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LOCHSA RIVER TRIBUTARIES ENHANCEMENT PROPOSAL

WALDE, DEADMAN, LOWER FISH, AND BOULDER CREEKS

ANADROMOUS FISH HABITAT SURVEY AND ENHANCEMENT PLAN

LOCHSA RANGER DISTRICT

Clearwater National Forest
Northern Region
United States Forest Service
United States Department of Agriculture

Final Report FY 1985 through 1986

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Project No. 84-31

by

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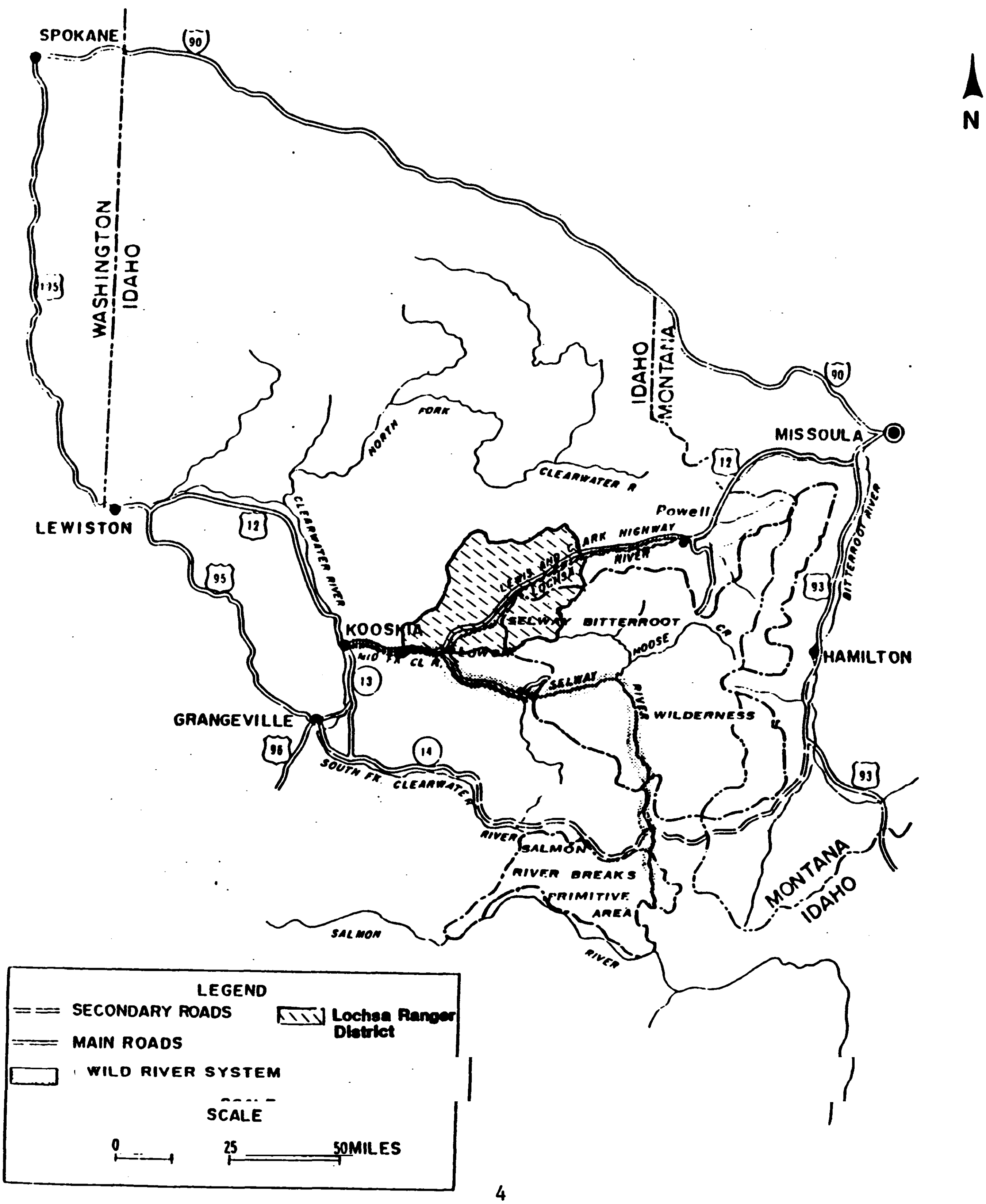
Abstract

In 1964, the Clearwater National Forest and Bonneville Power Administration entered into a contractual agreement (Project 84-31) to identify potential enhancement projects for anadrmous fish in the Clearwater River Basin. The primary objectives of this project were to survey potential stream and identify opportunities to mitigate for the effects of past and present influences . Selected tributaries of the Lochsa River were determined to be suitable for this type of project.

Four Lochsa River tributaries on the Lochsa Ranger District were identified as candidates for habitat mitigation. These streams were Walde, Deadman, lower Fish, and Boulder Creeks. These streams were surveyed and analyzed to determine: 1) limiting factors to fish production; 2) the extent and severity of these limitations, and; 3) the feasibility of eliminating and/or mitigating these factors. A plan was developed to display appropriate projects and costs associated with mitigating the impacts of identified limiting factors on fish.

VICINITY MAP



I. INTRODUCTION

The Clearwater National Forest (1.8 million acres) is located in north central Idaho and supports some of the most significant and valuable salmonid resources in the region. The Forest provides a total of 2,500 acres of spaming, rearing, and migratory habitats for two anadromous species - spring chinook salmon and summer steelhead trout. Of this total, 100 acres consist of high quality spawning habitat.

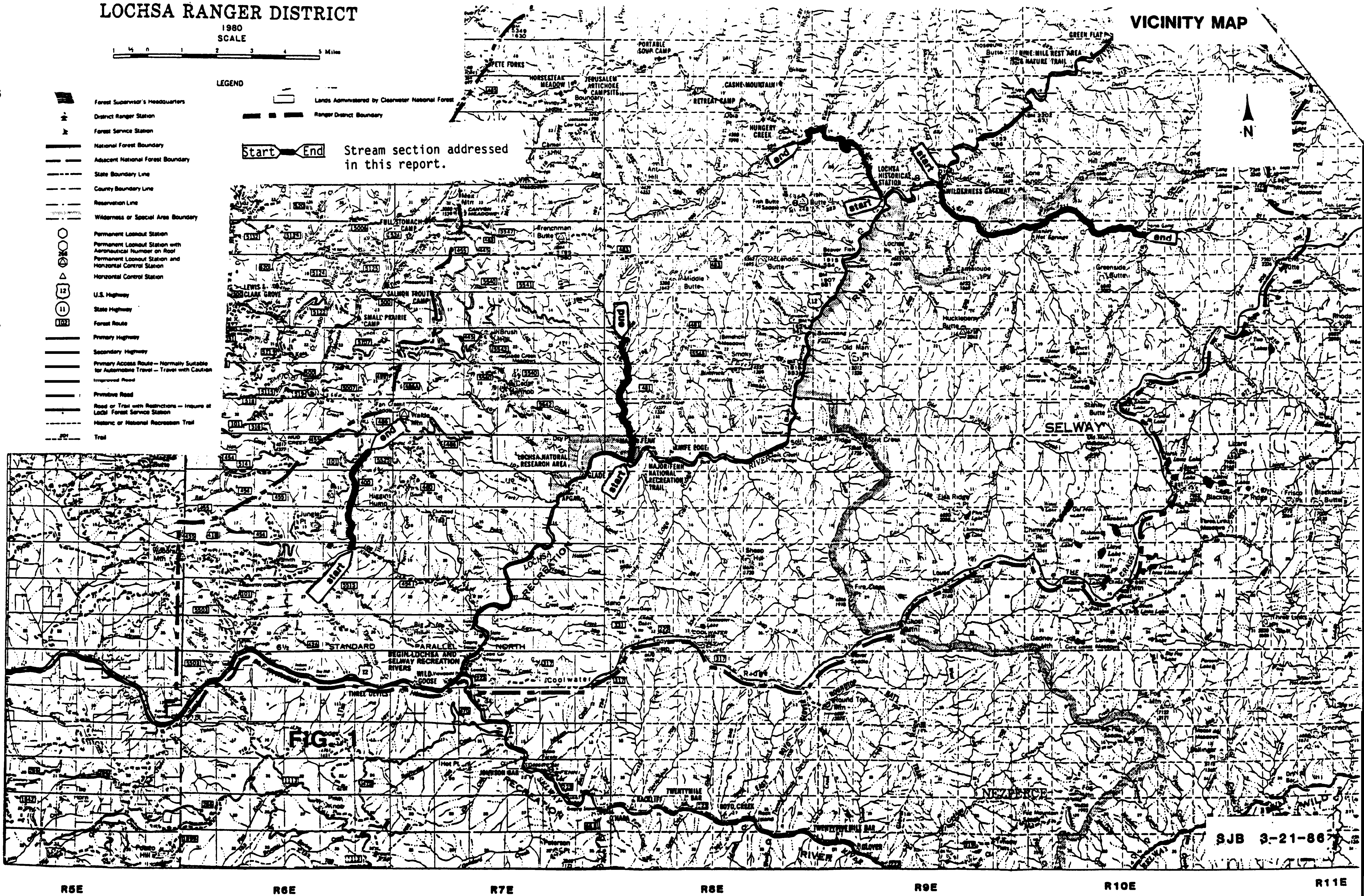
Recent history has documented the extensive hydroelectric development of the Columbia and Snake Rivers and their major tributaries. This development has depleted the basin's and Forest's fish resources. In 1927, a dam built near Lewiston, Idaho virtually destroyed the run of spring chinook salmon in the Clearwater River Drainage. In the early 1970's, Dworshak Dam on the North Fork of the Clearwater River eliminated 60 percent of the Forest's highest quality habitat for steelhead trout; and lower Granite Dam on the Snake River increased the mortality gauntlet to a total of eight dams on the system that fish destined for Idaho or the ocean had to negotiate. By the mid 1970's, Idaho stocks of anadromous fish had bottomed cut and were perched on the brink of extinction. Since that time, accelerated efforts of mitigation and restoration have actuated a trend of signif icant recovery - especially for steelhead trout.

In 1984, and under the auspices of the Northwest Power Act, the Clearwater National Forest and Bonneville Power Administration entered into a contractual agreement (Project 84-31) to identify potential enhancement projects for anadromous fish in the Clearwater River Basin. Four tributaries of the the Lochsa River were surveyed. These streams were Walde Creek, Deadman Creek, lower Fish Creek, and Boulder Creek (Fig. 1).

II. DESCRIPTION OF PROJECT AREA

The four streams drain landforms that include steep breaklands, colluvial uplands, fluvial, mass wasted slopes, and floodplains. Breaklands and colluvial uplands dominate these watersheds. The Idaho Batholith dominates the geologic landscape. Erosive, granitic soils typify the soil profile. The streams are third to seventh order tributaries flowing through a mix of coniferous and deciduous vegetation. All four stream support, or could potentially support, populations of steelhead and westslope cutthroat trout. Lower Fish Creek has been documented to support low populations of chinook salmon. Deadman and Boulder Creeks could potentialiy support chinook salmon.

The headwaters of Walde and Deadman Creek drainages have been extensively roaded for timber harvest. The first activity In the Walde Creek drainage occurred in the 1960% with the building of a high density logging read system. This activity heavily impacted the Walde Creek system with the construction of numerous roads at 300' elevation contours on erosive landtypes. Logging in the upper end of the Deadman Creek drainage began in the early 1970%. The lower road density and more stable landforms in the Deadman Creek drainage have kept impacts to Deadman Creek less severe than Walde Creek. The reaches of these streams that provide the fish habitat are virtually inaccessible by road.


LOCHSA RANGER DISTRICT
1980
SCALE
LEGEND
Forest Supervisor's Headquarters
District Ranger Station
Forest Service Station
National Forest Boundary
Adjacent National Forest Boundary
State Boundary Line
County Boundary Line
Reservation Line
Wilderness or Special Area Boundary
Permanent Lookout Station
Horizontal Control Station
U.S. Highway
State Highway
Forest Route
Primary Highway
Secondary Highway
Improved Road
Primitive Road
Historic or National Recreation Trail
Trail
Lands Administered by Clearwater National Forest
Ranger District Boundary
Start End
Stream section addressed in this report.
VICINITY MAP
N
LOCHSA HISTORICAL STATION
WILDERNESS GATEWAY
LOCHSA NATURAL RESEARCH AREA
SELWAY
NEZPERCE
STANDARD PARALLEL NORTH
BEGIN LOCHSA AND SELWAY RECREATION RIVERS
FIG. 1
SJB 3-21-86
T 35 N
T 34 N
T 33 N
T 32 N
R5E
R6E
R7E
R8E
R9E
R10E
R11E

There are several potential mining operations in the Walde Creek drainage. Damage to fish habibat attributable to past mining operations has been negligible. Current mining activity is at a relatively low level and is projected to remain so.

III. METHODS

A. Physical and Biological Survey

The methods used in performing the stream surveys for Walde, Deadman, lower Fish, and Boulder Creeks followed the guidelines established in the "Stream Survey Narrative - Clearwater National Forest Ocular Techinque for Multiple Use Planning Input - 196". The most important portion of the survey was to determine factors that were limiting production of anadromous salmonids. Specific attention was given to identifying: 1) barriers to upstream migration by adult steelhead ana chinook salmon; 2) abundance and availability of large woody debris (>6" diameter); and, 3) mixture and quality of spawning and rearing habitat.

In the Boulder Creek drainage, the major survey method was snorkeling. The purpose was to determine the extent of penetration by steelhead to aid in identifying upstream migration barriers. Physical stream features were estimated.

B. Physical and Biolcgical Modelling

A estimate of continued erosion and in-stream sediment loads was done for Walde and Deadman Creeks using the WATBAL watershed simulation model. The model is used to predict impacts to a watershed system from timber harvest and road construction activities. The impacts of erosion, sedimentation, stream flow are predicted from comparisons with modelled natural conditions.

In conjunction with WATBAL, the biological conditions of Walde and Deadman Creeks were estimated using the FISHSED Model (Stowell et al., 1983). This model uses existing in-stream sediment conditions and stream channel characteristics to predict the level of fish production relative to the potential of a given stream.

Analyses were also done to evaluate the physical limiting factors to steelhead rearing and spawning habitat on smolt production. The limiting factor analysis oversimplifys the complex factors affecting fish populations. However, it is useful to identify factors which have the greatest impact on the fishery.

The following assumptions were used in the limiting factor analysis:

- * full seeding of juveniles and biological potential at 10% (i.e., full biopotential);
- 6 fecundity rates of 6,000 eggs/steelhead (Dworshak National Fish Hatchery);
- ⁘ 13.7 m^2 spawning gravel/steelhead pair (Burner 1954);
- l embryo survival 30% (Bjornn 1978);
- 0 parr survival 20'; (Bjornn 1978);
- 8 parr survival over-winter 50X (Everest et al. 1984);
- * summer densities of juvenile steelhead at full biopotential estimated at 35/100 m of pool area (data from on the Clear-water and Nez Perce National Forests).

IV. RESULTS AND DISCUSSION

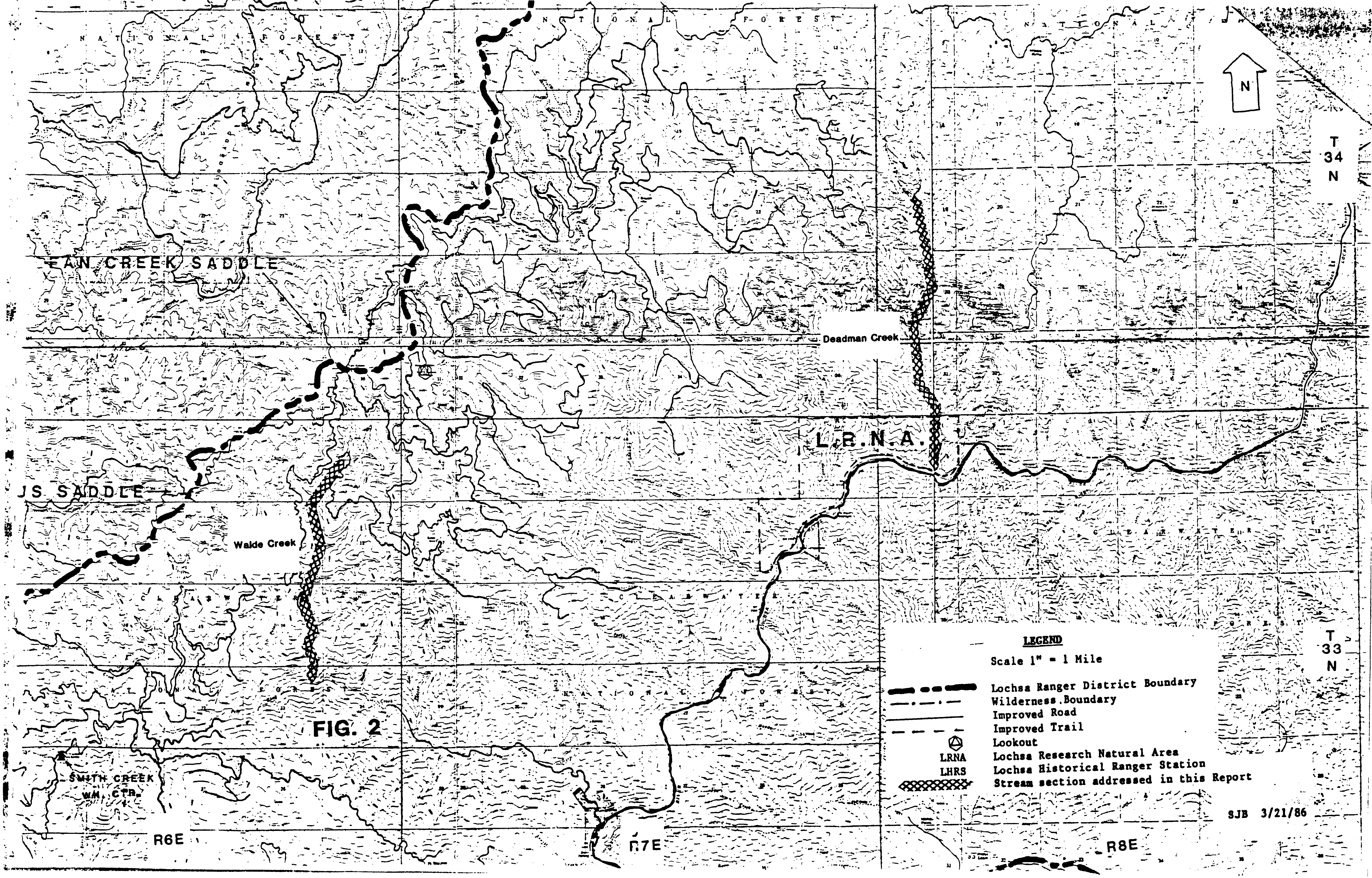
A. WALDE CREEK

1. Physical and Biological Characteristics

Walde Creek, a third order stream, enters Pete King Creek from the north at mile 5.0 (Murphy and Metsker, 1962). Walde Creek is approximately four miles in length and drains a watershed of approximately 5200 acres of National Forest Land. The stream flows from north to south (Fig. 2).

Walde Creek currently provides habitas for resident rainbow and cutthroat trout. Approximately 170 m of spawning gravel and 7965 m of rearing habitat are available. Stream gradient averages 6% with several short reaches (200 to 600 m) averaging 2-3%. The reach of Walde Creek surveyed averaged 3.0 m wide and 0.15 m deep. Two steep reaches with cataracts and falls prohibit upstream migration of steelhead to the spawning and rearing habitat In Walde Creek.

Only 10% of the spawning gravei (15 m^2) in this reach is in good condition. Most of the spawning gravel occurs in small areas l/2 to 5 m^2. Excessive sediment deposits are the primary cause for this condition. Sediment deposition in pools averages 40% of potential pool volume. Pool quality is fair. The percentage of sand and smaller size class stream channel substrate average 20+%; the small gravel to small rubble size class and the large rubble to bedrock size class are equally represented in the stream channel. Cobble embeddedness averages



NATIONAL FOREST
NATIONAL FOREST
NATIONAL
EAN CREEK SADDLE
JS SADDLE
Deadman Creek
L.R.N.A.
Walde Creek
CLEARWATER
CLEARWATER
CLEARWATER
NATIONAL FOREST
NATIONAL FOREST
FOREST
SMITH CREEK WK. CTR.
T 34 N
T 33 N
R6E
R7E
R8E
N
LEGEND
Scale 1" = 1 Mile
Lochsa Ranger District Boundary
Wilderness Boundary
Improved Road
Improved Trail
Lookout
LRNA Lochsa Research Natural Area
LHRS Lochsa Historical Ranger Station
Stream section addressed in this Report
SJB 3/21/86

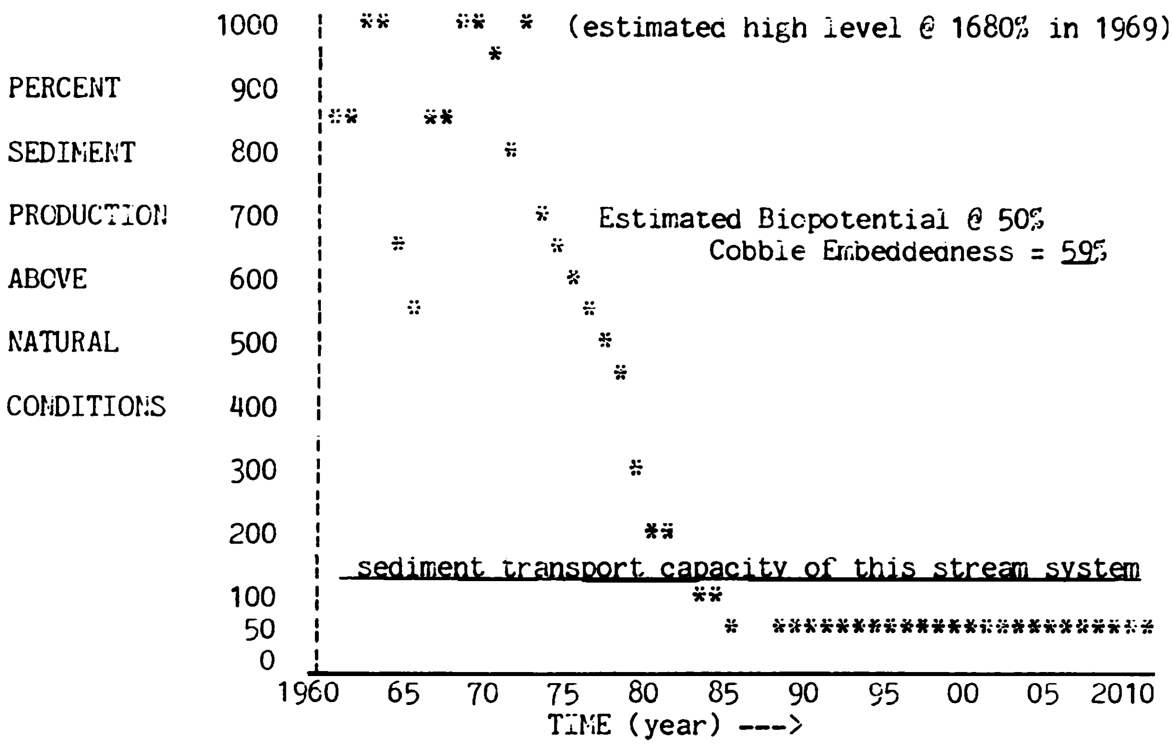
FIG. 2

about 50%. The pool to riffle ratio is about 30:70. The amount of instream debris (>6' diameter) is rated fair. Bank cover is provided by mature cedar trees, alder, and miscellaneous deciduous shrubs. Streambank cover is considered good. Benthos quality is poor.

2. Physical and Biological Modelling

a. Trends in Sediment Production (As Predicted by WATBAL)

Stream: Walde Creek



b. Limiting Factor Analysis on Potential Smolt Production -- WALDE CREEK

Optimum Physical Habitat Conditions (i.e., 50% pool habitat with no sediment impacts):

Surface Area (m^2) x 50% Pool Area x 35 Parr/100m^2 x 50% Over-winter Parr Survival = 7965 x .5 x .35 x .5 = 700 smolts produced at 100% biopotential

Spawning Habitat Conditions (i.e., full seeding and unlimited rearing habitat):

Spawning Area (m^2) x $13.7m^2$/Adult Female x 6000 Eggs/Adult Female x 30% Embryo Survival to Parr x 20% Summer Parr Survival x 50% Over-winter Parr Survival = 175 x 13.7 x 6000 x .3 x .2 x .5 = 2300 potential smolts produced based on the amount of available spawning gravels (raw area)

Rearing Habitat Conditions (i.e., based on estimated sediment impacts to biopotential):

Surface Area (m^2) x Pool Area (%) x 35 Parr/$loom^2$ x Estimated Biopotential (%) x 50% Over-winter Parr Survival = 7965 x .3 x .35 x .59 x .5 = 250 potential smolts produced based on current rearing habitat conditions

C. **Limiting Factor Stratification**

1) Principal Limiting Factor -- Inaccessible to adult steelhead for spawning. If the stream were accessible for spawning, the stream could produce an estimated 250 steelhead smelts. Making the area accessible would have a direct benefit of helping to seed the upper reaches of the mainsten of Pete King Creek.

a Secondary Limiting Factor(s) -- Deficient pool quality due to excessive sediment and a lack of large instream organic debris (trees). Increasing pool quantity and quality and reducing the amount of sediment travelling in the stream could increase potential smolt production to an estimated 700 smolts.

3. **Discussion and Management Opportunities**

Walde Creek is a tributary of Pete King Creek. Pete King Creek is a major tributary to the Lochsa River and enters the Lochsa at river mile 2.0. Pete King Creek is a major steelhead rearing stream providing approximately 53,000 m^2 rearing habitat and 890 m^2 of spawning gravels. Approximately 25% of the andromous fish rearing habitat in the Pete King Creek drainage occurs in 1.25 mile long reach immediately below the confluence of Pete King Creek and Walde Creek.

This upper reach of Pete King Creek has a channel gradient of about 6% and spawning gravels are quite scattered with only 5% of the 180 m^2 of spawning gravel in good condition. This reach is the highest that adult anadromous salmonids can currently penetrate the Pete King Creek system. Because of the amount of available rearing habitat and the generally poor quality spawning habitat, we feel this reach is significantly understocked with young steelhead.

Walde Creek has one reach approximately one mile above the confluence of Walde Creek with Pete King Creek that has an average gradient of 2-3% and an accumulation of suitable steelhead spawning gravels. However, three small barriers to upstream migration of adult steelhead occur between the reach with the spawning Gravels and the mouth of Walde Creek. Access tc this reach would occupy vacant habitat and increase seeding of the upper reaches of Pete King Creek.

The headwaters of Walde Creek will continue to contribute significant amounts of sediment to lower Walde and Pete King Creek. This is due tc the sediment from early logging and road construction that eroded and become trapped in the channel substrate and behind debris jams. Efforts to trap and remove sediment in this reach would reduce the amount of sediment transported to, and deposited in, the mains&m of Pete King Creek .

Fish habitat improvement opportunities in Walde Creek are limited to improving upstream access, enhancing existing spawning gravels, and reducing the dcwnstream movement of bedload sediment.

An excellent opportunity exists to stock Walde Creek with steelhead fry . The upper end of this reach is easily accessible to hatchery trucks during May.

B. DEADMAN CREEK

1. Physical and Biological Characteristics

Deadman Creek, a fifth order stream that enters the Lochsa River from the North at river mile 11.0 is approximately 7.5 n.iies in length and flows primarily from north to south. Deadman Creek drains a watershed of approximately 12,000 acres of National Forest Land. Approximately four miles of the lower reaches of Deadman Creek were surveyed (Fig. 2).

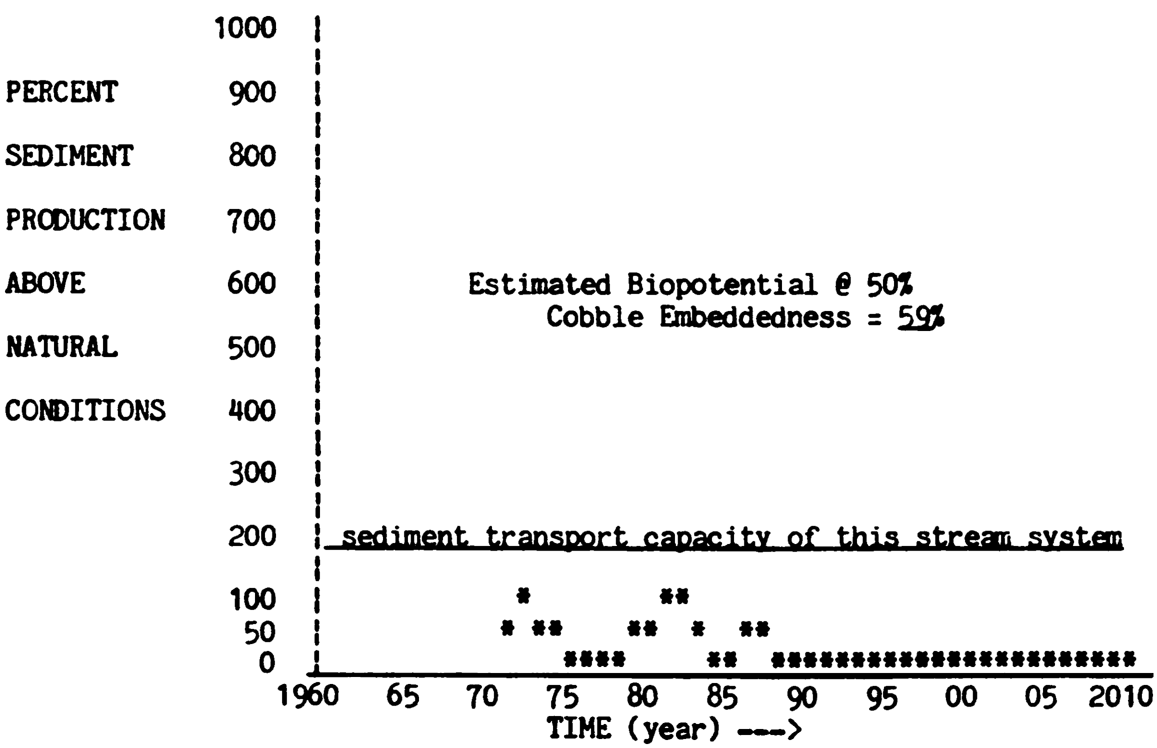
This stream currently provides habitat for steelhead, resident rainbow and cutthroat trout. Approximately 1160 m^2 of spawning gravel and 26,680 m^2 of rearing habitat are available. Stream gradient ranges from 1-6% and averages 2-3%. The surveyed reaches averaged 4.3 m wide and .22 m deep.

About 80% of the spawning gravel (980 m^2) in this reach is in good condition, Most of the spawning gravel occurs in small areas l/2 to 5 m^2. The percentage of sand and smaller size class stream channel substrate average 20+%; the small gravel to small rubble size class is about 45% of the substrate and the large rubble to bedrock size class is about 35% of the substrate. Cobble embeddedness averages about 50%. The pool to riffle ratio is about 30:70. The amount of instream debris (>6' diameter) is rated fair. Bank cover is provided by mature conifer trees, alder, and miscellaneous deciduous shrubs. Streambank cover is considered good.

2. Physical and Biological Modelling

a. Trends in Sediment Production (As Predicted by WATBAL)

Stream: Deadman Creek



b. Limiting Factor Analysis on Potential Smolt Production -- DEADMAN CREEK

Optimum Physical Habitat Conditions (i.e., 50% pool habitat with no sediment impacts):

Surface Area (m^2) x 50% Pool Area x 35 Parr/100m^2 x 50% Over-winter Parr Survival = 26,680 x .5 x .35 x .5 = 2300 smolts produced at 100% biopotential

Spawning Habitat Conditions (i.e., full seeding and unlimited rearing habitat):

Spawning Area (m^2) x $13.7m^2$/Adult Female x 6000 Eggs/Adult Female x 30% Embryo Survival to Parr x 20% Summer Parr Survival x 50% Over-winter Parr Survival = 1180 x 13.7 x 6000 x .3 x .2 x .5 = 15.500 potential smelts produced based on the amount of available spawning gravel3 (raw area)

Rearing Habitat Conditions (i.e., based on estimated sediment impacts to biopotential):

Surface Area (m^2) x Pool Area (%) x 35 Parr/$loom^2$ x Estimated Biopotential (%) x 50% Over-winter Parr Survival = 26,680 x .3 x .35 x .71 x .5 = 990 potential smelts produced based on current rearing habitat conditions

c. **Limiting Factor Stratification**

1) Principal Limiting Factor -- Deficient pool quality due to excessive sediment and a lack of large in&ream organic debris (trees). Increasing pool quantity and quality and reducing the amount of sediment travelling in the stream could increase potential smolt production from an estimated current production of 990 smolts to an estimated 2300 smelts (150+% increase in steelhead smolt production).

a Secondary Limiting Factor(s) -- None identified

3. Limiting Factors and Management Opportunites

Deadman Creek has been directly impacted by the removal and transport of cedar products (cedar shakes, shingles, and posts) within the riparian zone. This process removed large trees from the riparian zone. Perhaps more significantly, the stream channel itself was cleared of large debris to allow for the transport of the cedar products downstream during high water. This activity occurred over 10 years ago.

The riparian zone is still in excellent condition due to the abundance of other conifers >12" diameter. Rowever, large debris recruitment into the stream channel has been low because of the genera: youth and vigor of the conifers in the riparian zone.

The shortage of large debris in the stream is limiting the steelhead rearing capacity of the system by limiting habitat diversity which would provide for more high quality pools (only rated as fair, now).

Fish habitat Improvement opportunities in this stream are limited to improving pool quality by increasing and stabalizing large woody, debris. Access to this stream is limited to hiking only. Therefore, efforts to improve habitat diversity by increasing the amount of large woody debris would be labor intensive and limited to the use of chainsaws, portable winches, and cable.

An excellent opportunity exists to stock this reach with steelhead fry. The upper end of this reach is easily accessible to hatchery trucks.

C. LOWER FISH CREEK

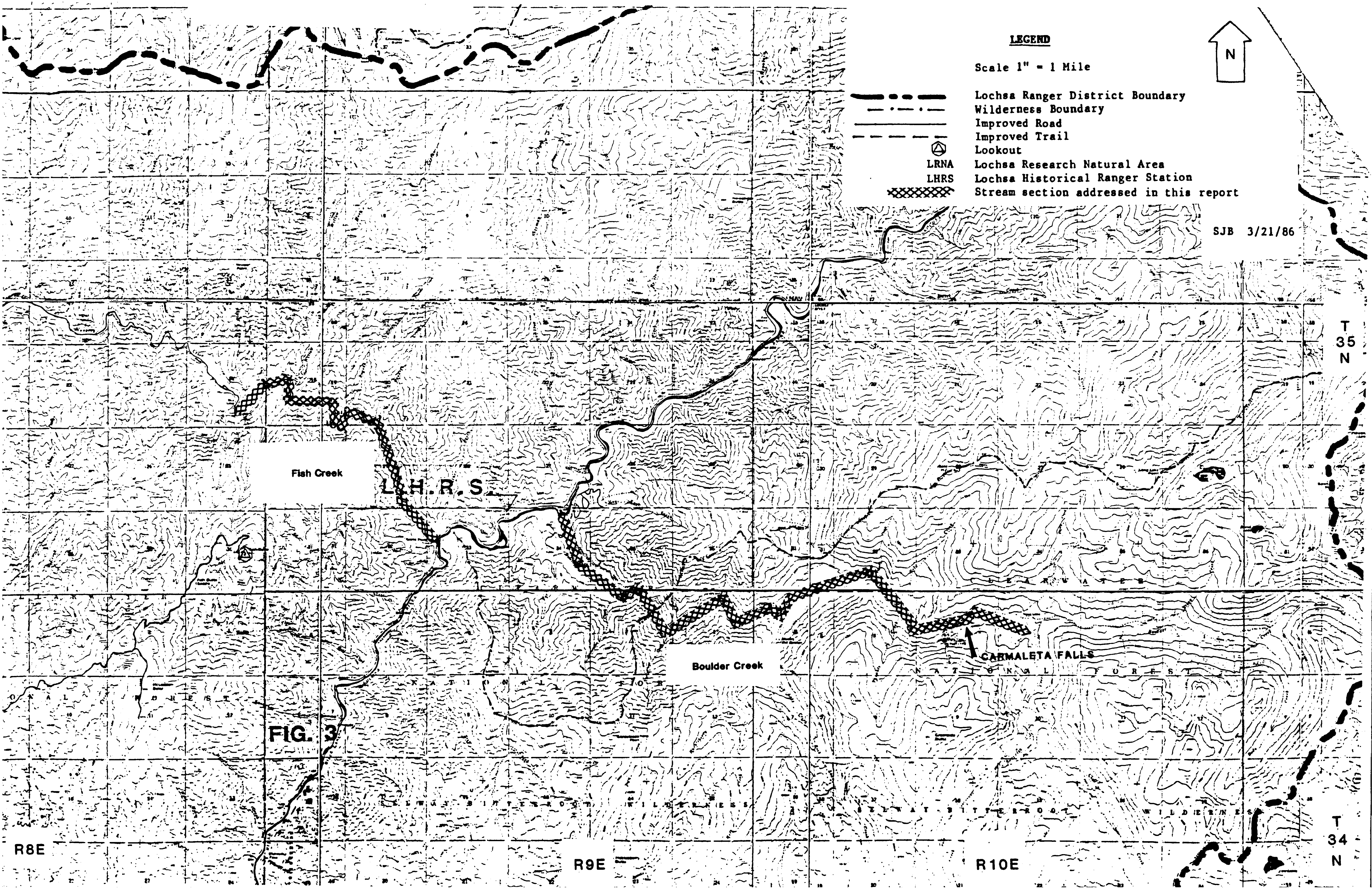
1. Physical and Biological Characteristics

Fish Creek, a seventh order stream, enters the Lochsa River from the North at river mile 25.5. Fish Creek is approximately 21 miles in length and drains a watershed of approximately 60,000 acres of National Forest land. The stream flows primarily from the northwest to the south and southeast (Fig. 3).

The Fish Creek drainage is a relatively pristine watershed. The fires of 1919 and 1934 burned through the drainage. Logging first appeared in the headwaters in 1971. The lower reach of Fish Creek (lower Fish Creek) averages 11.0 m wide and .45 m deep. There is little riparian vegetation overhanging the stream bank. Numerous large boulders provide deep pools as well as shade for the fish to hide and escape direct sunlight.

This stream currently provides habitat for steelhead, resident rainby and cutthroat trout, and chinook salmon. Approximately 660 m^2 of spawning gravel and 70,800 m^2 of rearing habitat are available. Most of the spawning gravel occurs in small areas l/2 to 5 m^2. Stream gradient ranges from 2-51 and averages 3%.

About 80% of the spawning gravel (550 m^2) in this reach is in good condition. The percentage of sand and smaller size class stream channel substrate average 5%; the small gravel to small rubble size class is about 20% of the substrate and the large rubble to bedrock size class is about 75% of the substrate. Cobble embeddedness averages less than 25%. The pool to riffle ratio is about 30:70. The amount of instream debris >6' diameter) is nearly non-existent. Pool quality is good. Bankcover is provided by miscellaneous deciduous shrubs. Streambank cover is considered poor. Benthos quality is fair.


LEGEND
Scale 1" = 1 Mile
Lochsa Ranger District Boundary
Wilderness Boundary
Improved Road
Improved Trail
Lookout
LRNA Lochsa Research Natural Area
LHRS Lochsa Historical Ranger Station
Stream section addressed in this report
N
SJB 3/21/86
Fish Creek
L.H.R.S.
Boulder Creek
CARMALETA FALLS
FIG. 3
T
35
N
T
34
N
R8E
R9E
R10E

2. **Physical and Biological Modelling**

a. Because of the lack of sediment effects on this reach, estimates of impacts of sediment production from the extreme headwaters on fish and fish habitat were not made.

b. Limiting Factor Analysis on Potential Smolt Production -- LOWER FISH CREEK

Optimum Physical Habitat Conditions (i.e., 50% pool habitat with no sediment impacts):

Surface Area (m^2) x 50% Pool Area x 35 Parr/100m^2 x 50% Over-winter Parr Survival = 70,800 x .5 x .35 x .5 = 6200 smelts produced at 100% biopotential

Spawning Habitat Conditions (i.e., full seeding and unlimited rearing habitat):

Spawning Area (m^2) x 13.7m^2/Adult Female x 6000 Eggs/Adult Female x 30% Embryo Survival to Parr x 20% Summer Parr Survival x 50% Over-winter Parr Survival = 660 x 13.7 x 6000 x .3 x .2 x .5 = 8670 potential smelts produced based on the amount of available spawning gravels (raw area)

Rearing Habitat Conditions (i.e., based on estimated sediment impacts to biopotential):

Surface Area (m^2) x Pool Area (%) x 35 Parr/100m^2 x Estimated Biopotential (%) x 50% Over-winter Parr Survival = 70,800 x .3 x .35 x 1.00 x .5 = 3700 potential molts produced based on current rearing habitat conditions.

C. **Limiting Factor Stratification**

1) Principal Limiting Factor -- Deficient pool quality due to a lack of large instream organic debris (trees). Increasing pool quantity and quality could increase potential smolt production from an estimated 3700 to 6200 steelhead smolts (65+% increase in steelhead smolt production).

2) Secondary Limiting Factor(s) -- Hone identified

3. **Discussion and Management Opportunities**

The riparian zone of lower Fish Creek is virtually void of nature conifersand tall deciduous trees/shrubs. The large wildfires in this drainage prior to 1935, burned and then re-burned through the riparian zone, consumed the mature conifers, and severely disrupted the conifer seed sources for i-e-seeding the riparian zone. Other than the catastrophic fires, this reach is pristine in character (i.e., it has not been impacted by sediment).

The impact of the removal of the riparian zone and a conifer seea source has been that re-establishment of the conifers is proceeding at a slow pace with many of the suitable tree sites already occupied by shrubs. As a result of the absent large debris component of the riparian zone, shading and insolation of the stream channel is virtually non-existent in this reach. Summer water temperatures have been recorded in excess of 20.3 C. This is suspected to occur regularly in this reach and for extended periods of the daylight hours during the summer. Estimates of the impacts on winter water temperatures, icing, and fish have not been made.

D. BOULDER CREEK

1. Physical and Biological Characteristics

Boulder Creek, a sixth order stream, enters the Lochsa River from the North at river mile 26.5. Boulder Creek is approximately 13 miles in length arid drains a watershed of approximately 28,000 acres of National Forest land. The stream flows primarily from the southeast to the northwest. Approximately 7.5 miles of this stream were sampled (Fig. 3).

The Boulder Creek drainage is a pristine watershed. Over 90% of the drainage is in the Selway-Bitterroot Wilderness Area. The fires of 1919 and 1934 burned through the drainage. The stream averages an estimated 10.7 m wide and .45 m deep. mere is little riparian vegetation overhanging the stream bank. Numerous large boulders provide deep pools as well as shade for the fish to hide and escape direct sunlight.

The primary purpose of the survey was to determine the degree of penetration by migrating adult steelhead. Snorkeling was done at representative reaches to determine if juvenile steelhead were present or absent. Approximately six miles above the mouth of Boulder Creek, the presence of juvenile steelhead in the fish population ceased. Above that point, no juvenile steelhead were observed.

At this point a sloping falls (Carmaleta Falls) stops upstream migration of adult steelhead. This falls is best described as a steep, smooth cataract rising 25-30′ in elevation and extending approximately 50′ in slope distance. An excellent take-off pool exists at the foot of the falls. However, there are no pockets for migrating adult steelhead (or chinook salmon) to escape the high water velocity travelling over the falls.

Densities of juvenile steelhead in the sampled reaches below the falls were quite law. Few fish of the year were observed. Spawning gravels were virtually non-existent because of steep stream gradients.

This stream currently provides habitat for steelhead, resident rainbow, cutthroat, bull, and brooktrout. Approximately I40 m of spawning gravel and 103,300 m of rearing habitat are available. Stream gradient ranges from 2-5; and averages 3%.

About 80% of the spawning gravel (90 m^2) in this reach is in good condition, Most of the spawning gravel occurs in small areas l/2 to 5 m^2. The percentage of sand and smaller size class stream channel substrate average 5%; the small gravel to small rubble size class is about 40% of the substrate and the large rubble to bedrock size class is about 55% of the substrate. Cobble embeddedness averages less than 25%. The pool to riffle ratio is about 25:75. The amount of instream debris **(>6'** diameter) is nearly non-existent. Pool quality is good.

2. Physical and Biological Modelling

a. Because of the lack of sediment effects on this reach, estimates of impacts of sediment production from the extreme headwaters on fish and fish habitat were not made.

b. Limiting Factor Analysis on Potential Smolt Production - **BOULDER CREEK**

Optimum Physical Habitat Conditions (i.e., 50% pool habitat with no sediment impacts):

Surface Area (m^2) x 50% Pool Area x 35 **Parr/100m^2** x 501 Over-winter Parr Survival = 103,300 x .5 x .35 x .5 = 9050 smolts produced at 100% biopotential

Spawning Habitat Conditions (i.e., full seeding and unlimited rearing habitat):

Spawning Area (m^2) x 1 3.7m^2/Adult Female x 6000 Eggs/Adult Female x 30% Embryo Survival to Parr x 20% Summer Parr Survival x 50% Over-winter Parr Survival = 140 x 13.7 x 6000 x .3 x .2 x .5 = 1850 potential smelts produced based on the amount of available spawning gravels (raw area)

Rearing Habitat Conditions (i.e., baaed on estimated sediment impacts to **biopotential):**

> Surface Area (m^2) x Pool Area **(%)** x 35 **Parr/100m**^{2} x Estimated **Biopotential** (%) x 50% Over-winter Parr Survival = 103,300 x .3 x .35 x **.59** x .5 = 4500 potential amolts produced baaed on current rearing habitat conditions

C. Limiting Factor Stratification

1) Principal Limiting Factor -- Inaccessible to adult steelhead for spawning. If the stream were accessible for spawning, the stream could produce an estimated increase of 2650 steelhead molts. This could increase estimated steelhead smolt production from a current level of 1800 to 4500 **(150+%** increase in steelhead smelt production.

2) Secondary Limiting Factor(a) -- Deficient pool quality due to a lack of large instream organic debris (trees). Increasing pool quantity and quality could increase potential smolt production to an estimated go50 smolts.

3. Discussion and Management Opportunities

The reach above Carmaleta Falls has abundant high quality spawning habitat. Gentle stream gradient and expansive accumulations of excellent quality spawning gravels typify the mainstem of boulder Creek for several miles. It is unknown how many square meters of high quality anadromous fish spawning gravels exist above the falls. However, it is estimated that enough high quality spawning gravels exists in this reach to fully seed the mainstem of Boulder Creek.

The riparian zone of Boulder Creek has a limited amount of mature conifers and tall deciduous trees/shrubs. The large wildfires in this drainage prior to 1935, burned through the riparian zone and consumed moat of the mature conifers. Other than the catastrophic fires, this reach is pristine in character. The riparian area is currently well stocked with sapling size conifers. It will probably take another 75-100 years before the riparian area has filly recovered from the large wildfires.

The impact of removing the riparian zone has been that large debris component of the riparian zone has been reduced$_6$ Summer water temperatures are estimated to seldom exceed 18.0 C due to topographic shading and the presence of some mature conifers in the riparian zone. Estimates of the inpacts on winter water temperatures, icing, and fish have not been made.

Enhancement Plan

A list of proposals for steelhead habitat enhancement projects follows on page 18. These projects are best estimates of the work that we could do to mitigate specific limiting factors in each of the surveyed streams. Projects like the removal of migration barriers accessing spawning gravels would begin to show returns in about five years. The projects to install structures in the streams to improve pool quality would also begin to show benefits in about five years. These types of projects would have almost immediate improvements to spawning and rearing habitat.

The project to plant conifers and deciduous trees in lower Fish Creek would not show benefits to fish habitat quality for many years. This is due to the time required to *grow* these seedlings into trees large enough to provide bank cover and large debris recruitment. It will also take a long time for these trees to grow large enough to provide insolation and insulation to moderate water temperatures in the summer and winter. Planting conifer and deciduous trees in the riparian zone of lower Fish Creek would speed. the natural recovery of the riparian zone by 30-50 years, It would also provide an earlier source of large debris because the planted deciduous trees grow larger and more rapid than conifers of the same age.

All the projects, except the fish passage improvement in Boulder Creek, have a high probability of being completed without complex planning or coordination. The Boulder Creek project , however, is entirely within the Selway-Bitterroot Wilderness. A project of this type could be outside the wilderness management policy of the Forest Service, In addition, the project is remote and intensive planning would be involved to improve fish passage without degrading wilderness values. These factors would require complex planning and coordination prior to approval and execution of this project .

The projects proposed in this enhancement plan could produce an estimated **7150** smelts at an estimated cost of $49,500. Assuming an estimated return rate of 1,65 adults/100 amolts, 115 adult steelhead could be produced, Assuming a value of $359)/adult steelhead (Meyer, 1982), this would equate to an estimated dollar value of $41,300/year[1/].

1/ Estimates of habitat or economic benefits associated with chinook salmon ' ive not been given consideration in this report. Without further data to ıpport the potential of these streams to support viable populations of chinook salmon, we feel estimates of benefits **associated with** this species would be "memature. We do feel that there is a strong possibility that these streams ›uld support chinook salmon if the escapement of larger numbers of chino& were to occur.

