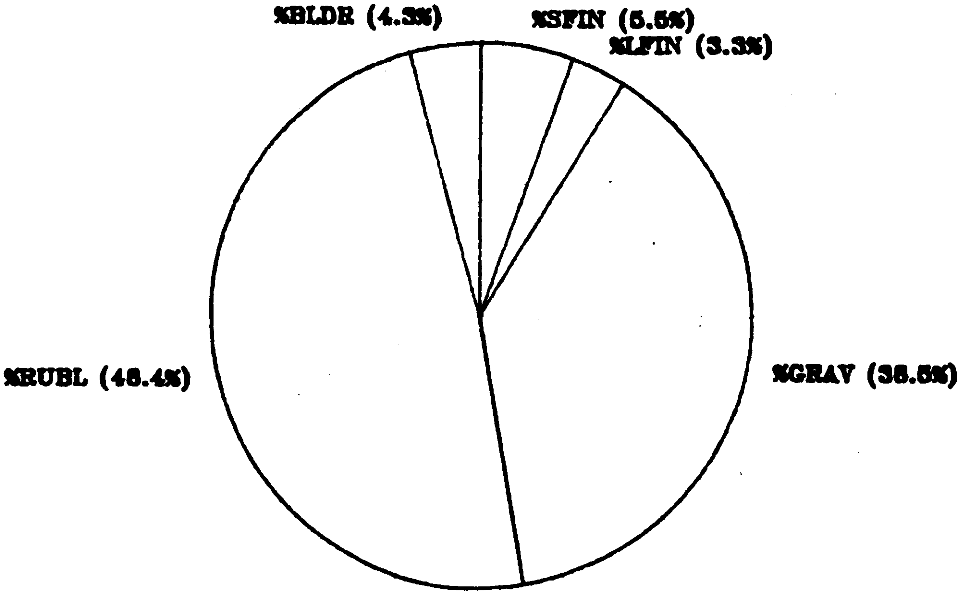
Figure B-1. Substrate embeddedness.



FM1=Forced Meander #1, Crooked River
FM2=Forced Meander #2, Crooked River
CHC=Channel Control, Crooked River
SLC=Sill Log Control, Crooked River
RRC=Lower Red River Control
RRT=Lower Red River Treatment
BVP=Bear Valley Poker Meadows
BVF=Bear Valley Fir Creek