PROPOSED STEELHEAD HABITAT ENHANCEMENT PROJECTS
Lochsa Ranger District

PROJECT DESCRIPTION	WALDE	DEAD-MAN	LOWER FISH	BOULDER
Fish passage improvement	$5000			$7000
Plant conifers and deciduous trees			$10,000 20 ac	
Tree felling & placement for debris recruitment and pool formation		$3000 60 st		
Install log weirs	$5000 15 st			
Install sediment trap	$3000 1 st			
Purchase suction dredge to clean sediment traps	$2500 1 unit			
Annual maintenance of sediment traps (two cleanings/yr)	$2000			

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APPENDIX

-Anadromous Fish Habitat Survey Summary, Lochsa Ranger District, 1985

ANADROMOUS FISH HABITAT SURVEY SUMMARY
Lochsa Ranger District, 1985

FEATURES	STREAM Walde	Deadman	Lower Fish	Boulder
Physical				
Mean Gradient (%)	6	3	3	[6]
Mean Width (m)	3.0	4.3	11.0	[10.7]
Mean Depth (m)	0.15	0.22	0.45	[0.45]
Surface Area (m^2)	7965	26,680	70,800	[103,300]
Pool to Riffle Ratio	30:70	30:70	30:70	[25:75]
Bank Stability	Fair	Good	Excellent	Excellent
Substrate				
<.25" dia.	20%	20%	5%	[5%]
0.25-6.0" dia.	40%	45%	20%	[40%]
>6.0" dia.	40%	35%	75%	[55%]
embeddedness	50%	50%	<25%	<25%
Habitat				
Spawning Gravel (m^2)	175	1180	660	[140]
(Good)	15	980	550	[90]
(Fair)	90	200	110	[50]
(Poor)	70	Ø	Ø	Ø
Pool Quality	Fair	Fair	Good	Good
Benthos Quality	Poor	Fair	Fair	Fair
Streambank Cover	Good	Good	Poor	Poor
Instream Debris >6" dia.	Fair	Fair	Poor	Poor

] = Estimates

LOCHSA RIVER TRIBUTARIES ENHANCEMENT PROPOSAL

Powell Ranger District

Clearwater National Forest

Region 1

Final Report FY 1985 through 1986

Funded by
Bonneville Power Administration
Division of Fish and Wildlife

Contract No, DE-AI79-84BP16121

Project No, 84-31

by

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Project Leader

INTRODUCTION

In 1984, and under the auspices of the Northwest Power Act, the Clearwater National Forest and Bonneville Power Administration entered into a contractual agreement (Project 84-31) to identify potential enhancement projects for anadromous fish in the Clearwater River Basin. The Lochsa River and its tributaries, more specifically Squaw, Doe, and Papoose Creeks, provide excellent opportunities for such a project (Fig. 1).

DESCRIPTION OF PROJECT AREA

The Clearwater National Forest (1.8 million acres) is Located in north central Idaho and supports some of the most significant and valuable salmonid resources in the region (Fig. 2). The Forest provides a total of 2,500 acres of spawning, rearing, and migratory habitats for two anadromous species - spring chinook salmon and summer steelhead trout. Of this total, 100 acres consist of high quality spawning habitat.

Recent history has documented the massive hydroelectric development of the Columbia and Snake Rivers and their major tributaries. This development has been costly in terms of the basin's and Forest's fish resources. In 1927, a dam built near Lewiston, Idaho virtually destroyed the run of spring chinook salmon in the Clearwater River, Drainage. In the early 1970's, Dworshak Dam on the North Fork of the Clear-hater River eliminated 60 percent of the Forest's highest quality habitat for steelhead trout and Lower Granite Dam on the Snake River increased the gauntlet of dams to eight that anadromous fish from Idaho had to negotiate. By the mid 1970's, Idaho stocks of anadromous fish had bottomed out and were on the brink of extinction. Since that time, accelerated efforts of mitigation and restoration have actuated a trend of significant recovery for steelhead trout. The recovery of chinook salmon, though on the increase, has been much slower.

The three streams in which mitigation practices are being proposed drain a variety of landforms that include glacial valley trains, steep breaklands, colluvial drift slopes, and alluvial flood plains, Breaklands and alluvial plains dominate these watersheds. Granite soils of the Idaho Batholith typify the geology of the area. The streams are all third and fourth order tributaries, that flow through dense, mixed coniferous stands of western red cedar, Douglas-fir, Englemann spruce, white pine, ponderosa pine, and larch. Few deciduous species are present within the riparian zones. Squaw and Papoose Creeks support- populations of chinook salmon, steelhead trout, bull trout, and westslope cutthroat. Doe Creek supports populations of steelhead trout, bull trout, and westslope cutthroat.

Tile Squaw Creek drainage and Doe Creek (a tributary of Squaw Creek) drainage have been heavily developed and impacted. The first activity in the drainages occurred in 1953 with the building of a jammer road system. This activity, however, had only a moderate impact on the system and it was not until 1968 when a large number of roads were constructed on slopes greater than 60 percent that sediment outputs exceeded the equilibrium threshold. Murphy and Metsker (1962) reported that these streams carried a considerable silt load following rains and rapid snow melts. Forest Service Roads (FSR) 108 and 566 were constructed on very sensitive land types which caused h major impact to the

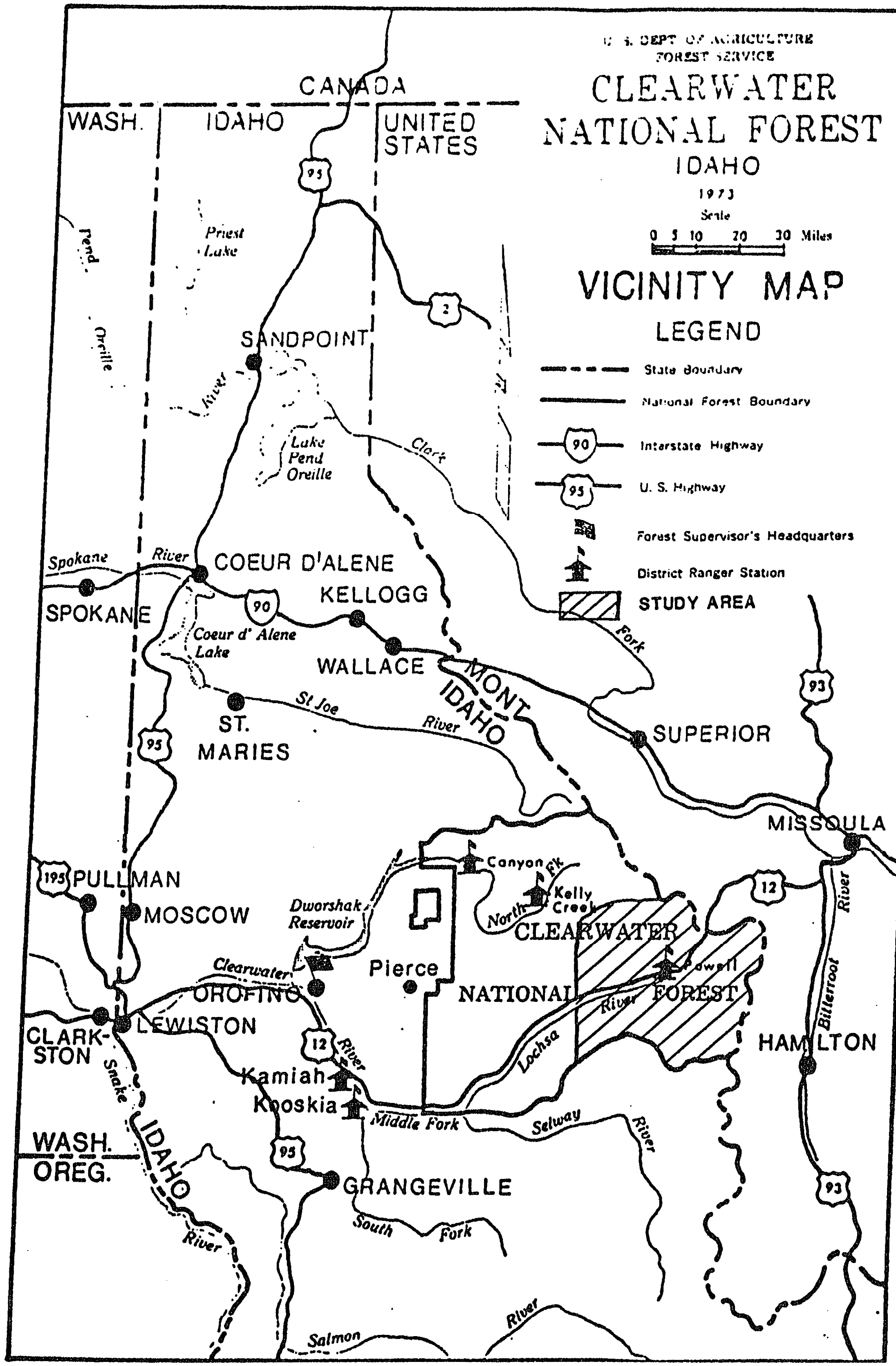

Figure 1. Project area.

streams. The roads encroach upon Squaw and Doe Creeks, respectively, in many areas (Fig. 3). On Squaw Creek several road crossings have occurred in the past with very little regard to stream habitat (Murphy and Metsker 1962). A similar scenario exists in the Papoose Creek drainage. Logging has been occurring in this basin since the early 1950's. Forest Service Road 568 encroaches upon the stream in several areas and causes streambank failure or completely eliminates the riparian zone between the stream and road. Road encroachment and its impacts are not as extensive along the mainstem of Papoose Creek in comparison to the road encroachment along Doe and Squaw Creeks. However, the East Fork of Papoose Creek has severe and extensive road encroachment.

Figure 3. Road encroachment.

OVERALL METHODS SUMMARY: 1984-1985 STREAM SURVEY

The methods used in performing stream surveys for Papoose, Squaw, and Doe Creeks foLlowed the guidelines established in the "Stream Survey Narrative - Clearwater National Forest Ocular Techinque for Multiple Use Planning Input - 1976" (Appendix D) . Several techniques were changed or added to meet the purpose of this project. Reach lengths were varied to create more homogeneous reaches from a habitat standpoint and left less bias in the summarized parameters. The following criteria were used for breaking reaches: a significant change in the stream gradient (2% or more), where a feeder creek which provided at least 10% of the flow entered the system, where a road crossed the creek, or where there was a major topographic or geological feature (i.e. a bedrock face or outcrop, or a well defined draw). As an upper level standard, no reach was to be more than l/2 mile in length. All station values were weighted by length for total reach values.

While conducting the survey, notes were taken on potential sites for structures and then marked on a topographic map. The type of structure that would be effective at the site, whether materials were readily available, location and the nearest machine access point were recorded, Location of raw materials needed for structure construction such as boulders, logs, and rip-rap were also recorded.

Additional techniques and parameters were developed to provide information on existing acting debris, potential debris recruitment, and riparian vegetation. The objective of collecting data on acting instream debris was to determine differences between an unimpacted; pristine stream and an impacted stream. In order for existing acting debris to be recorded it had, to be more, than negligibly providing instream habitat, Debris had to be stable and capable of providing habitat over an extended period of time, For this reason, debris under four inches in diameter which appeared to have been recently added to the system were not recorded. However, debris of this size which, had obviously I been in the creek channel for several years were recorded. Items such as exposed root masses of live standing trees or undercut banks were not counted unless they had caused the bank to slump and the root mass had entered the channel and was actively providing instream habitat. Massive amounts of debris causing one particular effect on a stream channel were recorded as one acting debris. Interlocked <debris which had component partsaffecting the channel independently of the otherdebris were counted by the component part.

The objective of the potential debris recruitment parameter was to gather d&a on trees which, potentially, could enter the stream channel and remain, effectively providing instream cover. Data gathered for this parameter was used in comparing an impacted bank of a stream and its values to an unimpacted bank of the same stream and it&values. Care must be taken in comparing data for banks to ensure that the banks used in the comparison are not influenced by natural constraints such as talus slopes or exposed bedrock. Delineation of trees which may be classified as potential debris recruitment trees was determined through the use of an angle gauge which utilizes a basal area factor (BAF) table. Measurements were taken for each bank every 110 yards. It was determined that the minimum size tree desired to provide the optimum amount of instream habitat is 12 in diameter at breast height (DBH). With a BAF of 20 a 12 in DBH tree would continue to be tallied up to a distance of 23.3 ft from the sampling point. It was decided that this was a desired maximum distance for a 12 in DBH tree because- the diameter of the tree 23.3 Et up the bole would be too small to withstand natural forces and would not stabilize and influence the creek for an extended period of time. Trees with DBH's larger than 12 in would provide a minimum diameter capable of withstanding these natural forces further up the bole of the tree and thus could be further away from the point of sampling. As an example, a tree with a 40 in DBH could be up to 77.8 ft from the sample point and still be tallied as a debris recuritment tree using a BAF of 20.

A more finite overview of what riparian vegetation existed was desired so parameters were developed, to reflect what species comprised the dominate and subdominate riparian vegetation. Data was collected every 110 yards. For the dominant riparian vegetation an estimate of the percentage at which each age class is stocked was recorded. Stocking rates could equal 100% for more than one age class and therefore are not additive. The percentage for each size class gives an idea of it's stocking relative to its potential. The age class parameters are as follows: seedling over 6 in in height and up to 0.9 in DBH, sapling 1-4 in DBH, pole T-8.9 in DBH, and saw 9 in plus DBH.

Road surveys, independent of the stream surveys, were performed for FSR's 566, 108, and 568 which run adjacent to Doe Creek, Squaw Creek, and Papoose Creeks, respectively (Fig. 1). The road survey identified areas where the road is failing directly into the stream and rip-rap is needed to protect and strengthen the area and sections of the road in which insloping, and/or redefining are needed to effectively buffer the stream. Set t ions were designated as requiring insloping when the road was within five feet of the stream and/or when it was apparent that road maintenance would directly deliver material to the stream. Wide sections of road with severe encroachment were identified to be re-defined to provide for an adequate buffer.

A WATBAL analysis was performed for each stream. WATBAL is a watershed simulation model which predicts impacts to a watershed system from various land management activities such as timber harvesting and road construction. Management impacts are compared with expected natural conditions annually over time in terms of stream flow, slope diversity, sediment carrying capacity, and sediment delivery, to provide a general analysis of watershed condition.

In conjunction with WATBAL, a FISHSED analysis was performed for each stream. FISHSED is a model that predicts the effects of sediment on the biological potential of streams. A recently developed model (Espinosa 1985) was utilized to determine the effects of quantity and quality of rearing habitat on the biological potential of each stream (Rearing Habitat Index, RHI). Existing smelt production was calculated by using the model which exhibited the greastest effect on the individual stream's biological potential.

Utilizing the information generated from the aforementioned models, a limiting factor analysis was performed which compared the effects of rearing habitat and spawning habitat on the smolt production. The following assumptions were used in the limiting factor analysis:

full seeding of juveniles and the biological potential at 100% with the optimum level of rearing habitat when computing potential smolt production from available spawning gravels;

fecundity rates of 6,00O/steelhead and 4,5OO/chinook (Dworshak National Fish Hatchery) ;

15 square yards spawning gravel/steelhead pair and lb/chinook pair (Burner 1951);

emergent fry survival, 30% (Bjornn 1978);

parr survival, 20% (Bjornn 1978);

smelt survival over-winter, 50% (Everest et al. 1984) and;

summer densities of juvenile steelhead and chinook at full seeding and existing conditions of 35/100 square meters and 70/100 square meters respectively (data colLected on the Clearwater and Nez Perce National Forests).

RESULTS AND DISCUSSION

SQUAW CREEK

During the 1984 field season a total of 4.1 miles of Squaw Creek were surveyed starting from the mouth at the Lochsa River and working, upstream. The survey ended where the stream splits and forms the East and West Forks (Fig. 4). The stream survey data has been summarized and described below in two sections because there are significant gradient and habitat differences between reaches A-E and F-O.

Approximately 55% of the area in the Squaw Creek watershed consists of undifferentiated parent material and 17% of Idaho Batholith granites and gneisses. Over 55% of the drainage includes landform types 60, 61, and 63. These landforms are predominately on slopes greater than 60% with a great potential for road construction problems which includes a very high risk of sediment being delivered to streams.

Development began in the Squaw Creek drainage in 1953. Shortly after this time sediment outputs began affecting fisheries habitat (sediment production exceeding 45% over natural is considered to be the threshold for impact on fisheries habitat). By l964, development was producing sediment which exceeded the stream stability or equilibrium threshold (the level at which physical damage is occurring in the stream, i.e. channel changes, point bar formation) of 212% over natural. The model indicates that recovery to fish habitat may begin in 1990, based on past and currently planned activities but, in actuality, the impact of road encroachment on the stream in this drainage and the fact that some areas still have not stabilized, prevents full recovery.

Overall cobble embeddedness (embeddedness) for Squaw Creek is 46% which corresponds with the effects predicted in the WATBAL model. Both the FISHSED and RHI models predicted similar effects on the biological potential for steelhead trout, 62% and 63% respectively, Chinook salmon are more sensitive to the effects of sediment, therefore, FISHSED predicts the biological potential to be lower at 57%.

The large culvert located at the mouth of the West Fork of Squaw Creek (Fig. 4), has been identified as a complete passage barrier for resident species and a partial barrier for steelhead. The culvert measures 52 ft in length 11.5 ft in width and 8.25 ft in height. It has a gradient of 3% and the drop from the lip of the culvert to the surface of the watersbelow is 1.9 ft. “The mean flow for the the West Fork of Squaw Creek during the months of May and June, which would cover the majority of the spawning period for both steelhead and cutthroat, is 39 cfs (7 year average). Calculated velocities for a culvert of this size exceed 8 ft/s. Steelhead can pass up to 50 ft between. resting pools in velocities up to 7 ft/s and cutthroat must have velocities less than 3 ft/s for this distance. Therefore, the jump plus the velocity barrier presents a total barrier for both species during the majority of the spawning season.

Due to the extent and impact of the road encroachment along Squaw Creek, a road survey was completed in order to identify problem areas. Forest Service Road 108 runs adjacent to the stream for virtually the entire length of the stream

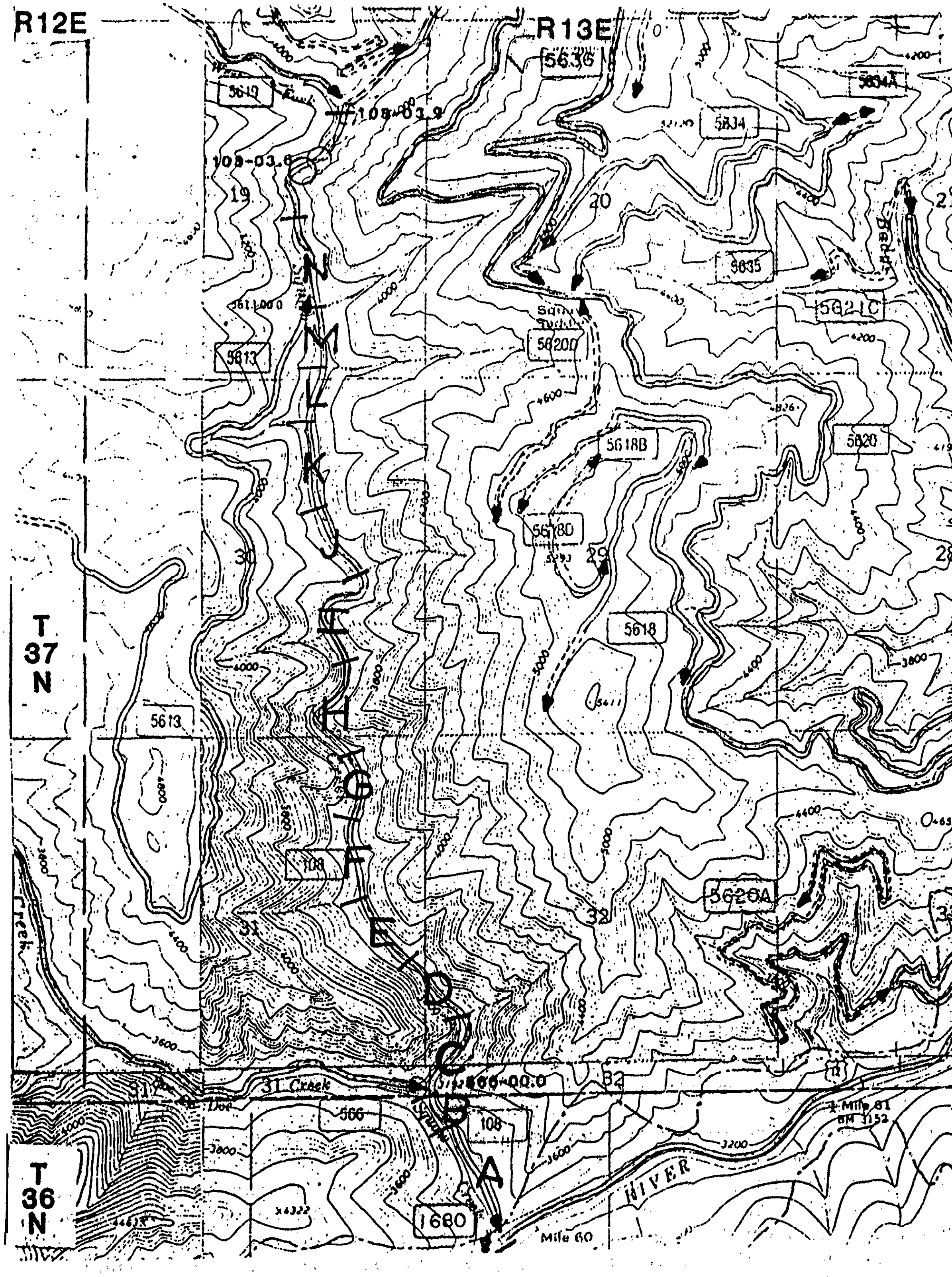

Figure 4. Squaw Creek stream survey by reach.

from the mouth up to the forks (Fig. 4). The road survey identified 11 sites where the roadbank is failing directly into the stream. Furthermore, 2.13 miles of FSR 108 have been identified as requiring insloping and/or redefining.

SQUAW CREEK REACHES A-E

Reaches A-E extend from the mouth of Squaw Creek, upstream for 1.3 miles, ending at a wet draw that comes into the stream from the west (Fig. 4). A mean gradient of 4.7 was calculated for these reaches, ranging from 4.0-6.0.

A pool-riffle ratio of 32:68 reinforces the general observation that long stretches of monotypic cascading water is prevalent for the reaches (Fig. 5). Pool quality rated as fair-good with an average value of 5.8 (Table 1). Reach C, and one fourth of reach D, consisted of water plummeting over boulders with high quality pools (Appendix B). In reach E the stream changed back to shallow, cascading, riffled water with low quality pools.

The effect of road encroachment on the right bank is demonstrated when comparing the recruitment tree (potential debris) value of 1.5 for the right bank with the left bank value of 4.7. Correlated to this is the overall bank cover value, 1.1, which is also low. The average number of acting debris, 41/mile, is suspected to be low because such a large percentage of area has been eliminated as a source of debris due to the road encroachment. Overall bank stability was good with a 1.5 value.

Cobble embeddedness is low in these reaches of the stream with an average of 0.26, ranging from 0.25-0.48. Ranges and averages for width and depth are shown in Table 1. Bottom material is composed largely of rubble to boulder-sized material (Table 1). Chinook gravels were measured from the mouth of Squaw Creek upstream to where Doe Creek entered the system (Fig. 4). A total of 88 square yards of chinook spawning gravels were measured with 73% rated good, 15% rated fair, and 12% rated poor (Table 2). A total of 255 square yards of steelhead gravels were measured with 8% rated good, 49% rated fair, and 43% rated poor (Table 2).

SQUAW CREEK REACHES F-O

Reaches F-O of Squaw Creek begin at the wet draw that enters the stream channel from the west and ends at the large culvert where the main channel splits and forms the East and West Forks (Fig. 4). These reaches total 2.8 miles in length and have an average gradient of 2.6%.

The majority of the stream, as demonstrated by an overall pool-riffle ratio of 25:75, consists primarily of monotypic reaches of shallow, riffled water with low quality pools. Overall pool quality is fair, with an average value of 5.2 (Table 1). Occasional higher quality pools do occur, especially in reaches F-O where the water cascades over larger substrate material.

Road encroachment is more continuous on Squaw Creek above Doe Creek and only diverges from the stream in Reach J, where riparian vegetation on the right bank is composed of mixed hardwoods. Elsewhere along these reaches of Squaw Creek, riparian vegetation is reduced to mostly grass, occasional brush and infrequent trees on the bank that is experiencing the road encroachment.

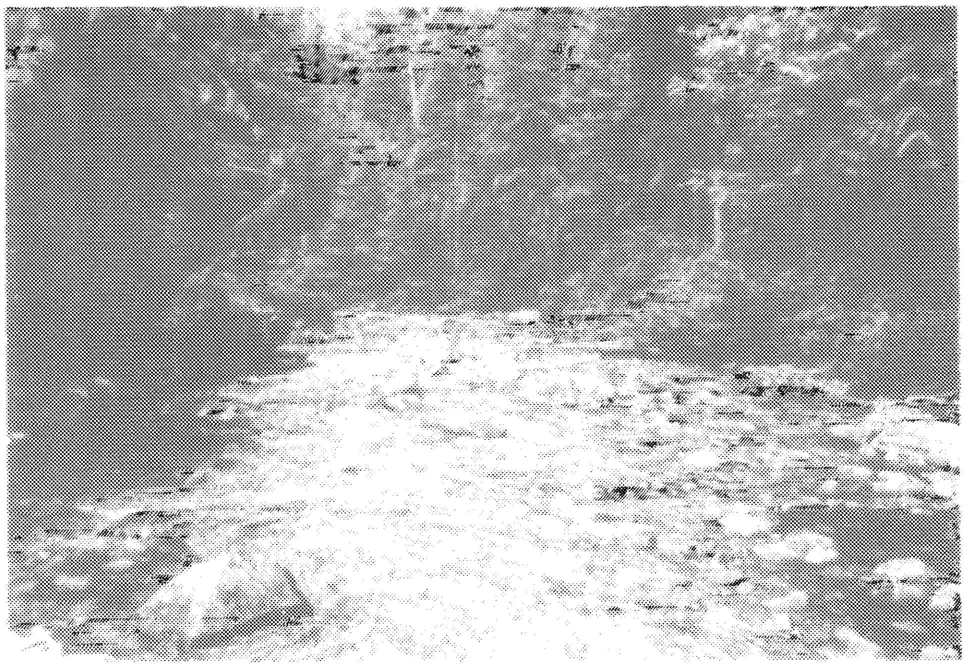

Figure 5. An example of a Squaw Creek reach.

Table 1. Ranges and weighted averages of respective parameters for Squaw Creek; 1984 survey.

Length (Miles)	Ave Grad	Range Grad	Ave P.O.	Range Pool O.	Pool	Run	RIF	Bottom Materials (% Surface Area) Br	Bo	LR	SR	Cg	Sg	Sa	Si	O	N	Ave Gasket[1]	Range Gasket	Ave Depth	Range Depth	Ave Width	Range Width
A-E 1.3 miles	4.7	4-6	5.8	4.5-6.9	28	4	68	1	27	28	21	16	6	1	0	0	0	0.26	.25-.48	0.5	.4-.6	28	20-34
F-O 2.8 miles	2.6	2-4	5.2	4.0-6.2	23	2	75	0	25	24	20	12	13	5	1	0	0	0.56	.37-.63	0.5	.4-.7	22	19-25

	Ave Bank Stab	Range Bank Cover	Ave Bank Stab	Range Bank Stab	Potential Debris Ave LB	Range LB	Ave RB	Range RB	Acting Debris No./mile	Range/mile	Riparian Vegetation Stocking Percentages Ave Seed	Range Seed	Ave Sap	Range Sap	Ave Pole	Range Pole	Ave Saw	Range Saw
A-E	1.1	1-1.2	1.5	1.4-1.5	4.7	3.6-7.0	1.5	0-2.8	41	12-58	7	3-18	10	2-17	15	3-27	35	27-44
F-O	0.8	.5-1.2	1.5	1.3-1.6	2.3	0.4-3.8	0.7	0-2.3	28	8-100	6	1-17	7	2-17	6	0-11	18	5-36

1. Gasket effect = cobble embeddedness.

Table 2. Spawning gravels measured (square yards) for Squaw Creek; 1984 survey.

Reaches	Chinook Good	Fair	Poor	Steelhead Good	Fair	Poor
A-E	64	13	11	20	126	109
	Total - 88			Total - 255		
F-O	0	0	0	71	130	359
	Total - 0			Total - 560		

Looking at potential debris recruitment tree values of 2.3 for the left bank and 0.7 for the right bank, it can be seen that the right bank value, which has eight reaches totaling 2.1 miles experiencing road encroachment, is low in comparison to the left bank, which has only two reaches totaling 0.7 miles experiencing road encroachment (Table 1). Both bank values are lowered slightly due to occasional talus slopes and bedrock faces. Overall, riparian vegetation is limited, to a small degree, by natural constraints. The road has obviously impacted the stream to a far greater extent, which is demonstrated by the above observations as well as by low riparian vegetation stocking (Table 1) and a low bank cover value of 0.8. This limiting effect, especially on larger sized riparian vegetation, is directly responsible for the low value of 28 acting debris/mile (Table 1). This lack of debris, in turn, is responsible for the low percentage of pools present as well as the low quality of existing pools.

The stream generally has stable banks with a bank stability value of 1.5. Cobble embeddedness ranges from 0.37-0.63 with an average value of 0.56. The increased embeddedness in reaches F-O in comparison to reaches A-E (Table 1) , may be because of the lower gradient in these reaches. Bottom materials are composed mostly of material larger than small rubble (Table 1).

A total of 560 square yards of steelhead spawning gravels were measured with 13% rated as good, 23% rated as fair, and 64% rated as poor (Table 2). The size requirements for chinook and steelhead spawning habitats are similar and chinook could utilize a majority of the habitat available to steelhead. The stream stage level would make approximately 20% of the steelhead spawning gravels unusable for chinook at their time of spawning, therefore of the 560 square yards of steelhead spawning gravels measured in reaches F-O, 448 square yards are utilizable by chinook.

DOE CREEK

During the 1984 and 1985 field seasons, over four miles (4.05) of Doe Creek were surveyed starting from the mouth of Doe Creek at Squaw Creek, and ending at the large culvert where the road switches back and begins to climb, diverging from the stream's edge (Fig. 6).

Doe Creek, which is a major tributary to Squaw Creek, has been heavily developed and impacted. The first activities in Doe Creek occurred in 1953 with the building of a jammer road system. This activity had a moderate amount of impact on the system but it was not until 1968 when a large number of roads were constructed on slopes greater than 60%, that sediment outputs exceeded the equilbrium threshold of 174%.

According to the WATBAL model, Doe Creek is back in equilibrium at 47% over natural and recovering slowly. The model is not totally sensitive to road location and is probably over-estimating that rate of recovery. FSR 566 was constructed on some very sensitive landtypes which caused a major impact to the stream. Since the model does not take into account that the road encroaches on Doe Creek in many areas, creating a constant sediment source, full recovery is not possible.

According to the WATBAL model, Doe Creek has not been below the fish habitat recovery threshold since 1956 (45% over natural for B channels). The stream

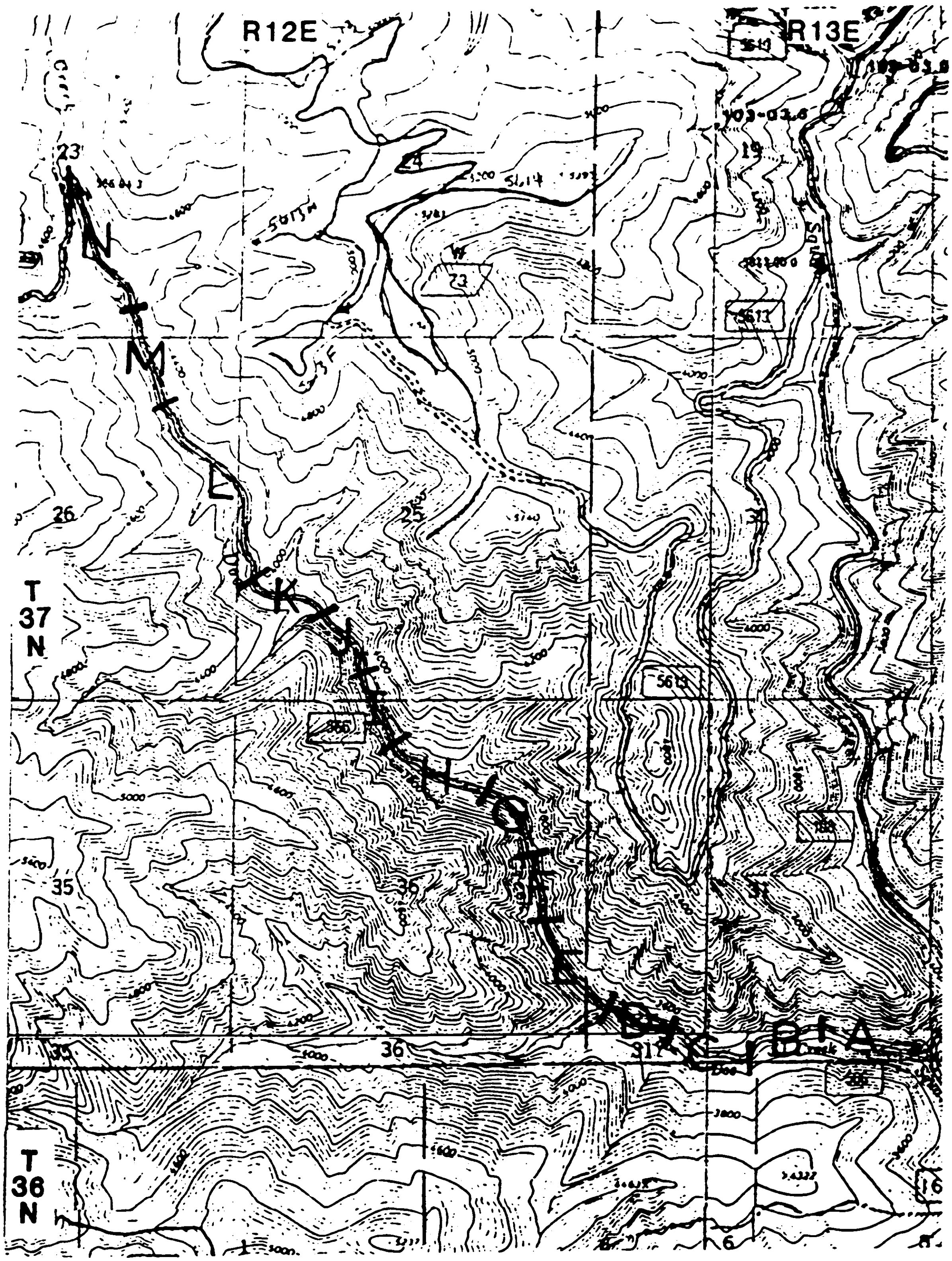

Figure 6. Doe Creek stream survey map by reach.

survey idicated that Doe Creek had an average cobble embeddedness of 43% (less than 25% is considered optimum). The FISHSED analysis indicated that the biological potential is at 65%, but since FISHSED is only sensitive to habitat degradation due to sediment, the biological potential is actually lower than this. The impact of the road and subsequent loss of habitat through removal of the riparian area on one side of the stream has lowered the biological potential of the stream to less than 57% as indicated by the RHI model. The location of the road has effectively eliminated the recruitment of organic debris to the stream and there has been no development of quality fish habitat since the road was constructed.

Forest Service Road 566 runs adjacent to the stream for approximately four miles from the mouth of Doe Creek, upstream (Fig. 6). Nine individual bank sites were actively failing into the stream. Approximately 1.53 miles of the road were identified as requiring insloping and/or redefining,

Tributaries also carry sediment into the system from previously roaded and logged areas. An average embeddedness of 0.43 (range .320.62) was measured for the length of stream surveyed. Road proximity also was responsible for the low values observed for bank cover and stability (.9 and 1.2 respectively , Table 3). Riparian vegetation was often either non-existent or reduced to grasses and sparsely stocked brush due to the road encroachment (Table 3). Cedar was the most frequently observed dominant riparian vegetation; fir, alder and mixed hardwoods were also common (Appendix B). The riparian zone exhibited an even distribution of most age classes, although mature stands predominated (Table 3).

The overall pool-riffle ratio is 36:64 with fair pool quality (4.9, Table 3). Road encroachment has effectively reduced the area, by 45%, from which natural debris recruitment would be expected to occur. The number of acting debris structures in the stream channel ranged from O-244/mile with an average of 104/mile for each reach (Table 3). The debris recruitment potential for the left bank ranged from 1.1-5.7 with a weighted average of 3.0 for the reaches (Table 3). For the right bank, which continually experienced road encroachment, a very low value of 0.7 was recorded (Table 3). The difference between averages reflects the drastic effect of the road encroachment on the right bank.

Of the 1,003 sq yds of suitable steelhead spawning habitat observed, 46% was categorized as poor (Table 4). Lack of good quality spawning gravel further supports impacts observed by road encroachment and the low biological potential demonstrated by the FISHSED analysis.

Table 3. Ranges and weighted averages of respective parameters for Doe Creek; 1984-1985 survey.

Length (Miles)	Ave Grad	Range Grad	Ave P.O.	Range Pool O.	Pool	Run	RIF	Br	Bo	LR	SR	Cg	Sg	Sa	Si	O	M	Ave Gasket[1]	Range Gasket	Ave Depth	Range Depth	Ave Width	Range Width
								Bottom Materials (% Surface Area)															
4.05	4.2	2-6	4.9	3.9-6.3	27	9	64	2	23	26	20	14	8	5	1	1	0	.43	.32-.62	.5	.4-.7	17	11-21

Ave Bank Cover	Range Bank Cover	Ave Bank Stab	Range Bank Stab	Potential Debris: Ave LB	Potential Debris: Range LB	Potential Debris: Ave RB	Potential Debris: Range RB	Acting Debris: No./mile	Acting Debris: Range/mile	Riparian Vegetation Stocking Percentages: Ave Seed	Range Seed	Ave Sap	Range Sap	Ave Pole	Range Pole	Ave Saw	Range Saw
.9	.5-1.5	1.2	.7-1.8	3.0	1.1-5.7	.7	.2-2.4	104	0-244	12	6-22	12	4-21	6	1-18	25	10-36

1. Gasket effect = cobble embeddedness.

Table 4. Spawning gravels measured (square yards) for Doe Creek; 1984-1985 survey.

Chinook: Good	Chinook: Fair	Chinook: Poor	Steelhead: Good	Steelhead: Fair	Steelhead: Poor
0	0	0	276	268	459
Total 0			Total 1,003		

PAPOOSE CREEK

During the 1984 field season, 4.4 miles of Papoose Creek were surveyed. Data was summarized and discussed based upon significant change in gradient and/or where the mainstem forks and forms the East and West Forks of Papoose Creek. The West Fork was surveyed for 0.65 miles upstream from the fork and ended where the stream takes on a definite northwesterly direction and a branch enters from the north (Fig. 7). The streams surveyed in the Papoose Creek drainage were summarized and discussed in the following manner based on habitat and gradient changes (Fig. 7):

Papoose Creek Reaches A-D
Papoose Creek Reaches E-H
Papoose Creek Reaches X-J
E. F. Papoose Creek Reaches K-N
W. F. Papoose Creek Reaches WA-WB.

The geology of the the Papoose Creek drainage is quite similar to Squaw Creek with 55% of the area consisting of undifferentiated parent material and 17% consisting of Idaho Batholith granites and gneisses. About 55% of the drainage consists of landforms with a very high risk of sediment delivery to streams, as was true in the Squaw Creek drainage.

Development began in Papoose Creek in 1955, which immediately brought the drainage above its equiblibium threshold of 191% over natural. Continued development prevented sediment production from falling below the equilibrium threshold until 1974.

The WATBAL model does not predict fish habitat recovery until 1994. Road stability and encroachment problems, and the fact that very little mitigation is performed on the privately owned lands in this drainage, will delay full recovery to well beyond 1994.

FISHSED and RHI models estimated the biological potential for steelhead to be 78% and 77% respectively. The biological potential for chinook salmon is estimated to be 70% by the FISHSED model.

The road survey performed for Papoose Creek ended where FSR 568 switches back and diverges from the East Fork of Papoose Creek (Fig. 7). The road survey identifies 3 sites in which the streambank is failing due to road encroachment. Approximately 0.69 mile of the road has been identified as requiring insloping and/or redefining.

PAPOOSE CREEK REACHES A-D

The first 1.17 miles of Papoose Creek from the mouth of the Lochsa River, reaches A-D (Fig. 7), has a gradient of 2%. An overall pool-riffle ratio of 44:56 was determined for the reaches which indicates fairly well balanced habitat components but overall pool quality is fair at 4.7 (Table 5). Riparian vegetation was composed of medium density sawlogs providing a moderate cover rating of 1.4 (Table 5). Potential debris recruitment values of 13.9 for the left bank and 15.2 for the right bank also reflect relatively well stocked riparian vegetation (Table 5). The average value for the number of acting debris, 104/mile (range 20-129/mile) is suspected to be low in comparison to streams that have not been impacted. The stream had a great deal of debris

Table 3. Ranges and weighted averages of respective parameters for Doe Creek; 1984-1985 survey.

								Bottom Materials (% Surface Area)															
Length (Miles)	Ave Grad	Range Grad	Ave P.Q.	Range Pool Q.	Pool	Run	RIF	Br	Bo	LR	SR	Cg	Sg	Sa	Si	O	M	Ave Gasket[1]	Range Gasket	Ave Depth	Range Depth	Ave Width	Range Width
4.05	4.2	2-6	4.9	3.9-6.3	27	9	64	2	23	26	20	14	8	5	1	1	0	.43	.32-.62	.5	.4-.7	17	11-21

				Potential Debris						Riparian Vegetation Stocking Percentages							
								Acting Debris									
Ave Bank Cover	Range Bank Cover	Ave Bank Stab	Range Bank Stab	Ave LB	Range LB	Ave RB	Range RB	No./mile	Range/mile	Ave Seed	Range Seed	Ave Sap	Range Sap	Ave Pole	Range Pole	Ave Saw	Range Saw
.9	.5-1.5	1.2	.7-1.8	3.0	1.1-5.7	.7	.2-2.4	104	0-244	12	6-22	12	4-21	6	1-18	25	10-36

1. Gasket effect = cobble embeddedness.

Table 4. Spawning gravels measured (square yards) for Doe Creek; 1984-1985 survey.

Chinook			Steelhead		
Good	Fair	Poor	Good	Fair	Poor
0	0	0	276	268	459
Total 0			Total 1,003		

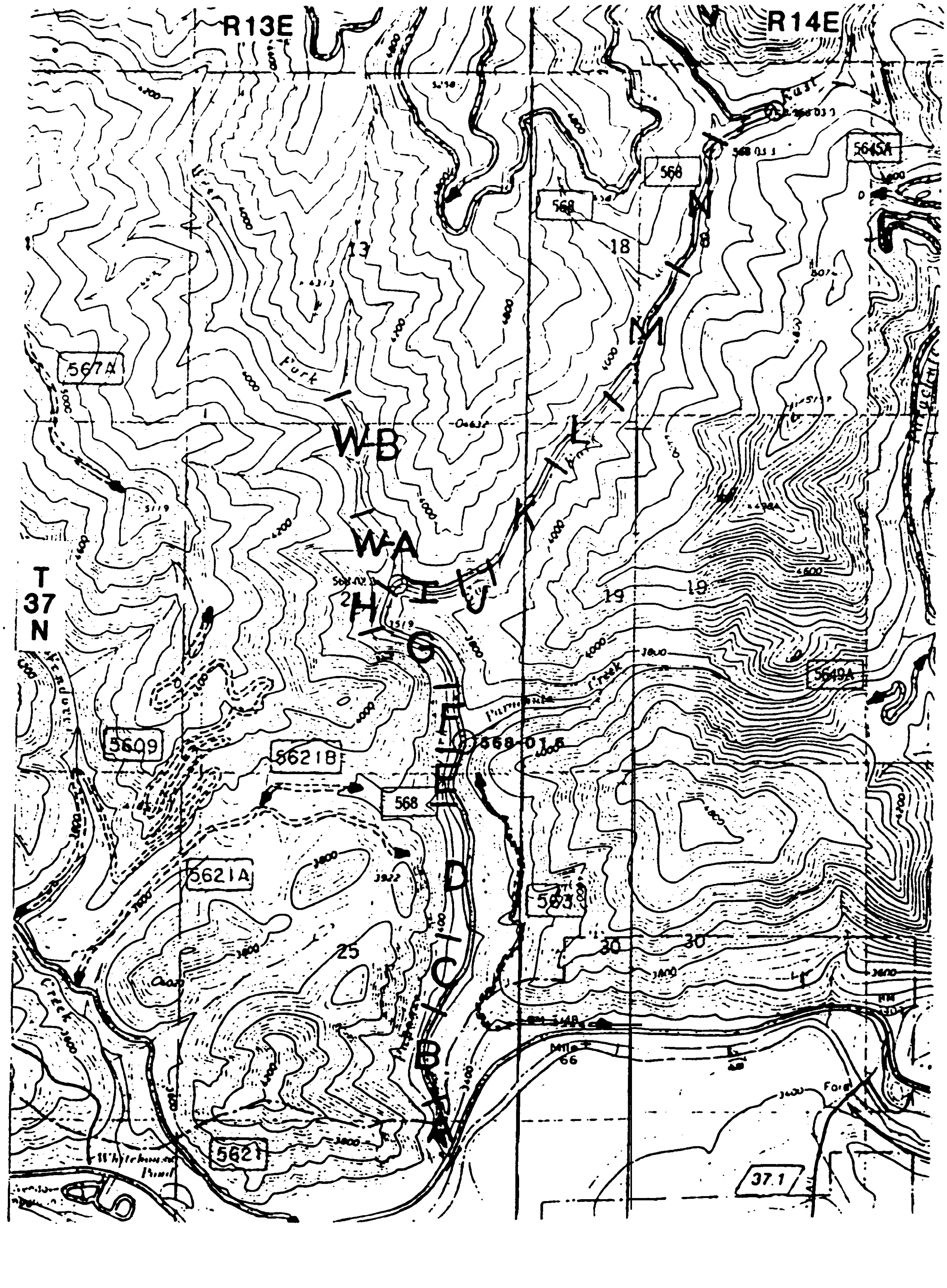

Figure 7. Papoose Creek stream survey map by reach.

Table 5. Ranges and weighted averages of respective parameters for Papoose Creek; 1984 survey.

Length (miles)	Ave Grad	Range Grad	Ave P.Q.	Range Pool Q.	Pool	Run	RIF	Br	Bo	LR	SR	Cg	Sg	Sa	Si	O	M	Ave Gasket[1]	Range Gasket	Ave Depth	Range Depth	Ave Width	Range Width
								Bottom Materials (% Surface Area)															
A-D 1.17 MI	2.0	2-2	4.7	3.0-5.5	29 -	15 -	56	0	11	25	29	20	9	2	2	2	0	.35	.25-.44	.5	.4-.7	27	25-30
E-H .79 MI	4.0	4-4	5.1	3.3-6.0	21 -	5 -	74	1	11	27	21	22	9	2	5	2	0	.25	.16-.33	.5	.4-.5	24	22-25
I-J .38 MI	7.0	7-7	6.5	5.5-7.5	12 -	5 -	83	6	16	24	27	17	7	3	0	0	0	.34	.25-.38	.3	.3-.3	14	12-16
K-N 1.39 MI	4.0	3-5	4.9	4.4-5.8	17 -	2 -	81	2	9	22	31	24	9	1	1	1	0	.25	.25-.25	.4	.3-.4	13	11-13
WA-WB .65 MI	3.5	3-4	6.7	6.5-6.9	30 -	4 -	66	4	18	24	25	20	7	1	0	1	0	.08	0-.15	.6	.4-.9	30	29-30

Segment	Ave Bank Cover	Range Bank Cover	Ave Bank Stab	Range Bank Stab	Potential Debris Ave LB	Range LB	Ave RB	Range RB	Acting Debris No./mile	Range/mile	Ave Seed	Range Seed	Ave Sap	Range Sap	Ave Pole	Range Pole	Ave Saw	Range Saw
											Riparian Vegetation Stocking Percentages							
A-D	1.4	1.1-1.6	1.4	1-1.5	13.9	8.3-23	15.2	5.8-21	104	20-129	13	3-23	10	1-25	7	3-12	48	17-64
E-H	1.2	1.0-1.5	1.4	1.3-1.5	3.7	3-5.4	3.2	2.3-5	123	72-187	13	7-25	20	12-38	18	9-34	46	39-48
I-J	1.2	1.1-1.3	1.5	1.5-1.5	.3	0-0.5	3.2	3-3.3	144	124-184	9	8-10	10	9-12	4	3-6	24	23-26
K-N	1.2	1.0-1.4	1.4	1.4-1.5	3.4	0-7.0	3.7	.4-6.8	150	103-190	13	10-16	17	9-21	16	9-27	41	36-46
WA-WB	1.2	1.0-1.3	1.6	1.5-1.6	5.6	4.3-7.3	5.0	4.5-5.5	109	104-113	8	6-9	11	10-12	19	9-30	62	58-66

1. Gasket effect = cobble embeddedness.

pulled from the channel during a 1975 barrier removal project. Although there is some mass wasting occurring in reaches B and C, overall bank stability is reasonably high, with an average of 1.39.

A total of 767 yards of chinook spawning gravels were measured in these reaches with 30% rated good, 49% rated fair, and 21% rated poor. In addition to this, 614 square yards of steelhead spawning gravels were measured, of which 2% rated good, 43% rated fair, and 55% rated poor (Table 6). Since discharge would be greater during the steelhead spawning season, the spawning habitat value for steelhead is in addition to the chinook spawning gravels. Bottom material composition, ranges and averages for width, depth, and embeddedness are shown in Table 5.

PAPOOSE CREEK REACHES E-H

Reaches E-II, 0.79 miles, extend upstream from a large established debris jam, to where the stream divides and forms the East and West Forks (Fig. 7). An average gradient of 4% was measured for these reaches. The road encroaches more frequently and the affected areas increase in length. Road encroachment in reaches E-H is also reflected in a reduced value for potential debris recruitment for the right bank where a 3.2 average value was determined in comparison to the right bank value of 15.2 for the group of reaches A-D, immediately downstream where road encroachment was less frequent (Table 5). The more frequent road encroachment may also be responsible for the decline in an average bank cover value of 1.2 observed for reaches E-H as opposed to a 1.4 value for reaches A-D.

The majority of the stream in these reaches is shallow, monotopic, cascading water in which the pools are generally fair in quality with an average value of 5.1. A pool-riffle ratio of 26:74 indicates a high degree of riffles (Table 5).

Mass wasting occurs for 50 ft in length in reach G. Exposed bedrock and decomposed granite are failing into the stream at this site. Overall, bank stability rated high with a value of 1.4 (Table 5). The banks in reaches E-H are taller and opportunities for enhancement structures are greater as compared to reaches A-D (Table 5). The number of acting debris structures with an average of 123/mile is similar to the value for reaches A-D. Again, this value is suspected to be lower in comparison to an unimpacted stream. Bottom material composition, ranges and averages for width, depth, and embeddedness are displayed in Table 5.

A total of 864 square yards of chinook spawning gravels were measured in reaches E-H with 26% rated good, 33% rated fair, 41% rated poor (Table 6). In addition to this, 199 square yards of steelhead spawning gravels were measured with 3% rated good, 37% rated fair, and 60% rated poor (Table 6).

PAPOOSE CREEK - East Fork (REACHES I-J)

The East Fork of Papoose Creek was surveyed for 1.77 miles upstream from the point where it diverges from the West Fork. The survey ended where a draw and creek, comprising 50% of the stream flow at this point, enter the system from the northwest (Fig. 7). For discussion purposes, the length of the East Fork

Table 6. Spawning gravels measured (square yards) for Papoose Creek; 1984 survey.

Reaches	Chinook			Steelhead		
	Good	Fair	Poor	Good	Fair	Poor
A-D	232	376	159	14	263	337
	Total - 767			Total - 614		
	Good	Fair	Poor	Good	Fair	Poor
E-H	221	290	353	5	74	120
	Total - 864			Total - 199		
	Good	Fair	Poor	Good	Fair	Poor
I-J	0	0	0	0	52	165
	Total - 0			Total - 217		
	Good	Fair	Poor	Good	Fair	Poor
K-N	0	0	0	16	101	269
	Total - 0			Total - 386		
	Good	Fair	Poor	Good	Fair	Poor
WA-WB	94	42	40	0	50	129
	Total -176			Total - 179		

that was surveyed has been broken into 2 parts based upon change of gradient. The lower portion of the East Fork, reaches I and J (Fig. 7), extends from its confluence with the West Fork, upstream for 0.38 miles to where a large natural log weir exists.

In reaches I and J the stream consists primarily of cascading water with very few pools. An overall pool-riffle ratio of 17:83 exists in these reaches. Pool quality rated as good with a value of 6.5 (Table 5). The predominance of pools exist where water plunges over and around bedrock.

The road lies immediately adjacent to the creek and encroachment is so severe that the streambank and roadbank are one in the same. The right streambank has a great deal of bedrock for nearly l/2 of these reaches. The combination of these factors account for the low bank cover value of 1.2 as well as a low average value for left bank and right bank potential debris recruitment trees, 0.3 and 3.2, respectively. Stocking levels for riparian vegetation (Table 5>, are also believed to be low in comparison to a stream not so heavily impacted by road encroachment. Bank stability is high with a value of 1.5. The value of 144/mile for acting debris is deceiving in that most of what is present is small and non-extensive, having only minimal influence on the stream habitat. Bottom material distribution reflects the steeper gradient by showing an increase in larger bottom materials (Table 5).

Steelhead spawning gravels totaled 217 square yards with 24% rated as fair and 76% rated as poor (Table 6). Utilization of the East Fork of Papoose Creek as a spawning ground by chinook is believed to be minimal, therefore all spawning gravels measured were expressed as steelhead spawning gravels. Ranges and averages for width, depth, and embeddedness are shown in Table 5.

PAPOOSE CREEK - East Fork (rEACHEs K-N)

The remaining 1.39 miles of the East Fork that were surveyed, reaches K-N (Fig. 7), have an average gradient of 4%. The road meanders and is not always directly at the stream edge, however, it still heavily impacts the stream. The bank cover value of 1.2 and potential debris recruitment values for the left bank, 3.4, and right bank, 3.7, are low and reflect the road encroachment.

A pool-riffle ratio of 19:81, an average depth of 0.4 ft and a fair pool quality value of 4.9 continue to demonstrate that the stream overall is shallow, riffled water with infrequent, low quality pools. Higher quality pools exist where debris has entered the channel and is causing some scouring. The average number of acting debris is 150/mile with more debris collecting and acting effectively in the first one-half of reach M (Fig. 7). Bedrock appears off and on throughout the streambed and is suspected to lie rather close to the surface when it is not actually exposed. Stocking of mature riparian vegetation has increased (Table 5) compared to Reaches I-J, this is partially due to a decrease in the amount of bedrock appearing on the right bank and also due to the fact that the road encroaches less frequently on the stream.

Bottom materials distribution (Table 5) indicates a shift towards smaller substrate materials. This occurs because of a slighter gradient, and is further reflected in the amount of spawning gravels measured. Steelhead spawning gravels totaled 386 square yards with 4% rated good, 26% rated fair, and 70% rated poor (Table 6). Ranges and averages for width, depth, and embeddedness are shown in Table 5.

PAPOOSE CREEK - West Fork - (REACHES WA AND WB)

The West Fork of Papoose Creek was surveyed for 0.65 mile upstream from where it merges with the East Fork (Fig. 7). An average gradient of 3.5% was measured in these reaches. A falls with three tiers and deep plunge pools exists 0.3 mile up into the West Fork. The falls do not present a migration problem because there are large deep pools above and below each tier and each tier only requires a 2 ft maximum vertical jump.

Pool quality rated as good overall with an average value of 6.7. Pool quality is suspected to be higher in these reaches due to less development. Although the value for the average number of acting debris in reaches WA-WB, log/mile , is similar to the previous reaches, lack of stream cleaning projects has left higher quality natural debris in these reaches. The pool-riffle ratio is 34:66. There are, however, a few long, monotypic, riffled sections that could use some deflector logs to create pools. Construction of log weirs would be difficult because of the extensive amount of bedrock on the right bank and poor access.

The presence of bedrock results in a good stable bank, reflected in the bank stability value of 1.6. The extensive presence of steep bedrock faces, however, is responsible for the low bank cover value of 1.2. The riparian vegetation stocking percentages (Table 5) are higher for larger size classes than previous downstream reaches. Combined with the fact that perhaps 30% of all of the streambank is bedrock (60% of right bank), often devoid or with scarce vegetative growth, one can further appreciate the effects of the presence and often close proximity of the road, as well as the barrier removal project of 1975 on the downstream reaches of the mainstem and the reaches on the East Fork. Overall, less streambank is suitable for growth of riparian vegetation; when suitable sites are available, the vegetation is stocked heavier than in those reaches that have been impacted. Potential debris recruitment tree values are 5.6 for the left bank and 5.0 for the right bank and are higher than all reaches in Papoose Creek, except for reaches A-D.

The majority of substrate materials upstream of the falls showed an even distribution of large rubble, small rubble, and coarse gravels (Table 5). The lack of sections with homogeneous coarse gravel substrate of acceptable size is the reason for the low values of both steelhead and chinook spawning gravels. One hundred and seventy-six square yards of chinook spawning gravels were measured with 53% rated good, 24% fair, and 23% poor (Table 6). For steelhead) a total of 179 square yards of spawning gravels were measured with 28% rated as fair and 72% as poor (Table 6).

SUMMARY

Development in the Squaw, Doe and Papoose Creek drainages has had a severe longterm impact on the fish habitat in these streams. Sediment production from logging and road building and the removal of riparian areas have affected all aspects of the fish's biological needs including spawning and rearing habitat. The overall result has been to substantially lower the biological potential of these streams from their former pristine condition.

The stream surveys document this impact with the low quality ratings for pools, pool-riffle-run ratios skewed heavily towards riffled water, often low values for acting debris (especially in areas experiencing continuous road encroachment), low values for potential debris recruitment trees on the bank experiencing road encroachment, and the low values for stocking of riparian vegetation across all age classes (Tables 1,3,5). Table 7 further demonstrates the impact of road encroachment on potential and acting debris. Squaw and Doe Creeks have the highest percentages of encroachment per mile of stream and also exhibit soale of the lowest values for both potential and acting debris. The East Fork of Papoose Creek in reaches I and J is the exception to this (Table 7). It exhibited one of the highest levels of acting debris with 100% of the length experiencing road encroachment. Survey data indicated that even though the number of acting debris is high, in reality the quality and size of the debris are very low in this reach when compared to other reaches.

Note in Squaw Creek, Reaches A-E and F-O, that the right bank potential debris is very low due to the road encroachment occurring on this side. Even though the left bank potentials are considerably higher and could feasibly help contribute to the number of acting debris in the stream, the actual numbers of debris remain low (Table 7). This is indicative of the impact of stream cleanup and salvage operations that have occurred in the past.

Thompson (1972) considered an optimum pool-riffle ratio to be 50:50. This is an oversimplification of limiting factors, since many interrelated factors work in conjunction , especially rearing habitat quality, to reduce the overall biological potential of a stream. The loss of quality resting pools created by instream debris, combined with inadequate instream cover reduces the quality of available spawning and rearing areas for all species. The limiting factor analysis may be a simplistic view of the complex factors affecting fish populations (Table 8) but serves as a guide in pointing out factors which have the greatest impact on the fishery.

In all streams examined, estimated potential production under optimum rearing conditions far exceeds the existing situation (Table 8). The lowest potential for increase is exhibited in lower Doe Creek with a 2.4 fold increase for steelhead and a high in the West Fork of Squaw Creek with a 3.4 fold increase for steelhead. These large estimated increases are fairly realistic in view of the fact that the amount of actual rearing habitat is the driving force in the analysis. The survey indicated that compounding low pool-riffle ratios in all the streams surveyed was the low pool qualities, therefore, the estimated existing smolt production may actually be high.

Spawning habitat played a secondary effect in the analysis. It was only in the West Fork of Squaw Creek for steelhead and the mainstem of Squaw Creek for chinook that spawning habitat appears to be limiting over rearing habitat (Table 8). This analysis does not take into account that in almost all situations, the amounts of suitable spawning gravel by stream were mostly of

Table 7. Comparision of potential debris, acting debris, and miles of road encroachment by stream, 1984.

Stream and reach	Potential Debris LB	RB	Combined Avg	Acting Debris/Mi	Miles of Road Encroachment*	Amount of Impact**
Squaw A-E	4.7	1.5	3.10	41	.65	50%
Squaw F-O	2.3	0.7	1.50	28	1.48	53%
Doe A-N	3.0	0.7	1.85	104	1.53	38%
Papoose A-D	13.9	15.2	14.50	104	0	0%
Papoose E-H	3.7	3.2	3.50	123	.10	13%
EF Papoose I-J	0.3	3.2	1.75	144	.38	100%
EF Papoose K-N	3.4	3.7	3.55	150	.21	15%
WF Papoose WA-WB	5.6	5.0	5.30	109	0	0%

* Road within 5 ft of stream.
** Total miles of encroachment divided by total miles of stream surveyed.

Table 8. Limiting Factor Analysis.

Stream	Existing Gravel (Sq. Yds.)	Pot. Smolt Prod. w/Full Seed. and Exist. Gravels.[1]	Rearing Habitat (%)	Length) (Miles)	Ave. Width (ft)	Biological Potential (%)	Existing Smolt Prod.	Pot. Smolt Prod. w/Opt. Rear. Hab.[2]
				Steelhead				
Doe Creek	1,003	12,060	36	4.0	17	57	1,215	2,955
Doe Creek Upstream of culver	56	720	27	1.3	12	65	229	644
All of Doe Crk combined		12,780					1,608	3,599
Squaw Creek	815	9,720	27	4.1	24	61	1,369	4,224
Squaw Cr. WF	92	1,080	19	3.0	10	78	378	1,288
Squaw Creek combined		10,980					1,738	5,511
Papoose Cr.		44,520	29	4.4	21	78	1,767	3,948
Grand Total		68,280					5,113	13,058
				Chinook				
Squaw Creek	740	6,210	27	4.1	24	59	2,672	8,447
Papoose Cr.	1,807	15,255	29	4.1	21	70	3,206	7,896
Grand Total		21,465					5,878	16,343

1. Assumes unlimited rearing habitat.
2. Assumes spawning habitat and seeding, not limiting.

very poor quality Therefore spawning habitat may be playing a more important role in limiting the fishery than is exhibited by the analysis.

The FISHSED and RHI analyses for each stream estimated similar reductions in biological potential independent of each other; indicating that lack of quantity and quality rearing habitat, and sedimentation of spawning and rearing habitat are both affecting production.

The road surveys performed for FSR's 108, 566, and 568 which run alongside Squaw, Doe, and Papoose Creeks respectively, reveal 23 sites where the streambank is failing resulting from the road encroachment and will require 602 square yards of rip-rap (Table 9). The survey also identifies 4.35 miles of road that will require insloping and/or redefining of the road width to eliminate direct delivery of sediments originating from road maintenance practices (Table 9). The road survey clearly reflects the extreme, direct impact and influences that roads built within the riparian area create. In conjunction with the road surveys, the stream surveys effectively demonstrate the loss of diversity of instream habitat directly associated with the elimination of a buffer riparian. Eradication of a riparian zone equates directly into a loss of sites in which future debris can be recruited into a stream channel, which in turn equates directly into a loss of instream habitat diversity.

The proposed enhancement work on Squaw, Doe, and Papoose Creeks are designed to eleviate and mitigate for the respective road encroachments and impacts, as well as diversify instream habitat and improve the productive capabilities of the streams. Redefining the road width, insloping and rip-rapping failures will create a buffer which will prevent the deposition of sediment into the drainage. The instream structures (Tables 10-12) will increase the existing rearing habitat by eliminating the current inadequate pool-riffle ratios (Tables 1,3,5) and creating the optimal situation with a pool-riffle ratio of 50 : 50. Overall instream cover will be increased, thus increasing the quality of available spawning gravels. Many structures will collect and/or scour out new spawning gravels thereby increasing the amount of spawning habitat. Removal of passage barriers will extend fish distribution and increase fish production.

Estimated costs for completing the proposed instream habitat structures, streambank stabilization and road rip-rapping, barrier removal, and road reconstruction projects are $102,083 for Squaw Creek, $53,805 for Doe Creek, and $58,393 for Papoose Creek (Tables 9 and 13).

A benefit/cost ratio was calculated for all work on Squaw, Doe and Papoose Creeks at a 4% discount rate. In addition to the above estimates (Table 9 and 13), additional maintenance costs were figured in the calculation. In years three and four a structural maintenance cost was included at $3,000 and $1,500, respectively, and a $20,000 road reconstruction cost in years ten and twenty.

Table 9. Estimated road reconstruction costs.

Creek	Length of Road being Insloped/Redefined and Resurfaced with Crushed Gravels	Cost[1]	Amount of Rip-Rap Required (Sq Yds)	Cost[2]	Culvert Passage Barrier Removal Cost	Total Cost
Doe	1.53	$ 31,172	254	$ 3,376	800	$ 35,348
Squaw	2.13	43,397	323	4,293	30,000	77,690
Papoose	.69	14,058	25	332	0	14,390
Grand Total						$ 127,428

1. Insloping/redefining and resurfacing with crushed gravels cost $20,374/mile.
2. Delivery and placement of Rip-Rap cost $13.29/cubic yard.

Table 10. Potential habitat enhancement structures in Squaw Creek, 1984 survey, by reach.

Structure Type	Reach A-E No.	Reach F-O No.	Total
Boulder Reach	9	2	11
Deflector Log	10	29	39
Root Wad	1	3	4
Log Weir	3	38	41
Bedrock Pool	1	0	1
Total	24	72	96

Table 11. Potential habitat enhancement structures in Doe Creek, 1984 survey, by reach.

Structure Type	Reach A-N No.
Boulder Reach	0
Deflector Log	31
Root Wad	1
Log Weir	34
Bedrock Pool	0
Total	66

Table_12_. Potential habitat enhancement structures in Papoose Creek, 1984 survey, by reach.

Structure Type	Reach A-D No.	Reach E-H No.	Reach I-J No.	Reach K-N No.	Reach WA-WB No.	Total
Boulder Reach	0	6	6	15	1	28
Deflector Log	1	10	7	13	3	34
Root Wad	2	6	0	3	1	12
Log Weir	5	10	6	25	2	48
Bedrock Pool	0	0	0	5	0	5
Total	8	32	19	61	7	127

Table_13_. Estimated costs of instream habitat enhancement.

Creek	Length of Stream Treated (Miles)	No. of Proposed Structures	Personnel Salary	Travel and Transportation	Materials and Supplies	Construction and Services	Total
Doe	4.05	66	$ 4,302	$ 205	$ 912	$ 13,033	$ 18,457
Squaw	4.1	96	5,703	206	1,208	17,276	24,393
Papoose	3.73	127	10,801	742	960	31,500	44,003
Grand Total							$ 86,853

It was assumed that all instream structures have a longevity of 30 years, based on past experience. Values of increase in smolt production (Table 8) were calculated by converting smolts to returning adults (smolt to return adult survival of 1.65% for steelhead and 0.60% for chinook) and multiplying the result by $550/chinook and $359/steelhead (Meyer 1982). It was assumed that only half of the yearly benefit would be realized in year five and the full benefits would be realized in year 6-30.

Present Value Benefit = $1,082.601 = 4.5
Present Value Cost = $ 236,057 1

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APPENDICES

Appendix A: Addendum

Appendix B: Habitat Parameter Summaries by Reach

Appendix C: Summary of Project Expenditures - Plan Development

Appendix D: Stream Survey Narrative--Clearwater National Forest Ocular Technique for Multiple Use Planning Input-1976.

APPENDIX A

ADDENDUM

During the 1985 field season, the instream enhancement work that was proposed for Squaw and Doe Creeks as well as the streambank stabilization project for Squaw, Doe, and Papoose Creeks (FSR's 108, 566, and 568 respectively) were completed with the use of USDA Forest Service funds. All of the proposed enhancement structures (Tables 10-12) were not necessarily built; final numbers and types of structures were changed on a site by site basis to meet individual site material availabilities during construction. Sixty-six instream habitat structures within Doe Creek and 113 structures within Squaw Creek were installed (Table 14). Materials for log weirs were obtained from areas across the stream's respective roads rather than hauling the logs in. Boulders were hauled to each proposed site from a single common source. Additional boulders, when available, were utilized from the road edge. Also, additional boulders were often acquired upon excavation of several sites. Root wads were acquired from the riparian zone where past logging practices left them exposed and easy to acquire, or else from along the road edge where they were pushed and left intact when the roads were constructed. Figures 8-15 show several types of structures installed in 1985.

At the site of the large culvert on Doe Creek (Fig.16), which posed a partial passage barrier for steelhead and a complete barrier for resident species, two successive log weirs were hand constructed (Fig. 17) (Table 15). Since the limiting factor analyses (Table 8) demonstrated that once rearing habitat was enhanced and elevated to the optimum 50:50 pool-riffle ratio on Squaw Creek, spawning habitat for chinook would become a limiting factor and the addition of spawning gravels would be required. Upon completion of all instream habitat construction and strengthening the streambank, all of the disturbed streambanks and newly added rip-rap were seeded with a grass mixture to accelerate vegetative growth and stabilization.

Costs of instream habitat enhancement totaled $22,462 for Doe Creek and $25,329 for Squaw Creek (Tables 15 and 16). Streambank stabilization and road rip-rapping costs totaled $8,001 for Doe, Squaw, and Papoose Creeks (FSR's 566, 108, and 568 respectively).

Table_14_. Completed instream habitat enhancement structures for Squaw and Doe Creeks, 1985.

	Structure Type and No. Constructed						
Creek	Upstream V	Root Wad	Log Weir	Deflector Log	Boulder Reach No. Boulders	Boulder Weir	Total No. of Structures
Doe	1	18	22	13	8/69	4	66
Squaw	0	34	27	25	26/179	1	113
Total	1	52	49	38	34/248	5	179

Table_15_. Actual cost of culvert barrier removal for Doe Creek, 1985.

Creek	No. of Completed Structures	Personnel Salary	Construction and Services	Total Cost
Doe	2	$ 1,920	$ 119	$ 2,039

Table_16_. Actual instream habitat enhancement costs.

Creek	Length of Stream Treated (Miles)	No. of Completed Structures	Personnel Salary	Travel and Transportation	Materials and Supplies	Construction and Services	Total
Doe	4.05	66	$ 6,755	$ 589	$ 2,009	$ 11,070	$ 20,423
Squaw	4.1	113	9,782	664	2,266	12,617	25,329
Grand Total							45,753

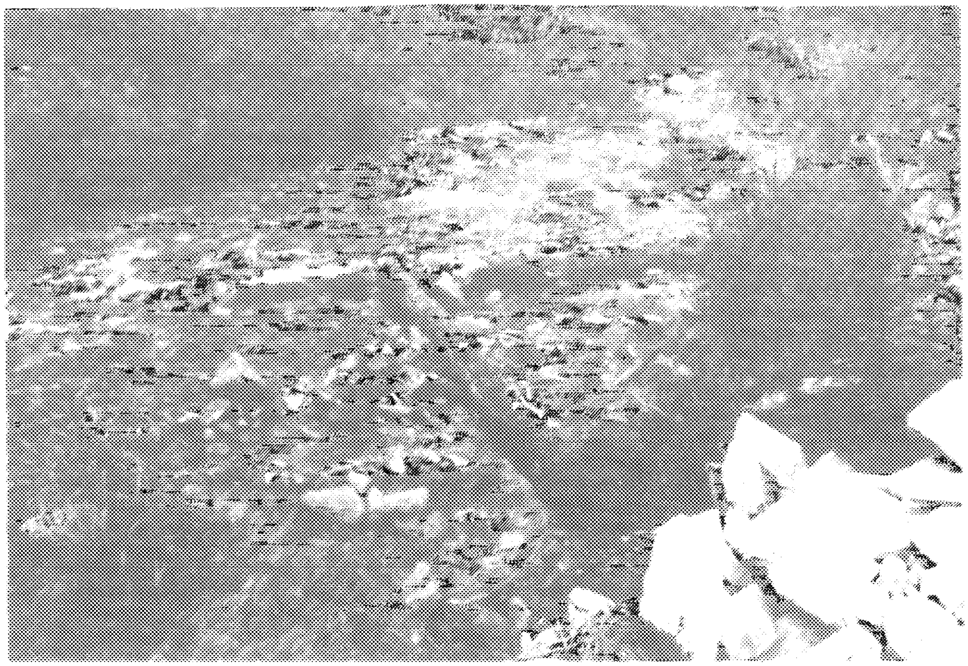


Figure 8. Back-braced deflector log.

Figure 9. Boulder-braced deflector log.

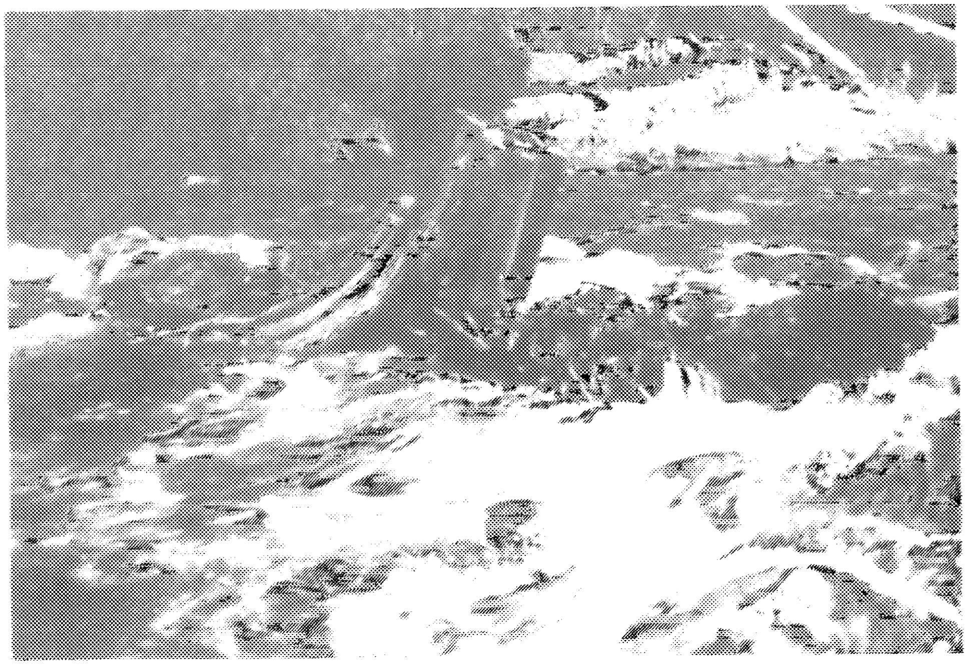


Figure 10. Root wad.

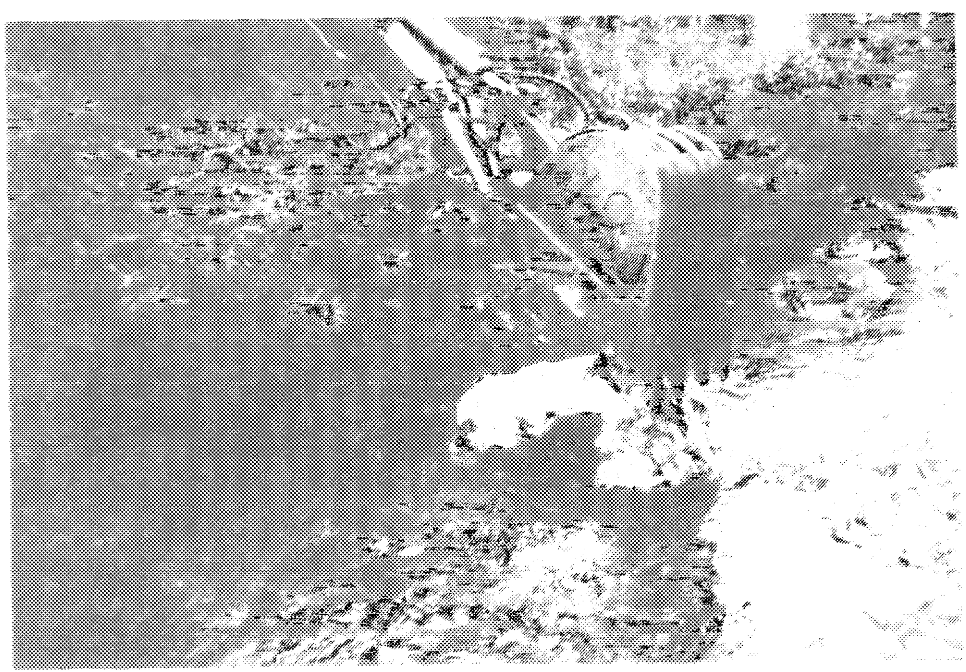


Figure 11. Boulder reach under construction.

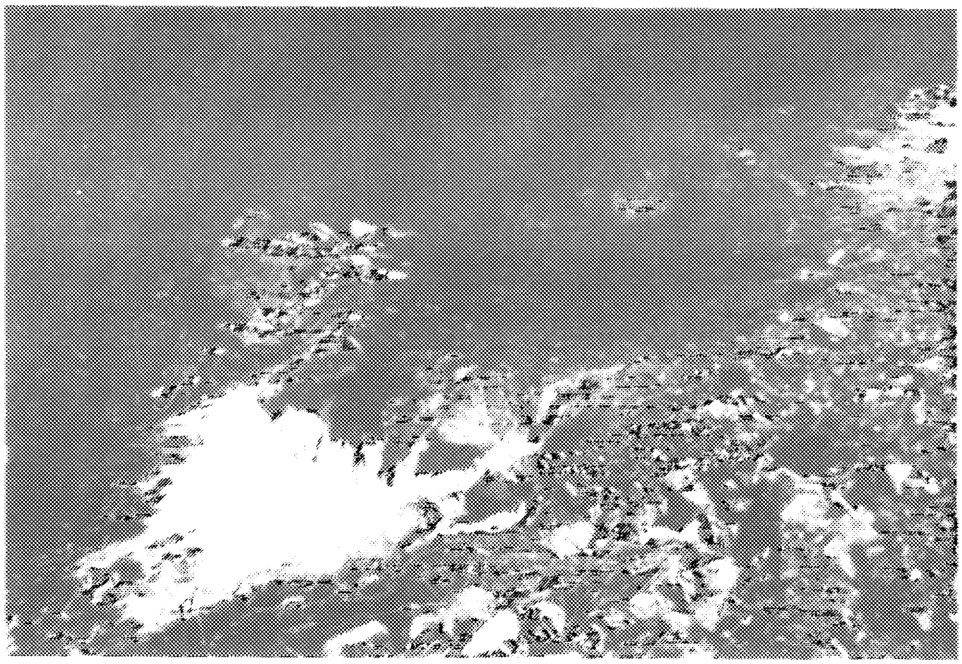


Figure 12. Boulder weir with spawning gravels.

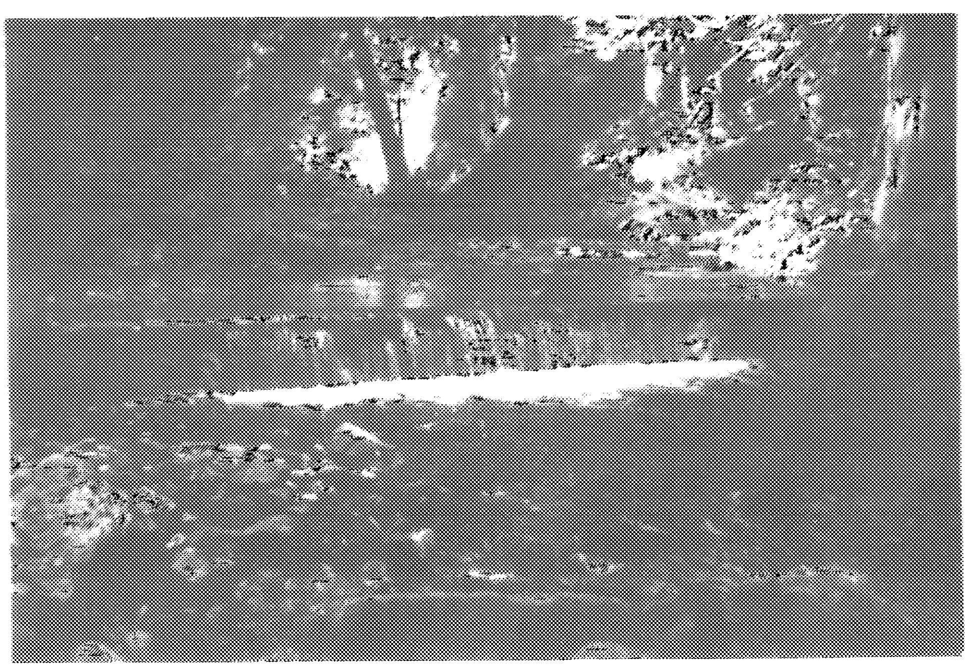


Figure 13. Log weir.

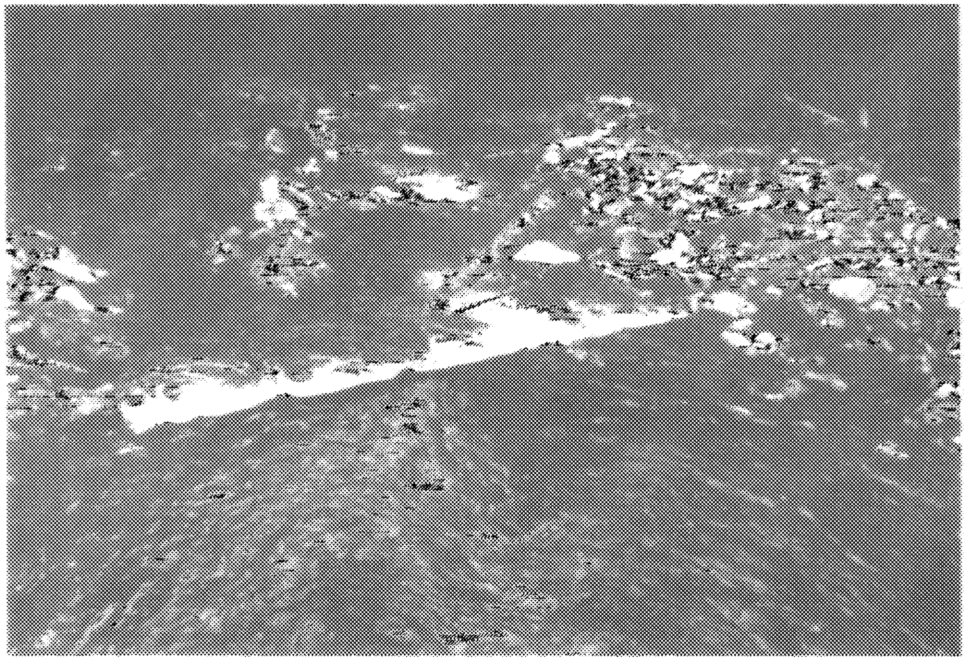


Figure 14. Log weir with log in downstream pool.

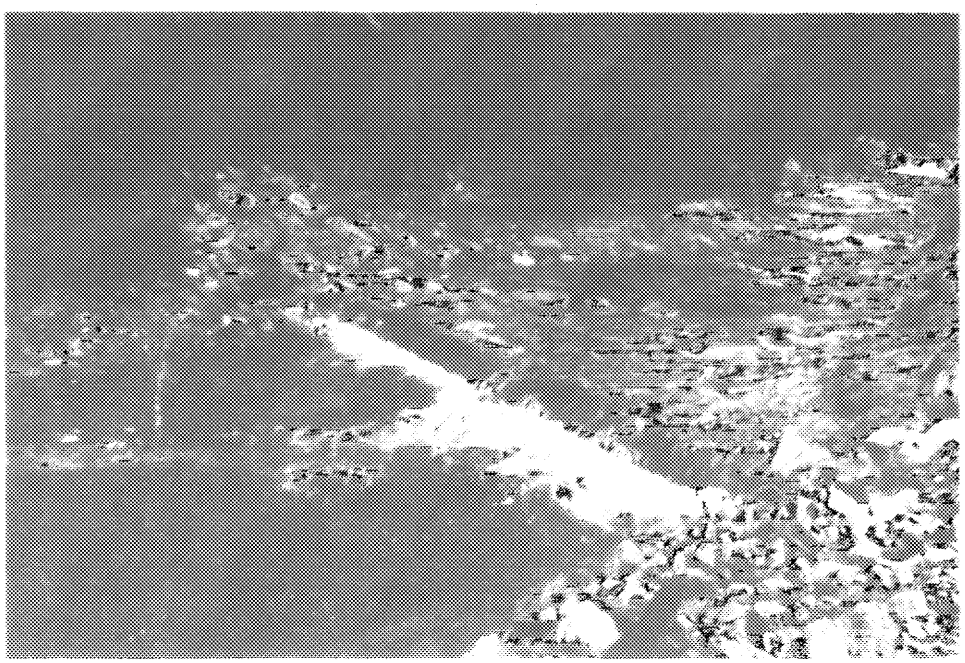


Figure 15. Log weir with log in downstream pool.

Fig. 16. Doe Creek, before.

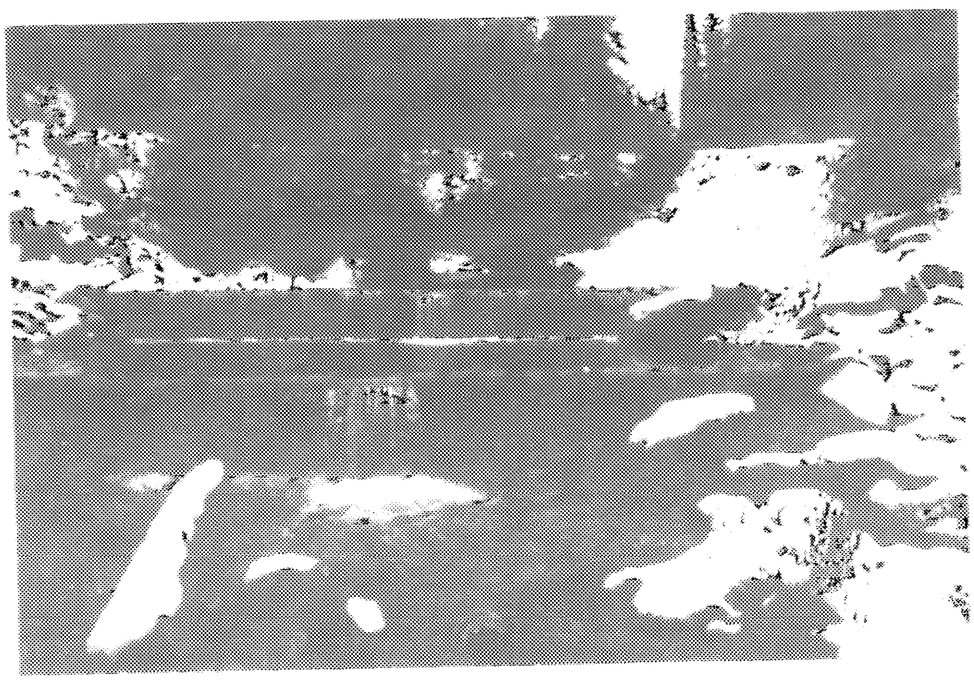


Fig. 17. Doe Creek, after.

APPENDIX B

Squaw Creek-Ranges and weighted averages of respective parameters by reach; 1984 survey.

Reach	Grad.	POOL Qual.	P	Run	Ri	Br	Bo	LR	SR	Cg	Sg	Sa	Si	O	M	Gask.
A	5.0	5.0	32	1	67	2	23	32	21	17	3	2	0	0	0	.33
B	4.5	6.0	31	2	67	0	30	29	21	15	4	1	0	0	0	.25
C	6.0	6.9	40	1	59	0	49	25	14	9	3	0	0	0	0	0
D	4.0	6.5	26	14	60	0	21	27	24	18	9	1	0	0	0	.25
E	4.0	4.5	14	1	85	0	10	26	26	26	10	2	1	0	0	.48
F	2.0	4.5	9	1	90	0	14	30	28	22	5	1	0	0	0	.50
G	2.0	5.3	20	2	78	0	16	31	24	19	7	2	1	0	0	.54
H	3.0	5.4	34	1	65	0	28	30	20	13	7	1	1	0	0	.47
I	3.0	6.2	32	1	67	0	34	29	21	10	3	1	2	0	0	.50
J	2.0	3.7	28	2	70	0	10	25	25	23	13	3	1	0	0	.50
K	2.0	5.5	14	1	85	0	9	22	20	20	21	7	1	0	0	.47
L	2.0	4.3	19	2	79	0	6	13	21	25	21	12	1	1	0	.50
M	3.0	4.0	24	2	74	0	21	20	23	17	14	5	0	0	0	.63
N	2.0	5.3	27	2	71	0	29	18	11	18	15	9	0	0	0	.50
O	4.0	6.2	25	3	72	1	37	19	12	12	14	5	0	0	0	.37

Squaw Creek-Ranges and weighted averages of respective parameters by reach; 1984 survey.

Reach	LENGTH (Yds.)	DEPTH (Ft.)	WIDTH (Ft.)	BANK Cover	BANK Stab.	SPAWNING HABITAT CHINOOK G	F	P	SPAWNING HABITAT STEELHEAD G	F	P	POT. DEB. LB	RB	ACTING Debris/Mi	DOM. Rip	SUBDOM. Rip	STOCKING Seed	Sap	Pole	Saw
A	550	.6	34	1.2	1.4	64	13	10	0	0	18	3.6	2.8	58	Cedar	Mixed Hrdwoods, Fir	6	7	13	39
B	344	.5	31	1.0	1.5	0	0	1	0	0	0	3.7	1.0	56	Cedar		18	17	27	32
C	463	.4	29	1.0	1.5	0	0	0	0	12	9	4.5	0	42	Cedar		7	14	19	27
D	449	.4	27	1.0	1.5	0	0	0	15	27	10	7.0	2.5	12	Cedar		5	8	11	44
E	500	.5	20	1.2	1.5	0	0	0	5	87	72	4.6	1.0	39	Cedar	Mixed Hrdwoods	3	2	3	31
F	477	.7	25	1.1	1.5	0	0	0	0	2	49	3.8	2.3	18	Cedar		4	3	3	36
G	344	.5	23	1.2	1.3	0	0	0	0	2	8	1.7	0.3	15	Cedar		1	17	0	27
H	716	.6	21	0.7	1.5	0	0	0	0	13	4	1.3	0	12			3	6	1	14
I	623	.6	20	0.5	1.5	0	0	0	0	33	18	2.8	0	23			6	5	7	5
J	428	.5	21	1.0	1.5	0	0	0	4	4	39	3.0	0.5	25			11	8	6	13
K	440	.4	20	0.8	1.4	0	0	0	4	18	119	0.8	0	44	Fir		7	11	8	8
L	513	.6	20	1.1	1.3	0	0	0	63	38	58	1.8	1.3	100			2	2	4	13
M	234	.5	20	0.6	1.5	0	0	0	0	4	8	2.0	0.5	8			3	2	11	5
N	477	.5	23	0.5	1.6	0	0	0	0	2	23	4.3	0	22	Cedar		17	13	8	34
O	635	.6	19	0.5	1.5	0	0	0	0	14	33	0.4	2.0	8			10	5	7	18

Doe Creek-Ranges and weighted averages of respective parameters by reach; 1984-1985 survey.

Reach	Grad.	Pool Qual.	P	Run	Ri	Br	Bo	LR	SR	Cg	Sg	Sa	Si	O	M	Gask.
A	6	4.4	33	1	66	0	30	25	18	13	10	3	1	0	0	.38
B	4	4.6	16	0	84	0	21	26	25	16	8	4	0	0	0	.45
C	3	4.8	23	1	76	0	18	21	22	19	13	6	1	0	0	.50
D	4	6.3	26	1	73	0	21	24	22	15	8	9	0	1	0	.38
E	3	5.0	16	1	83	1	12	19	23	23	12	8	1	1	0	.32
F	3	5.3	32	2	66	0	35	21	20	14	6	4	0	0	0	.45
G	6	5.7	26	2	72	1	33	22	19	12	9	4	0	0	0	.50
H	3	4.5	34	1	65	0	36	25	17	11	6	5	0	0	0	.50
I	4	4.6	40	1	59	2	37	25	16	11	6	3	0	0	0	.44
J	6	5.0	41	1	58	1	39	26	17	8	6	3	0	0	0	.36
K	5	5.8	35	2	63	0	24	18	19	19	9	9	1	1	0	.62
L	6	5.6	22	22	56	3	5	36	20	12	11	10	0	3	0	.50
M	3	4.5	16	35	49	1	16	36	20	13	9	3	0	2	0	.37
N	2	3.9	23	32	45	1	19	26	25	15	8	4	1	1	0	.37

Doe Creek-Ranges and weighted averages of respective parameters by reach; 1984-1985 survey.

Reach	Length (Yds.)	Depth (Ft.)	Width (Ft.)	Bank Cover	Bank Stab	Spawning Habitat G	F	P	Pot. Deb. LB	RB	Acting Debris /Mile	DOM. Rip	SUBDOM. Rip	STOCKING Seed	Sap	Pole	Saw
A	620	.5	20	0.8	0.7	0	7	48	3.4	0.2	71	Cedar Mixed Hrdwds	Mixed Hrdwoods	21	21	2	27
B	508	.5	15	0.6	0.9	4	12	42	1.1	0.6	76	Cedar Ald	Ald Cedar	10	8	5	10
C	481	.7	21	0.7	0.9	65	37	52	3.5	0.5	66	Cedar	Mixed Grasses	10	10	12	27
D	394	.5	19	0.8	1.4	21	27	78	2.5	.16	170	Cedar	Mixed Hardwoods Fir	12	10	6	30
E	555	.4	18	0.8	0.8	54	18	27	3.4	0.2	38	Cedar	Mixed Hrdwoods Grass, Fir	6	6	1	20
F	350	.4	18	1.0	1.0	50	10	24	5.7	0.9	0	Cedar Fir	Fir Mixed Cedar	8	4	20	
G	422	.4	19	0.8	1.0	0	36	27	4.9	0	33	Cedar	Fir Ald, Fir	10	11	7	36
H	302	.4	21	0.9	1.2	0	11	23	3.8	2.4	58	Cedar	Mixed Hrdwoods Fir	9	11	5	28
I	501	.5	19	0.7	1.2	0	2	29	4.1	1.5	46	Cedar	Mixed Hrdwoods Fir, Spruce	9	10	3	27
J	699	.4	17	0.5	1.2	4	3	12	2.7	1.1	93	Cedar	Grass, Fir Mixed, Spruce				
K	464	.5	11	1.1	1.4	27	32	20	2.4	1.9	102	Ald Fir	Cedar, Ald Spruce				
L	550	.5	14	1.2	1.8	0	14	12	3.2	0	189	Mixed Hrdwds	Spruce				
M	433	.4	15	1.4	1.5	9	11	25	1.8	0.3	244	Mixed Hrdwds	Spruce				
N	853	.5	14	1.5	1.5	42	48	40	1.3	0.6	190	Mixed Hrdwds	Spruce				

Papoose Creek-Ranges and weighted averages of respective parameters by reach; 1984 survey.

Reach	Grad.	POOL Qual.	P	Run	Ri	Br	Bo	LR	SR	Cg	Sg	Sa	Si	O	M	Gask.
A	2	3.0	18	15	67	1	22	32	25	12	4	2	1	1		.25
B	2	5.5	32	20	48	0	4	23	30	25	10	3	2	3		.38
C	2	5.3	35	14	51	1	3	21	30	26	14	2	1	2		.31
D	2	4.6	28	14	58	1	14	24	31	16	9	2	2	1		.44
E	4	5.7	24	6	70	0	3	25	29	27	11	2	2	1		.33
F	4	6.0	25	3	72	0	7	23	32	26	10	1	1	0		.17
G	4	3.3	15	6	79	1	15	29	30	17	7	1	0	0		.25
H	4	5.4	23	5	72	1	18	32	25	15	8	1	0	0		.25
I	7	5.5	10	7	83	10	17	28	24	12	7	2	0	0		.38
J	7	7.5	15	3	82	2	14	21	29	22	8	4	0	0		.25
K	4	5.8	15	2	83	5	14	19	29	24	7	2	0	0		.25
L	4	4.6	16	2	82	1	8	24	31	24	11	1	0	0		.25
M	3	4.8	15	3	82	0	5	18	35	28	11	2	0	1		.25
N	5	4.4	20	1	79	3	11	28	30	20	6	1	0	1		.25
WA	3	6.9	27	6	67	4	17	26	24	20	8	1	0	0		.15
WB	4	6.5	33	2	65	5	17	23	25	20	8	1	0	1		0

PAPOOSE CREEK-Ranges and weighted averages of respective parameters by reach; 1984 survey.

						SPAWNING HABITAT														
	LENGTH	DEPTH	WIDTH	BANK	BANK	CHINOOK			STEELHEAD			POT. DEB.		ACTING	DOM.	SUBDOM.	STOCKING			
Reach	(Yds.)	(Ft.)	(Ft.)	Cover	Stab.	G	F	P	G	F	P	LB	RB	Debris/Mi	Rip	Rip	Seed	Sap	Pole	Saw
A	440	.4	28	1.6	1.5	2	77	8	0	47	23	14.3	21.3	20	Cedar		23	8	4	49
B	440	.5	25	1.6	1.3	16	66	39	4	66	74	9.8	12.5	124	Cedar	Mixed Hrdwoods	3	1	3	17
C	660	.4	30	1.4	1.0	145	125	66	10	107	171	8.3	5.8	128	Cedar		8	6	8	64
D	517	.7	27	1.1	1.4	69	108	55	0	43	69	23.4	21.3	129	Cedar		18	25	12	60
E	323	.5	22	1.3	1.3	103	91	58	3	29	35	5.4	3.1	131	Cedar		8	12	25	51
F	330	.5	22	1.0	1.5	84	75	78	2	31	36	3.7	5.0	187	Cedar		7	12	9	48
G	440	.4	25	1.1	1.3	19	78	130	0	7	28	3.0	2.3	72	Cedar		25	38	34	47
H	294	.5	25	1.5	1.3	15	46	87	0	7	21	4.3	2.7	120	Cedar		13	19	6	39
I	453	.3	12	1.1	1.5	0	0	0	0	52	165	0.5	3.3	124	Cedar		8	12	6	26
J	220	.3	16	1.3	1.5	0	0	0	0	38	69	0	3.0	184	Cedar		10	9	3	23
K	481	.4	11	1.0	1.4	0	0	0	8	43	151	0	6.8	154	Cedar		16	21	9	36
L	550	.3	13	1.0	1.4	0	0	0	2	32	54	4.0	3.4	166	Cedar		10	19	27	46
M	648	.3	14	1.4	1.5	0	0	0	4	23	49	2.5	4.3	190	Cedar		11	21	13	43
N	770	.4	13	1.3	1.4	0	0	0	2	3	15	7.0	0.4	103	Cedar		13	9	16	41
WA	506	.8	30	1.0	1.5	43	27	35	0	37	44	7.3	5.5	104	Cedar		6	12	30	66
WB	639	.4	30	1.3	1.6	51	15	5	0	13	85	4.3	4.5	113	Cedar	Mixed Hrdwoods	9	10	9	58

APPENDIX C

Salaries	$8,717
Non-expendable Equipment and Material	-----
Expendable Equipment and Material	575
Operations and Maintenance	3,758
Overhead*	-----
Total	$13,050

*Removed at the Supervisors Office

APPENDIX D

STREAM SURVEY NARRATIVE --
CLEARWATER NATIONAL FOREST OCULAR TECHNIQUE
FOR MULTIPLE USE PLANNING INPUT
1976

STREAM ORDERS

We will use the following description of Stream Orders in relation to aquatic habitat. This description is not synonymous with the dendritic numbering system used by hydrologists.

First Order - Small intermittent streams that have a defined channel whose flow is not perennial. Such streams can be important for spawning purposes during high water periods.

Second Order - Small perennial streams that flow less than 10 C.F.S. at peak discharge, and whose channel width is less than 4 feet. These streams can provide good spawning and rearing habitat for brook, cutthroat, and steelhead trout.

Third Order - Medium stream channels range in width from 4 to 10 feet, and whose discharges range from 50 to 200 C.F.S.

Fourth Order - Large stream channels range in width from 10 to 50 feet, and whose discharges range from 50 to 250 C.F.S.

Fifth Order - Rivers, channel width and discharge are in excess of

50 feet and 250 C.F.S., respectively.

All streams are important; they are part of a drainage network. Our most significant fishery resources on the Clearwater will be contained in Stream Orders 3-5; however, water quality in Stream Orders 1 and 2 will largely determine the quality of habitat in larger Stream Orders. Smaller streams are most likely to be the first that are heavily impacted by development activity.

STATION

Each station will be a 0.25 mile in length (1320 feet, and 440 yards, and 400 meters); summarize and record your observations for each 0.25 mile station. Try to locate your first station either at the mouth of a stream or in its headwaters area -- if access is available. Try to survey as much of the stream as possible; at least cover significant portions of the upper, middle, and lower sections of the drainage. Record your stations on U.S.G.S. maps, 7.5 minute series (topographic).

Sub-record observations of the following parameters in a field notebook per 110 yards segment of each 0.25 mile station; average quality ratings for the four segments and record as value for the station.

Parameters

Pool Quality

Bank Cover

Bank Stability

Bottom Materials

Pool-Riffle-Run Ratio

Gasket Effect

Benthos Quality

MEAN GRADIENT

Determine stream gradient with Sunnto clinometer four times per station; average for the station and record; determine gradient 100 feet upstream and downstream from your point of observation and then average; determine gradient at the start and end of your station -- and at equal intervals between these points -- i.e., 147 yards. Gradient is an important physical parameter; the slope or gradient of a stream interacting with the land type and geology of the area will largely determine the configuration of a stream (both longitudinal and cross-sectional); these relationships will determine the magnitude of meandering (sinuosity) downcutting, (dissecting or degrading) and aggradation (deposition) which in turn will determine the habitat profile of a stream -- Pool-Run-Riffle ratios.