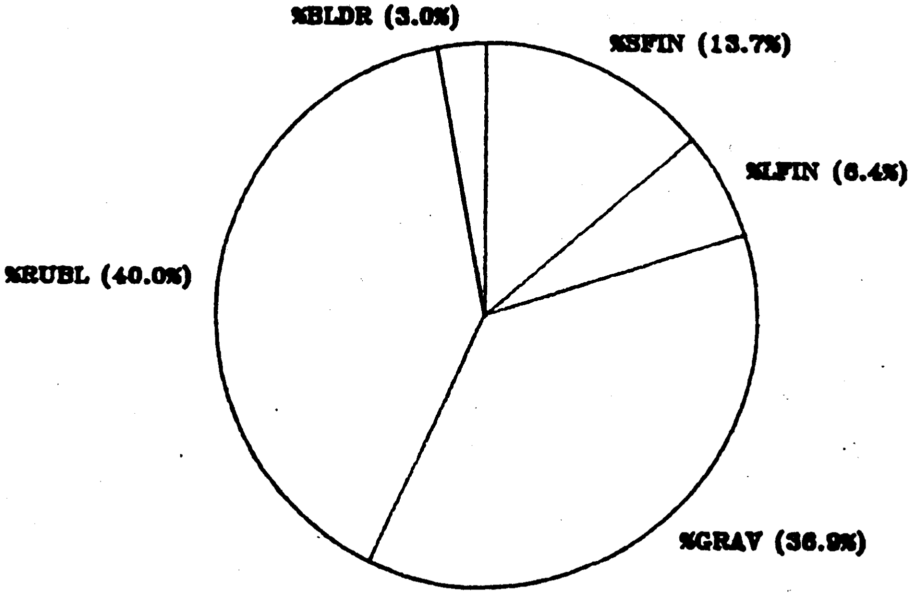
Substrate composition by size class

Crooked River, Forced Meander No. 1



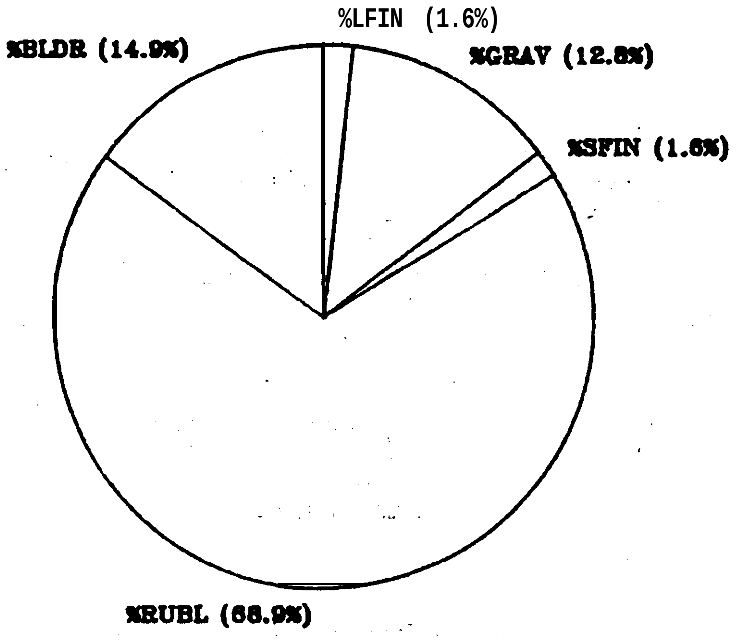
Substrate composition by size class

Crooked River, Forced Meander No. 2



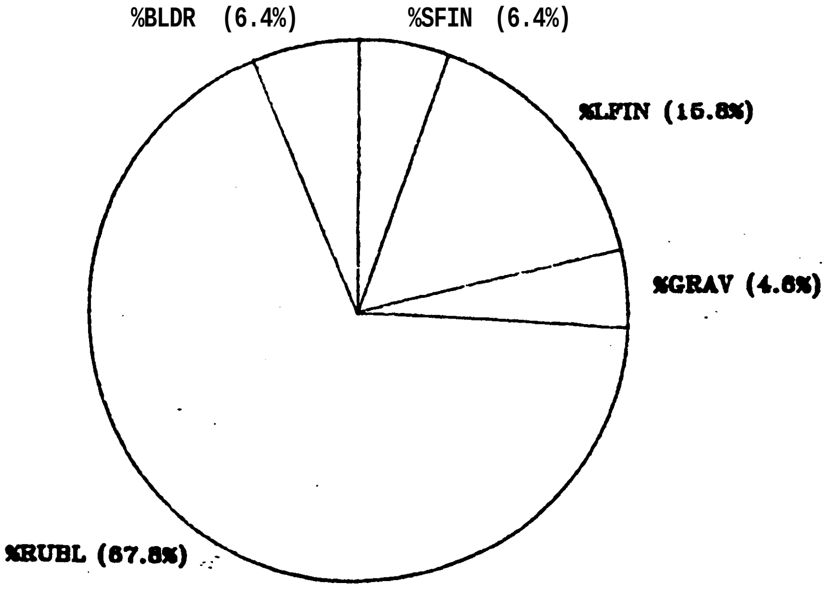
Substrate composition by size class

Crooked River, Sill Log Control



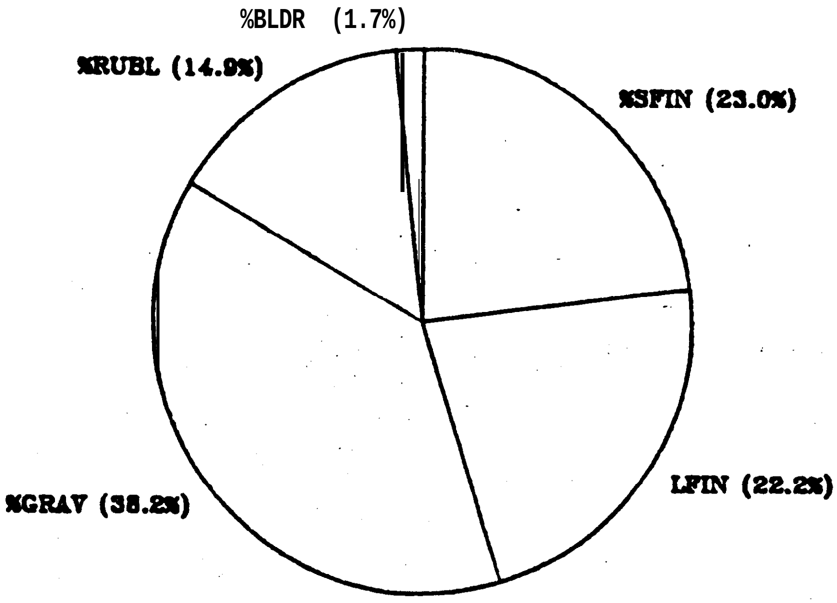
Substrate composition by size class

Crooked River, Channel Control



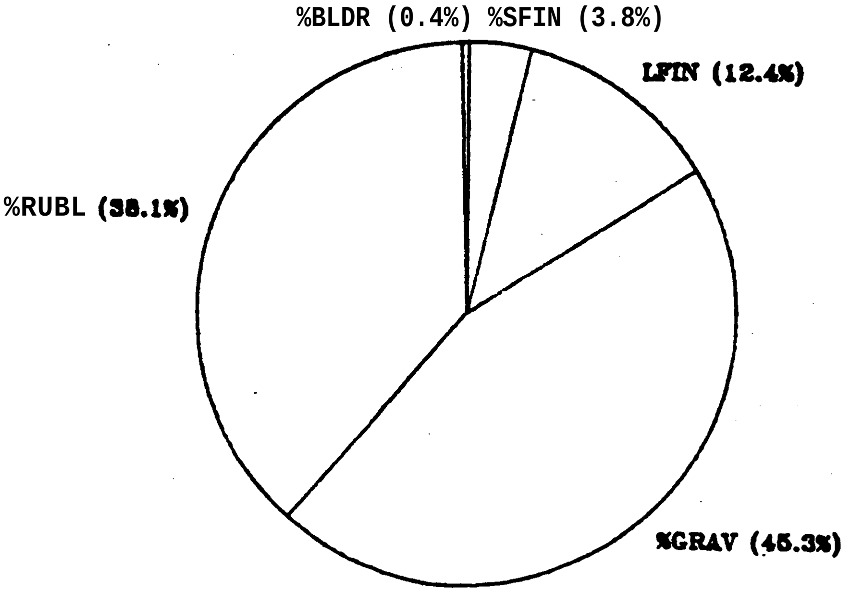
Substrate composition by size class

Bear Valley Creek, Fir Creek



Substrate composition by size class

Bear Valley Creek, Poker Meadows



Appendix D

Stream
Subbasin
EPA Reach #

BPA PROJECT: :
Strata
Section

Date
Length (M)
Vertical Drop (M)
Gradient (%)

Collectors
Comments

Transect (m from ownstream)	Width (m)	Habitat	Location on transect (l to r)	Depth (m)	Velocity @ 0.6 depth (unit)	% Substrate Class by area						Embeddedness	Bank	Under-cut (m)	Over-hanging vegetation (m)
						Fine sed. (< •)	Coarse sed. (•-○)	Sand f.s.+ c.s.)	Gravel (up to 3")	Rubble (3" to 12")	Boulder (>12")				