WIDTH AND DEPTH

Measure these physical parameters at the same points that gradients are determined (four measurements). Width is measured from edge of wetted surface to opposite edge; measure depth (in inches) at quarter intervals -- i.e., ¼, ½, and ¾ distances across the channel and then compute the average depth.

The depth readings are averaged by addition and division by 4 which gives weight to zero depths at bank points. Compute the averages for the 0.25 mile section and record on data form.

POOL QUALITY

We will use the Region One qualitative rating scheme. Three characteristics are important in determing quality: size, depth, and cover.

SIZE

Rate 3 - if pool is much longer or wider than average width of stream within 100 feet above and below the point of observation.

Rate 2 - if pool is about as wide or long as the average width of stream within 100 feet above and below the point of observation.

Rate 1 - if pool is much shorter or narrower than average width of stream within 100 feet above and below point of observation.

DEPTH

Rate 3 - if deepest part of pool is greater than three (3) feet.

Rate 2 - if deepest part of pool is between two and three feet deep.

Rate 1 - if deepest part of pool is less than two (2) feet.

COVER consists of many types and forms: undercut banks, logs, boulders, overhanging riparian vegetation, roots, rippled water surface, and submerged vegetation.

A final classification is based on a composite rating of all three characteristics:

TOTAL RATING	POOL CLASS	QUALITY
8-9	1	Excellent
6-7	2	Good
5	3	Fair
3-4	4	Marginal

Keep in mind that your pool quality evaluation for a station will be an overall perspective or composite rating for all pools within that section. Record the total rating figure for each 0.25 mile station.

BANK COVER (Riparian Zone Vegetation)

Stream-side vegetation provides shelter, shade, nutrients and substrate for forage organisms (terrestrial insects) for fish. Cover will usually consist of the following elements:

1. Trees (conifers and herbaceous)
2. Tall shrubs, taller than two feet
3. Low shrubs, less than two feet
4. Forbs
5. Grasses

For the types of plants to be effective as cover, they must be located within ½ of their total height of the streambank. Streambank cover will be evaluated as a composite rating for both banks according to to the following schemes:

Rate 2 - if bank are medium or heavily covered with trees and tall shrubs. Shrubs extensively overhang the edge of the channel. Crown-Canopy: opening ratio = 70:30 or greater (conifers and/or tall herbaceous trees)

Rate 1.5 - if banks have scattered (moderate spacing) trees and tall shrubs. Shrubs moderately overhang the edge of the channel. Crown-Canopy: opening ratio = less than 70:30 but greater than 50:50.

Rate 1.0 - if banks are medium to heavily covered with grass and forbs, and/or low shrubs -- or only one bank is medium (heavily) or moderately covered with trees and/or tall shrubs. If banks are medium to heavily covered with low shrubs. If one bank is medium or moderately covered with trees and/or tall shrubs and the other with overhangings, dense low shrubs. Crown - Canopy: opening ratio = less than 50:50 but greater than 30:70.

Rate 0.5 - if banks are covered with scattered grass and forbs, or are predominantly exposed. Shrubs are widely spaced with no overhanging features. Crown-Canopy: opening ratio = less than 30:70.

BANK STABILITY

This qualitative parameter is difficult to define. Our ecological interest here is extremely unstable areas -- natural or unnatural -- that would function as significant erosion sources. Unstable stream - banks are usually characterized by finely-textured soils and as poorly vegetated areas in vertical profile. Stable banks are usually associated with densely vegetated areas with large or solid rock interspersed. Look for evidence of channel side slumping. Overgrazing by cattle or sheep allotments usually results in significantly decreased bank stability. The bank stability rating is a composite evaluation for both banks for each station:

Rate 2.0 - if both banks are totally stable throughout the section.

Rate 1.5 - if 50% or more of both banks are stable.

Rate 1.0 - if less than 50% stable.

Rate 0.5 - if totally unstable.

BOTTOM MATERIALS

Estimate the percentage of the streambed area composed of the following elements for each station:

Organic

1. Debris (0) - undecomposed, sticks, leaves, logs or other woody and herbaceous material.
2. Much (M) - decomposed organic material, usually black in color.

Inorganic

1. Silt (Si) - fine sediments with little grittiness.
2. Sand (Sa) - particles smaller than 0.25 inches (6.35mm) diameter.
3. Small Gravel (SG) - 0.25 to 1.0 inches.
4. Coarse Gravel (CG) - 1.0 to 3.0 inches.
5. Small Rubble (SR) - 3.0 to 6.0 inches.
6. Large Rubble (LR) - 6.0 to 12.0 inches.
7. Boulders (Bo) - greater than 12.0 inches.

8. Bedrock (Br) - large masses of solid rock.

Heterogeneity (without excesses) in bottom materials is what is required for good fish habitat. Large cobbles (rubble - 6 to 12 inches) in riffle areas provide excellent aquatic insect habitat. Fine to coarse gravel (0.25 to 3.0 inches) without excessive amounts of sand and/or silt interspersed provides good spawning materials for resident salmonids. Small rubble (3 to 6 inches) provides good spawning habitat for steelhead trout, Chinook salmon, and large Adfluvial Salmonids (lake-run fish). Excessive amounts of sand and/or silt characterize less-productive, degraded stream ecosystems.

POOL: RUN: RIFFLE RATIO

This ratio provides an index of fish habitat heterogeneity in a stream system. Estimation of the ratio considers habitat type frequency and magnitude. It is the partition of the total stream area into these three habitat types.

A 1:1:1 ratio is generally accepted as providing a good fish habitat physical profile. Pools -- relatively deep, slack water areas provide cover and resting zones; riffles -- shallow, turbulent water areas with moderate to rapid water velocities function as feeding and spawning areas.

Runs -- these are transitional areas -- intermediate between pools and riffles in physical profile -- runs can be characterized as moderately deep areas of laminar flow (minimum of turbulence) with slight to moderate water velocities. Runs function as feeding, resting, and spawning areas.

MIGRATION BLOCKS

Several criteria are utilized to evaluate migration barriers. First of all you must determine if fish passage is required. Knowledge of species composition in the drainage will assist you in this determination -- i.e., brook trout migrate short distances; passage usually not required; kokanee and fluvial cutthroat trout migrate relatively long distances, passage usually required. Knowledge of the species will also assist you in determing if passage is required at high water (spring) -- cutthroat (spring spawners) -- or at low water (fall) -- kokanee, mountain whitefish (late fall), and dolly varden (fall spawners). Migration blocks affect passage by creating jump, velocity, and simply physical barriers. A velocity greater than 4 feet per second will effectively block passage for most resident salmonid species -- cutthroat, kokanee, rainbow, brook, and small dolly varden. Larger fish such as steelhead and salmon can negotiate velocities up to 6 feet per second. A jump of 1.5 - 3.0 feet will also prevent passage of most smaller resident species, whereas steelhead and salmon can make it over barriers of 6-10 feet in height provided an adequate "take-off" pool is located below the barrier. Most surveys will be conducted during the low water periods; try to visualize the barrier at high water -- i.e., high water will probably eliminate at least 1 foot and perhaps 2 feet in a jump barrier and increase the velocity from 2 to 4.0 feet per second.

Evaluate unnatural barriers such as log jams for their stability, and if they are providing and/or enhancing habitat. Log jams that are well anchored in the streambed or streambank and are not likely to go out during spring runoff -- and are providing needed cover and shade or are functioning as effective sediment traps should not be removed as they will tend to degrade water quality.

COBBLE IMBEDDEDNESS (Gasket Effect)

This is a relative index that measures the extent that a cobble (3-12 inches in diameter) is surrounded by fine and coarse sediments (any particle less than 0.25 inch sieve size). The more sediment that surrounds and is compacted around the cobble, the less habitat there will be for aquatic insects (less surface area, less cover). Try to visualize a "gasket" of sediment surrounding the cobble. The magnitude of imbeddedness will be assessed as follows:

No effect: Cobble easily moved - resting and surrounded by large substrate (greater than 0.25 inch).

¼ gasket: Cobble still easily moved; however, ¼ of surface area surrounded by sand and fine material.

½ gasket: Cobble difficult to move with hand or foot; ½ of surface area lost to sand and fine material.

¾ gasket: Cobble very difficult to move; ¾ of surface area lost to sand and fine material.

Full gasket: Cobble almost impossible to dislocate from streambed; surface area needed for aquatic insect habitat completely choked off or eliminated; "gasket" of sediment even with upper surface of cobble.

To evaluate the amount of surface area lost to "gasket" effect -- try to visualize a 'full gasket" effect where sediments surrounding the cobble are even with the upper surface of the cobble; remember the underside and edge of the cobble provide the bulk of the habitat for most aquatic insects -- use that as a baseline for assessing the magnitude of effect. Evaluate "gasket effect" only for riffle and run habitat types.

FISH SPECIES OBSERVED (SIZE)

It will be difficult to assess species composition without sampling with a fish shocker, net, explosives, or angling gear. Brook trout (white border zone on fins) kokanee (bright red spawning livery) are easily identified by sight. If time permits, try to secure an identification sample by sport angling but do not expend more than one (1) hour during a stream survey day on sport angling for identification. If you are unable to identify the species present, just list -- "fish observed - unidentified" and describe their size -- fry, less than 1.5 inches; fingerlings, 1.5 to 6 inches; adults, greater than 6 inches.

SPAWNING HABITAT

AVAILABILITY AND QUALITY

This is one of the most important components of the stream survey report. Good spawning habitat is generally characterized by three basic com-

ponents (specific requirements will vary according to the species):
1) the proper size of streambed substrate (spawning gravels) free of excessive sand and fine sediments; the proper gravel size for smaller salmonids (6-24 inches) will range from 0.25 - 2.5 inches; optimum size will range from 0.50- -.50 inches; larger fish such as salmon and steelhead require larger sized gravel - range, 0.25- 6.0 inches; optimum, 1.50 - 4.0 inches. Gravel size is the first element you should "key" on in delineating spawning habitat.

Estimate the surface area (pace-off or measure with tape) of each station that has available spawning habitat and record as total square yards; if a portion of the area is blocked by a migration barrier, estimate the percent of the area that is available and non-available; a complete block in a lower section will render anything above that point as non-available; however, list and describe additional upstream blocks, estimate available area within a specific section.

2) Proximity of cover and resting pools; desirable spawning habitat will contain -- within a distance of 100 feet up or downstream -- pool areas of sufficient depth (greater than 2 feet) and cover (under-cut banks, boulders, logs) to provide shelter and rest.

3) Moderate current velocities; current velocities of 0.5 - 4.0 feet per second are considered optimum and desirable for spawning activity and incubation requirements.

Spawning habitat that provides all three components should be rated as "good" quality habitat.

Habitat that shows proper gravel size but no or poor quality pool areas and borderline velocities should be rated as "fair"; if the habitat meets the pool and velocity criteria -- but the gravels show signs of sediment impacts -- "cemented" effect, gravels are difficult to move; ½- ¾ gasket effect, rate as "fair". Rate as "fair" if gravel size is borderline -- e.g., small fish, predominantly 3-inch gravel. Rate as poor when sediment impacts are excessive -- ¾ to full gasket effect, gravels nearly impossible to move by hand or foot; or proper gravel size and quality are present but area is completely exposed without any nearby pool areas for resting and cover -- and current velocities are excessive (greater than 4 feet per second). Evaluate the total spawning area within the section into the three quality categories.

Since stream surveys will be conducted during low flow periods, estimates of spawning habitat for spring spawners will be difficult. Try to locate the high water channel mark as a point of reference. Then estimate the spawning areas within the high water marks that will likely remain watered until mid-July.

Spring Spawners	Fall Spawners
Cutthroat Trout	Spring Chinook Salmon
Steelhead Trout	Dolly Varden Trout
Resident Rainbow Trout	Brook Trout
	White fish

BENTHOS QUALITY (Sample only in riffles)

Benthos is defined as stream bottom organisms -- usually larval stages of aquatic insects (nymphs) in lotic environments. In Batholith streams, we are dealing with low fertility (productivity) and depauperate benthic fauna, low diversity and relatively small size. As far as preferred forage species are concerned, we should look for four types (major groups) of aquatic insect larvae:

(1) May flies, Emphemeroptera:

A. 3-tailed, long, slender, rarely 2.

B. Elongated body, but variable.

(2) Stoneflies, Plecoptera:

A. Body form depressed.

B. Two-tailed, long.

(3) Caddisflies, Tricoptera:

A. Living in portable cases - made of sticks and small pebbles.

(4) Trueflies, Diptera

In our streams, usually simuliids -- black flies, gnats;

A. Body soft, socklike - widest near posterior third.

B. Larvae attached to stones, vegetation or other objects, in swiftest part of streams.

If all four types are present at an abundance level of 10-15 organisms per 6 to 12 inch cobble (N= 10 for cobbles) in a section, rate as excellent quality "3"; if three of four types are present at the previous abundance level, rate as good "2.5"; if 2 of 4 are present at the same abundance level, rate as fair "2"; also if all are present at an abundance level of 5-10 organisms per 6-12 cobble, rate as fair. If only one type is present at 5-10 organisms per cobble, rate as a 1.5 (marginal). If only one type is present at a level of 3-5 organisms or less organisms per cobble, rate poor "1".

EROSION SOURCES (Magnitude)

Identify as to type:

A. Lateral bank erosion (natural or un-natural)

B. Road fill failure

c. Cutbank failure

D. Culvert failure

E. Grazing allotment

(1) bank sloughing, stomping

F. Road encroachment - no buffer strip - direct contact between stream and road fill. Channel constriction via streamside road.

Describe magnitude, i.e., excessive, large, number of failures per section; estimate length of streambank subjected to lateral bank erosion. Estimate area of exposed cutslope surface. Estimate length of lateral bank erosion. If time permits, measure the magnitude of severe impact areas.

ADDITIONAL OBSERVATIONS

Utilize this section for general comments or for more detailed information on any of the block items on the stream survey forms. You might use this section to describe or identify the riparian zone and submerged vegetation. A description of the land type or geology of the area would be helpful. Observation on sport angling pressure could also be included. Also include your catch per unit effort data obtained during sport fishing sampling.

AIR - WATER TEMPERATURE

1. Take at station #l, record time. Re-measure at two-hour intervals during length of survey.

STREAM VELOCITY (If no headrod or current meter is available)

1. Measure once at mouth or at start of major stream section, using float, timed interval technique.
   A. Film canister makes an excellent float.
   B. Time over a lo-foot distance.
   C. Avoid current patterns with back eddies, or severe turbulence.
   D. Repeat measurement two times; average the three observations.
   E. Calculate velocity and record as feet per second.

LENGTH OF STREAM AND/OR RIPARIAN ZONE ALTERATIONS (Developed watersheds)

A. Estimate distance on both channel sides where the stream has been altered in some fashion, e.g., channel change, road encroachment, extensive rip-rapping, dredging.

B. No buffer strips left (crown-canopy) during logging operations on both sides of channel.

C. One side has a buffer strip.

D. Buffer strips lack "integrity" and heterogeneity (bi-level configuration).

   1. Crown-canopy: opening ratio reduced beyond 70:30 level, 100 feet horizontal distance from channel edge.

   2. Estimate crown-canopy opening ratios in logged-over areas for both sides of channel.

CHANNEL AND ADJACENT LANDFORM CONFIGURATION

Record by station as: V-shaped = "V"
U-shaped = "U"
Wide-bottom = "W"

Abbreviation List for Fish Species

CT = Cutthroat Trout

SHT = Steelhead Trout

BT = Brook Trout

DVT = Dolly Varden Trout

RRB = **Resident** Rainbow Trout

D = **Kokanee Salmon**

CHS = **Chinook Salmon**

WF = **Whitefish**

AG = **Artic Grayling**

SU = **Sucker**

D = **Date**

RSS = **Red-sided Shiner**

SC = **Sculpin**

Eldorado Creek Fish Passage

Final Report

By

Wally Murphy
District Biologist
Pierce Ranger District
Clearwater National Forest

Al Espinosa Jr., Project Leader
Forest Fisheries Biologist
Clearwater National Forest

Funded By
The Bonneville Power Administration
Division of Fish and Wildlife

December 2, 1985

Modification M001 to Agreement
DE-A179-54BP16535
Project 84-6

Final

I. ACKNOWLEDGEMENTS:

In addition to those people mentioned in the 1984 Annual Report we would especially like to thank D and B Drilling and Blasting of Dayton, Washington, for a job well done.

II. INTRODUCTION:

The 1984 Eldorado Creek Fish Passage Annual Report, by Murphy and Espinosa, detailed project origination, objectives, description of the project area, methods and materials used in 1984 and the results, conclusions and recommendations, based on our 1984 accomplishment. Page 16, "V. Summary and Recommendations", outlined specific areas which required further improvement (refer to Appendix D). Generally, these recommendations called for improving length, width, and depth of the pools created in 1984. These recommendations were the basis for extending the project into 1985.

In 1985, an additional $13,000 was allocated for the Eldorado Creek Barrier Removal Project Number 84-6, Agreement Number DE-A179-84BP-16535, Modification Number M001. The action brought the total project funding to $30,668.

The following report is a description of the 1985 methodologies, results and conclusions.

III. METHODS AND MATERIALS:

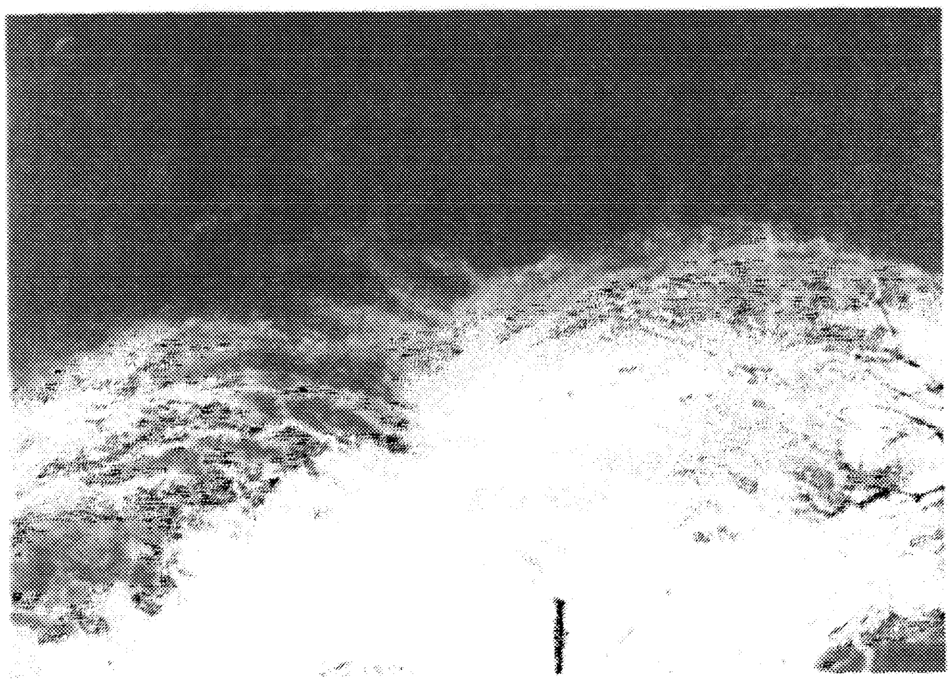
To test the accuracy of our recommendations for further work, we again contracted the services of Dr. John F. Orsborn, a Hydraulic Engineer and Fish Passage Consultant, from Washington State University at Pullman, Washington. A copy of Dr. Orsborn's report is presented in Appendix C. Dr. Osborn's analysis agreed with recommendations for Sites #1 and #2. At Site #3, Dr. Orsborn suggested enlarging Pool A to include the area that Pool B was to occupy and sheer off the face eliminating the need for Pool C (refer to 1984 Annual Report and Appendix C). At Site Number 4, Dr. Orsborn recommended eliminating the ledge where rock weirs were placed to form Pools B and C. This action would eliminate the need for these weirs (refer to 1984 Annual Report and Appendix C).

Based on our 1984 results and our limitations on the Forest, we decided to contract the 1985 drilling and blasting. A contract for $11,690 was awarded to D and B Drilling and Blasting, owned and operated by William Rowling of Dayton, Washington.

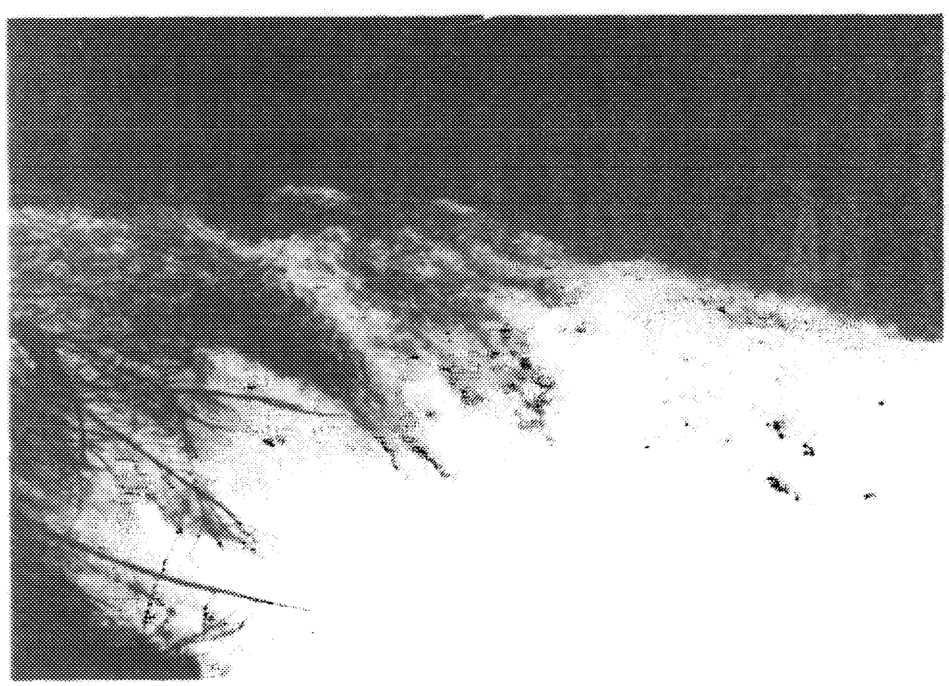
IV. RESULTS AND DISCUSSION:

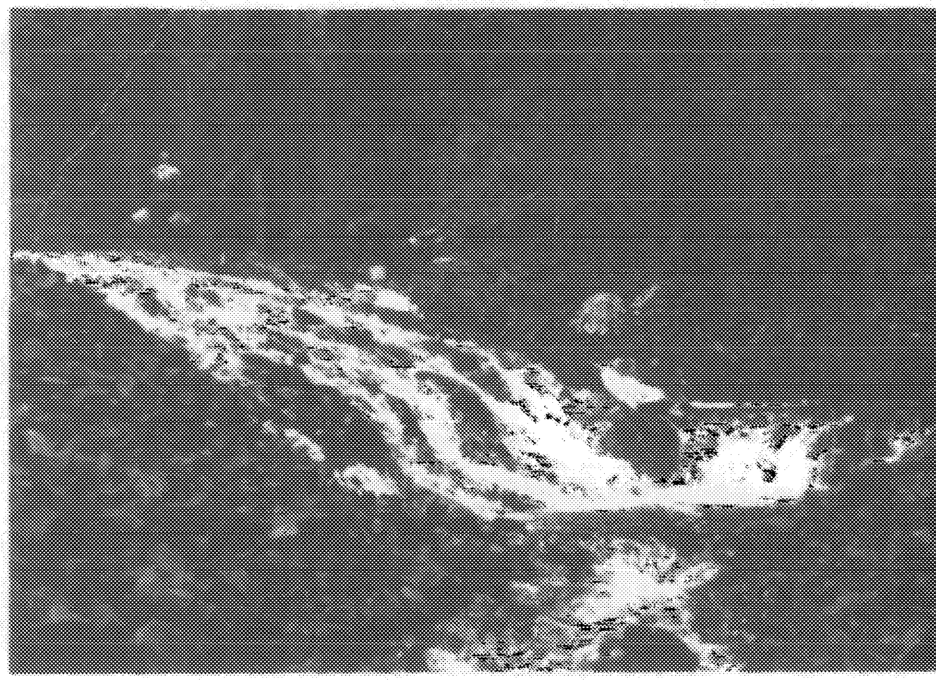
Site Numbers 1, 2, 3, and 4, were treated according to Dr. Orsborn's plan.

At Site Number 1, five pools were created. Pool parameters are shown in detail in Appendix I. With only a few minor exceptions the created pools met or exceeded Dr. Orsborns design standards. Appendix E presents a schematic drawing of the results at Site Number 1. Figures 1 through 7, photographs of Site Number 1 show the site during peak runoff in 1985 and also the results of our 1985 work. Please note that the pool lettering between 1984 and 1985 is not comparable, refer to Appendix I.

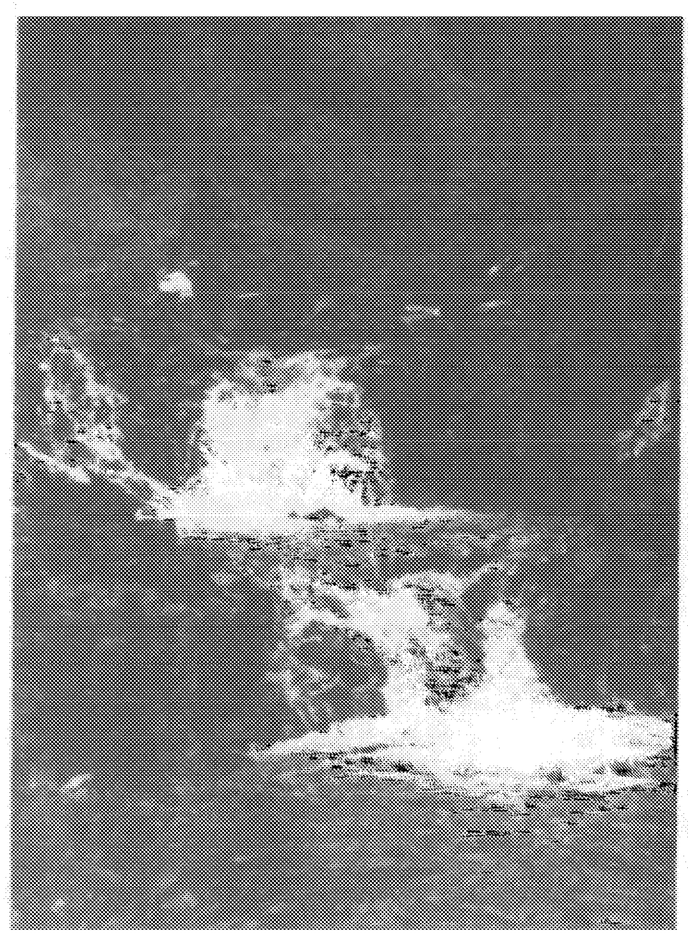


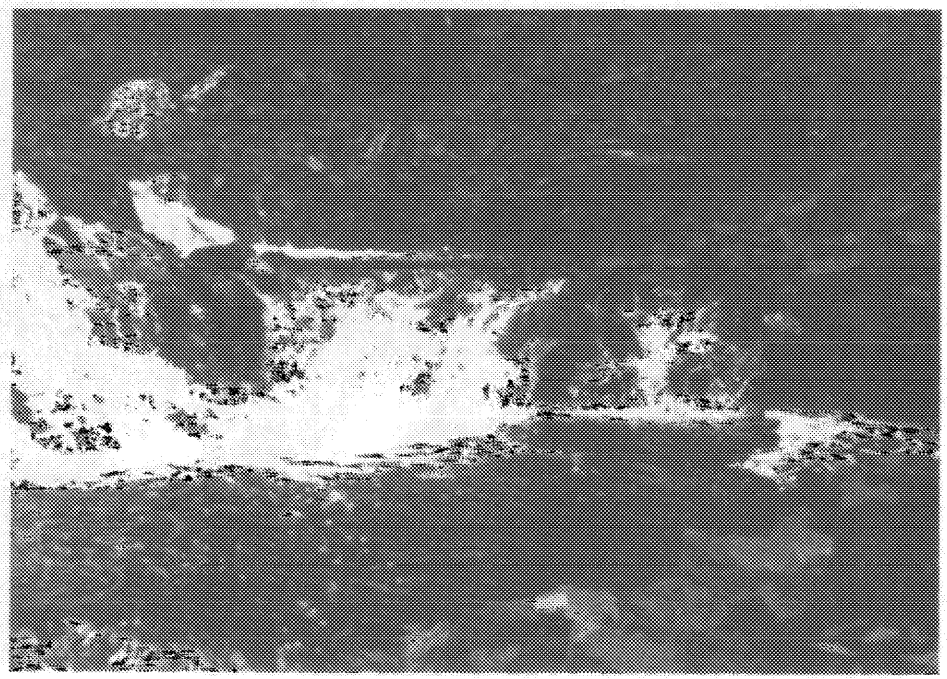
Figures 1 and 2. Site Number 1 during high water in June 1985.



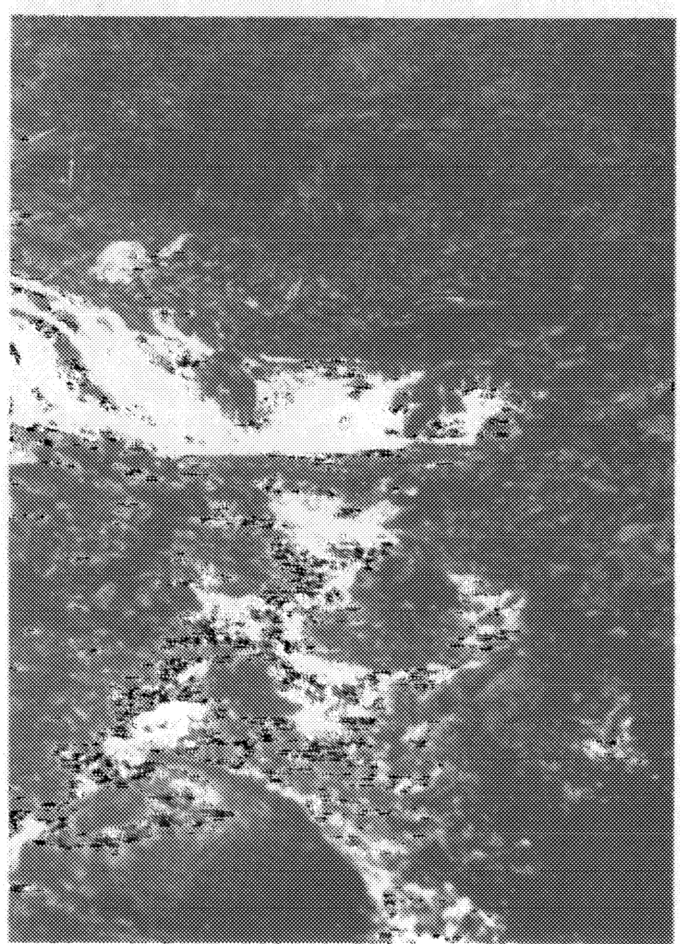


Figures 3 and 4. Upper and lower photos show residual rock being removed from site 1.





Figures 5 and 6. Upper photo shows Pools C and D. Lower photo shows Pools D and E. Site Number 1.



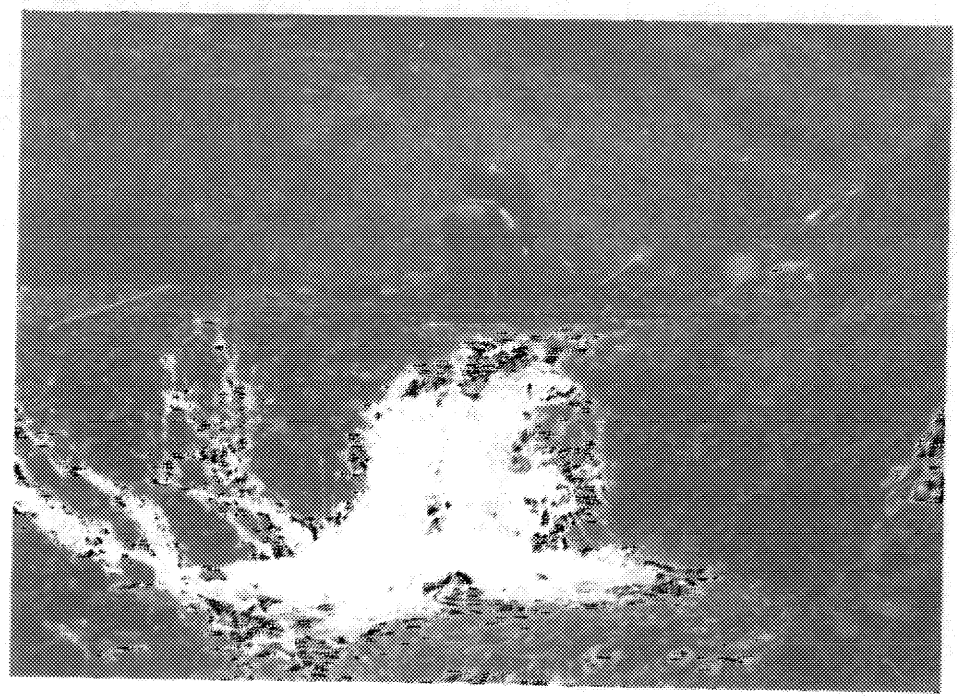
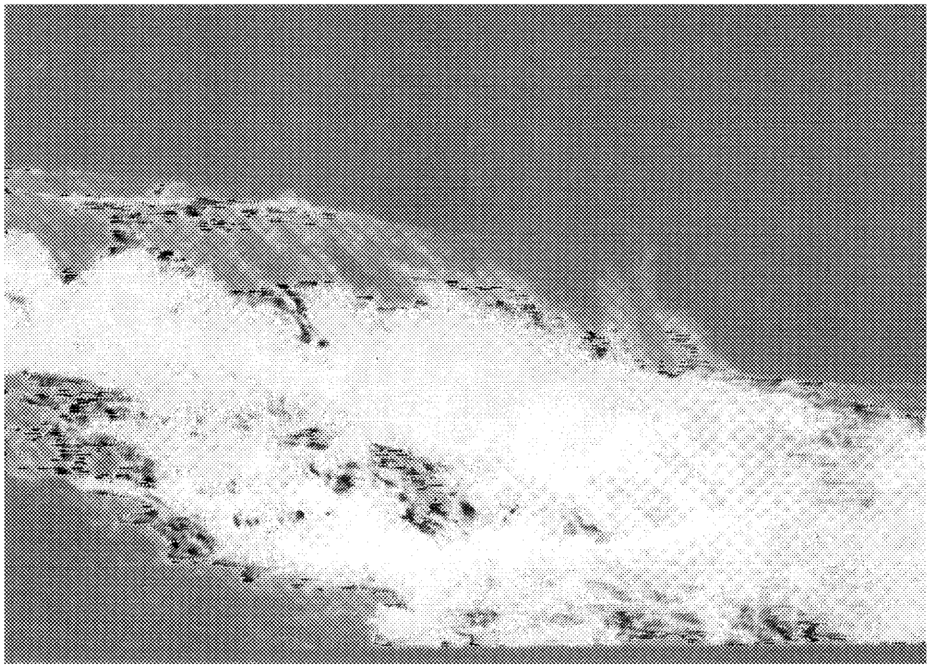


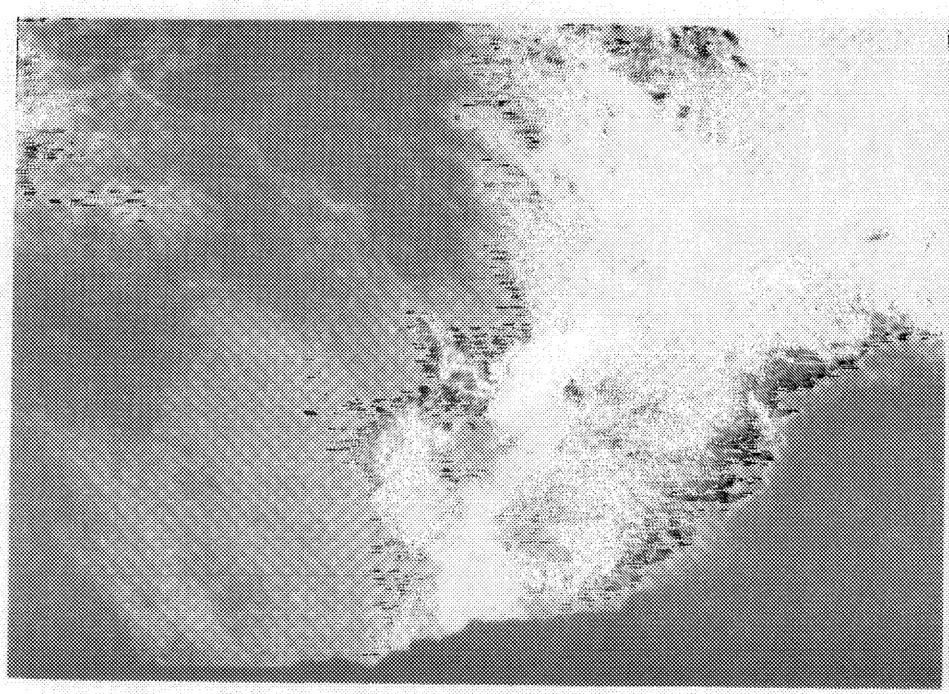
Figure 7. Photo shows Pool B and rock being removed from Pool A. Site number 1.

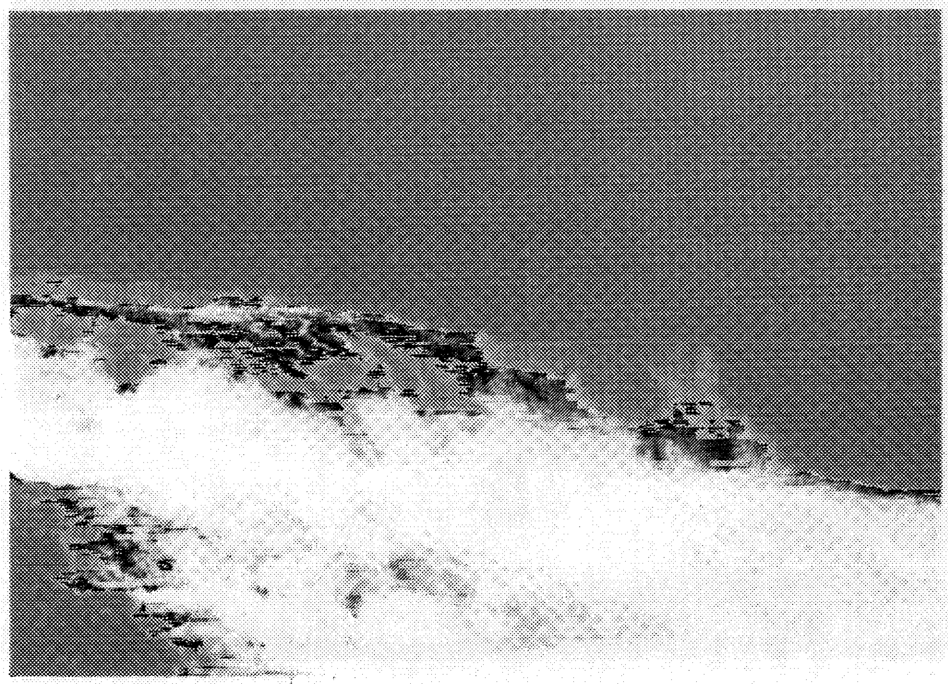
At Site Number 2, all of Dr. Orsborn's suggested goals were exceeded. Pool A was deepened and widened significantly and the drop to Pool B reduced. Pool B was deepend, widened and lengthened. Pool C was deepened and the rock weir made more permanent. Pool parameters are shown in detail in Appendix I and schematically in Appendix F. Figures 8 through 15 are photographs showing Site Number 2 during spring runoff in 1985 and the site after the 1985 blasting.

At Site Number 3, Eldorado Falls, Dr. Orsborn's modified plans called for creating one large pool at the top and "facing" off the falls. The results matched the plan well. Pool A was widened to 3.7 meters, lengthened to 4.5 meters and deepened to 0.5 meters (refer to Pool Parameters Appendix I). Appendix G shows the results schematically. Figures 16 through 24 are photographs of Site Number 3 during spring runoff in 1985 and the results of the 1985 blasting.

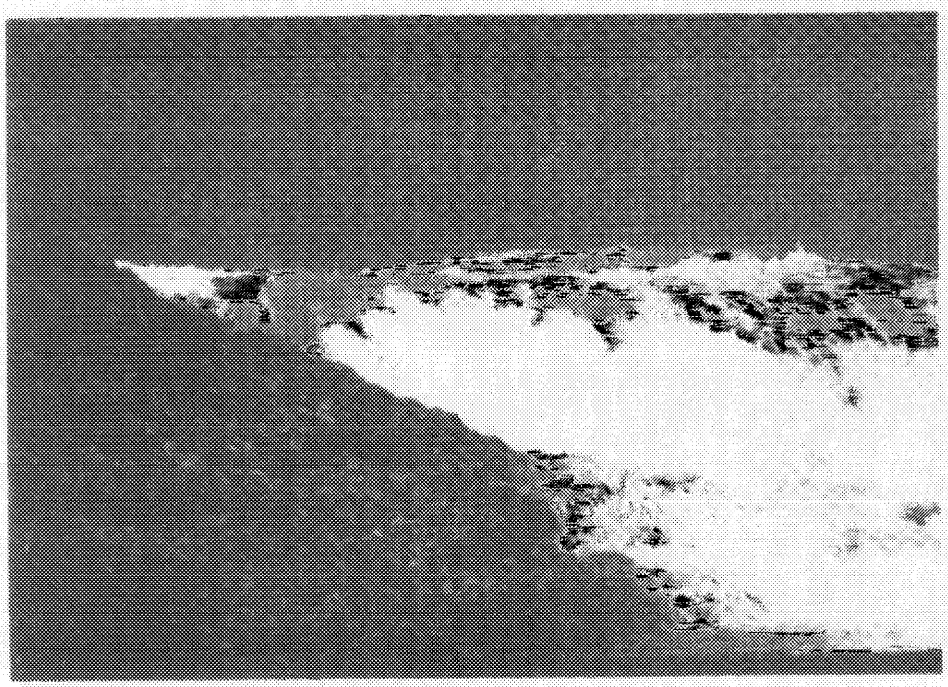


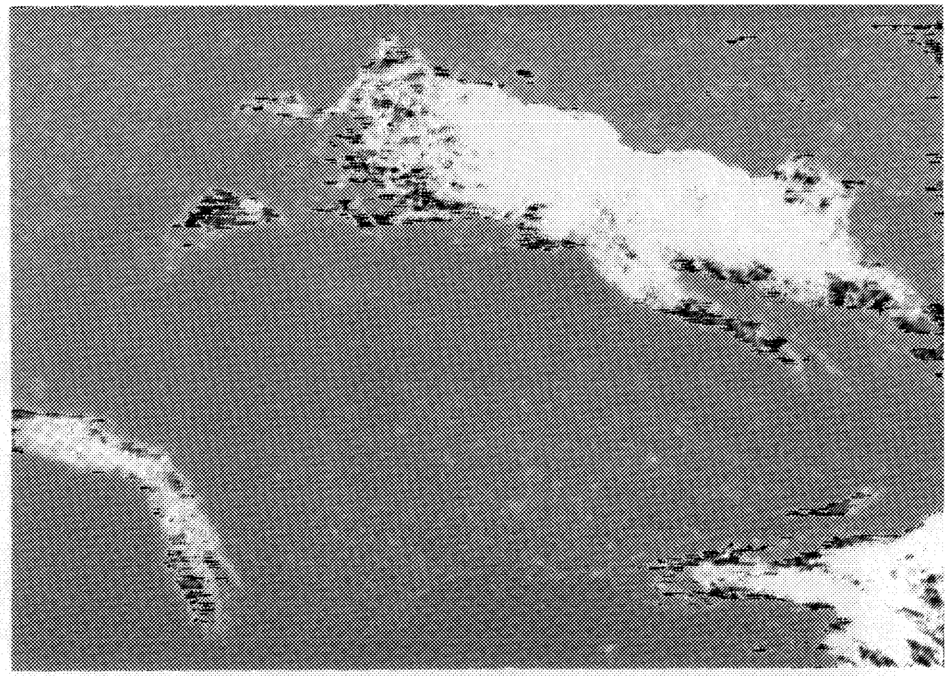
Figures 8 and 9. Upper and lower photos show Site 2 during high water in June, 1985.



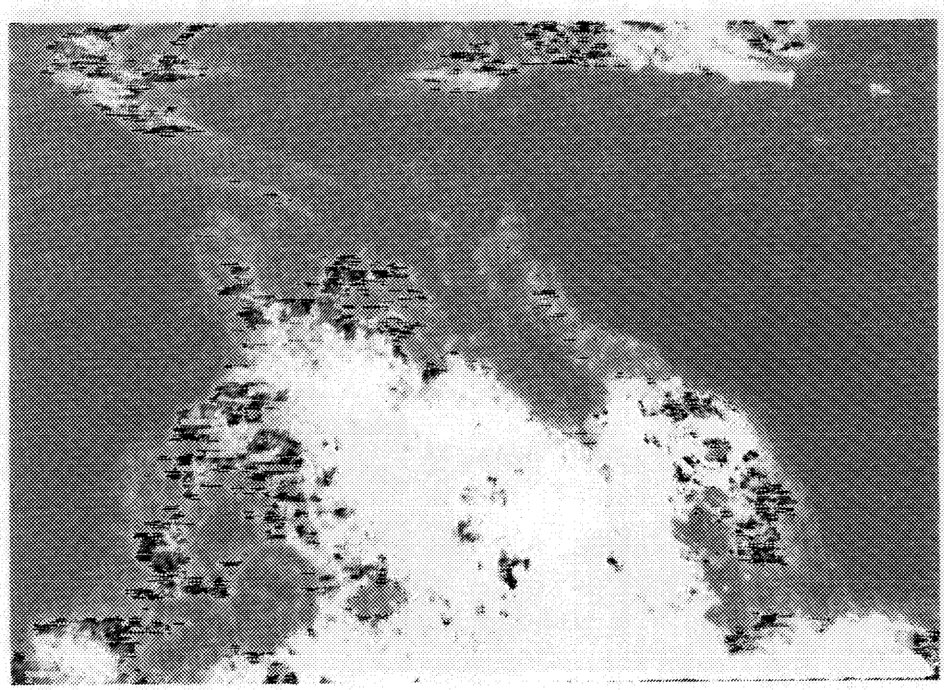


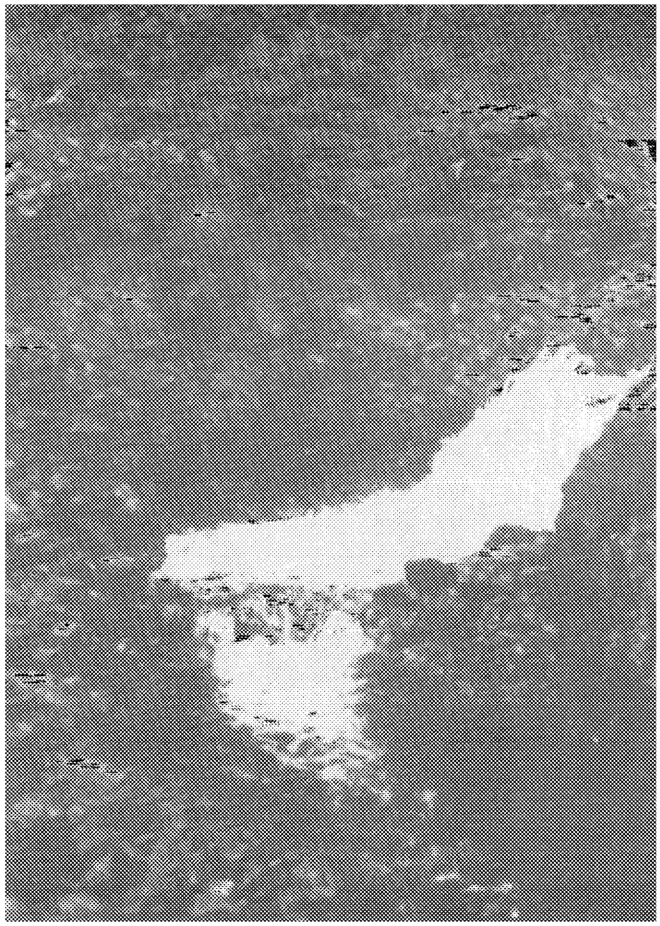
Figures 10 and 11. Upper and lower photos show Site Number 2 during high water in June, 1985.



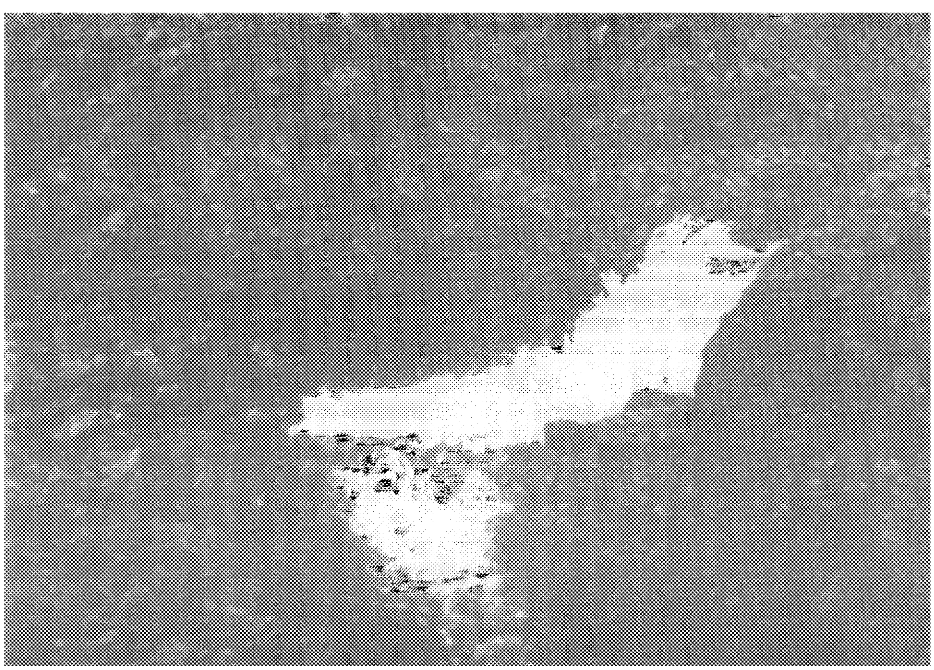


Figures 12 and 13. Upper photo shows Pools A, B, C, and D. Lower photo shows drop from pool A to B, at Site Number 2.