			1/4 1/2 3/4										L - R	-	-
			1/4 1/2 3/4										L - R	-	-
			1/4 1/2 3/4										L - R	-	-
			1/4 1/2 3/4										L - R	-	-
			1/4 1/2 3/4										L - R	-	-
			1/4 1/2 3/4										L - R	-	-
			1/4 1/2 3/4										L - R	-	-
			1/4 1/2 3/4										L - R	-	-
			1/4 1/2 3/4										L - R	-	-
			1/4 1/2 3/4										L - R	-	-

abitat: 1 = Pool; 2 = Run; 3 = Pocket Water; 4 = Riffle
Embeddedness: 1 = <5%; 2 = 5-25%; 3 = 25-50%; 4 = 50-75%; 5 = >75%

Stream ______________ Date __________ Collectors ______________

Subbasin ______________ Comments ______________

EPA Reach # ______________

BPA Project: ______________

Reach ______________

Section ______________

Section Area __________ M^2 Visibility: (m) __________ Methods: __________

Length Class (in)	RAINBOW - STEELHEAD				RESIDENT SPECIES			
	Total	Wild and Natural	Adipose Clipped	Hatchery Catchable	Cutthroat	Brook	Bull	Whitefish
< 2								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
> 12 (specify length)								

Age 0 Chinook

Age 1 Chinook

Adults/Redds

Submitted by:

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