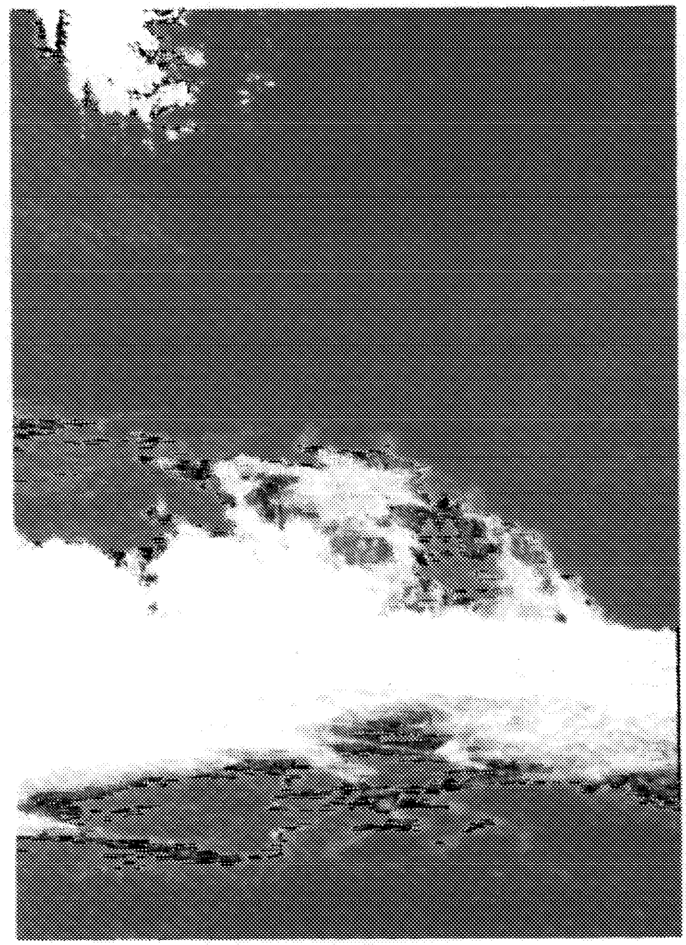
Figures 14 and 15. Upper and lower photos shows pools B and C. Note enlargement of B, at Site Number 2.



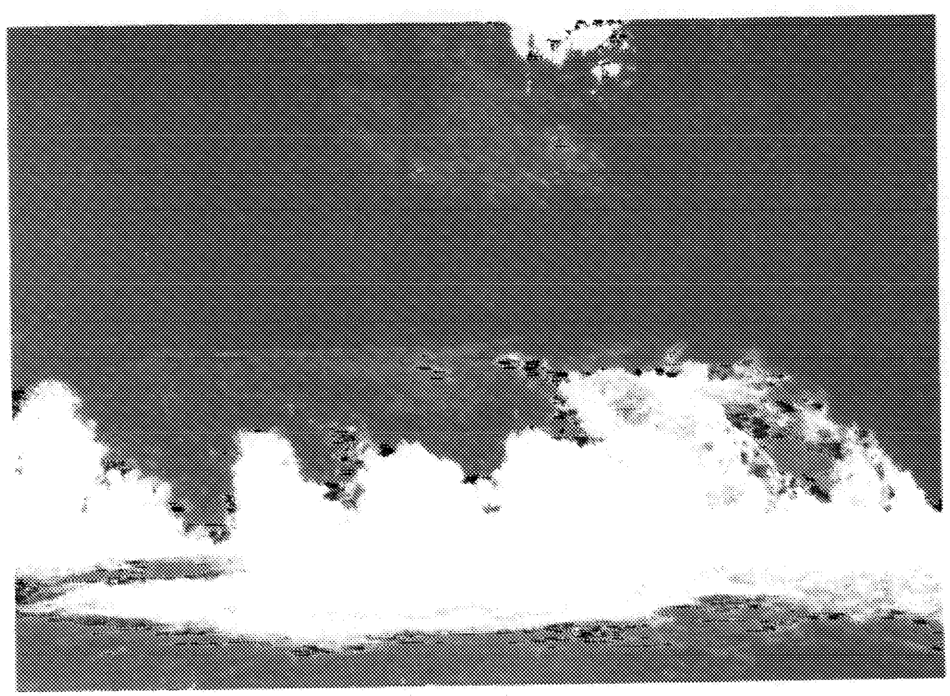
The blasting at Site Number 4 was minor. The work consisted of eliminating a shelf where 2 rock weirs were made in 1984 to create Pools B and C (refer to 1984 Annual Report). Eliminating the shelf would effectively link Pools A and D and eliminate the need for the rock weirs. The results were exactly as planned (refer to Appendix I, Pool Parameters and Appendix H, a schematic of the results at Site Number 4). Figures 25 through 28 are photographs showing Site Number 4 during spring runoff in 1985 and after the 1985 blasting.

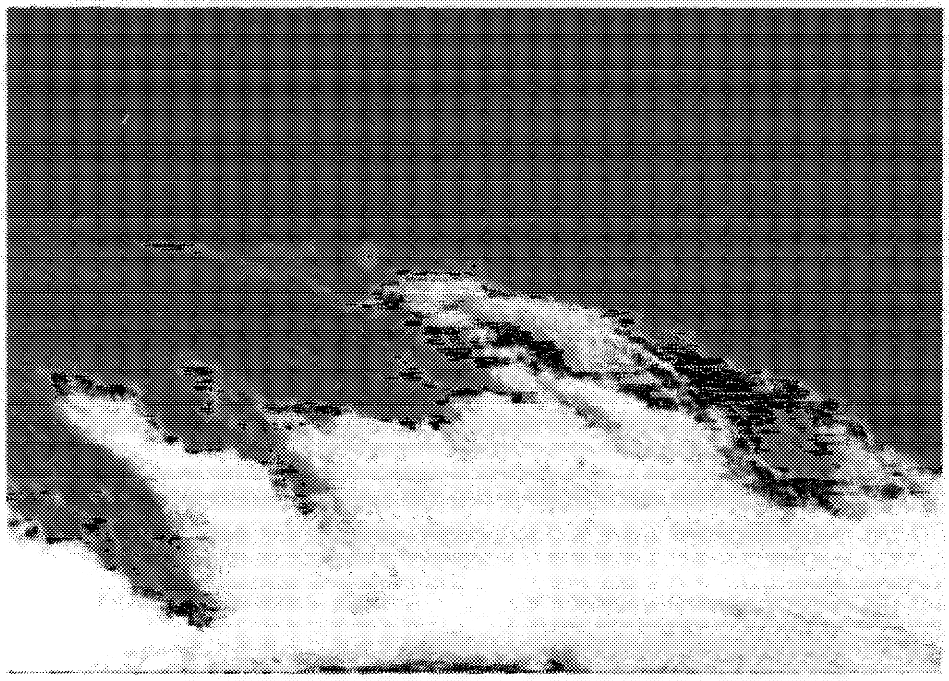
V. SUMMARY AND RECOMMENDATIONS:

Corrective actions taken in 1985 have eliminated high and low flow upstream migration barriers for anadromous fish at all 4 sites in Eldorado Creek. The results obtained in 1985 are were completely satisfactory. No further work is necessary.

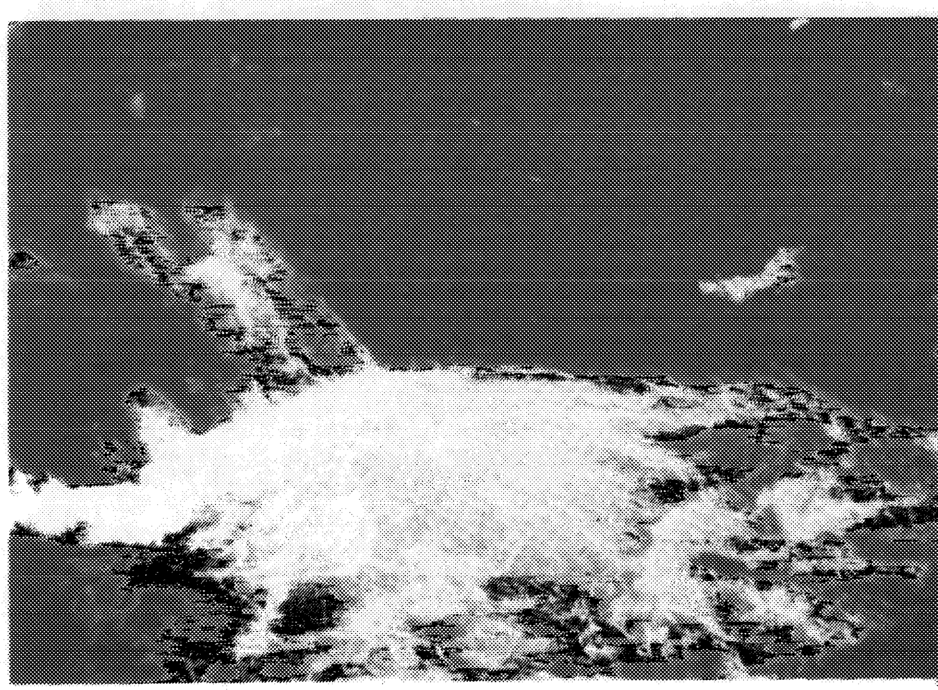


Figures 16 and 17. Upper and lower photos show Site Number 3, Eldorado Falls during high water in June 1985.





Figures 18 and 19. Upper and lower photos show Site Number 3, Eldorado Falls during high water in June, 1985.



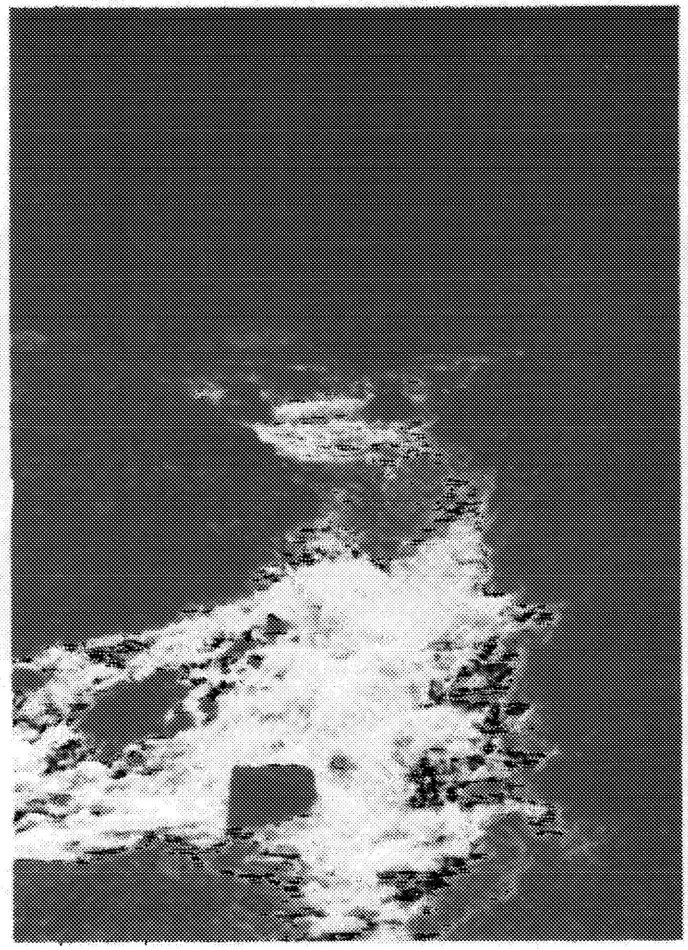
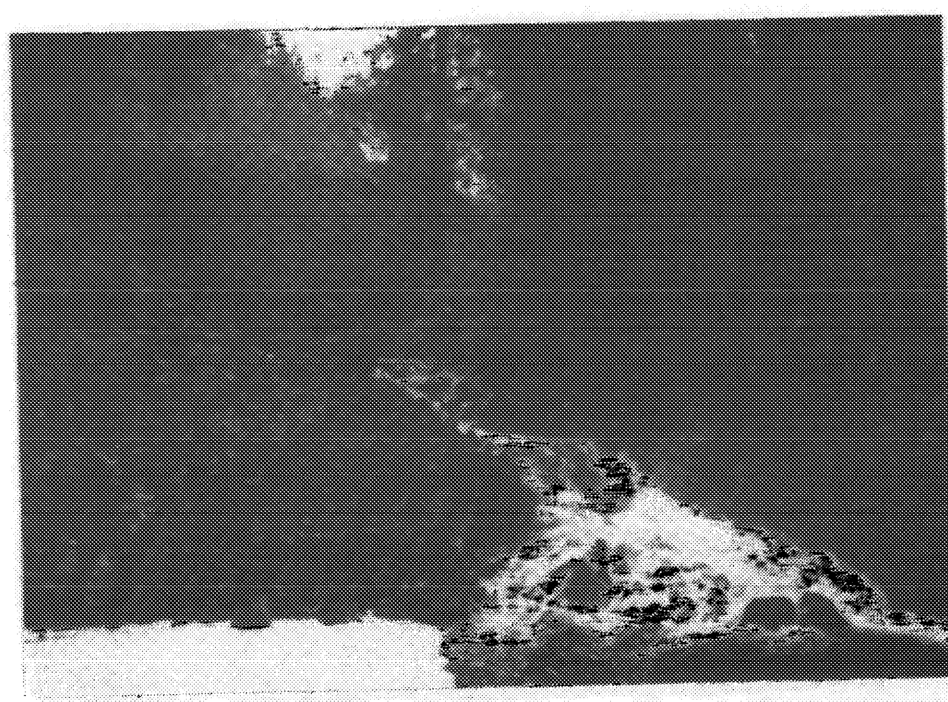
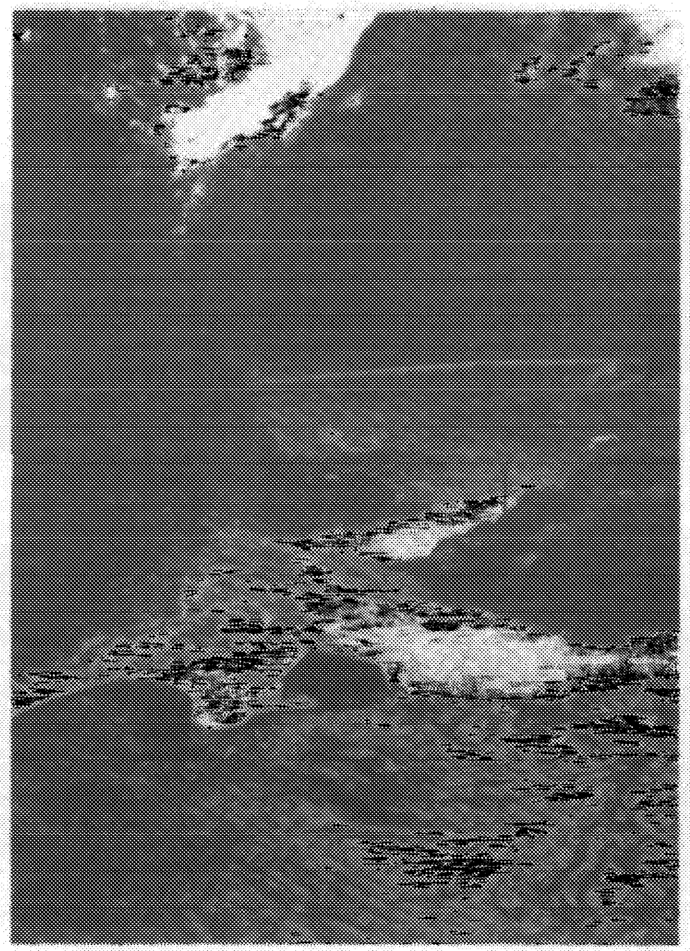
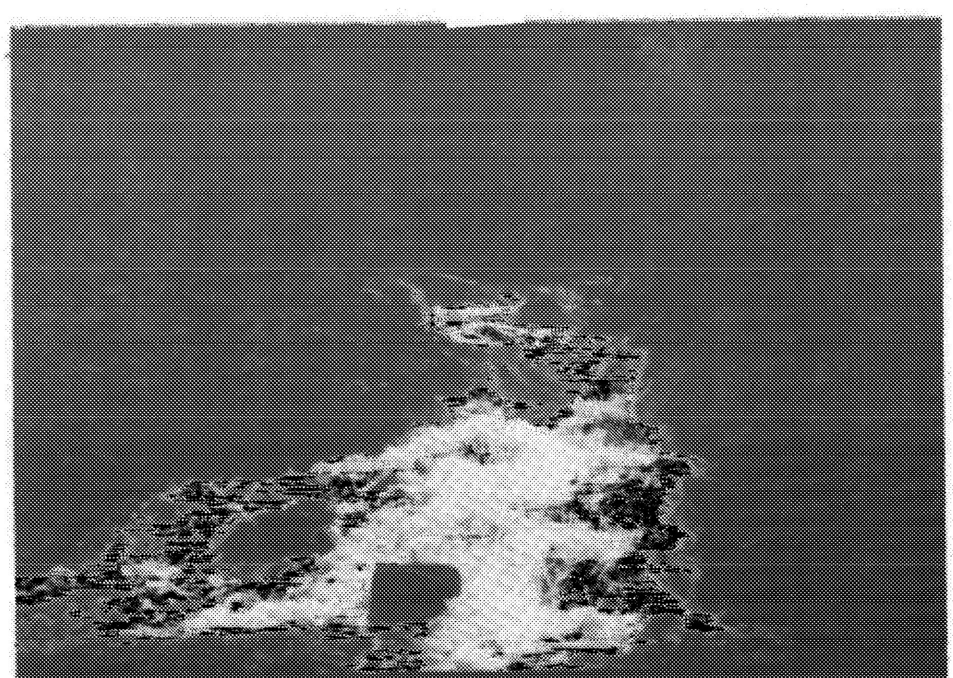


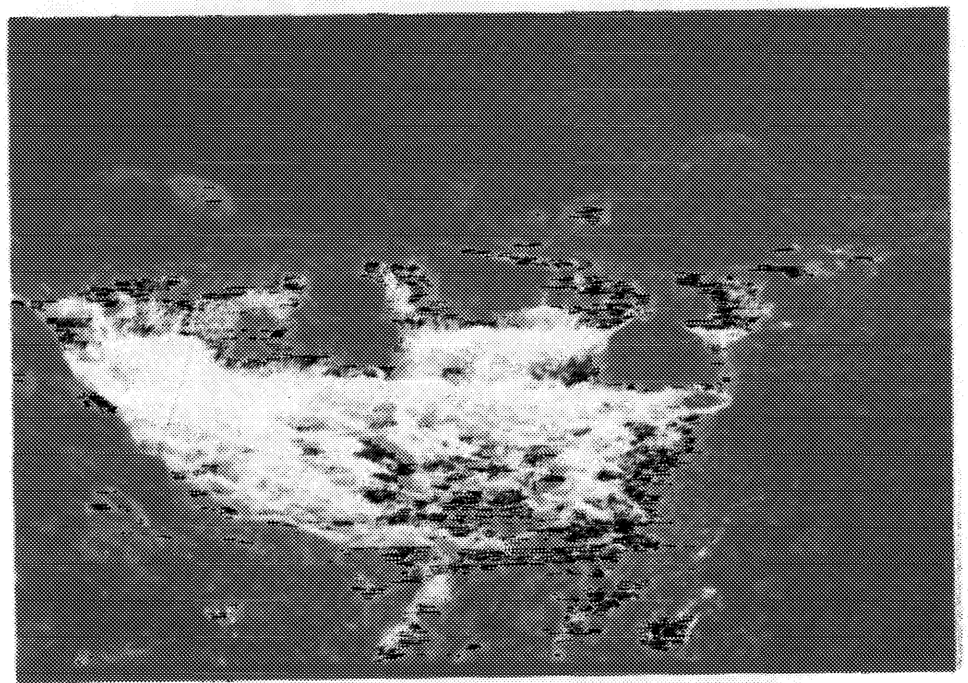
Figure 20. Photo shows Site Number 3, Eldorado Falls just after blasting. Note pile of rock below drill steel.



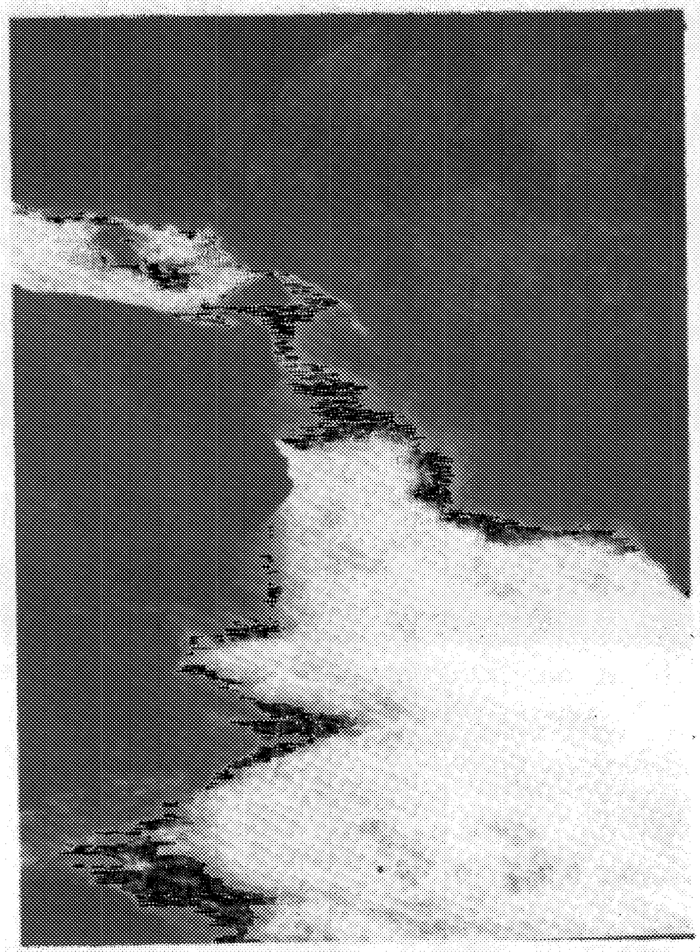


Figures 21 and 22. Upper and lower photos show Site Number 3, Eldorado Falls after removal of residual rock. Note large piles left and right.

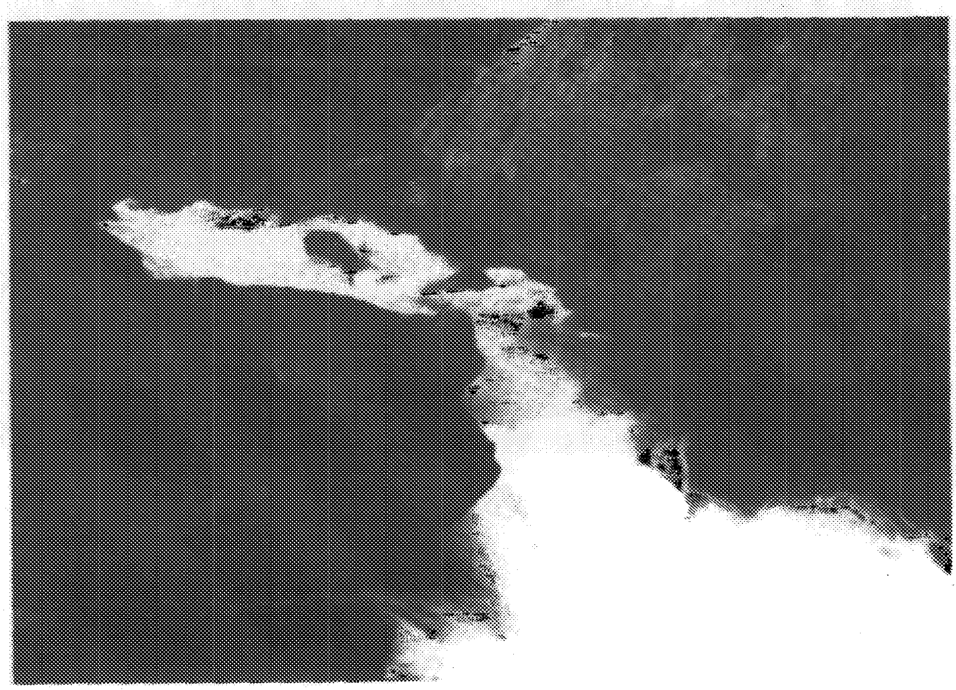


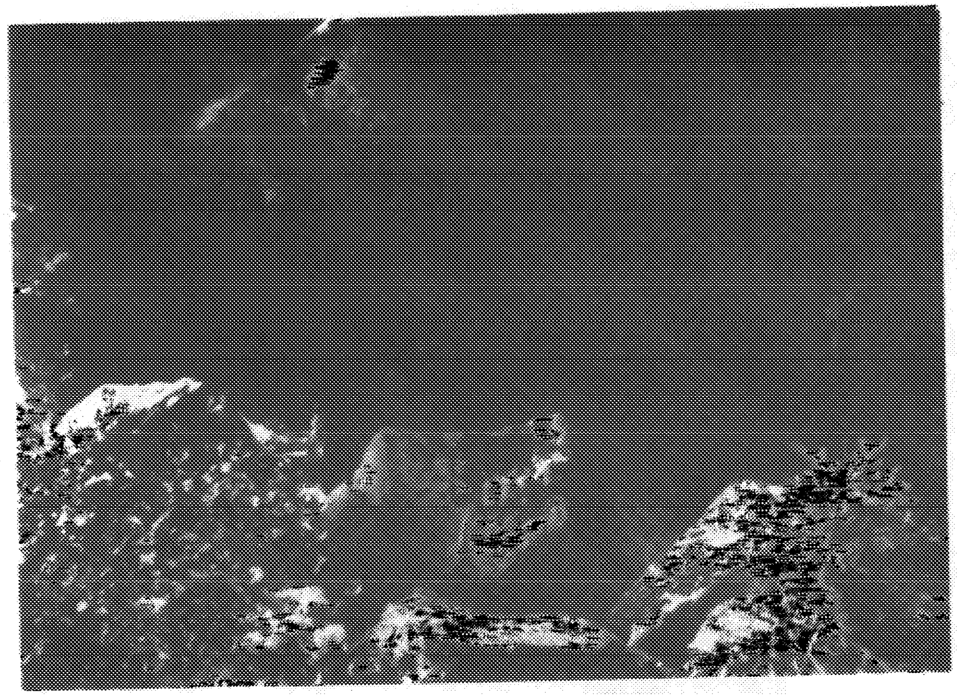


Figures 23 and 24. Upper photo shows Pool A grading into trough and then Pool B after rain in September 1985. Lower photo shows Pool A after September 1985 rain.



Figures 25 and 26. Upper and lower photos show barrier 4 during high water in June 1985.





Figures 26 and 27. Upper and lower photos show barrier 4 after the shelf has been trimmed.

VI. APPENDICES:

A. Vicinity Map

B. Project Area Map

C. Report by Fish Passage Consultant, Dr. J. R. Orsborn

D. Summary and Recommendations based on 1984 Results

E. Schematic of Site Number 1

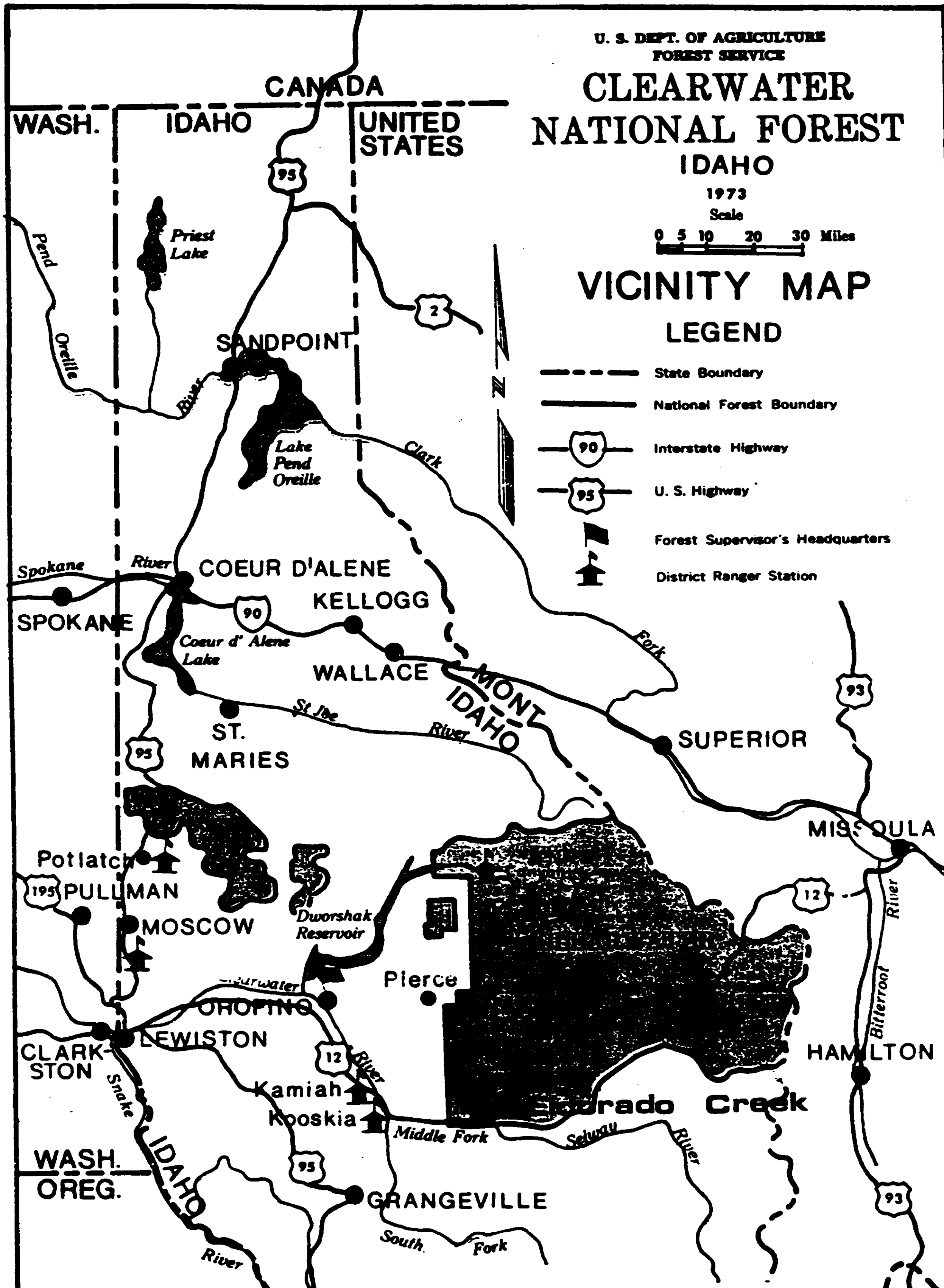
F. Schematic of Site Number 2

G. Schematic of Site Number 3

H. Schematic of Site Number 4

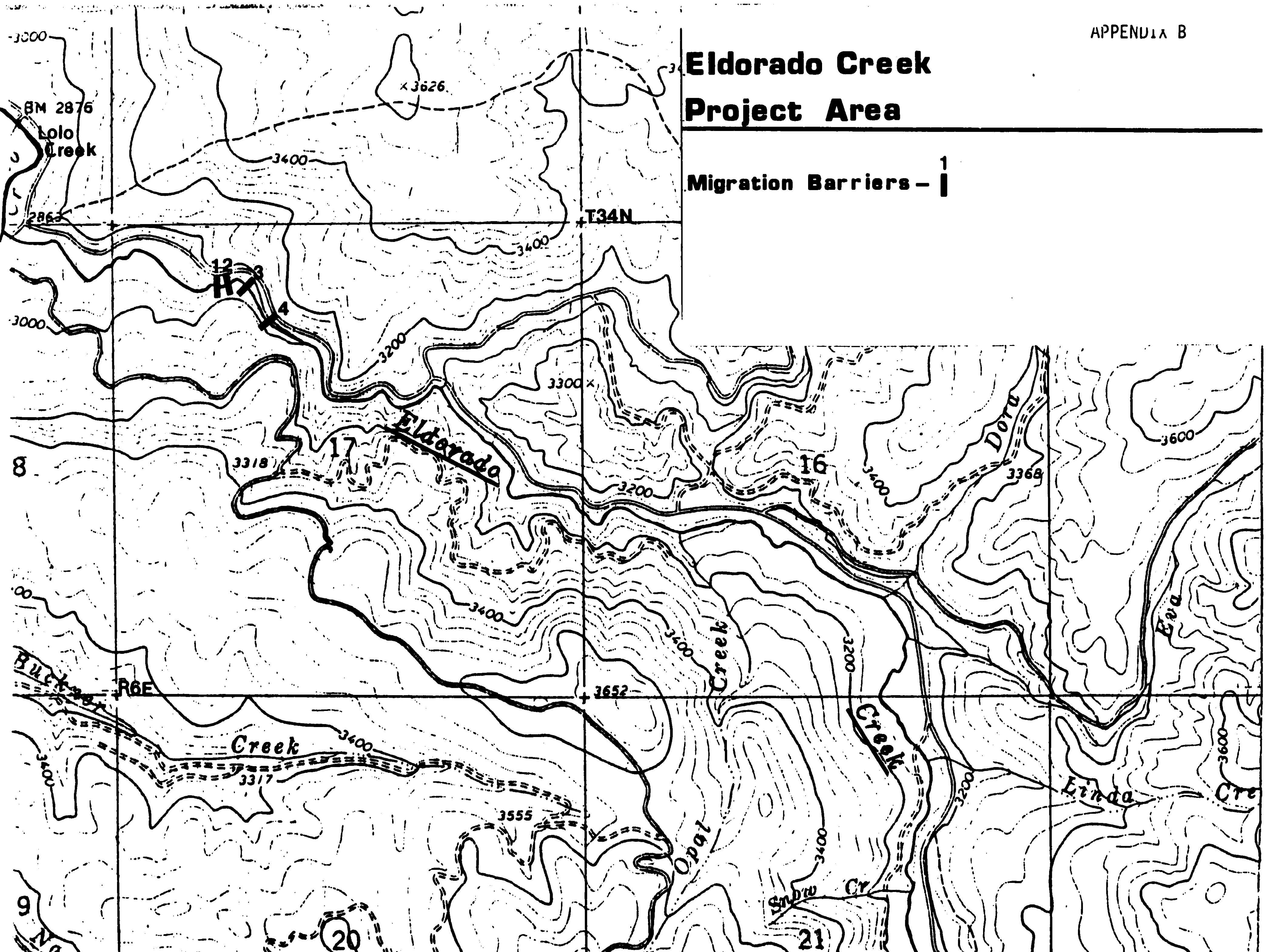
I. Pool Parameters

J. Summary of Expenditures


U. S. DEPT. OF AGRICULTURE
FOREST SERVICE
CLEARWATER
NATIONAL FOREST
IDAHO
1973
Scale
0 5 10 20 30 Miles
VICINITY MAP
LEGEND
State Boundary
National Forest Boundary
Interstate Highway
U. S. Highway
Forest Supervisor's Headquarters
District Ranger Station
N
CANADA
WASH.
IDAHO
UNITED STATES
95
2
90
93
195
12
Priest Lake
Pend Oreille River
SANDPOINT
Lake Pend Oreille
Clark Fork
Spokane River
COEUR D'ALENE
KELLOGG
SPOKANE
Coeur d' Alene Lake
WALLACE
MONT
IDAHO
St Joe River
ST. MARIES
SUPERIOR
MISSOULA
Potlatch
PULLMAN
MOSCOW
Dworshak Reservoir
Pierce
OROFINO
LEWISTON
CLARKSTON
Snake
River
Kamiah
Kooskia
Middle Fork
Selway
River
Bitterroot River
HAMILTON
WASH.
OREG.
GRANGEVILLE
South Fork
River
Salmon

Eldorado Creek Project Area

Migration Barriers – 1



APPENDIX C

BARRIER ANALYSIS ON ELDORADO CREEK, CROOKED FORK AND SKULL, QUARTZ AND ISABELLA CREEKS

CLEARWATER NATL. FOREST

Prepared for:

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August 31, 1985

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Work conducted under Purchase Order No. 40-0276-5-477

PROJECT 8511 — ORSBORN, J.F.

CLEARWATER NATL. FOREST — Aug. 31, 1985 — 1/14

WATERFALL ANALYSIS ON: (Barriers to migration)

1. Crooked Fork of the Lochsa River;
2. Eldorado Creek; and
3. Skull, Quartz and Isabella Creeks.

INTRODUCTION

This work was accomplished in two phases:

1. A review of the blasting and waterfall modifications made at the sites on Crooked Fork and Eldorado Creek in 1984; and
2. The recommendations for modifying the barriers (potential) to upstream migration by kokanee in Skull, Quartz and Isabella Creeks.

Field visits were made to the Eldorado Creek sites on Aug. 12, 1985 and the Crooked Fork sites were visited on Aug. 13, 1985. The Skull, Quartz and Isabella Creek Sites in the Canyon Ranger District were visited on Aug. 30, 1985.

ELDORADO CREEK SITES - Pierce District

(Refer to Eldorado Creek Fish Passage Annual Report by Murphy and Espinosa, dated Nov. 20, 1984, for details of site conditions and 1984 work). (See Appendix C for Orsborn's report of Aug. 7, 1984).

Using the 1984 numbering system, Barriers 1 (lowest in Creek) to 4 (highest) were only partially modified due to limitations on the portable drilling equipment and the fractured character of the basalt rock.

Plans for completing the schedule of modifications were discussed on site at each of the four barriers. At SITE NO. 1, the lengths, widths and depths, and outlet elevations, were to be adjusted in the four pools along the left bank. Final configurations were to depend (in detail) on how the rock broke as a result of future blasting by a contractor. There is enough space in the upper shelf area (Pt. A, Orsborn, p. 2/8). The lower chute and pool(s) from points B to C needed only enlargement and the construction of the resting pool along the side of the channel.

Because of the fractured nature of the rock, some outflow sills may have to be constructed of notched logs anchored to the bedrock with cables, or concrete sill-weirs may need to be constructed.

At SITE No. 2 just upstream, the following modifications are needed (see p. 48, Orsborn, '84):

1. Cut notch (slot) in overflow section from pool 1 to pool 3;
2. Enlarge (double, at least) the size of pool No. 3, especially length & depth;
3. Widen channel No. 4 and install 2(?) log weirs for helping control pool depth and energy dissipation; and
4. Be sure jets falling into pools 3 and 6 are free of splash rocks, which disorient leaping fish, and have 2' min. depth.

SITE No. 3, known as Eldorado Falls, needs two existing changes to complete the work:

1. enlarge the pool which was started in 1984; and
2. Cut the downstream slope of the falls vertically to improve leaping.

In addition, two additional steps will help improve passage success:

1. remove the splash rock just to the left of center at the toe of the falls; and
2. place the largest available rock that can be handled in a flat berm across the pool outlet to raise the downstream pool about one foot.

Small rock was placed by hand in 1984 and did not hold during high flow. An anchored log weir-sill (or gabion structure) might hold better, and would be easier to construct without heavy equipment. Care should be taken to assure that the weir structure does not create a velocity-chute barrier downstream. If a log is placed to form the sill of the downstream pool the log should be placed in a slot cut in the bed of the rock sill. The log sill should have a notch to concentrate the flow (3'W x 1'D) and be anchored with cables and anchor bolts in epoxied anchor holes.

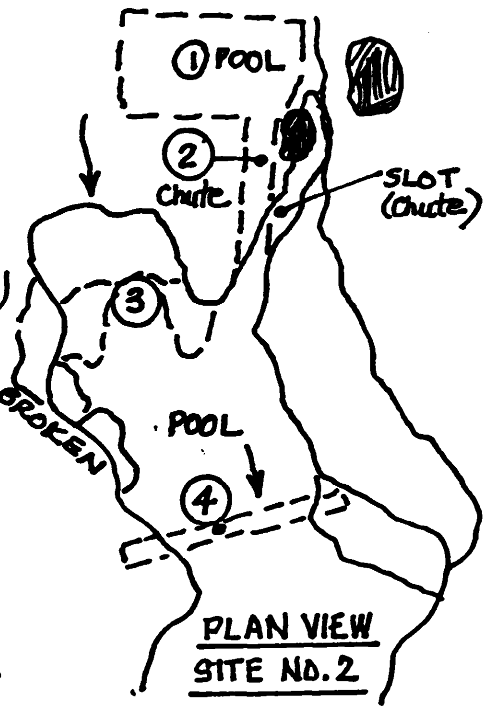
At SITE No. 4, where the barrier has been created by large boulders rolling into the stream from the road fill, most of the work has been completed. The main pool depth needs to be increased and the overall size of the pool increased.

CROOKED FORK SITES - Powell District

Complications due to unusual rock breakage at some sites in 1984 was the main reason for visiting sites (Barriers) 2-7 in 1985.

At SITE No. 2 (No. 1 not visited) four (4) separate alternative steps were discussed:

(1) Excavate upstream pool;
(2) Enlarge the existing chute;
(3) Square the downstream (d/s) rock face in the middle pool and deepen it;
(4) Install a log weir at the d/s end of the pool to raise the pool and reduce the jump height.



PLAN VIEW
SITE NO. 2

Priorities were set on the alternative modifications, with observations of flow conditions to be made after each modification. Unnecessary modifications were to be eliminated from further consideration. The priority was:

(1) upstream pool; (A1)
(2) square the falls face; (A3)
(3) deepen the downstream pool; (A3)
(4) install the log weir; and (A4)
(5) enlarge the chute. (A2)

SITES 3-7 had been modified in 1984, and for the most part just needed some further adjustments. SITE No. 5 (p.12 in Orsborn report*) was completed according to plan in 1984 and did not need to be adjusted. At SITE No. 6 (p.12, also) the central pool slab did not hold due to thin layers and weakness in the granite. Redrilling had been accomplished and the overall plan of adjustment looked adequate.

---

* Appendix B in Kramer, R.P., P.K. Murphy and F.A. Espinosa. n.d. Upper Crooked Fork Fish Barrier Removal Project. Annual Report. BPA Project DE-AI79-84BP-16535. (1984-JFO)

At SITE No.7 (p.11) the modified blasting (drill) holes had been drilled and marked. Pool deepening was needed in the central pool (Pt. B in figure on p.11 of App. B), but several planned charges were eliminated to maintain correct flow conditions and maintain structural integrity.

The V-Rock Berm installed downstream was partially washed out by high flows this past spring because only hand-placed rock was used and not keyed. It was recommended that the berm be rebuilt using several, interlocking rows of rock, only one rock high. This berm will raise the lower pool and improve leaping conditions at the first step in SITE No.7.

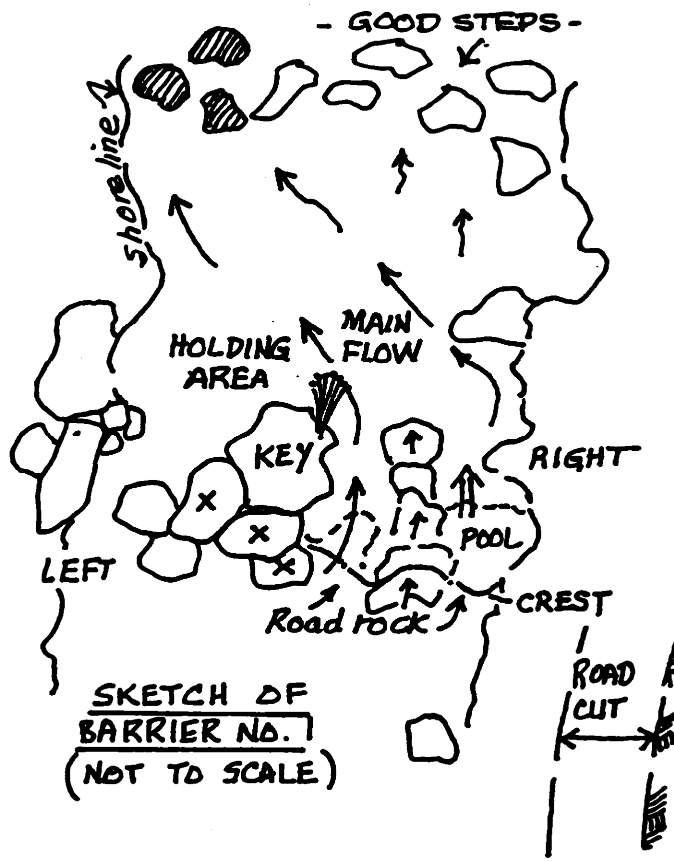
SKULL, QUARTZ AND ISABELLA CREEKS-
Canyon District

Passage needs to be improved at some sites in these three creeks for Kokanee from the Dworshak Reservoir to reach more spawning area. Most of the barriers are formed by the wedging of a cluster of large boulders into a narrow bedrock reach of channel. Narrowing has been caused by the construction of the roads beside Skull and Quartz Creeks. At some of the barrier sites, large rocks from road excavation have been pushed into the streams and have formed the barriers. They are the source of future problems. (Similar to Barrier No. 4 on Eldorado Creek)

The Forest Fisheries Biologist, District Biologist and District Blaster were on the site visit (Aug. 30, 1985). Preliminary Corrections, if needed, were discussed at each site. As modification plans were finalized the District Biologist sketched modifications and noted drilling patterns as recommended by the blaster. Modifications at each site requiring adjustment were viewed and discussed from several vantage points before final recommendations were documented.

SKULL CREEK

Barrier No. 1 (lowest barrier in the system --- the farthest downstream) is typical of several others. One large key boulder is surrounded by several others. The right side of the channel is plugged with rock blasted from the roadway cut. Other road rock is hanging just above the stream, ready to add to the height of the barrier following a subsequent flood.



SKETCH OF BARRIER NO. 1 (NOT TO SCALE)

Suggested revisions include : (see sketch)

(1) install more rocks downstream  to raise the pool level and decrease the height of the crest barrier;

(2) Clear out the splash rocks on the right side of the channel to improve leaping conditions; and

if passage conditions do not improve considerably, then:

(3) blast the KEY rock and move large (downstream) rocks (X) into the pool area to form a new series of smaller steps as now exist downstream on the right (good steps).

<u>Barrier No. 2</u> (moving upstream) is similar in geometry to Barrier No. 1, except that the reach of stream upstream of Barrier No. 2 is steeper.

Steps to improve passage at Barrier No. 2 include:

(1) placing spaced <u>LARGE</u> rock on line with the existing rock downstream;

(2) clearing the flow passage ⊗ to the left of the key rock;

(3) Lowering the crest elevation on the right side; and

(4) placing 5 or 6 LARGE rock upstream between the crest of the barrier and the natural rock berm just upstream.

Also, the crest face should be made as vertical as possible, and the plungepool should be enlarged (cleared of splash and other excess rocks).

After the right crest is lowered, the flow upstream will become faster and shallower, because the streambed will be steeper. Placing the LARGE ROCK (4) upstream of the crest will provide resting places and better passage conditions than now exist.

Barrier No.3 - just remove large, brown rock.
Barrier No.4 - No change
No.5 - Remove half of big rock on crest on right bank.
Barrier No.6 - Like barrier No. 1, except not so close to the road (loose, large rock);
(1) Clear right passage;
(2) Raise downstream pool level with rock berm;
(3) Check passage conditions; and
IF NECESSARY,
(4) Blast the center boulder and let the rest of the boulders adjust. Check to see if a barrier has been created upstream.

In upstream section 6A remove left rock next to bed rock.

Other potential barriers upstream in Skull Creek were left for observation, because the stream steepens considerably.

QUARTZ CREEK

Barrier No.1 has two main flow passages--- one on either side of the central rock. The right passage seems to functioning properly. The left (dominant) flow passage has a rock protrusion on the right side which must be removed. The protrusion deflects the flow and causes the kokanee to jump in a disoriented manner.

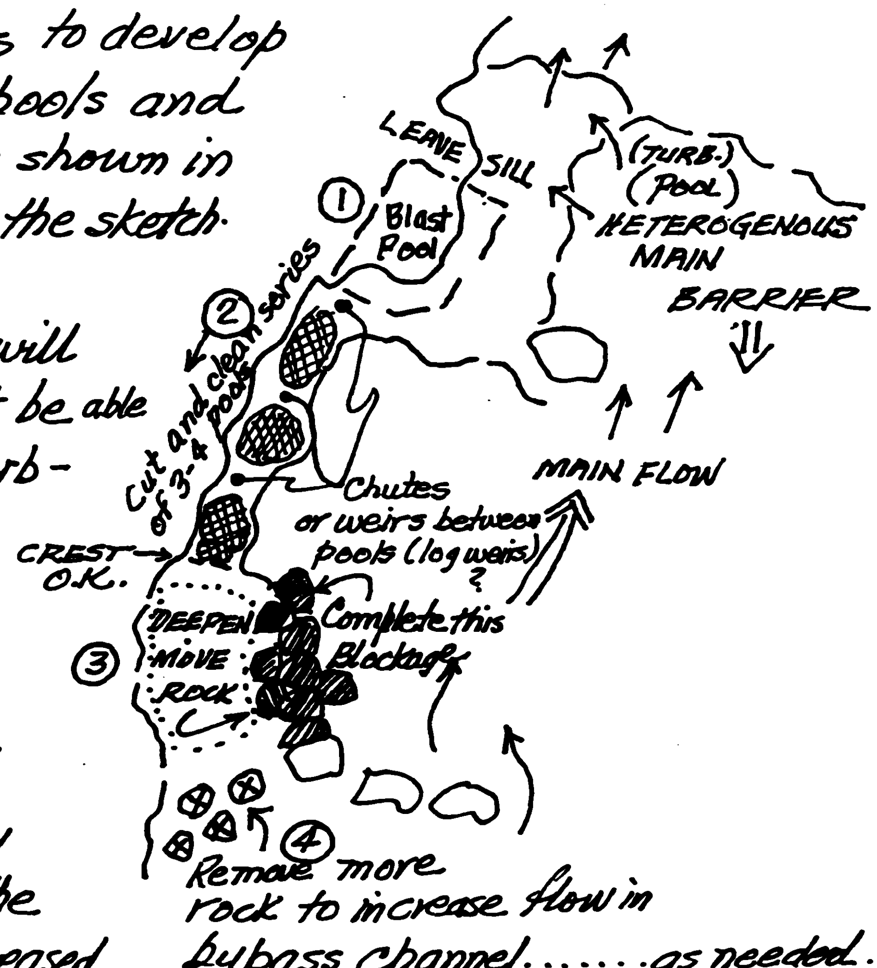
Just upstream at Upper Site No.1, excavate the left side of the right crest between the two large rocks. Also move the single yellow rock (just upstream) into a notch in the left crest to partially block the flow.

Site No.2 was considered to not be a barrier.

The main part of Barrier No. 3 in Quartz Creek consists of the remnants of an old rock slide resting on irregularly eroded bedrock. Due to the complexity of the barrier it was decided to construct a channel and downstream holding pool along the left edge of the barrier in bedrock.

Modifications to develop the bypass pools and channel are shown in sequence in the sketch.

The kokanee will probably not be able to hold in the turbulent pool on the first level of the main barrier, and will fall off into the newly cut pool on the left. The increased flow down the new passage channel



PLAN VIEW OF QUARTZ CREEK BARRIER No. 3

should be adequate to attract them to move from the pool and around the barrier using the new channel. The entrance to the new channel is in the wake of an irregular shoreline and may have to have rocks removed each year just prior to the annual migration period in order to maintain passage flow down the chute and pool channel.

ISABELLA CREEK

The only barrier site visited on Isabella Creek was at a place where the left bedrock bank constricts the channel. It is a partial barrier in that some fish were observed passing along the base of the left bank last year, during higher passage flow conditions.

The rearrangement of rocks to form a passage way down the right side of the channel was discussed, as was the removal of some large woody debris which had clogged a passage just downstream of the channel constriction.

SUMMARY AND RECOMMENDATIONS BASED ON 1984 RESULTS

Corrective actions taken in 1984 at 4 rock barriers in Eldorado Creek have facilitated upstream passage of chinook salmon and steelhead trout. Barrier Number 4 is considered essentially corrected and will require no futher work with explosives. Some pool berms at Site Number 4 may require additional reinforcement with larger substrate materials. This site will be evaluated after spring run-off. If additional work is needed, heavy equipment will be contracted to complete the job.

TABLE I
Specific Areas Needing Further Work in 1985

Site Number 1:

1.	Pool A	-	Increase depth and reduce drop
2.	Pool B	-	Increase length and depth
3.	Pool C	-	Adequate
4.	Pool D	-	Increase length and depth

Site Number 2:

1.	Pool A	-	Increase width, depth and drop
2.	Pool B	-	Increase depth
3.	Pool C	-	Increase depth
4.	Pool D	-	Increase width
5.	Pool E	-	Increase width

Site Number 3:

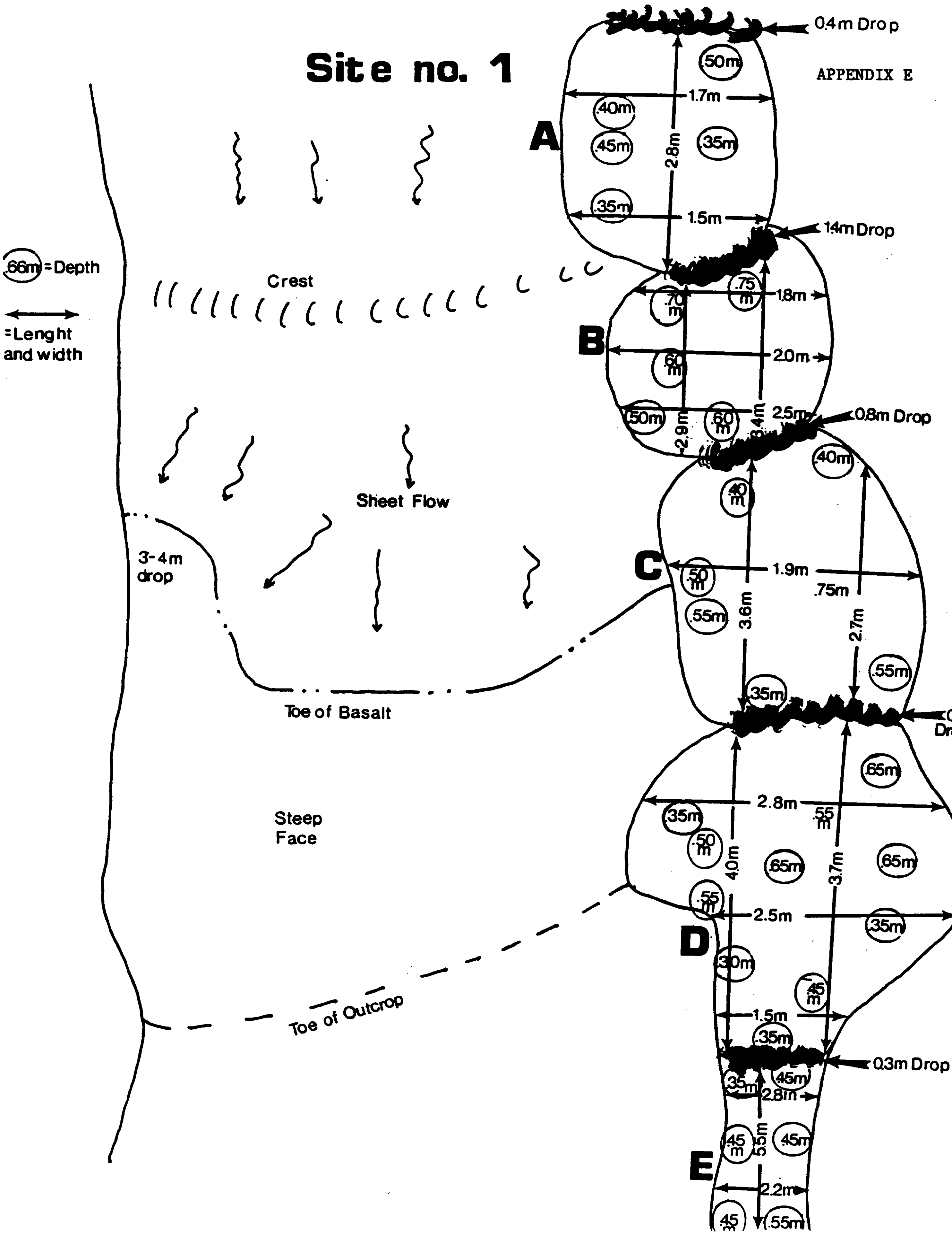
1.	Pool A	-	Increase depth and lessen drop
2.	Pool B	-	Construct
3.	Pool C	-	Optional construction
4.	Pool D	-	Adequate

Site Number 4: Correction of pool berms (placement of larger substrate materials).

Barrier Numbers 2 and 3 are considered partially corrected. Total correction will involve enhancement of the pools created in 1984 (Table I), to comply with design standards (Appendix C).

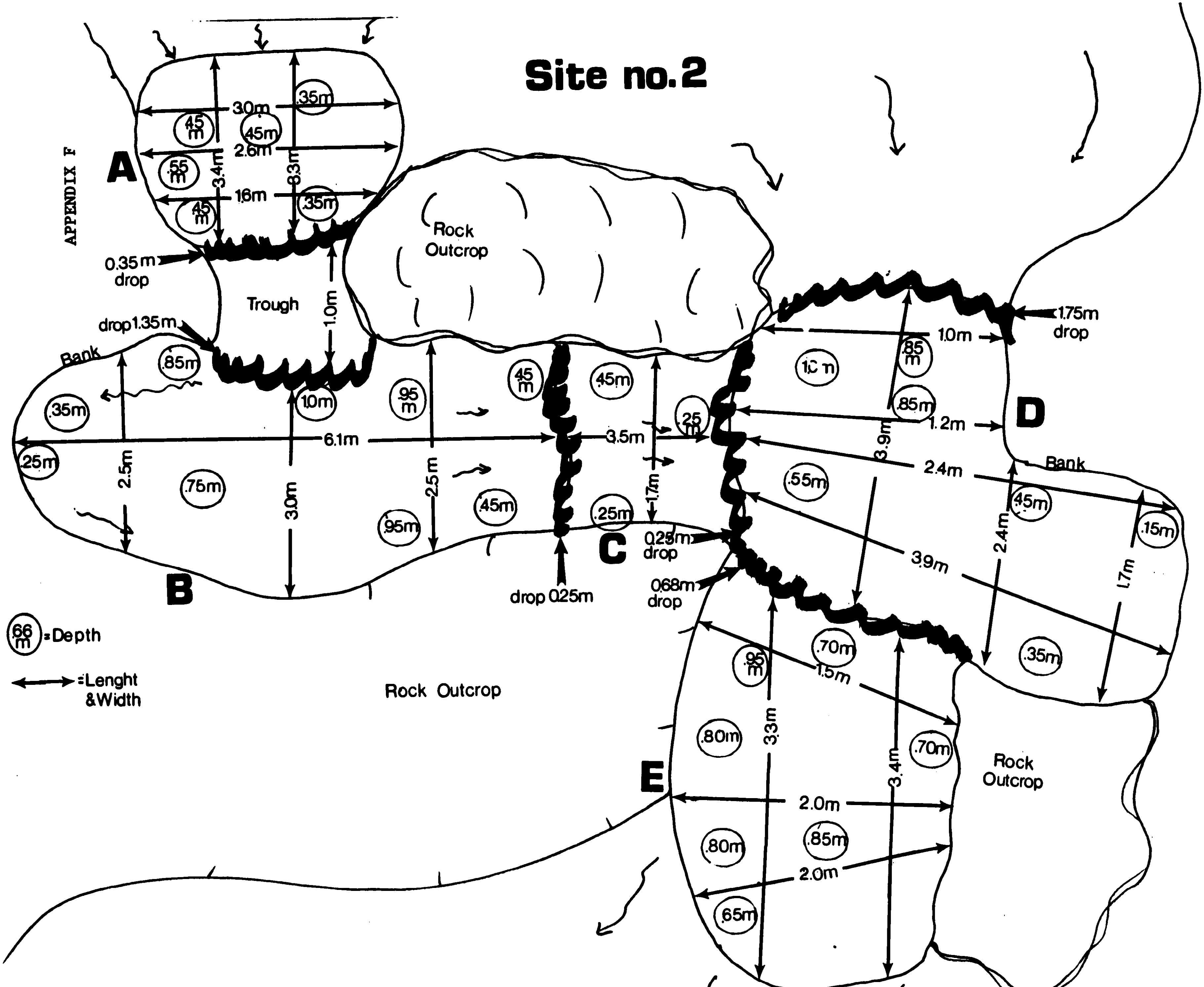
Corrective actions at Site Number 3 are considered incomplete. Those taken in 1984, were successful. However, to totally correct this barrier, 1 or 2 pools will be required along with elemination of the splash rock.

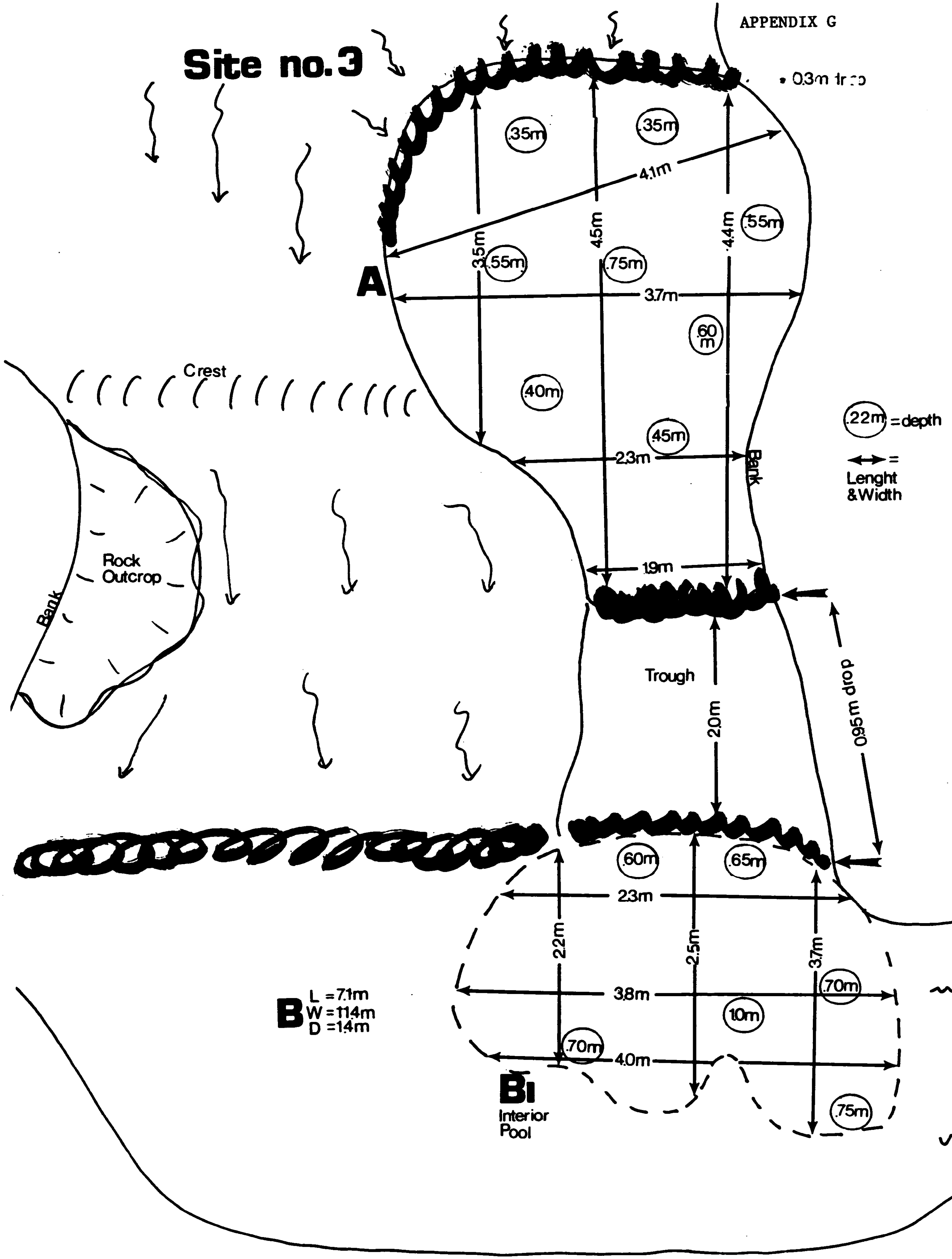
APPENDIX E



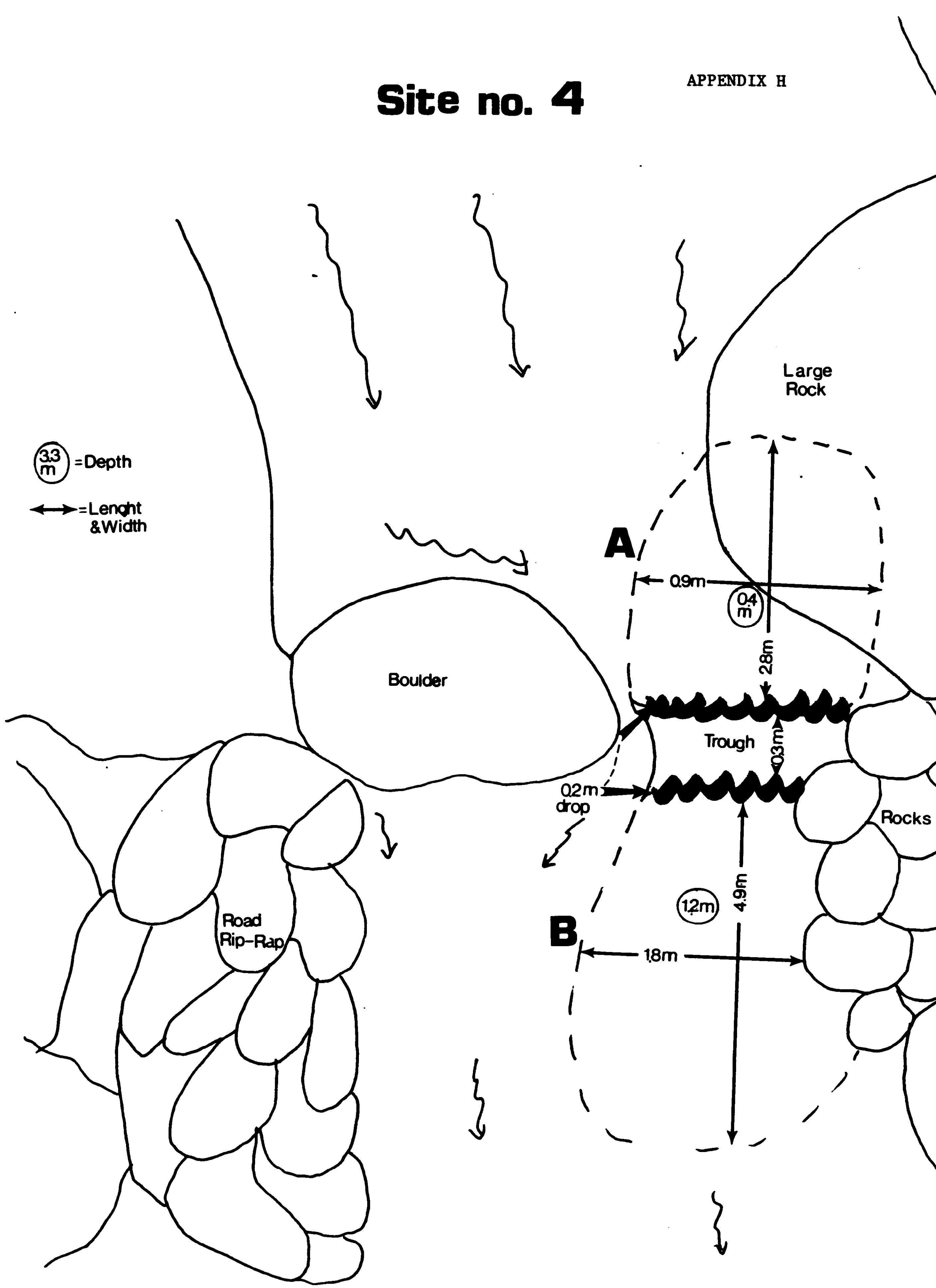
Site no. 1
.66m = Depth
= Lenght and width
Crest
Sheet Flow
3-4m drop
Toe of Basalt
Steep Face
Toe of Outcrop
A
B
C
D
E
0.4m Drop
1.4m Drop
0.8m Drop
0.3m Drop
.50m
1.7m
.40m
.45m
2.8m
.35m
.35m
1.5m
.75 m
1.8m
.70 m
2.0m
.60 m
2.5m
.50m
.60 m
2.9m
3.4m
.40m
.40 m
1.9m
.50 m
.75m
.55m
3.6m
2.7m
.55m
.35m
.65m
2.8m
.35m
.55 m
.50 m
4.0m
.65m
3.7m
.65m
.55 m
2.5m
.35m
.30m
.45 m
1.5m
.35m
.35m
.45m
2.8m
.45 m
5.5m
.45m
2.2m
.45 m
.55m

APPENDIX F

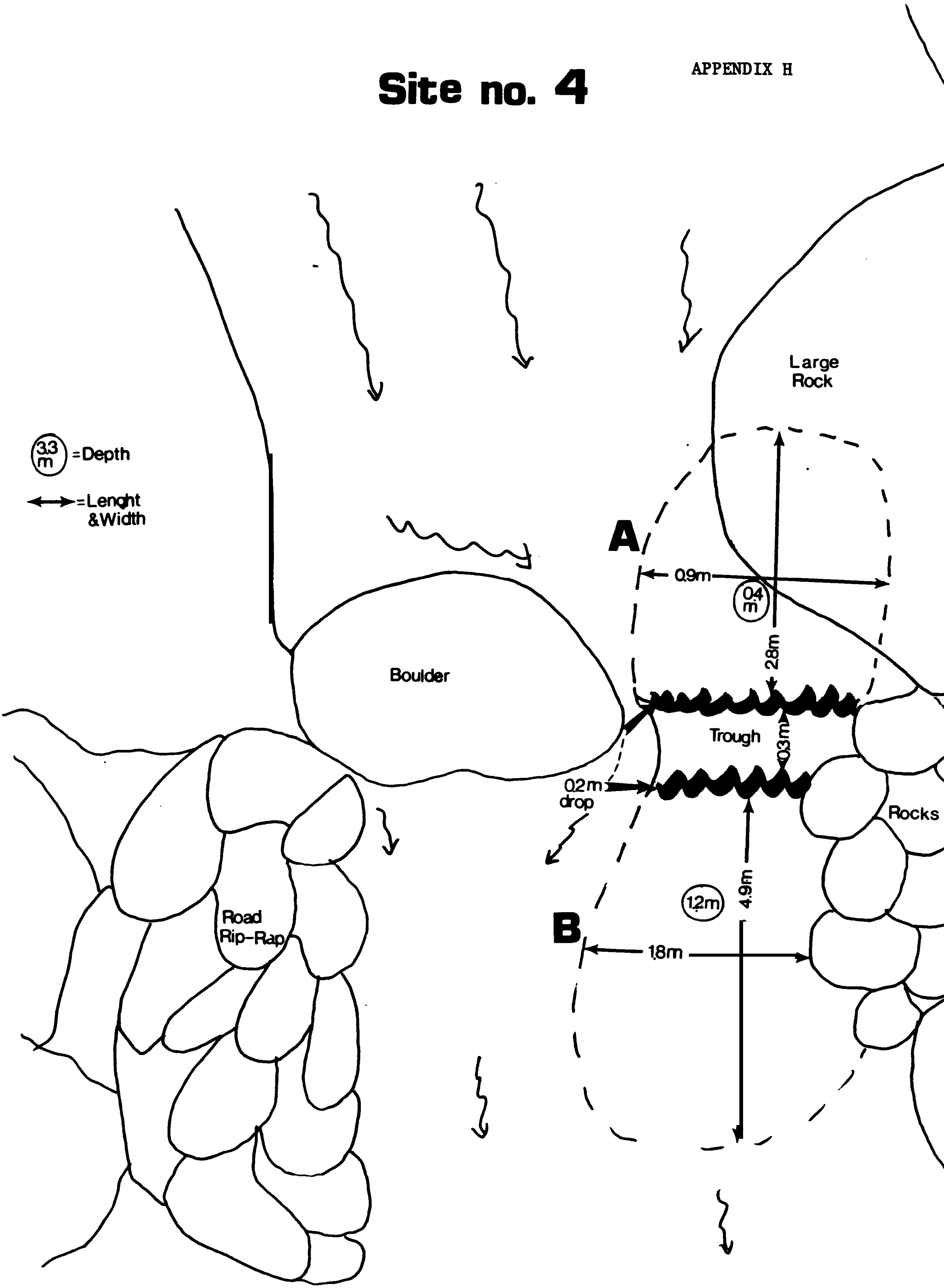

Site no.2
A
B
C
D
E
Rock Outcrop
Trough
Bank
0.35m drop
drop 1.35m
1.75m drop
0.25m drop
drop 0.25m
0.68m drop
3.0m
2.6m
1.6m
3.4m
3.3m
1.0m
6.1m
2.5m
3.5m
1.7m
1.2m
2.4m
3.9m
1.5m
2.0m
.35m
.45m
.55m
.85m
.95m
.75m
.25m
.70m
.80m
.65m
.15m
66 m = Depth
= Lenght &Width


Site no.3
0.3m
.35m
.35m
4.1m
3.5m
4.5m
4.4m
.55m
.55m
.75m
A
3.7m
.60 m
Crest
.40m
.45m
2.3m
Bank
.22m =depth
= Lenght &Width
1.9m
Rock Outcrop
Bank
Trough
2.0m
0.95m drop
.60m
.65m
2.3m
2.2m
2.5m
3.7m
.70m
3.8m
1.0m
B L =7.1m W =11.4m D =1.4m
.70m
4.0m
B1 Interior Pool
.75m

Site no. 4


3.3 m =Depth
=Lenght &Width
Large Rock
A
0.9m
0.4 m
2.8m
Boulder
Trough
0.3m
0.2m drop
Rocks
B
1.2m
4.9m
1.8m
Road Rip-Rap

Site no. 4


3.3 m =Depth
=Lenght &Width
Large Rock
A
0.9m
0.4 m
2.8m
Boulder
Trough
0.3m
0.2m drop
Rocks
1.2m
4.9m
B
1.8m
Road Rip-Rap

APPENDIX I

Comparison of Designed and Measured Pool Parameters by Site After 1985 Blasting

A. Site Number 1:

1. Pool A* (upstream)	Designed	Measured	Treatment
a. Length	2.2M	2.8M	complete
b. Width	1.3M	1.6M	complete
c. Depth	0.5M	0.4M	adequate
d. Drop to Pool B	0.8M	1.4M	adequate
2. Pool B*			
a. Length	2.2M	3.2M	complete
b. Width	1.8M	2.1M	complete
c. Depth	0.6M	0.7M	complete
d. Drop to Pool C	0.8M	0.8M	complete
3. Pool C*			
a. Length	2.2M	3.2M	complete
b. Width	1.8M	1.9M	complete
c. Depth	0.6M	0.5M	adequate
d. Drop to Pool D	0.8M	0.5M	complete
4. Pool D*			
a. Length	2.2M	3.9M	complete
b. Width	1.8M	2.3M	complete
c. Depth	0.6M	0.5M	adequate
d. Drop to Pool E	0.6M	0.3M	complete
5. Pool E* (not designed)			
a. Length	0	5.5M	complete
b. Width	0	2.6M	complete
c. Depth	0	0.5M	adequate
d. Drop to Main Channel	0	0.2M	complete

* 1985 Pools are different than 1984 in location and lettering A-B-C etc. (see #6).

6. Comparison of 1984-85 Pools at Site #1:

1984	1985
none	A
A	B
B	C
C	D
D	D
none	E

B. Site Number 2:

	Designed	Measured	Treatment
1. Pool A (upstream)			
a. Length	2.2M	3.3M	complete
b. Width	1.8M	3.3M	complete
c. Depth	0.6M	0.5M	adequate
d. Drop to Pool B	0.8M	1.0M	adequate
2. Pool B			
a. Length	2.2M	6.1M	complete
b. Width	1.8M	2.5M	complete
c. Depth	0.6M	0.7M	complete
d. Drop to Pool C	0.8M	0.2M	complete
3. Pool C (designed this year)			
a. Length	1.2M	3.5M	complete
b. Width	1.2M	1.7M	complete
c. Depth	0.4M	0.3M	adequate
d. Drop to Pool D	0.2M	0.25M	complete
4. Pool D (natural)			
a. Length	0	3.4M	adequate
b. Width	0	0.7M	adequate
c. Depth	0	1.0M	adequate
d. Drop to Pool E	0	0.7M	adequate
5. Pool E (natural)			
a. Length	0	3.3M	adequate
b. Width	0	1.9M	adequate
c. Depth	0	0.8M	adequate
d. Drop to Main Channel	0	0.1M	adequate

C. Site Number 3:

1. Pool A[a]	Designed	Measured	Treatment
a. Length	3.7M	4.2M	complete
b. Width	2.2M	3.4M	complete
c. Depth	0.6M	0.5M	adequate
d. Drop to Pool B	1.0M	0.95M	complete

2. Pool #2 (combined with A)

3. Pool #3 (now a trough from A-B)

4. Pool B (natural)			
a. Length	0	7.1M	adequate
b. Width	0	11.4M	adequate
c. Depth	0	1.4M	adequate
d. Drop to Main Channel	0	0.1M	adequate

5. Pool B (created by excess rock)[a]			
a. Length	0	3.7M	NA
b. Width	0	2.5M	NA
c. Depth	0	0.9M	NA
d. Drop to Pool B	0	NA	NA

D. Site Number 4

1. Pool A (not treated 1985)	Designed	Measured	Treatment
a. Length		2.8M	NA
b. Width		0.9M	NA
c. Depth		0.4M	NA
d. Drop to Pool B		0.2M	NA

2. Pool B and C combined with D			
a. Length	0	4.9M	complete
b. Width	0	1.8M	complete
c. Depth	0	1.2M	complete
d. Drop to Main Channel	0	0.0M	complete

[a]Expect it will not exist in Summer 1986.

APPENDIX J

SUMMARY OF EXPENDITURES

		1984	1985
Salaries		$ 7,360	$ 4,363
Supplies		2,100	1,155
Contracts		500	12,190
Overhead		1,500	1,500
	Total	$11,460	$19,208
Allocated		$17,668	$13,020
Used		11,460	19,208
		$ 6,208 held over	-$ 6,188 paid from '84 holdover

Total Costs	$30,668
Total Allocated	30,688
Not Used	$ 20

ELDORADO CREEK

A Plan for Enhancement of
Key Anadromous Fish Habitat in the
Clearwater River Basin

Pierce Ranger District
Clearwater National Forest

by

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I. INTRODUCTION:

In 1984, and under the auspices of the Northwest Power Planning Council, the Clear-water National Forest and the Bonneville Power Administration entered into an agreement (Project #84-31) to identify potential enhancement projects for anadromous fish in the Clearwater River Basin. Eldorado Creek provides an excellent opportunity for such a project.

A. Project Overview:

This document describes the reasons for and recommended methods of, enhancing anadromous fish habitat in Eldorado Creek. Enhancement is recomnended for both impacted and natural reaches in main Eldorado Creek and six of its major tributaries: Fan, Trout, Lunch, Four-Bit, Dollar, and Six-Bit Creeks. Enhancement activities will benefit spawning habitat (2.5 acres) and rearing habitat (54 to 64 acres). Smolt production capability is expected to increase by 200 percent. To achieve this goal it is estimated that a total of 346 fish habitat improvement structures will be necessary. It is estimated that the project will take 4 years, at an estimated total cost of $86,775.

This proposal is part of a canprehensive effort by the Clearwater National Forest to improve the quantity and quality of anadromous fish habitat. With the cooperation and guidance of the Bonneville Power Administration, intensive habitat improvement projects have been successfully completed on several of the tributaries of the Clearwater River. This proposal represents a continued commitment to this program.

B. Project Objectives:

The ultimate objective is to increase the productive capability of the Eldorado Drainage for anadromous fish. The secondary objective is to partially mitigate the juvenile and adult anadromous fish losses accrued through hydroelectric development in the Columbia and Snake River Systems. Enhancement is designed to ameliorate the limiting factors in both spawning and rearing habitat with the selective placement of in-stream structures.

Primary Objectives:

1. Increase productive capacity and overall utilization of the existing 'habitat (12 miles in Eldorado Creek and 5.1 miles of tributaries).

   a. Increase the standing crop of salmonids by 200 percent.

2. Improve 2.5 acres of spawning habitat (2.0 main Eldorado and 0.5 in tributaries), by reducing in situ sediment levels by 50 percent and increasing available cover by 50 percent.

3. Improve 54 to 64 acres (40 to 50 in main Eldorado and 14 in the tributaries) of summer and winter rearing habitat.

increase the overall productive capacity of the habitat by 50 percent.

4. Increase the diversity of the rearing habitat.

a. Increase the surface area of pool and "pocket water" habitat types by 30 percent.

II. DESCRIPTION OF THE PROJECT AREA:

A. Drainage Description:

Eldorado Creek drainage is contained entirely within the administrative boundary of Pierce Ranger District, Clearwater National Forest (Appendix A). Eldorado Creek is a 6th order tributary of Lolo Creek, an important anadromous fishery. The drainage contains 48 square miles or 30,620 acres. Elevation ranges from 2,850 feet at the Lo10 Creek confluence to 5,480 feet at the headwaters near Pete Forks Junction. Main Eldorado Creek is 18 miles long. Major tributaries to Eldorado Creek include; Cedar, Fan, Trout, Lunch, Four-bit, Dollar, Six-bit, and Austin Creeks.

Soils consist mainly of silt-loams with subsoil decomposed granitics and gniesses. The granitic subsoil is very erosive. Landtypes include moderate relief rolling uplands and mountain slopelands. Habitat types include western red cedar/pachistima on dryer, shallow soils and subalpine fir/pachistima on well drained ridges (Daubermire, 1984). Mixed stands of western red cedar, Engelmann Spruce, Douglas-fir, grand fir, and white pine are found along Eldorado Creek and its tributaries. A large meadow complex exists in the headwaters of Eldorado Creek. This enviromnt was formed and is maintained by poor cold air drainage creating a “frost pocket” situation. Vegetation in this meadow complex is primarily sedges, poa, lady fern, willow, and alder.

B. Fish Populations:

Historically, anadromous fish utilized the spawning and rearing habitats of the Eldorado Creek watershed. The Lewis and Clark Expedition observed what they called "salmon-trout” in Eldorado Creek near its confluence with Dollar Creek. Since their observations were made in early June, it is very likely that the fish were spawning steelhead trout. Natural rock barriers near stream mile 0.5 and low summer flaws would have completely blocked spring chinook salmon from upstream habitats. Eldorado Creek is, however, large enough to support populations of chinook salmon.

Since that time, populations of anadromous fish in Idaho have experienced catastrophic changes; mostly associated with the hydro-electric development of the Columbia and Snake River systems. Populations have precipitously declined over a sustained period of time.

In 1927, a dam built near Lewiston, Idaho virtually destroyed the run of spring chinook salmon in the Clearwater drainage and on the Forest. In the early 1970's, Dworshak Dam on the Snake River increased the mortality gauntlet to a total of eight dams on the system that fish destined for Idaho or the ocean had to negotiate. By the mid 1970's, Idaho stocks of anadromous fish had bottomed out and were perched on the brink of extinction. Since that time, accelerated efforts of mitigation and restoration have actuated a trend of significant recovery--especially for steelhead trout (Figure I).

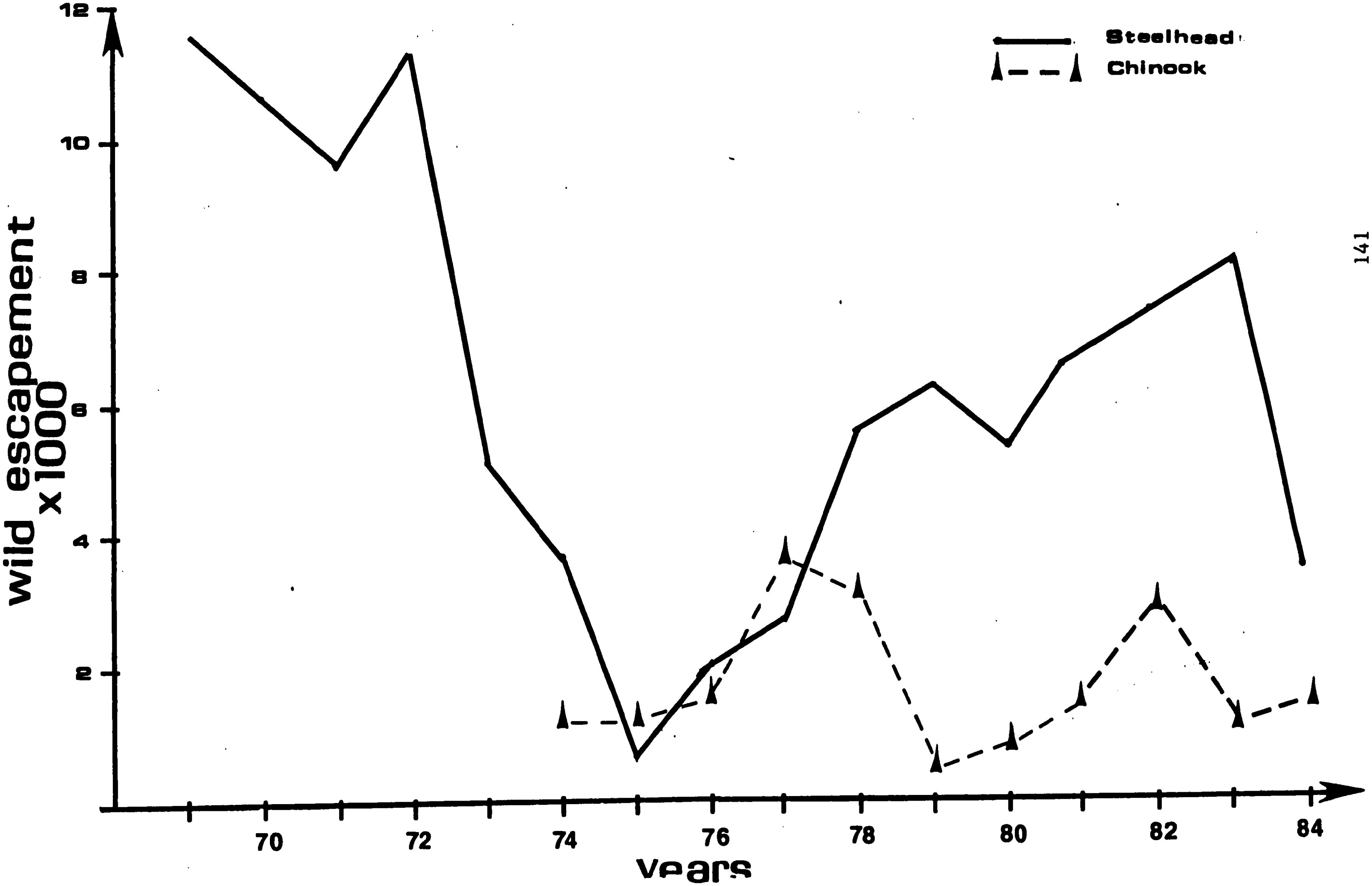
Despite such losses and problems, Idaho stocks have shown an amazing resiliency in the face of chronic, devastating impacts. Recent trends in escapement indicate that the prognosis for steelhead trout is optimistic (Figure I). The 1985 run for wild steelhead to the Clearwater Basin has been predicted at 10-15,000fish--an escapement level that has not been seen since the late 1960's and early 1970's (Figure I). If this run materializes, it would be sufficient to fully seed all the rearing habitat within the Basin.

The situation for chinook salmon is much different and the prognosis remains uncertain. Escapement trends have remained static--hovering near 2,000 fish during the last few years (Figure I). Populations of chinook salmon in the Basin are at or near the minimum level of viability in many drainages. In some Clearwater tributaries, the runs have become extinct. It is mandatory for stock survival that downstream mortality problems are resolved within the next few years.

In addition to impacts emanating from power development, habitat has been degraded or lost through various land management activities. Such is the case in Eldorado Creek. Road construction and logging practices have had a big influence on the amount of sediment entering Eldorado Creek. Logging in the Drainage began in 1950. It is estimated that 100 million board feet will be harvested within the next 10 years. Construction of Forest road #500, which parallels Eldorado, in the 1950's substantially altered the configuation of the channel in critical areas and effectively blocked the upstream migration of steelhead. During construction, large riprap was side-cast into a natural side channel that fish utilized to by-pass a difficult, steep gradient reach. Apparently at some flows, a few extradordinary fish have been able to negotiate this uppermost barrier. Occasional reports of steelhead in the upper reaches of Eldorado have been received.

In 1983, biologists from the Nez Perce Tribe sampled the fish populations of Eldorado. They observed only one species--westslope cutthroat--at all three sample locations (Fuller et al, 1984). However, juvenile age classes of rainbow-steelhead trout have been observed in Eldorado Creek (Stowell and Murphy, pers. comm., 1984). In 1978 and 1983, the Idaho Department of Fish and Game released "B"-stock steelhead fry from Dworshak National Fish Hatchery into the upper reach of Eldorado near Dollar Creek. In 1983, 625,000 fry were stocked. The first returns of this plant should be observed in the spring of 1987.

figure 1


Steelhead
Chinook
wild escapement x1000
12
10
8
6
4
2
70
72
74
76
78
80
82
84
years

141

Historically, the game fish community of Eldorado consisted of a sympatric population of summer steelhead trout (B-stock) and westslope cutthroat trout. The release of spring chinook salmon (Rapid River stock) into Eldorado will constitute a new introduction, although chinook are native to the Lolo Creek system. Anadromous and nonanadromous (basically cutthroat trout) fish stocks have successfully co-existed in the Basin for eons. Research conducted in the Lochsa River sub-basin has shown that salmon, steelhead, and cutthroat distribute and segregate themselves to minimize competitive interaction (Everest, 1969). No significant adverse impacts to the existing fish community are anticipated upon introduction of chinook salmon.

C. Fish Habitat:

Table I displays the drainage averages for important fish habitat parameters as determined by "The Clearwater National Forest Ocular Stream Survey."

Table I

Mean Fish Habitat Parameters for Eldorado Creek

Parameter	Value
Cobble Embeddedness	50%
Width	29.7 feet
Depth	1.5 feet
Gradient	1.4%
Pool:Riffle:Run	43:4:53

In 1984, the Clearwater National Forest and the Bonneville Power Administration entered into an agreement (M001-DE-A19-54BP16535 Project #84-6), to correct four anadromous fish migration barriers in Eldorado Creek, (Appendix H). All four barriers were within 3/4 mile of the mouth of Eldorado Creek. The barriers will be totally corrected by the Fall of 1985.

III. FISH HABITAT EVALUATION:

For the purpose of this report and its supporting analysis we have divided Eldorado Creek into three major sections: Section "A", lower Eldorado; Section "B", mid-Eldorado; and Section "C", upper Eldorado. Section "A" includes all of the Cedar Creek drainage and that portion of main Eldorado from the Cedar Creek confluence to the mouth of Eldorado Creek (1.5 miles). Section "B" extends from the Cedar Creek confluence upstream 7.5 miles to the Lunch Creek confluence. Section "B" contains these tributaries; Fan, Trout, and Lunch Creeks. Section "C" extends 3 miles from the Lunch Creek confluence to the Dollar Creek bridge. This section contains 2 major tributaries, Dollar and Four Bit Creeks. Refer to Appendix E.

There are 3 main sections to this evaluation:

1. The WATBAL summary (current watershed condition based on projected sediment input and transport);

2. The fish habitat evaluation including ocular stream survey data detailing fish habitat quality, and the "Rl Channel Stability Survey" detailing channel and bank stability, and;

3. A summary of management implications based on the surveys and computer models.

A. WATBAL Summary:

WATBAL is a computer analysis system developed for the purpose of determining watershed stability. The system identifies and describes impacts to a watershed system from various land management activities such as timber harvesting and road construction. Management impacts are compared with expected natural conditions annually over time, in terms of stream flow, slope diversity, sediment carrying capacity, and sediment delivery, to provide a general analysis of watershed condition. WATBAL models current conditions and stability, and simulates potential impacts over time. The system also computes flood frequency and can assess changes in flaw patterns and modifications in peak flows. When used as part of the planning process for various land management activities, the system can help to minimize sediment production and maintain water quality.

An analysis of the Eldorado Creek watershed and its tributaries was completed in 1984. The results show the adverse effects of past logging and road construction within the drainage. Sediment loads are 2 to 4 times higher than under natural conditions. Cobble embeddedness, a measure of the amount of instream sediment and the extent to which this sediment covers up cobble-sized rocks on the stream bottom, is as high as 100 percent within significant portions of the middle reach (B) where the majority of spawning gravel is located. Therefore, field data from habitat surveys have confirmed sediment conditions predicted from WATBAL. Table I summarizes this analysis.

Table II

Summary of Eldorado Drainage "WATBAL" Analysis

Stream(s) Area	Year	Projected Percent Sediment Over Natural in the Stream
1. Combined Drainage (Eldorado Creek)	1980	116%
2. Lower Eldorado Including Cedar Cr. (A)	1980	60%
3. Middle Eldorado (B)	1980	157%
4. Fan Creek	1980	258%
5. Trout Creek	1980	408%
6. Lunch Creek	1980	454%
7. Four-bit Creek	1980	58%
8. Upper Eldorado (C)	1980	29%
5. Dollar Creek	1980	37%
10. Six-bit Creek	1980	5%

Table II clearly supports the conclusion that mid-Eldorado (B) section has received the heaviest sediment inputs from management related activities in the drainage.

Four-Bit, Trout, Far, Lunch, and Cedar Creeks show the greatest **impacts** from timber harvest and associated activities.

Historically all of the important tributaries sustained major impacts from increased sedimenation, as indicated by Table III.

Table III

Historic Sediment Impacts to Eldorado Creek Tributaries

Stream	Year	Percent Sediment Increase Over Natural (3 Yr. X)
1. Trout Creek	1978	393%
2. Fan Creek	1975	366%
3. Lunch Creek	1979	842%
4. Six-bit Creek	1972	232%
5. Cedar Creek	1959	393%
6. Dollar Creek	1957	357%

These conditions clearly indicate that the placement of in-stream habitat structures might reduce sediment levels by channeling and directing flows (e.g., log weirs, large organic debris, boulder clusters), and subsequently, improve aquatic habitat.

3. Ocular Stream Survey and Channel Stability:

In September 1984, Eldorado Creek was surveyed from the Dollar Creek bridge (SE1/4, section 12, T. 34 N., R. 6 E.) to its confluence with Lolo Creek (NE1/4, section 18, T. 34 N., R. 6 E.). A total of 12 miles were surveyed. The 6 major tributaries included in this analysis were surveyed during a 5 year period (6/73 to 7/83). Each survey consisted of two parts; first the "Clearwater Forest Ocular Stream Habitat Survey" and second the "Rl Stream Reach Inventory and Channel Stability Evaluation."

1. (Ocular) Stream Habitat Survey:

The Clearwater Ocular Stream Habitat Survey technique is designed to quantify specific stream parameters which are important components to the life cycle of salmonids. These parameters are: pool quality (low 0.5 - high 3.0), percent pool:riffle:run, average percent of bottom materials, average cobble embeddedness, bank cover quality (low 0.5 - high 2.0) and quantity and quality of spawning habitat (square yards; good; fair; and poor). Included in the ocular estimate are 4 measured parameters; stream length, width, depth and gradient.

a. <u>Main Lolo Section A</u>: Section A (refer to Appendix E), extends 1.5 miles from the mouth of Eldorado Creek upstream to the confluence of Cedar Creek. Table IV displays the results of the survey.

<u>Table IV</u>

<u>Main Eldorado - Section A - Results, Ocular Stream Survey</u>

Parameter	Quantity
Available Habitat	5.2 acres
Stream Length	1.5 miles
Mean Depth	0.9 feet
Mean Width	28.6 feet
Mean Gradient	4.4 percent
Major Bottom Material Components (small gravel through boulders)	90 percent
Pool:Riffle:Run	14:71:15
Mean Cobble embeddedness	25 percent .
Bank Cover Rating (0.5-2.0)	1.0
Pool Quality Rating (0.5-8.0)	7.0
Spawning Habitat:	

	Square Yards		Percent	
	Steelhead	Chinook	Steelhead	Chinook
good	24.0	0	52	0
fair	14.0	45.0	30	38
poor	8.5	117.0	18	2
Totals	46.5	162	100	100

Section A is a high gradient high energy reach. Bottom materials are large and cobble embeddedness is low. The pool:riffle:run ratio is skewed to riffle. Spawning habitat totals 0.2 percent of the total habitat available in this reach. The bank cover rating is low while the pool quality rating is high. This section contains the 4 migration barriers mentioned earlier.

b. <u>Main Eldorado Section B</u>: Section B (refer to Appendix E), extends 7.5 miles from the Cedar Creek confluence to the Lunch Creek confluence. Table V displays the results of the ocular stream survey.

Table V

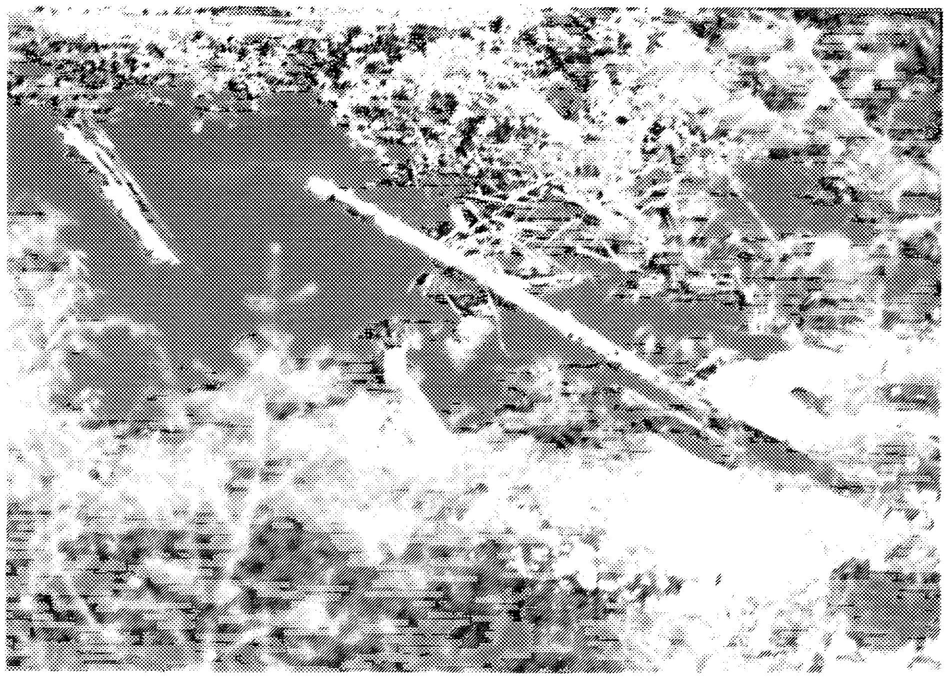
Main Eldorado - Section B - Results, Ocular Stream Survey

Parameters	Quantity
Available Habitat	24.4 acres
Stream Length	7.5 miles
Mean Depth	0.81 feet
Mean Width	26.8 feet
Mean Gradient	1.4 percent
Major Bottom Material Components (silt through large rubble)	89 percent
Pool:Riffle:Run	16:42:42
Mean Cobble embeddedness	
Bank Cover Rating (0.5-2.0)	1.3
Pool Quality Rating (0.5-8.0)	5.4
Spawning Habitat:	

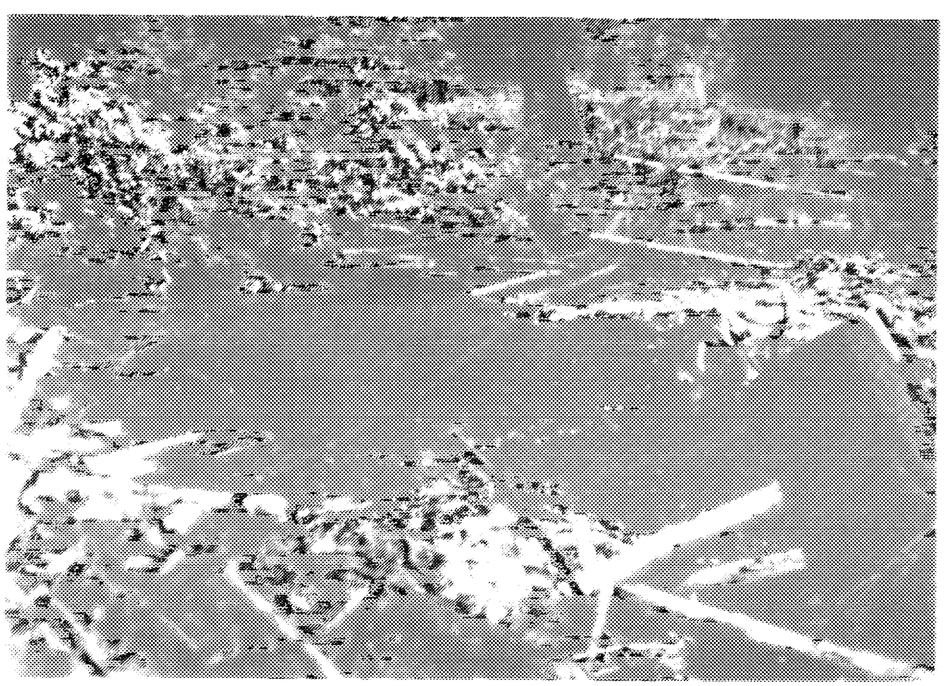
	Square Yards		Percent	
	Steelhead	Chinook	Steelhead	Chinook
good	1053	975	29	23
fair	1587	2415	45	58
poor	916	800	26	19
Totals	3556	4190	100	100

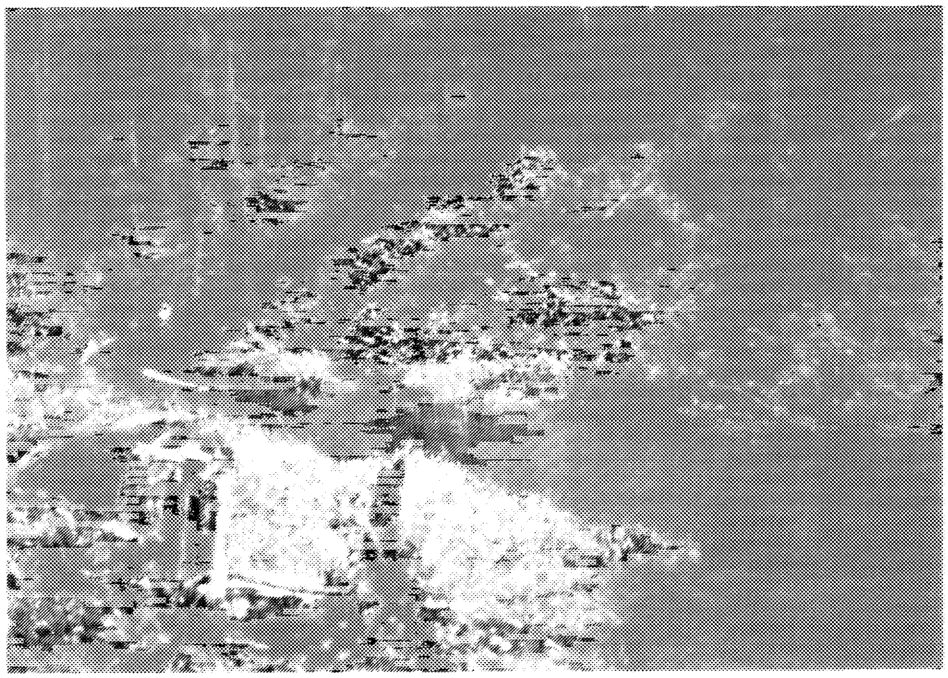
Section B is a low gradient highly variable reach (refer to Figures 2 through 5). Two percent of this section is spawning 'habitat. Bottom materials are mid-sized and cobble embeddedness is significantly higher than Section "A". Pool frequency (16%) is low and pool quality (5.4) is fair. The bank cover rating is poor (1.3).

c. Eldorado - Section C: Section C (refer to Appendix), extends 3.0 displays from the Lunch Creek confluence to the Dollar Creek bridge. Table VI displays the results of the ocular stream survey.



Figures 2 and 3. Upper and lower photos show debris routing in Section B.





Figures 4 and 5. Upper and lower photos show variability in Section B.

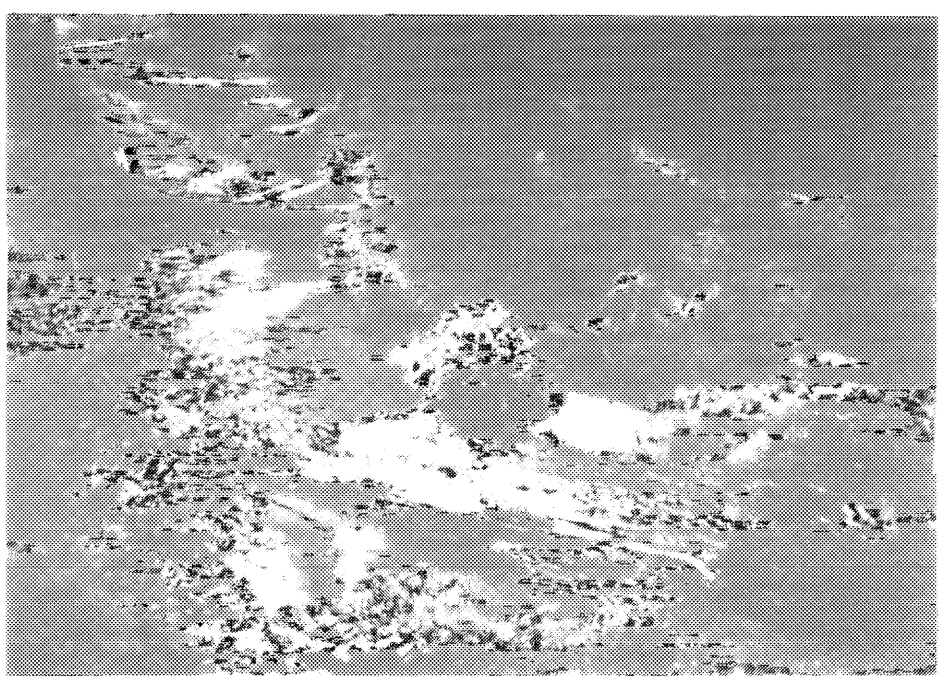


Table VI

Main Eldorado - Section C - Results, Ocular Stream Survey

Parameters	Quantity
Available Habitat	1.1 acres
Stream Length	3.0 miles
Mean Depth	1.5 feet
Mean Width	29.7 feet
Mean Gradient	1.4 percent
Major Bottom Material Components (muck to sand)	92 percent
Pool:Riffle:Run	43:04:53
Mean Cobble Embeddedness	100 percent
Bank Cover Rating (0.5-2.0)	1.1
Pool Quality Rating (0.5-8.0)	5.9

Spawning Habitat:

	Square Yards		Percent	
	Steelhead	Chinook	Steelhead	Chinook
good	0	0	0	0
fair	0	0	0	0
poor	151	0	100	0
Totals	151	0	100	0

Section C is a flat, greatly meandering, deep channeled reach. Hydrologically this reach acts as a filter trap for sediment entering upper Eldorado Creek. The stream banks are low and are over-flowed during peak flows. Bottom material includes all of the finer materials. Spawning habitat is essentially non-existent. Pool quality and bank cover ratings are fair. A lack of pool cover was noted by the survey crew. Riffles are essentially absent.

d. Limiting Factor Analysis - Mainstem Eldorado:

Summer Rearing Habitat - Steelhead Trout

Quantity

18 miles = 95,040 ft. x 29.7 (mean width)
= 2,822,688 ft^2
= 262,239 m^2 (64.8 acres)

Summer Pool Habitat = 262,239 m^2 x .43 (pool habitat type)
= 112,763 m^2

Summer Density of Juvenile Steelhead (Parr) at full seeding and existing conditions (50% cobble embeddedness) (FISHSED) = 30 x .62 = 19 fish/100 m^2

Summer Production of Steelhead Pass = 19 x 1,127.63
= 21,424 Parr

Winter Mortality = 21,425 x .50 (extrapolated)

Smolt Production = 10,712
based on rearing
habitat

Spawning Habitat - Eldorado Creek and Tributaries - Steelhead Trout

Total Amount of Spawning Habitat (yds^2) = 4008.0 yds^2

Number of Spawners = 267 females
15 yds^2 per Spawning Pair

Fecundity = 6,000 x 267 = 1,602,000 eggs (Dworshak Stock)

Emergent fry = 480,600 fry
(30% survival - existing conditions)

Parr (20% survival = 96,120)

Smolt Production = 48,060
(over-winter survival - 50%)
based on spawning habitat

Conclusion: In relation to spawning habitat, summer rearing habitat is limiting production in Eldorado Creek. A similar scenario was constructed for spring chinook salmon and the conclusion remains the same - rearing habitat is limiting.

e. Eldorado Creek Tributaries: Although there are 8 major tributaries to Eldorado Creek, Cedar and Austin Creeks are not considered in our evaluation or in our project proposal. Austin Creek is too small to support anadromous fish. Although Cedar Creek is 6.0 miles long with three major tributaries of its own, there is no suitable spawning habitat for anadromous fish.

The six major tributaries analyzed for potential enhancement are: Fan, Trout, Lunch, Four-Bit, Dollar, and Six-Bit Creeks. Ocular Stream habitat surveys were conducted on these streams over a 5 year period from 1979 through 1983. The following is a synopsis of these surveys, presenting the significant data, detailing the factors limiting anadromous fish production.

Figures 6 and 7. Upper and Lower photos show slow meandering channel in Section G with sediment load.

1) Fan Creek: Fan Creek is a third order stream with a moderate gradient (2.25%) and a total length of 2.50 miles. The total habitat available to anadromous fish is approximately 3.0 acres. Table VII presents the limiting factors in Fan Creek.

Table VII
Ocular Survey - Limiting Factors - Fan Creek

1.	Pool:Riffle:Run		19:44:37
2.	Cobble Embeddedness		50 percent
3.	Spawning Habitat:		
		Square Yards	
		0	good
		2	fair
		5.5	poor
	Total	7.5	

The pool frequency is below optimum by 14 percent and cobble embeddedness is high. There is also a definite lack of spawning habitat.

2) Trout Creek: Trout Creek is a third order stream with a steep gradient of 5.8 percent and a total length of 2.3 miles. The total habitat available to anadromous fish is 2.2 acres. Table VIII presents the limiting factors in Trout Creek.

Table VIII
Ocular Survey - Limiting Factors - Trout Creek

1.	Pool:Riffle:Run	27:44:29	
2.	Cobble embeddedness	50 percent	
3.	Spawning Habitat:		
		Square Yards	
		8	good
		14	fair
		20	poor
	Total	32	

Cobble embeddedness is moderately high and the pool frequency is 8% below optimum. Spawning habitat is relatively abundant, however 80 percent is in fair and poor condition.

3) Lunch Creek: Lunch Creek is a third order stream, with a fairly steep gradient (4.0%) and a total length of 1 mile. The total amount of habitat available to anadromous fish is 0.8 acres. Table IX presents the limiting factors in Lunch Creek.

Table IX
Ocular Survey - Limiting Factors - Lunch Creek

1. Pool : Riffle : Run		28:34:38	
2. Cobble embeddedness		78 percent	
3. Spawning Habitat :			
	Square Yards		
	7	good	
	17	fair	
	14	poor	
Total	38		

Cobble embeddedness is extremely high, 78 percent. The pool frequency is 7 percent below optimum. Spawning habitat is 82 percent fair and poor.

4) Four-bit Creek: Four-bit Creek is a third order stream, with a fairly steep gradient (4.3%) and a total length of 2.8 miles. Table X presents the limiting factors in Four-bit Creek. The total amount of habitat available to anadromous fish is 2.6 acres. Table X presents the factors limiting fisheries in Four-Bit Creek.

Table X
Ocular Survey - Limiting Factors - Four-Bit Creek

1. Pool:Riffle:Run		26:42:32	
2. Cobble Embeddedness		50 percent	
3. Spawning Habitat:			
	Square Yards		
	12	good	
	23	fair	
	25	poor	
Total	60		

The primary limiting factors in Four-bit Creek include the moderately high cobble embeddedness (50%) and the low quality of the spawning habitat, 80 percent in fair and poor condition.

5) Dollar Creek: Dollar Creek is a fourth order stream with a low gradient of 2 percent and a total length of 3.3 miles. There is' a total of 4.1 acres of habitat available to anadromous fish. The pool:riffle:run ratio is 42:4:54. The primary limiting factor in Dollar Creek is the increasing cobble embeddedness, which is now at 55 percent. Cobble embeddedness in 1981 was 50 percent. There is a total of 82 square yards of spawning habitat, of which 43 percent is rated as good and 57 percent rated as fair.

6) Six-bit Creek: Six-bit Creek is a third order stream with a moderate gradient (2.6%) and a total length of 2.5 miles. There is a total of 1.6 acres of habitat available to anadromous fish. The pool:riffle:run ratio is (39:32:29). Cobble embeddedness is again the primary limiting factor at 52 percent.

Table XI is a summary of the biological potential of steelhead trout and chinook salmon based on the relationship between habitat quality and cobble embeddedness :

I Table XI

Biological Potential of Anadromous Fish
Based on Cobble Embeddedness
In Major Eldorado Creek Tributaries

		Biological Potential[1]	
Tributary	Cobble Embeddedness	Steelhead Trout	Chinook Salmon
Fan Creek	50%	59%	49%
Trout Creek	50%	59%	49%
Lunch Creek	75%	40%	35%
Four-bit Creek	50%	59%	49%
Dollar Creek	55%		
Six-bit Creek	52%		

1 Determined from FISHSED, Stowell et al., 1983.

2. Channel Stability Survey:

The "R1 Stream Reach Inventory and Channel Stability" technique blends the relative stability indicators for upper banks, lower banks and bottom material into an over ail reach stability index; excellent, good, fair, and poor. Table XII displays the items rated using this technique.

Table XII

KEY NUMBER ON FIELD CARDS

	Item Rated	
Upper Banks -	Landform Slope	1
	Mass Wasting or Failure (existing or potential	2
	Debris Jam Potential (Floatable Objects)	3
	Vegetative Bank Protection	4
Lower Banks -	Channel Capacity	5
	Bank Rock Content	6
	Obstructions Flow Deflectors Sediment Traps	7
	Cutting	8
	Deposition	9
Bottom -	Rock Angularity	10
	Brightness	11
	Consolidation or Particle Packing	12
	Bottom Size Distribution and Percent Stable Materials	13
	Scouring and Deposition	14
	Clinging Aquatic Vegetation (Moss and Algae)	15

In summary, the survey identifies the magnitude of the hydraulic forces that work to detach and transport both organic and inorganic components within a watershed system. Finally, the inventory catagorizes how resistant these components are to stream flow energies.

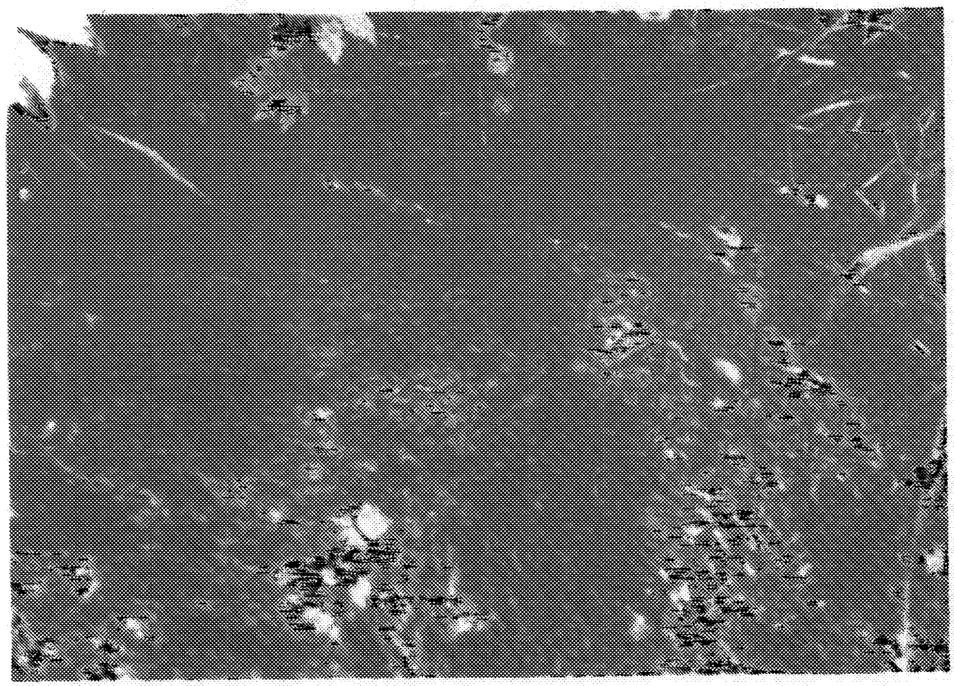
Eldorado Creek was rated as fair for overall channel stability, reflecting the land management activities that have taken place within the watershed during the last 30 years. The potential for on site erosion of the channel with down stream sediment damage is evident. Normal high water conditions are causing undercutting and increasing sedimentation. Stream flows are stong enough to carry debris downstream, decreasing bank protection and increasing the potential for debris jams. Accumulations of considerable amounts of sediment behind these obstructions is evident. The deposition of small gravels, sand, and silt is occurring with moderate frequency. Pool habitat is decreasing accordingly.

All six tributaries; Fan, Trout, Lunch, Four-bit, Dollar, and Six-bit Creeks were rated fair overall for channel stability. The primary problem involved increased sedimentation. Numerous observations were made of small debris jams catching fine sediment, raising the water level and resulting in bank cutting and bank failure. The frequency of raw banks and unstable nature of the channels with high sediment loads, resulted in the fair rating (refer to Figures 8 through 13).

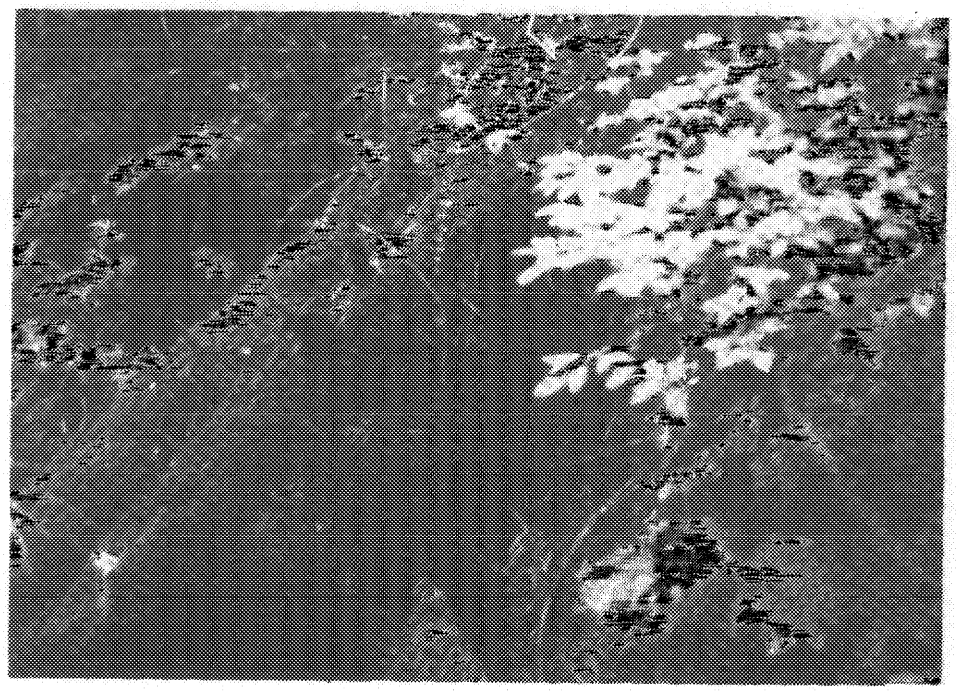
c. Analysis of Limiting Factors and Management Implications:

The results of the analysis show that Eldorado Creek is currently a good resident fishery with the potential to be a good producer of anadromous fish smolts, despite the decrease in habitat, quality related to the timber management activities. Throughout the drainage improvements (can be made in these areas; quantity and quality of spawning habitat, quantity of cobble embeddedness, quantity and quality of instream cover, and quantity and quality of bank cover.

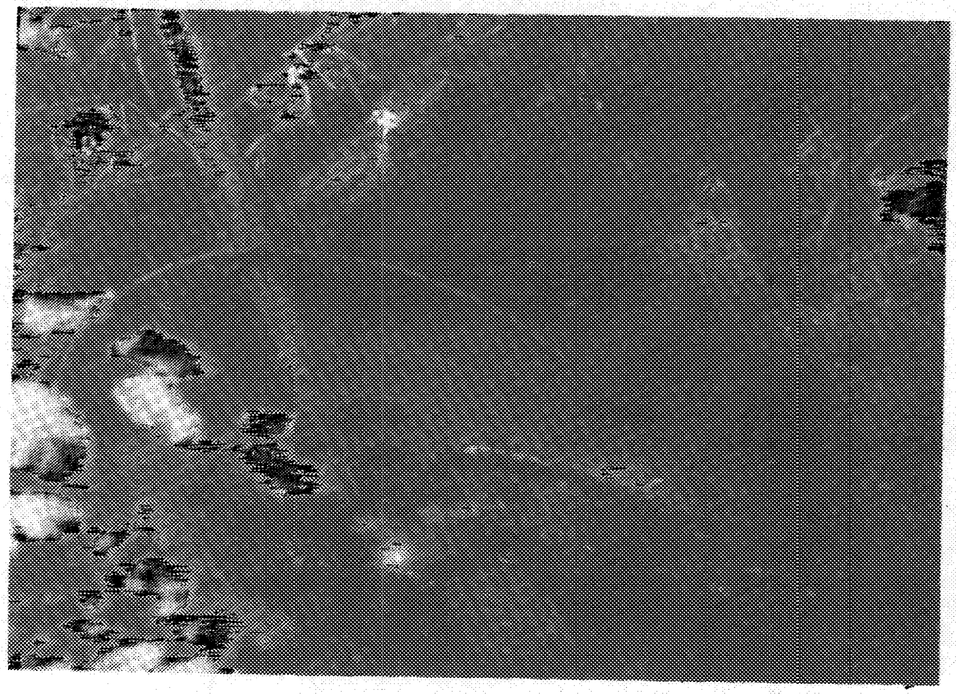
One of the historic timber management activities, which has had a direct effect on the quantity and quality of fish habitat in Eldorado Creek, is the salvage' of western red cedar, which have blown down and entered the aquatic system. With the knowledge that instream cover is a limiting factor throughout the Eldorado drainage the retention of this source of large organic debris becomes very important.



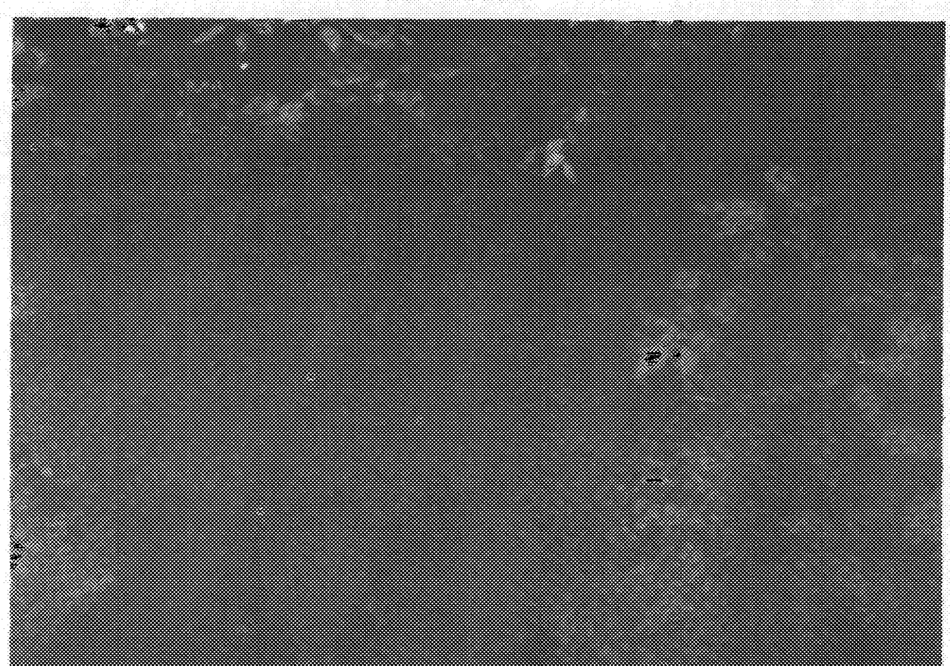
Figures 8 and 9. Upper and lower photos show cobble embeddedness in Trout Creek.



Figures 10 and 11. Upper and lower photos show accumulating sediments and debris in Fan Creek.



Figures 12 and 13. Upper and lower photos show sedimentation in Lunch Creek.



a. Main Eldorado Creek:

Section "A" of the Eldorado Creek is not typical of the rest of the system, cobble embeddedness is low (25%), gradient is high (4.4%), the pool:riffle:run ratio is skewed to riffle (72%) and bottom materials are large with high occurence of bed rock. For these reasons the limiting factors in this section differ somewhat from other sections in the Eldorado system. Those factors which limit fish production in Section "A" include:

Stream Bank Stability: Stream bank instability in this section is a result of the close proximity of road fills to the main channel. This has resulted in direct sedimentation and migration barriers.

Pool:Riffle:Ratio: Seventy-two percent of the available habitat is riffle. The overall habitat use could be improved by modifying this condition (adding diversity).

Quality of Spawning Habitat: Forty-eight percent of the spawning habitat for steelhead trout and 100 percent of the spawning habitat for chinook salmon is in fair or poor condition. Improvement in the quality of spawning habitat is possible through a reduction of site specific cobble embeddedness.

Section "B" is the longest reach in the Eldorado drainage (7.5 miles). Section "B" contains most of the problems common in Eldorado Creek. Since this reach contains the majority of the spawning habitat in main Eldorado Creek (96%) the quantity and quality of fish habitat is very important. Those factors limiting fish production in Section "B" include:

Cobble Embeddedness: Cobble embeddedness averages 50% over the entire reach. At this level of cobble embeddedness, biological potential for steelhead trout and chinook salmon is reduced by 41 percent and 51 percent, respectively.

Pool Quality and Quantity: Pool quality is sub-optimal as both pool depth and pool cover are rated low. Pool frequency is 16 percent throughout this reach.

Quality of Spawning Habitat: Seventy-one percent of the spawning habitat for steelhead trout and 77 percent of the spawning habitat for chinook salmon is in fair to poor condition. This is primarily the result of the moderately high cobble embeddedness.

Section "C" is essentially devoid of spawning habitat and has a cobble embeddedness of 100 percent (i.e. a sand bottom). However, gradient and depth in this meandering system led to the conclusion that this reach could be a highly productive rearing habitat for chinook salmon. Those factors which might limit this goal include:

Pool Quality: Although pool frequency averages 43 percent throughout this reach, pool depth was usually limited. Instream cover, primarily in pools, was generally lacking.

Stream Stability: Stream banks were generally unstable, which had a significant effect on the availability of bank cover.

B. Selected Tributaries of Eldorado Creek:

Fan Creek lacks adequate spawning habitat and cobble embeddedness is fairly high. Management emphasis should be directed toward rearing anadromous fish. Those factors limiting rearing habitat include:

Streambank Stability:The introduction of moderately large amounts of small woody material has acted as sediment traps, resulting in several negative effects on stream habitat. The increase in sediment has decreased pool depth and eliminated pool cover. The availability of spawning habitat is also decreased. Although not constant in Fan Creek this problem is of a frequency worth noting.

Pool Quantity and Quality: Pool frequency averages 19 percent in Fan Creek and as described above pool quality is not optimum.

Cobble Embeddedness Cobble embeddedness is 50 percent which lowers biological potential for salmonids significantly (refer to Table IX).

Trout Creek is typical of the majority of the tributaries to Eldorado Creek. The pool:riffle:run ratio (27:43:30) is adequate, cobble embeddedness is 50 percent; 80 percent of the spawning habitat is in fair or poor condition and stream bank stability is a concern. Those factors limiting fish production include :

Pool Quality: Pool frequency is adequate although not ideal 27 percent of the available habitat. Pool quality is law (refer to Fan Creek - Streambank Stability).

Cobble Embeddedness: The cobble embeddedness level (50%) has a significant effect on fish production (refer to Table IX).

Spawning Habitat Quality: Reduced quality of spawning habitat is a direct result of the moderately high level of cobble embeddedness.

Stream Bank Stability: Stream banks are in fair condition.

Lunch Creek is also typical of the majority of the tributaries to Eldorado Creek except that the gradient is high (4.0%) and the cobble embeddedness is very high (78%). The pool ratio is 8 percent below optimum. The availability of spawning habitat is good, however, condition classes are low. We would expect the high cobble embeddedness to have a serious effect on the quantity and quality of spawning habitat. The primary factor limiting fish production is:

<u>Cobble Embeddedness</u>: Biological potential for salmonids is seriously reduced by the high cobble embeddedness in Lunch Creek (refer to Table IX). This level of sedimentation also has the negative effect on fish habitat outlined under "Stream Bank Stability - Fan Creek".

Four-bit Creek is a classic Eldorado Creek tributary with the exception of its high gradient (4.3%). Eighty percent of the spawning habitat is in fair or poor condition and the cobble embeddedness is 50 percent. Those factors limiting fish production include:

<u>Stream Bank Stability</u>: Similar to the situation in Fan Creek.

<u>Cobble Embeddedness</u>: Moderately high embeddedness has a negative effect on biological potential of salmonids (refer to Table IX).

<u>Spawning Habitat Quality</u>: The relative condition of the spawning habitat is due to the moderately high cobble embeddedness.

Dollar Creek contains the largest amount of habitat of all of the tributaries we are considering in Eldorado Creek (4.1 acres). The majority of the spawning habitat is in fair condition (57%). The relatively low gradient (2%) has resulted in a lack of riffle habitat (4%). Cobble embeddedness is moderatley high and increasing, due to timber management activities. The primary importance of Dollar Creek is spawning habitat for steelhead trout and rearing habitat for chinook salmon. Those factors influencing production of salmonids include :

<u>Cobble Embeddedness</u>: Cobble embeddednes is moderately high (55%) and increasing. The effects on the biological potential of selected salmonids is presented in Table IX.

<u>Spawning Habitat Quality</u>: Fifty-seven percent of the spawning habitat is in fair condition, however, there is no poor spawning habitat.

Six-bit Creek is also a classic Eldorado Creek tributary. Cobble embeddedness is moderately high (52%), the pool:riffle:run ratio is adequate (39:32:29) and 89 percent of the spawning habitat is in fair to poor condition. Those factors limiting fish production include:

<u>Cobble Embeddedness</u>: The moderately high embeddedness has a negative effect on the biological potential of salmonids (Table IX).

Spawning Habitat Quality: The majority of the spawning habitat is in fair and poor condition, 89 percent. This is a primary result of the moderately high cobble embeddedness.

Stream Bank Stability: Stream bank stability has been negatively effected by the increased sediment load. Specific areas of raw banks do exist on a moderate frequency.

Management Implications:

Anadromous fish habitat in Eldorado Creek and six of its tributaries can be improved through techniques designed to ameliorate the limiting factors. In summary these factors include; the quantity and quality of spawning habitat, moderately high to very high levels of cobble embeddedness, quantity and quality of pool habitat, quantity and quality of bank cover and instream cover and low pool frequencies.

IV. Project Proposal:

A. Techniques Considered Appropriate to Ameloriate Limiting Factors:

The introduction of in stream structures and planting of deciduous stocks have been selected as the treatments of choice for Eldorado Creek. Specifically in stream structures such as log weirs and boulders can clean and sort gravels, create pools and add instream cover. Deciduous stocks can be used for both overhead cover and stream bank stabilization. Research on in stream structures, to date, has emphasized the associated fish population dynamics rather than quantifying physical channel changes. However, physical changes in channel morophology are necessary to ameloriate the factors limiting fish population potential. Based on our analysis of limiting factors for mainstem Eldorado, the project will key on rearing habitat. Secondarily, we shall attempt to enhance the quality of spawning habitat.

B. Identification of Treatment Reaches and Selected Treatments:

Main Eldorado Creek: Utilizing a system developed by Forest Fisheries Biologist, Al Espinosa, stream reaches were identified within the three main sections of Eldorado Creek, that were both suited to and could benefit from in stream enhancement. This system provides guidelines for identifying channel characteristics which are suited to a particular type of in stream enhancement. The system also provides guidelines for relating stream bottom characteristics to specific structure types to achieve the desired results.

1. Section "A":

The two primary goals for enhancement in this section are; 1) improve streambank stability and 2) increase pool frequency. In-stream enhancement opportunities are limited, in this section, due to: the steep gradient, frequency of bedrock outcrops, and limited equipment access. Treatments selected for Section "A" include several log weirs, large single boulders, felled riparian conifers and stream stabilization through deciduous planting. Refer to Table XIII for a summary of the enhancement proposed for Section "A". Refer to project map in Appendix E, for the locations of the proposed enhancement in this section.

2. Section "B":

The four primary goals for enhancement in this section are: 1) improve streambank stability, 2) reduce cobble embeddedness, 3) improve pool frequency, and 4) improve pool quality. A secondary goal will be to improve the quantity and quality of spawning habitat. Treatment selected for Section "B" includes: large single boulders, root wads, log and boulder weirs, partial treatment of debris jams, felled riparian conifers and deciduous planting. Refer to Table XIII for a detailed summary of the proposed enhancement for Section "B". Refer to project map in Appendix E for locations of proposed enhancement.

3. Section "C":

The primary goals for enhancement in this section are: 1) improve streambank stability, 2) improve pool quality, and 3) improve in-stream and streambank cover. Treatments selected for this section include: felled riparian trees, introduction of organic debris in pools, and deciduous planting. Refer to Table XIII for detailed summary of the proposed enhancement for Section "C". Refer to project map in Appendix E for locations of proposed enhancement.

Table XIII

Summary of the Enhancement Proposal for Main Eldorado Creek by Section

Phases I and II:

Section A:

Reach A1 - 2 log weirs
A2 - 10 large boulders
XX - 8-10 felled and cabled conifers throughout the section.
- deciduous planting throughout the section for stream bank improvement.

Section B:

Reach B1 - 30 large boulders and 5 root wads
B2 - 2 log weirs and 1 boulder weir
B3 - 1 log weir and 1 boulder weir
B4 - 3 log weirs and 1 boulder weir
B5 - 1 log weir and 1 boulder weir
B6 - 25 large boulders and 5 root wads
B7 - 1 log weir and 1 boulder weir
B8 - 2 log weirs, possibly handmade
XX - 2 debris jams will be partially removed
- 30 riparian conifers felled and cabled throughout this section
- deciduous planting throughout this section for pool cover - 50 pools

Section C:

Reach C1 - 20 felled and cabled riparian trees
- pool enhancement, introduction of organic cover
- deciduous planting for pool cover, 50 pools

Total Structures (improvements) by Type:

1. 8 log weirs
2. 3 log weirs with wings
3. 5 boulder weirs
4. 60 large boulders
5. 60 anchored large conifers
6. 20 anchored root wads
7. 1.5 miles of riparian enhancement, deciduous planting
8. 100 pools, bank cover, deciduous planting
9. 48 instream structures, pool cover
10. Totals:
    a. 204 structures
    b. 100 pools planted
    c. 1.5 miles of stream stabilized

Selected Eldorado Creek Tributaries:

Based on our analysis of limiting factors, enhancement of tributary habitat will key on spawning habitat and habitat for 0+ steelhead and salmon. The treatment selected for each of the 6 Eldorado Creek tributaries are hand made log weirs, Refer to Table XIV. The primary goals for the tributaries include: 1) reduce existing cobble embeddedness, 2) improve pool frequency and quality, and 3) increase the quantity and quality of spawning habitat. Refer to maps in Appendix G for specifics concerning treatable areas of each tributary.

Table XIV

Summary of the Enhancement Proposal for
Six Eldorado Creek Tributaries

Stream III and IV:

Stream Name	Survey Year	Acres of Summer Rearing Habitat	Square Yards of Spawning Habitat	Treatable Acres	# of* Structures
Fan Cr.[2]	6/79	3.0	7.5	0.90	15
Trout Cr.[2]	6/79	2.2	42	0.70	14
Lunch Cr.[2]	6/79	0.8	-	0.26	35
Four-Bit Cr.[1]	6/79	2.6	60	0.70	9
Dollar Cr.[1]	8/81	4.1	82	2.50	28
Six-Bit Cr.[1]	7/83	1.6	63	0.80	41

* All handmade log weirs.
1. Year 1 of the tributary project - 64 structures
2. Year 2 of the tributary project - 78 structures

142 Total

C. Scheduling of Project Activities:

The proposed Eldorado Creek enhancement project will take 4 years to complete i.e. 4 phases are required to accomplish the proposed enhancement. Phase I will involve the construction and placement of in-stream structures in main Eldorado Creek. Phase II will involve ail of the necessary deciduous planting along main Eldorado Creek. Phase III includes construction of in-stream structures in Four-Bit, Dollar, and Six-bit Creeks. Phase 4 includes the construction of instream structures in Fan, Trout, and Lunch Creeks. Refer to Tables XIII and XIV for specifics.

D. Costs and Outputs:

The proposed Eldorado Creek Fish Habitat Improvement Project will take 4 years to complete at a total cost of $86,775 or an average of $21,700 per year. A total of 346 structures, 1.5 miles of riparian zone improvement and cover enhancement of 100 pools are planned. Average cost per structure is approximately $175, average cost per mile of riparian improvement is $12,600 and the average cost of pool improvement is $200. Refer to Table XV for specifics on time frames, cost/phase and expected outputs.

Table XV

Costs and Outputs per Phase of the Proposed Eldorado Creek Enhancement Project

Phase	Timing	Costs	Outputs
I	year 1	$40,475	240 structures
II	year 2	$18,850	1.5 miles planted 100 pools planted
III	year 3	$12,360	64 structures
IV	year 4	$15,070	78 structures

Refer to Appendix B and C for specific cost breakdowns.

E. Project Benefits:

The removal of the fish passage barriers at stream mile 0.7 will open up 47.3 acres of rearing habitat for summer steelhead trout and spring chinook salmon in mainstream Eldorado Creek. The tributary network will add 14.3 acres of rearing habitat for steelhead. The tributary streams are too small for salmon spawning and rearing. The existing quality of Eldorado's rearing habitat is capable of producing 10,712 steelhead and 24,00 salmon smolts per annum. The tributaries will add 3,752 steelhead smolts at their present quality level. Therefore, the Eldorado system, before any instream enhancement, can produce (if fully seeded) a total of 14,474 steelhead and 24,000 salmon smolts annually.

Upon implementation and completion of the instream enhancement, we have projected an increase of 50 percent in the productive capacity of the rearing habitat. With the advent of full seeding, this increase in habitat quality would produce an additional 8,131 steelhead and 12,000 chinook salmon smolts. Total projected production for the Eldorado system would then equal 22,605 steelhead and 36,000 chinook smolts annually.

The net increase of 8,131 steelhead and 12,000 chinook smolts was subjected to the economic analysis utilizated in the Forest planning process. The. net smolt increase taken over a 20 year period translates to a total net economic value for steelhead of $1.58 MM dollars and $2.15 MM dollars for spring chinook. The total net economic value of the project would then equal $3.73 MM dollars. These values are undiscounted dollars. When factors for present value and discount rate (4%) are applied, the total net discounted value equals $2.54 MM dollars. We have assumed an effective life span of 20 years for the enhancement sructures.

The total cost of the project has been estimated at $93,775, including maintenance. The benefit/cost ratio is projected at:

$$\frac{\$2.54\ MM}{\$93.78\ M} = 27.1:1$$

or a ratio of benefits per cost of $27.10.

V. Summary:

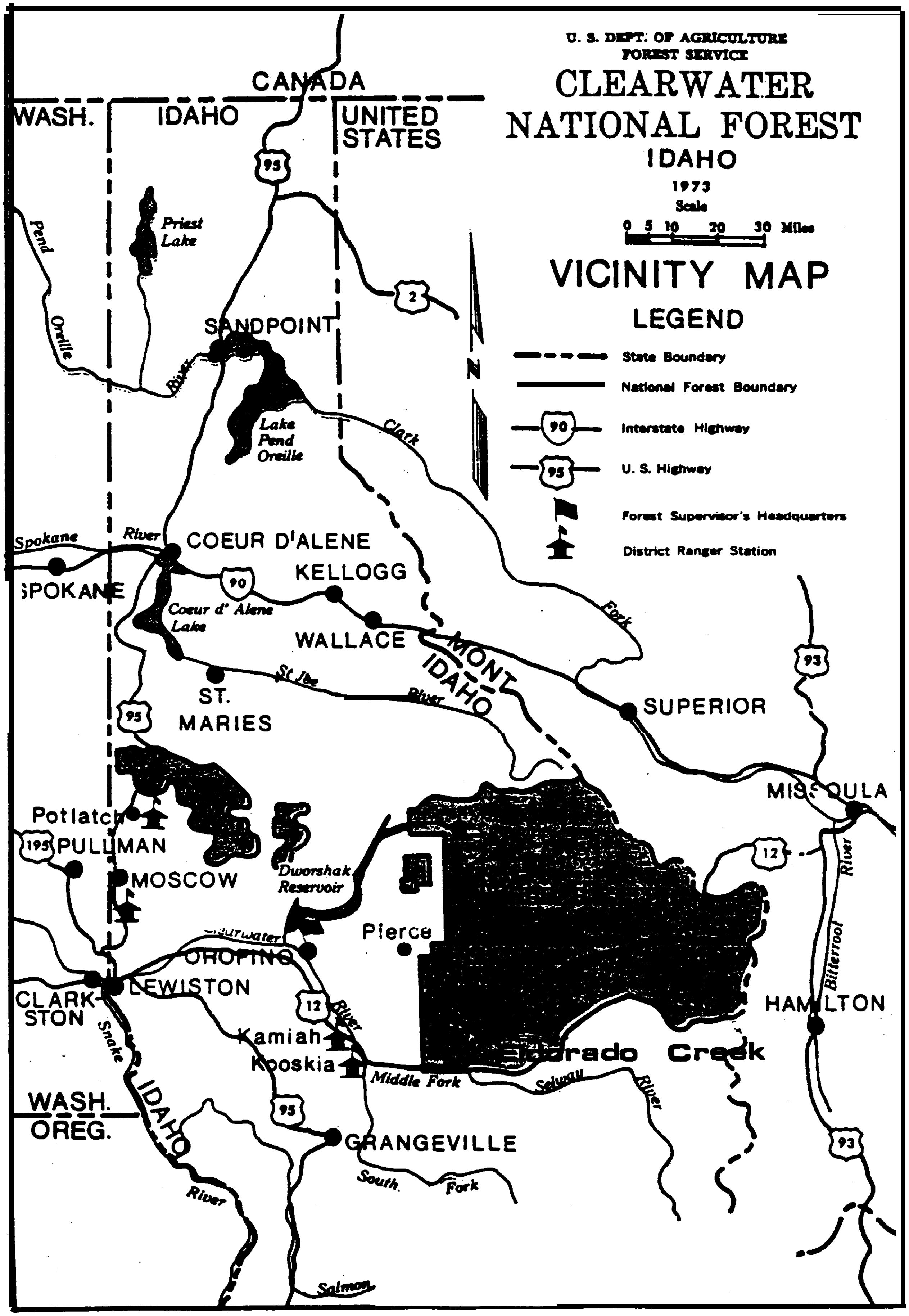
The objective of the proposed Eldorado Creek Habitat Improvement Project is to improve the productive capability of 12 miles in Eldorado Creek and 5 .I miles in six selected tributaries. A total of 54 to 64 acres of summer and winter r-earing habitat would be enhanced over a 4 year period. in addition, 2.5 acres of anadromous spawning habitat would be improved for spring chinook salmon and steelhead trout.

Current conditions throughout the Eldorado Creek rearinG system indicate that pool frequency, pool quality, bank stability, and cobble embeddedness are areas where enhancement efforts should be concentrated. In-stream structures designed to ameloriate these factors were chosen as the treatment of choice for the Eldorado Drainage. Reintroduction of streamside cover was also indicated.

A total of 346 structues, 1.5 miles of riparian zone, and 100 pools will be constructed or planted under this proposal at a total cost of $93,775. Average annual cost is $21,700. Average cost per Structure is $175. The benefit cost ratio for the proposal is 27.1 to 1.

VI Appendices:

A. Vicinity Map
B. Cost analysis for main Eldorado.
c. Cost analysis for six selected tributaries.
D. Main Eldorado Project Area.
E. Main Eldorado Project Map
F. Selected Eldorado Tributaries Project Area
G. Selected Eldorado Tributaries Project Map
  1. Six-bit Creek
  2. Dollar Creek
  3. Lunch Creekand Four-bit Creek
  4. Fan Creek and Trout Creek
H. Map of Eldorado Creek Fish Passage Barriers
I. Implementation Phase
  1. Mainstem Eldorado Creek (FY 85)


U. S. DEPT. OF AGRICULTURE
FOREST SERVICE
CLEARWATER
NATIONAL FOREST
IDAHO
1973
Scale
0 5 10 20 30 Miles
VICINITY MAP
LEGEND
State Boundary
National Forest Boundary
90 Interstate Highway
95 U. S. Highway
Forest Supervisor's Headquarters
District Ranger Station
N
CANADA
UNITED STATES
WASH.
IDAHO
Priest Lake
Pend Oreille River
SANDPOINT
Lake Pend Oreille
Clark Fork
Spokane River
COEUR D'ALENE
SPOKANE
KELLOGG
Coeur d' Alene Lake
WALLACE
MONT
IDAHO
St Joe River
ST. MARIES
SUPERIOR
MISSOULA
Potlatch
PULLMAN
MOSCOW
Dworshak Reservoir
Pierce
OROFINO
LEWISTON
CLARKSTON
Kamiah
Kooskia
Middle Fork
Selway River
Bitterroot River
HAMILTON
Snake
IDAHO
WASH.
OREG.
GRANGEVILLE
South Fork
River
Salmon
95
90
2
93
195
12

BUDGET FOR ENHANCEMENT STRUCTURES
FOR MAIN ELDORADO

Phase I:

Personnel	Days	Cost/Day	Cost
1 - GS/11 Forest Fisheries Bilogist	10	$120	$1,200
1 - GS/9 District Biologist	30	$100	$3,000
1 - GS/5 Crew Leader	50	$55	$2,750
2 - GS/4 Crew	50	$100	$5,000

Transportation:

1 - 1/2 ton P.U. @ $.22 mile for 50 miles/cay x 50 days	$550

Equipme t and Contracts:

Professional Faller	3 days @ $250/day	$750
12 Yard Dump Truck	32 hours @ $40/hour	$1,280
966 Front End Loader	32 hours @ $35/hour	$1,120
Rubber Tired Skidder	24 hours @ $35/hour	$840
Crawler Backhoe	160 hours @ $95/hour	$15,200
Move In and Out		$1,200

Supplies:

Drift Pins	100 @ $l/each	$100
Hardware Cloth	2 rolls @ $413/each	$826
Fence Wire	20 rolls @ $75/roll	$1,500
Staples	1 box @ $25/box	$25
Hog Nose Clips	5 boxes @ $2/box	$10
Cable Clamps	150 @ $1.05/each	$160
Wedges	2 @ $10/each	$20
Gas and Oil		$50
Wader s	3 pair @ $65/pair	$195
Arm length gloves	8 pair @ $20/pair	$160
Aluminum wader cleets	5 pair @ $40/pair	$200

Overhead:

12 percent		$4,340
	TOTAL	$40,475

Budget for
Riparian Zone and Pool Habitat
Enhancement of Main Eldorado Creek

Phase II:

Personnel	Days	Cost/Day	cost
1 - GS/11 Forest Fisheries Biologist	3	$120	$360
1 - GS/9 District Biologist	10	$100	$1,000
1 - GS/5 Crew Leader	35	$55	$1,925
1 - GS/4 Assistant Crew Leader	35	$50	$1,750
2 - GS/3 Crew	35	$90	$3,150

Transportation:

1 - 1/2 Ton P.U.	@ 224/mi. for 50 miles/day x 35 days	$385

Deciduous Stock:

Quaking Aspen	7,000 @ $.39/each	$2,730
Streambank Willow	7,000 @ $.79/each	$5,530
	Overhead:	
	12 percent	$2,020
	TOTAL	$18,850

Budget for Enhancement of
Six Eldorado Creek Tributaries

Phases III and IV:

Personnel (2 year project period)	Days	Cost/Day	Cost
1 - GS/11 Forest Fisheries Biologist	10	$120	$1,200
1 - GS/9 District Biologist	20	$100	$2,000
1 - GS/9 Crew Leader	100	$55	$5,500
2 - GS/4 Crew	100	$100	$10,000

Transportation:

1 - 1/2 Ton P.U.	@ $.22/mile for 50 miles x 100 days	$1,100

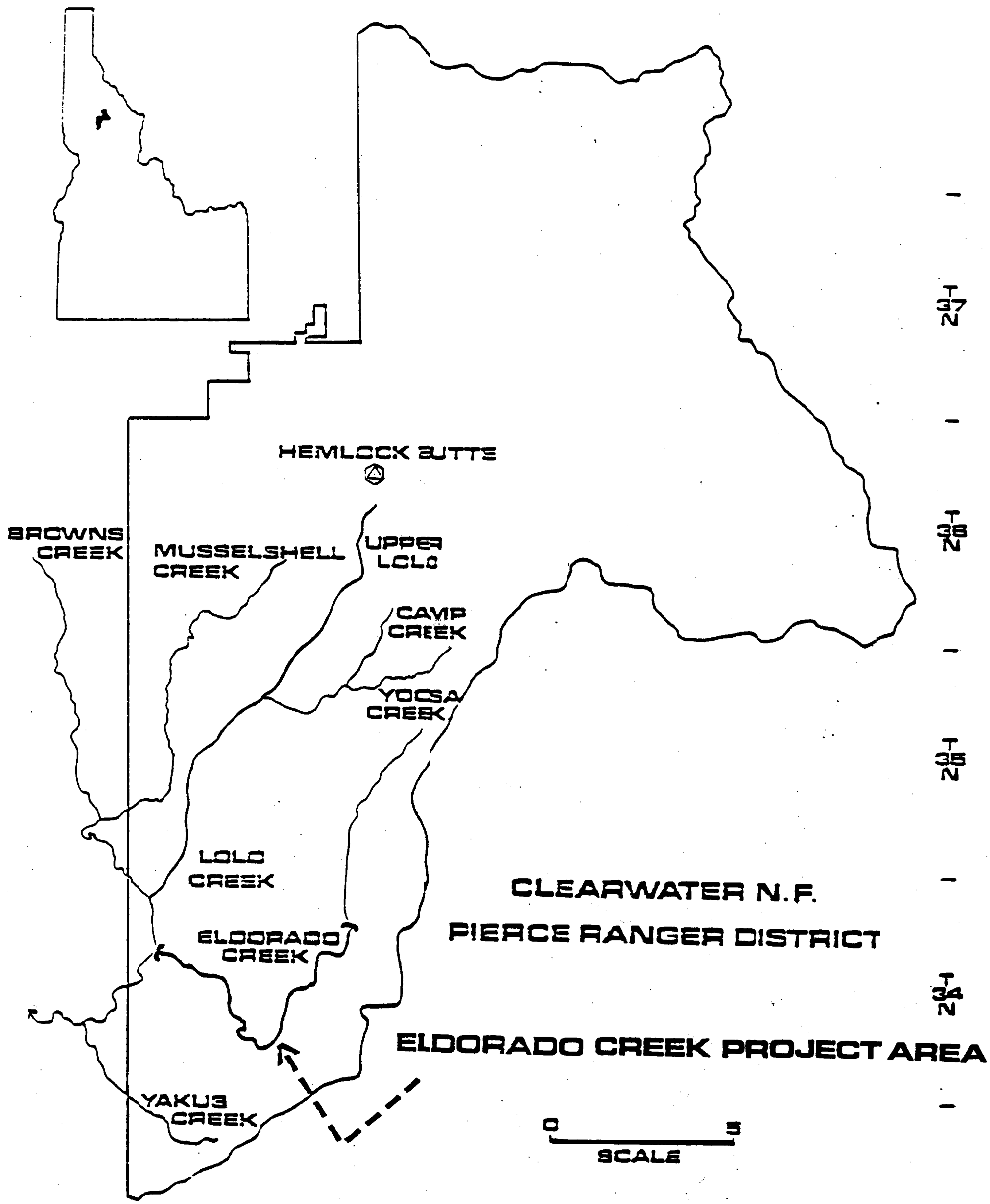
Supplies:

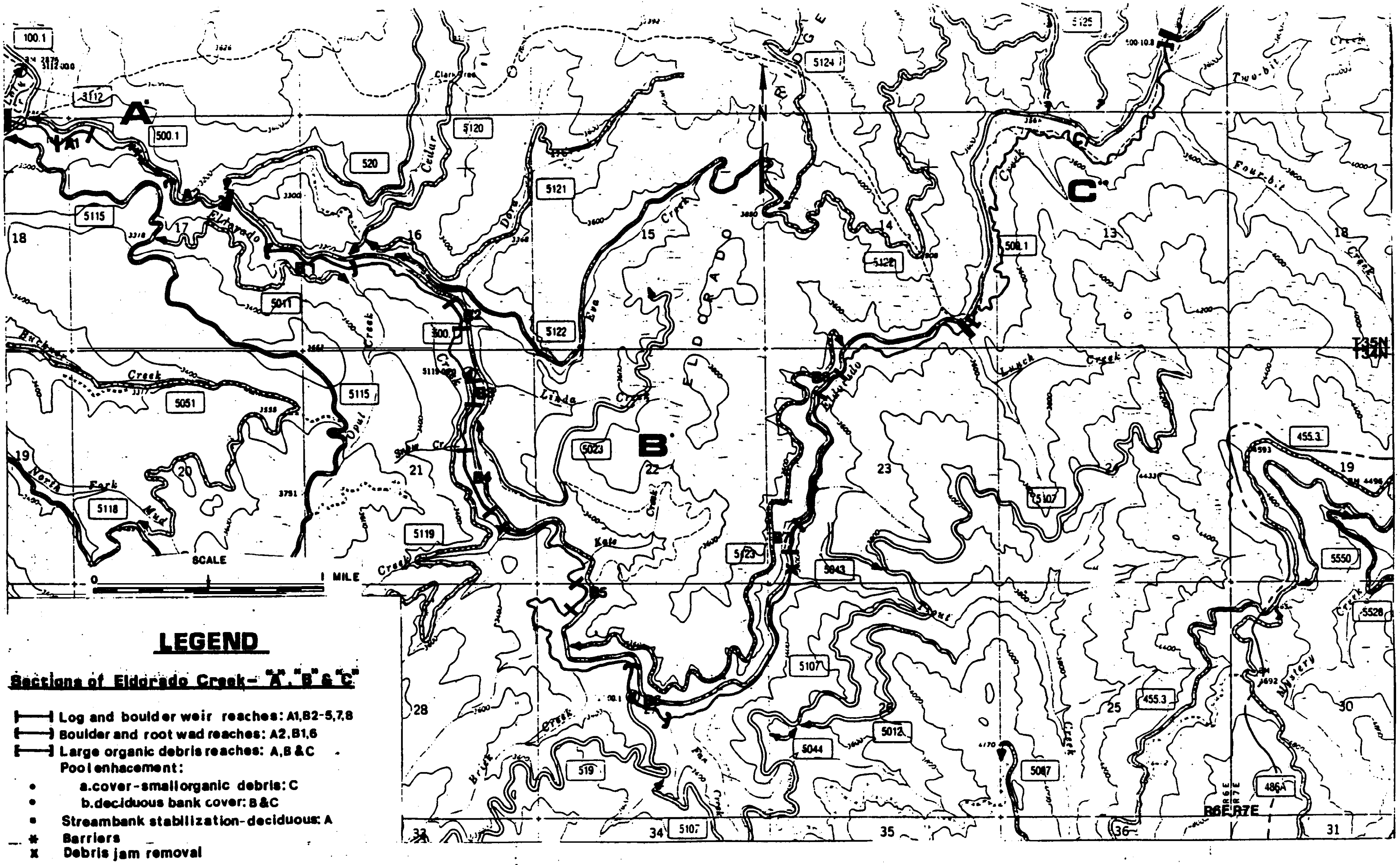
Hardware Cloth	2 rolls	$41 s/each	$826
Fence Wire	43 rolls	$75/each	$3,225
Staples	1 box	$25/box	$25
Hog Nose Clips	5 boxes	$2/box	$10
Wedges	2	$10/each	$20
Rubber Gloves	8 pair	$20/pair	$160
Chest Waders	6 pair	$65/pair	$390
Gas and Oil			$50

Overhead:

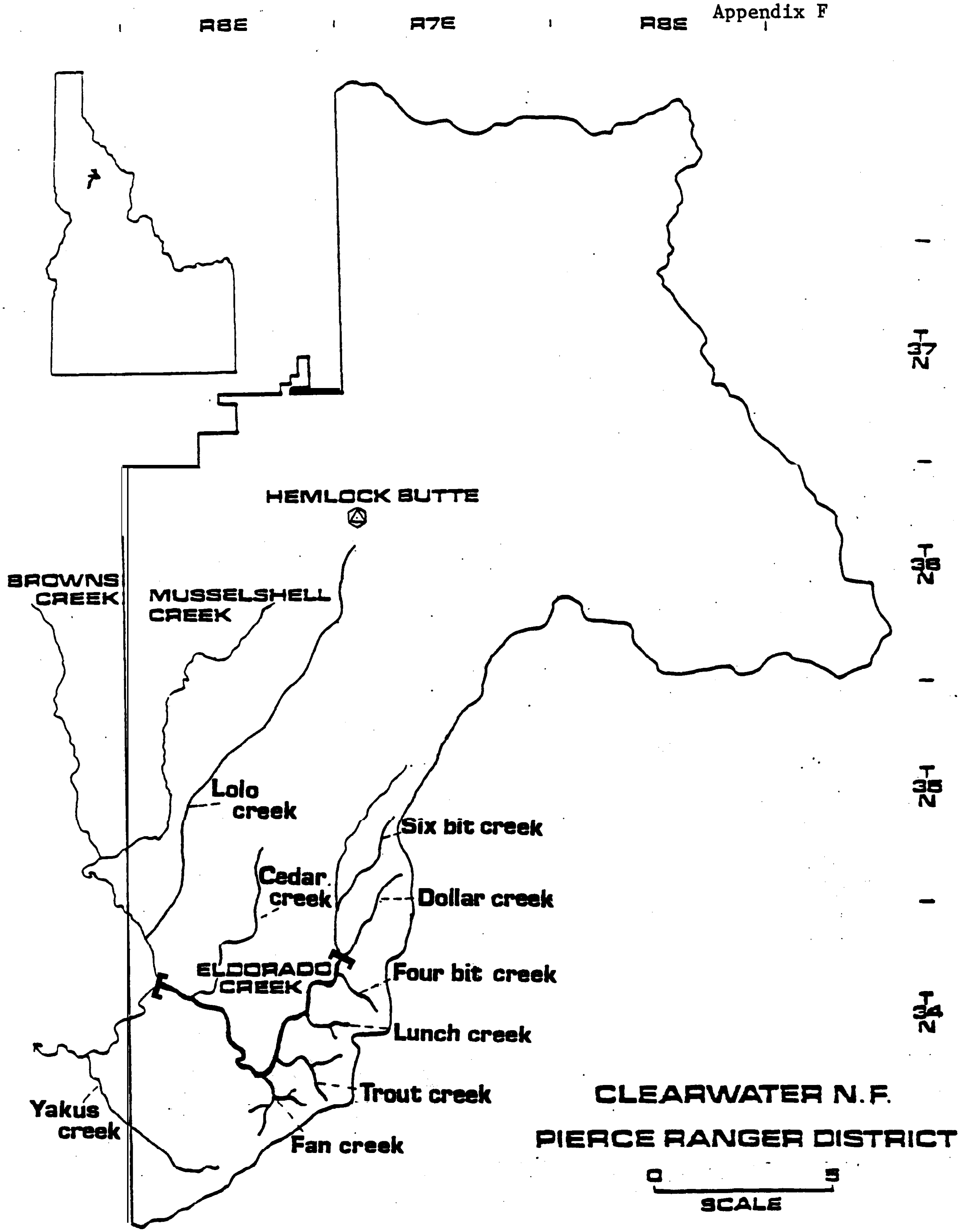
12 percent		$2,940
	TOTAL	$27,450*

* Year 1 of the project $12,360 (45%
Year 2 of the project $15,090 (55%)

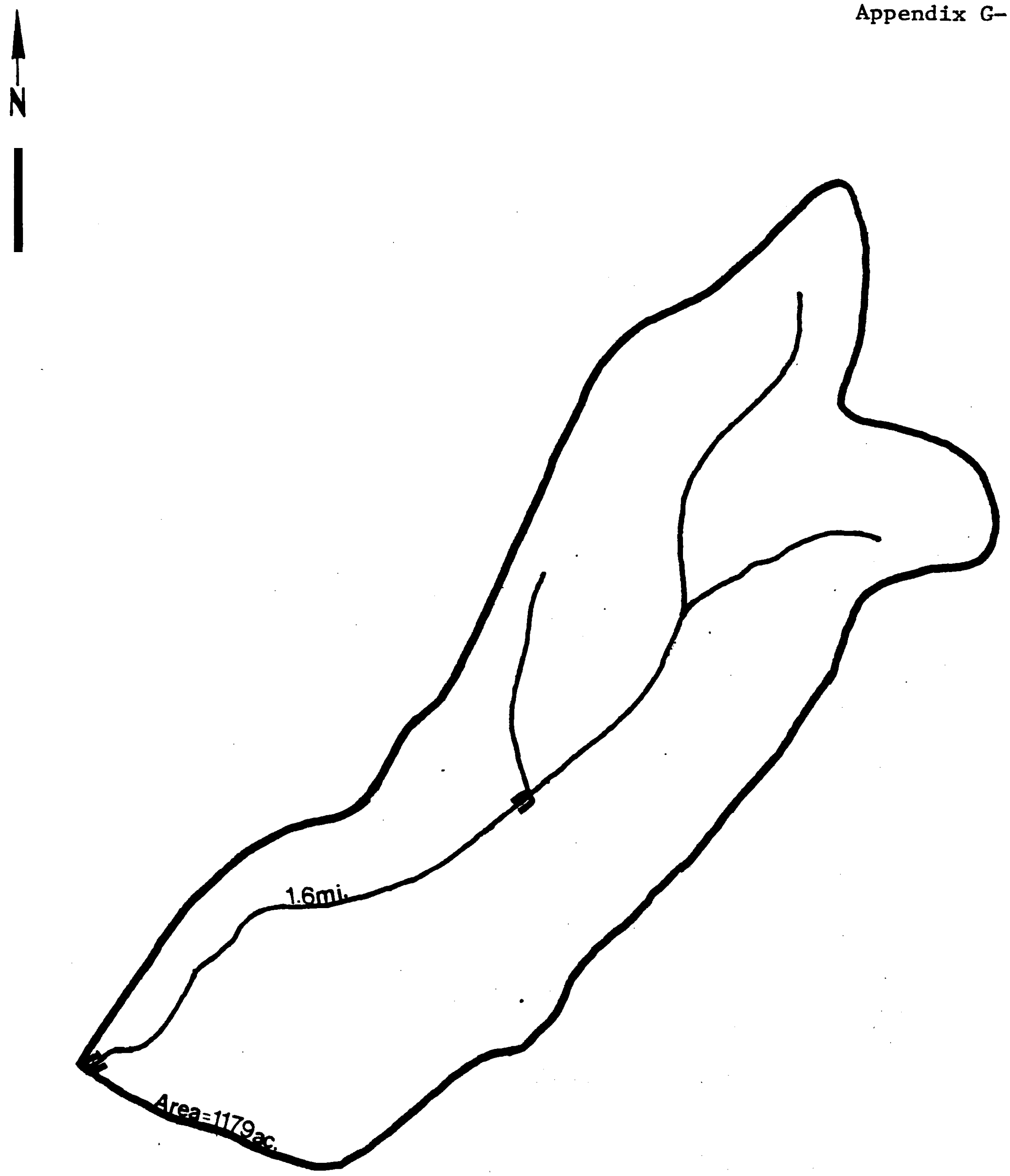

R3E
R8E
T 37 N
T 36 N
T 35 N
T 34 N
HEMLOCK BUTTE
BROWNS CREEK
MUSSELSHELL CREEK
UPPER LOLO
CAMP CREEK
YOOSA CREEK
LOLO CREEK
ELDORADO CREEK
YAKUS CREEK
CLEARWATER N.F.
PIERCE RANGER DISTRICT
ELDORADO CREEK PROJECT AREA
0
5
SCALE



PROPOSED BPA PROJECT MAP - ELDORADO CREEK



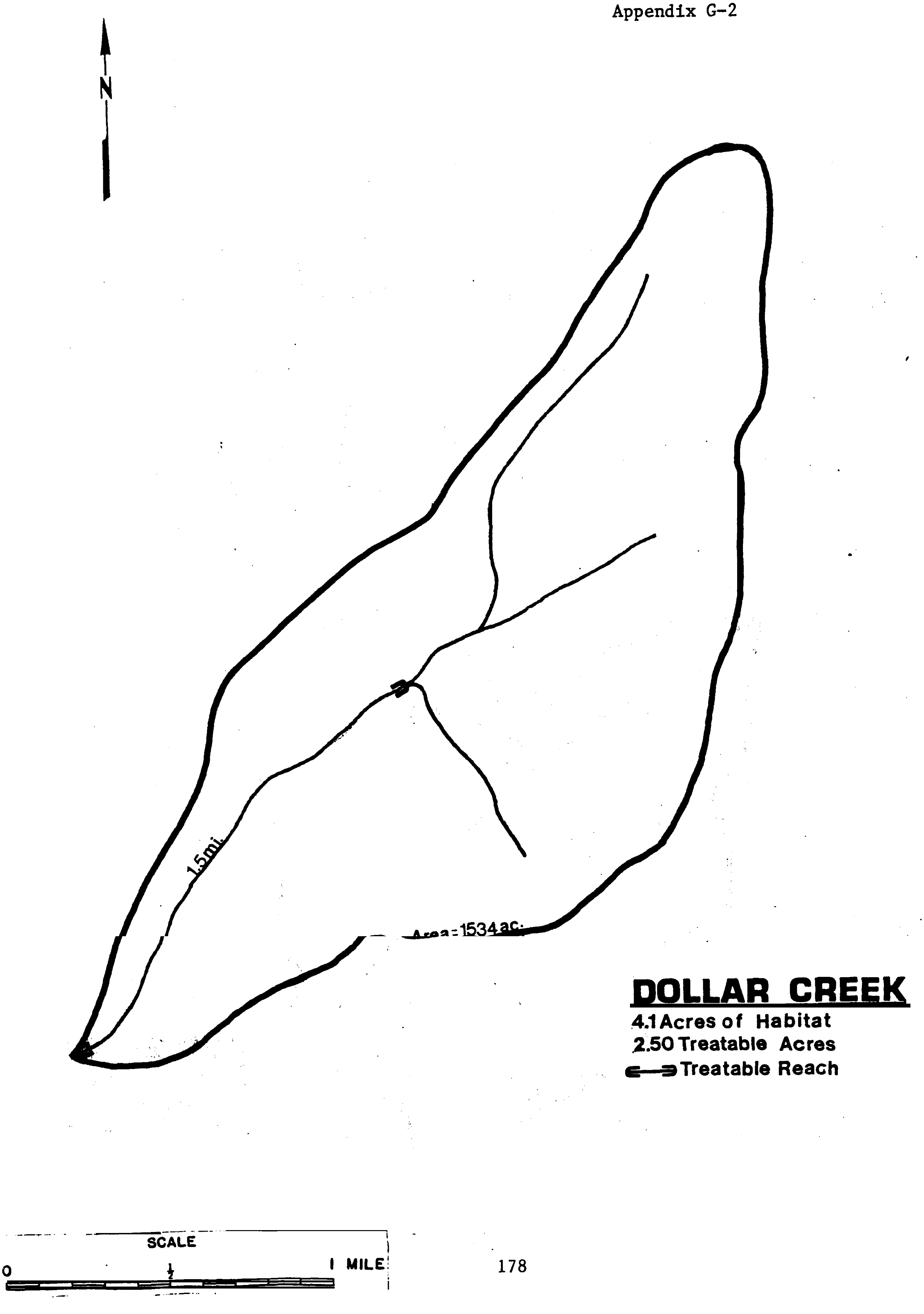
Eldorado Creek - Project Tributaries.



SIX·BIT CREEK

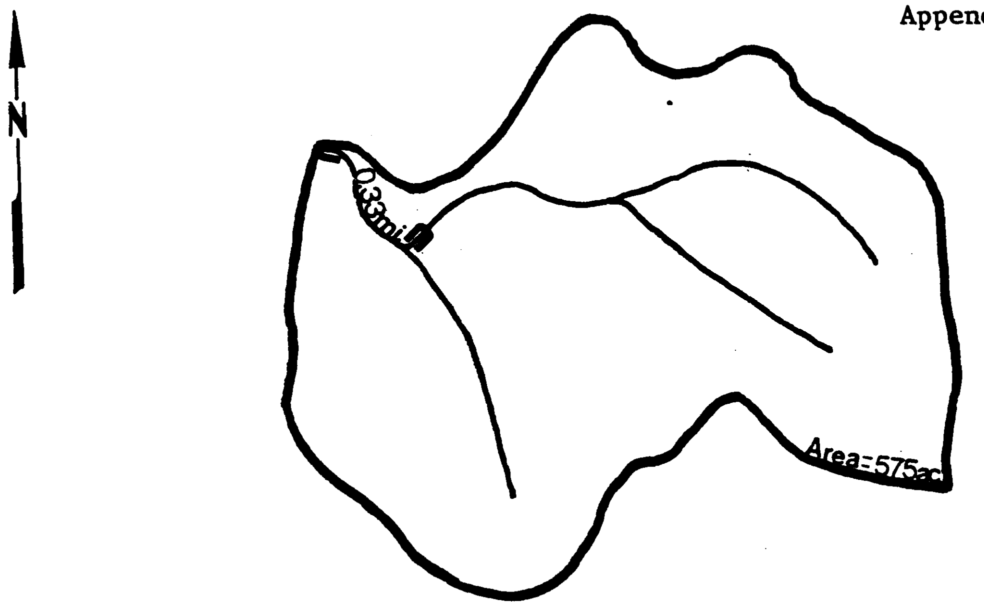
1.6 Acres of Habitat
0.80 Treatable Acres
Treatable Reach

SCALE
½
1 MILE



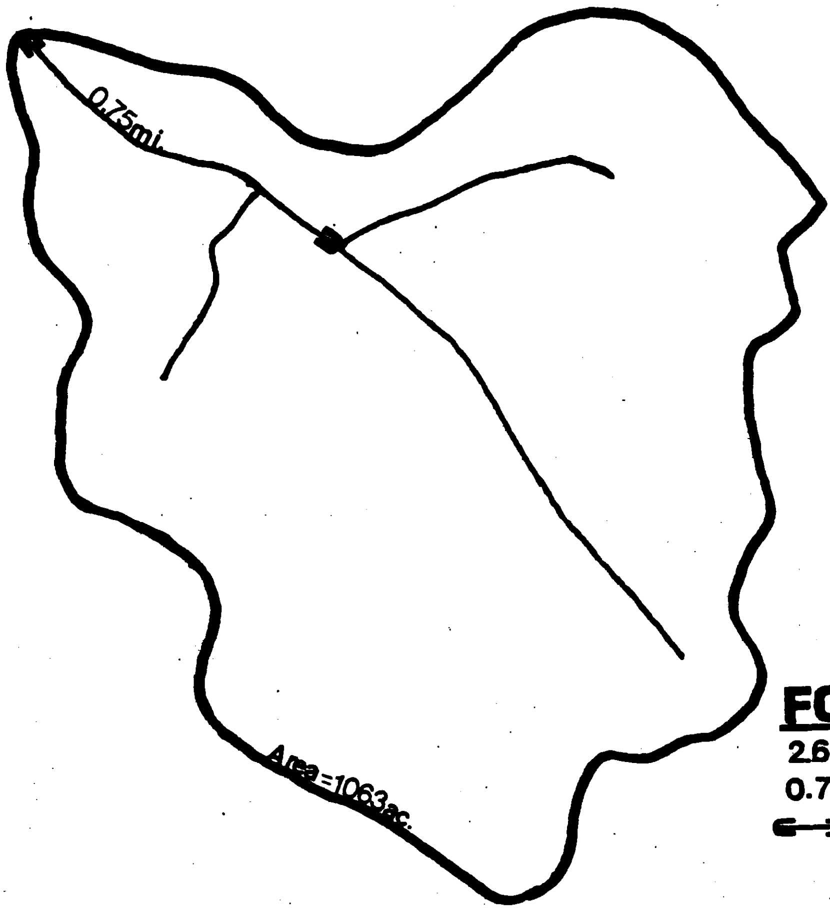
DOLLAR CREEK

4.1 Acres of Habitat
2.50 Treatable Acres
Treatable Reach



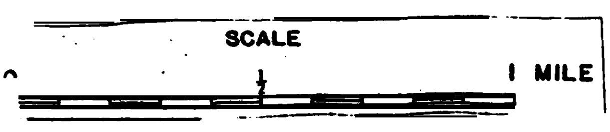
LUNCH CREEK

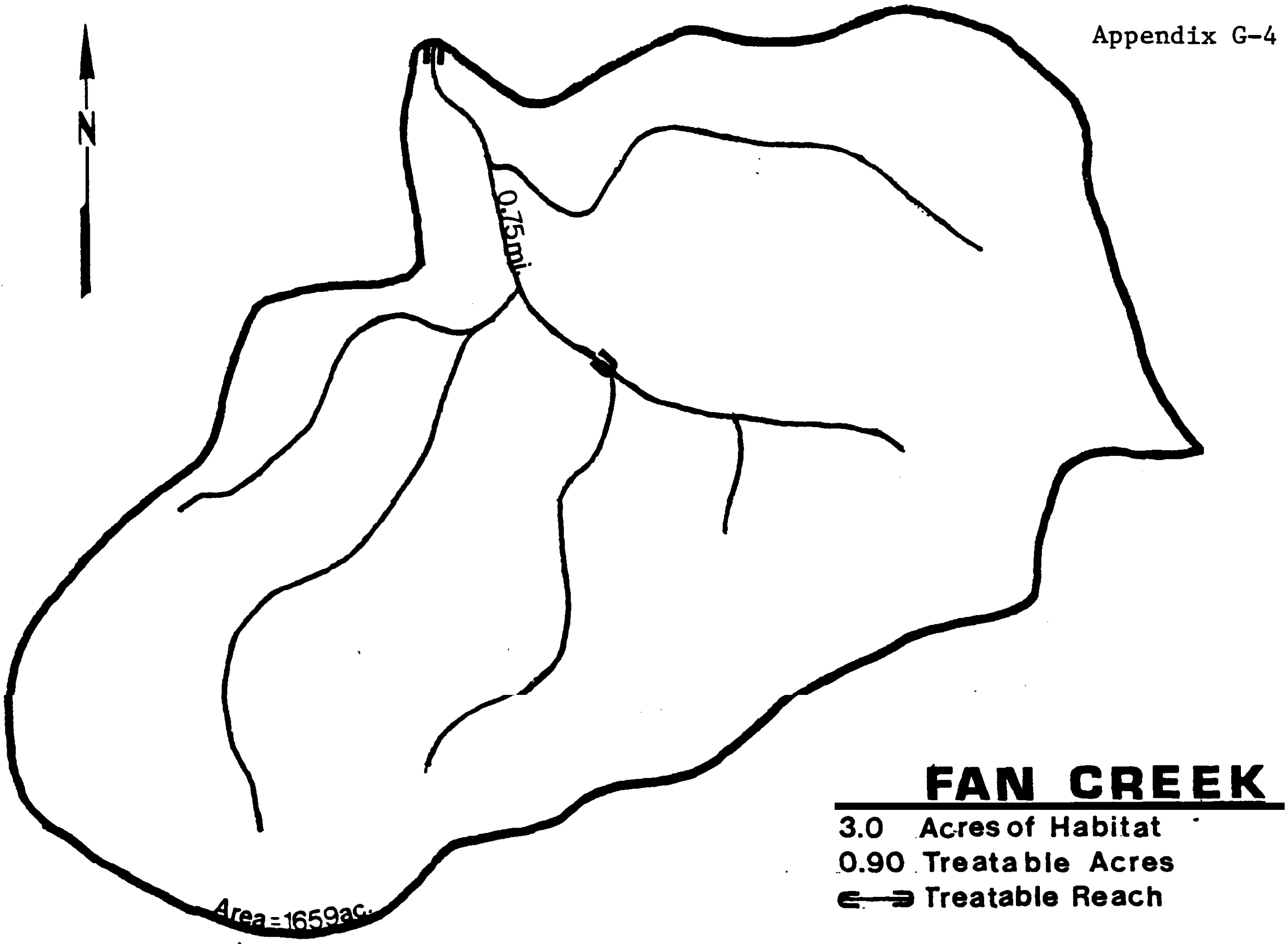
0.8 Acres of Habitat
0.26 Treatable Acres
⟵⟶ Treatable Reach



FOUR·BIT CREEK

2.6 Acres of Habitat
0.70 Treatable Acres
⟵⟶ Treatable Reach




N
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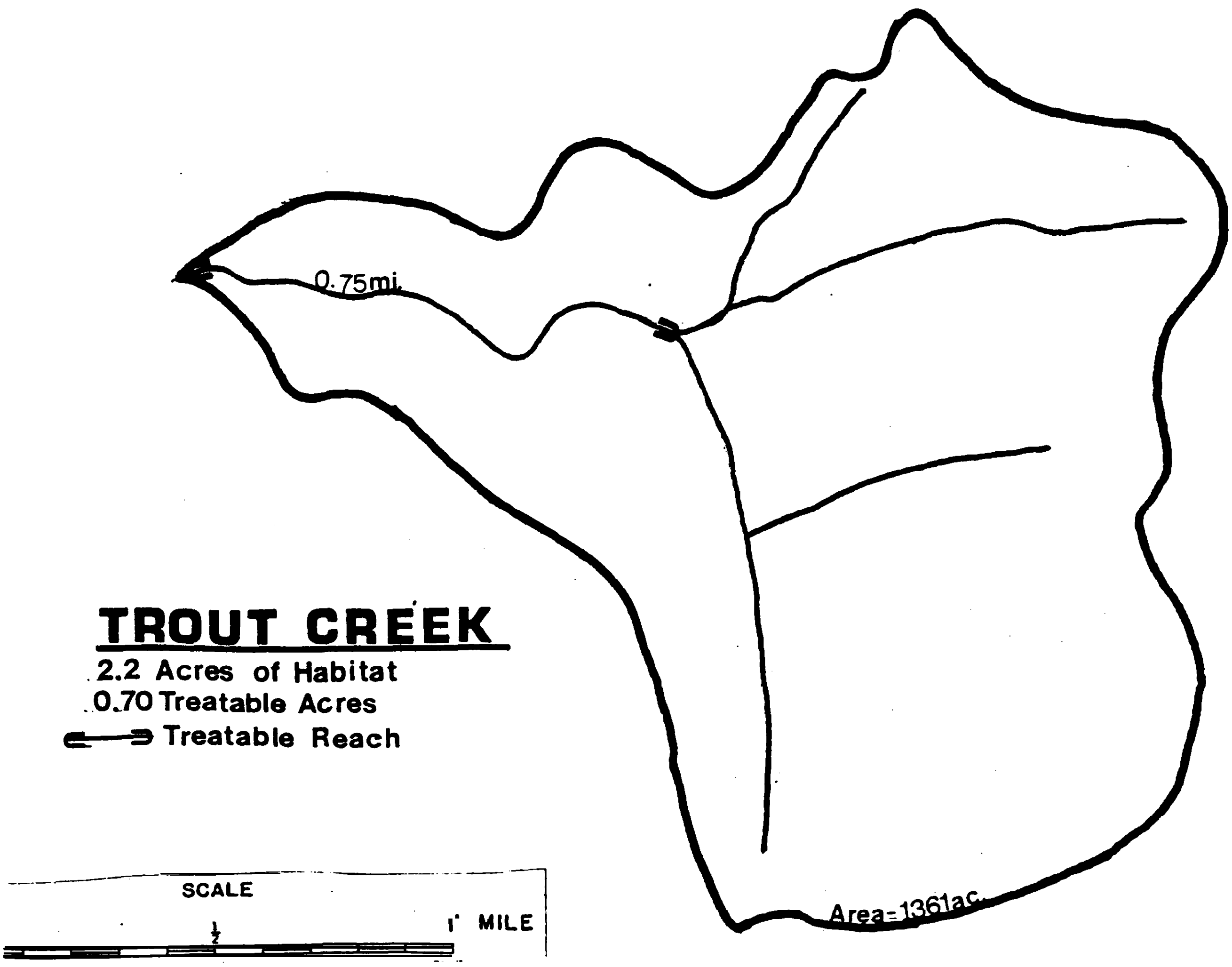
FAN CREEK
3.0 Acres of Habitat
0.90 Treatable Acres
Treatable Reach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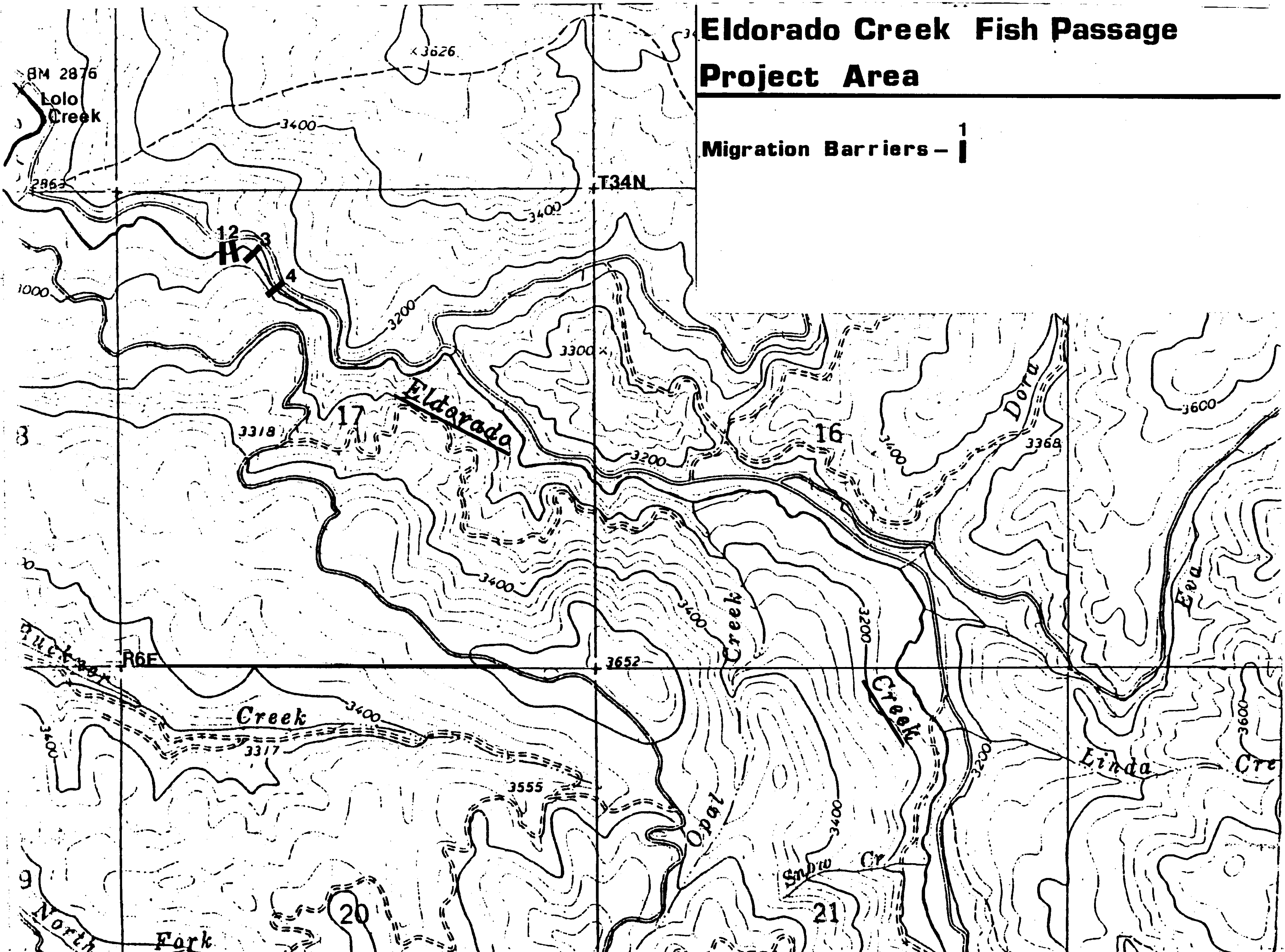
Area=1361ac.
TROUT CREEK
2.2 Acres of Habitat
0.70 Treatable Acres
Treatable Reach
SCALE
½
1' MILE


Eldorado Creek Fish Passage
Project Area
Migration Barriers – 1
BM 2876
Lolo Creek
2863
3626
3400
T34N
R6E
1 2
3
4
1000
3200
3300
Eldorado
17
16
8
3318
3368
3600
Dora
Eva
3652
Creek
Opal
Linda
Cre
Creek
3317
3555
9
20
21
Snow Cr.
North
Fork

APPENDIX I

Eldorado Creek

implementation of the Plan for Enhancement

of Key Anadromous Fish Habitat in the

Clearwater River Basin

FY 85

I. INTRODUCTION:

In 1985, the Pierce Ranger District, Clearwater National Forest, began implementation of the Eldorado Creek Anadromous Fish Habitat Enhancement Plan. Although the plan was not in "final" form, it was complete enough to provide guidance for habitat enhancement. Funding for the project was provided by the U. S. Forest Service through the "Anadromous Fish Habitat Initiative" passed by Congress in FY 85. A total of $26,000 was allocated by the Forest Supervisor's Office for implementation of Phase I of the plan.

II. TIMING AND ACTIVITIES:

Timing involved scheduling four major project activities: layout, gathering and localizing support materials, construction and mitigation. Project layout began in early June and ran through the first week in July. Activities associated with the phase include: locating sources of support materials, locating reaches, locating structure sites within reaches, and organizing the remainder of the project. During project layout we determined the decidious planting and pool enhancement in Reach C were a low priority. The remainder of July was spent gathering and localizing support materials. This phase involved mining and transporting boulders, up-rooting and hauling root wads and falling and limbing trees.

Construction of habitat enhancement structures began in August. Actual construction time was 12 days: 3 days of felling large organic debris and 9 days of constructing structures with the Cat 225 excavator (backhoe). Mitigation of impacts to local sites was carried out in late September. This work involved revegetating and erosion control of ingress, egress equipment access and structure sites. Field work involved: water barring, landscaping, seeding, and fertilizing each site. Root wads and large organic debris were also cabled at this time.

III. RESULTS:

A total of 179 structures were placed or constructed in Eldorado Creek in 1985. The 179 structures directly affect 4.4 miles of stream and extensively affect 6.6 miles of stream. Intensively the structures are spaced one structure per 135 feet and extensively the structures are spaced one structure every 196 feet (refer to map - last page). Table I displays the total number of structures by structure type.

TABLE I
Types of Structures

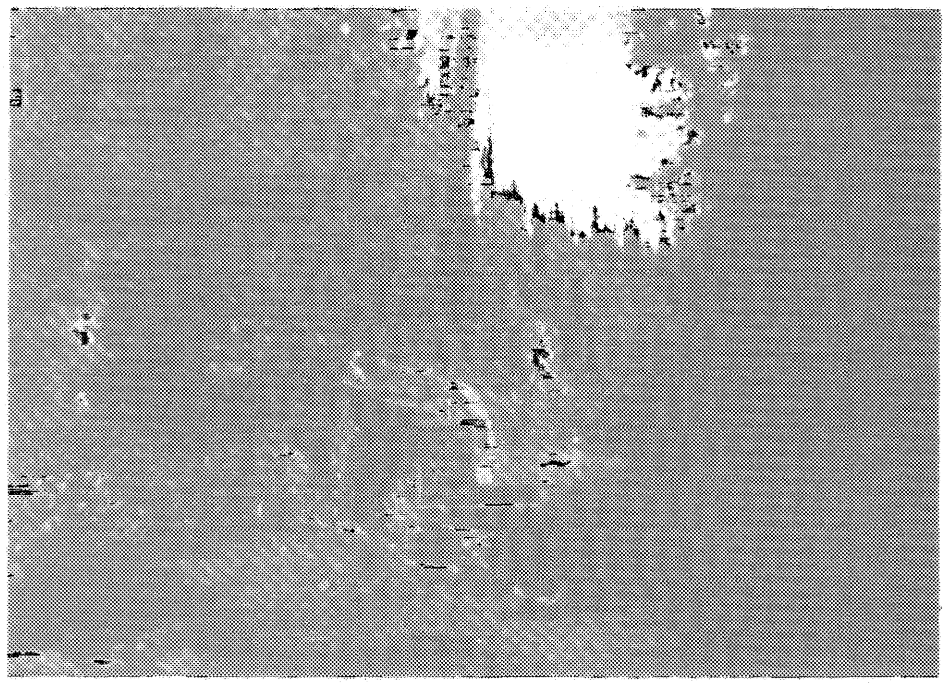
Structure Type	# Constructed
Root Wads	37
Boulder Weirs	12
Log Weirs	12
Large Organic Debris	55
Debris Jam Removal	2
Side Channels	2
Single Boulders	61
Total	179

A total of 8 structure and 6 large organic debris reaches were treated. Figures 1-6 show some of the construction techniques. Table II displays the structures types by reach.

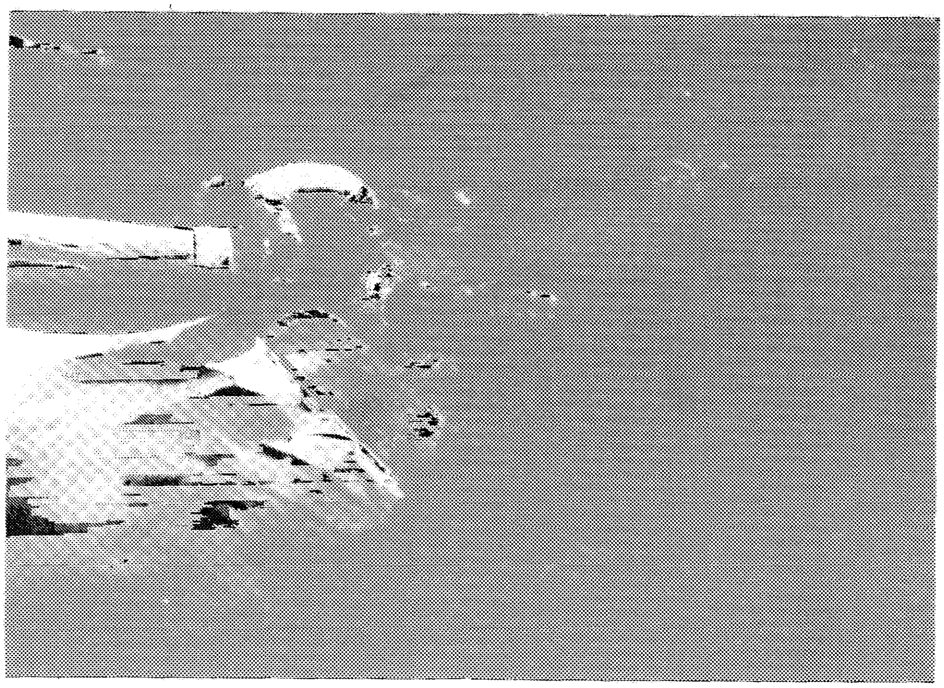
TABLE II
Structure Types by Reach

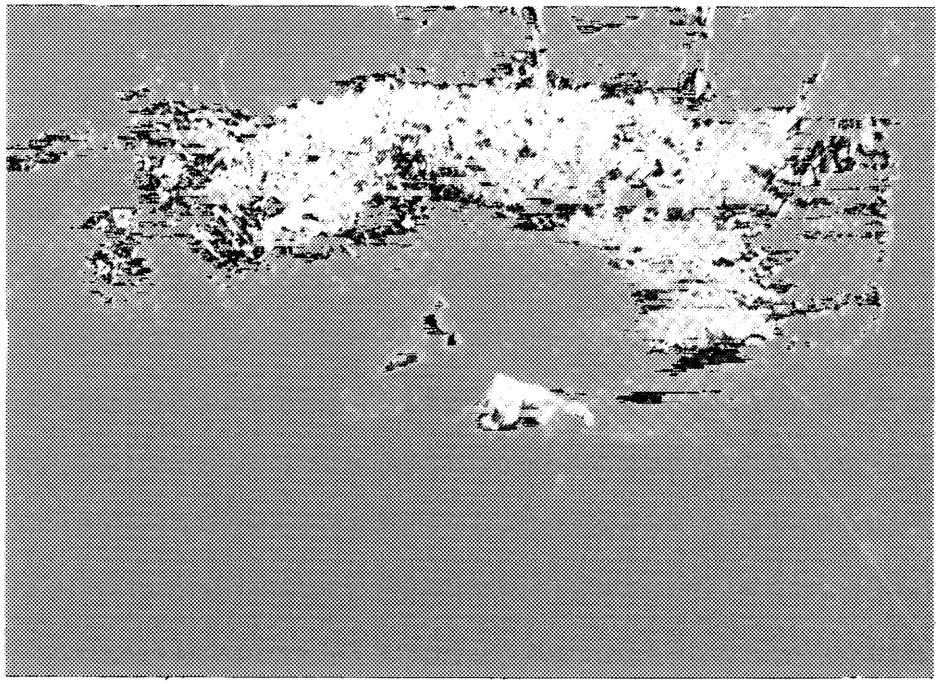
Reach	RW[1]	BW[2]	LW[3]	LOD[4]	DJ[5]	SC[6]	SBR[7]
R1[8]	2	1	1	-	-	-	-
R2	2	3	3	-	2	1	1
R3	8	2	2	2	-	-	-
R4	9	1	2	10	-	1	-
R5	2	1	1	2	-	-	1
R6	-	2	1	-	-	-	1
R7	12	-	2	3	-	-	2
R8	-	2	-	-	-	-	1
LD1[9]		-		17	-	-	-
LD2		-		6	-	-	-
LD3		-		3	-	-	-
LD4		-		3	-	-	-
LD5		-		3	-	-	-
LD6	-	-		5	-	-	-

1 RW = Root Wad
2 BW = Boulder Weir
3 LW = Log Weir
4 LOD = Large Organic Debris
5 DJ = Debris Jam
6 SC = Side Channel
7 SBR = Single Boulder Reaches
8 R1 = Reach One
9 LD1 = Large Organic Debris Reach One

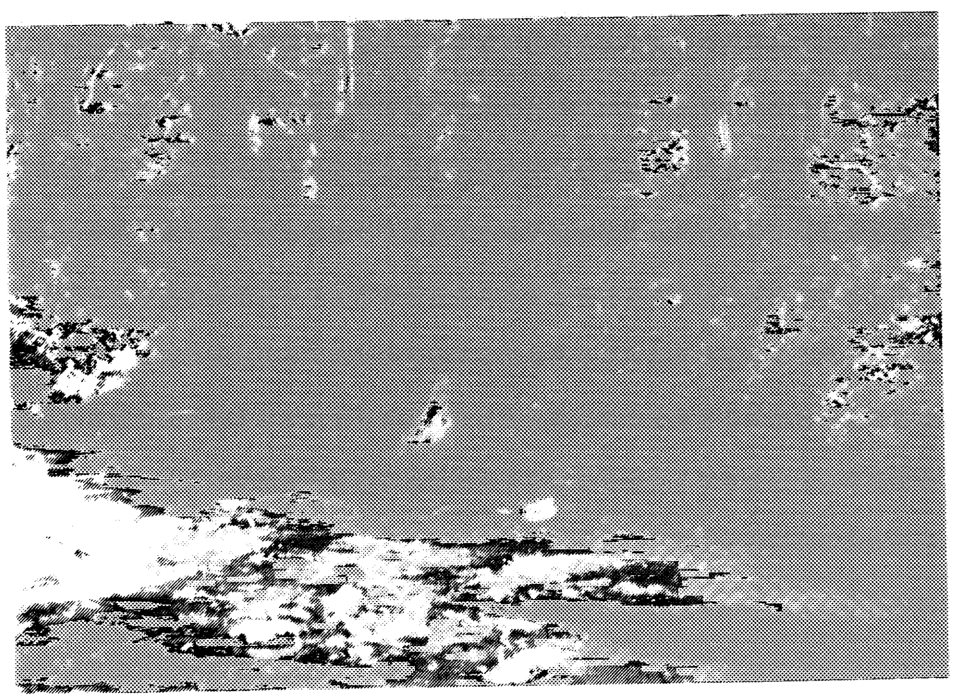


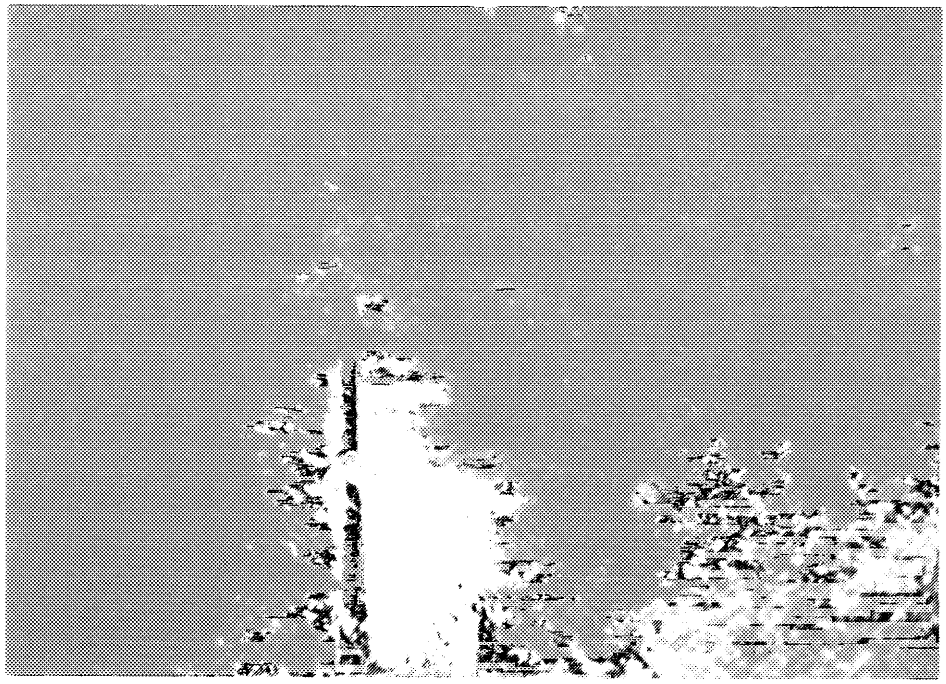
Figures 1 and 2. Upper photo shows backhoe constructing a small side channel. Lower photo shows 1985 crew constructing a log weir.



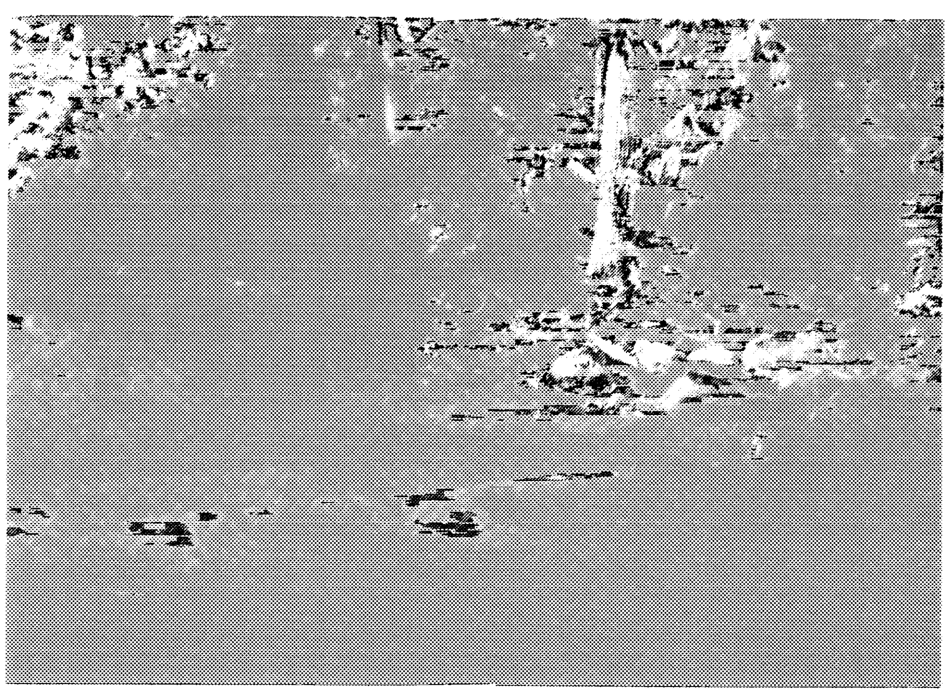


Figures 3 and 4. Upper photo shows a completed boulder weir, The lower photo shows a typical root wad,





Figures 5 and 6. Upper and lower photos show completed log weirs.

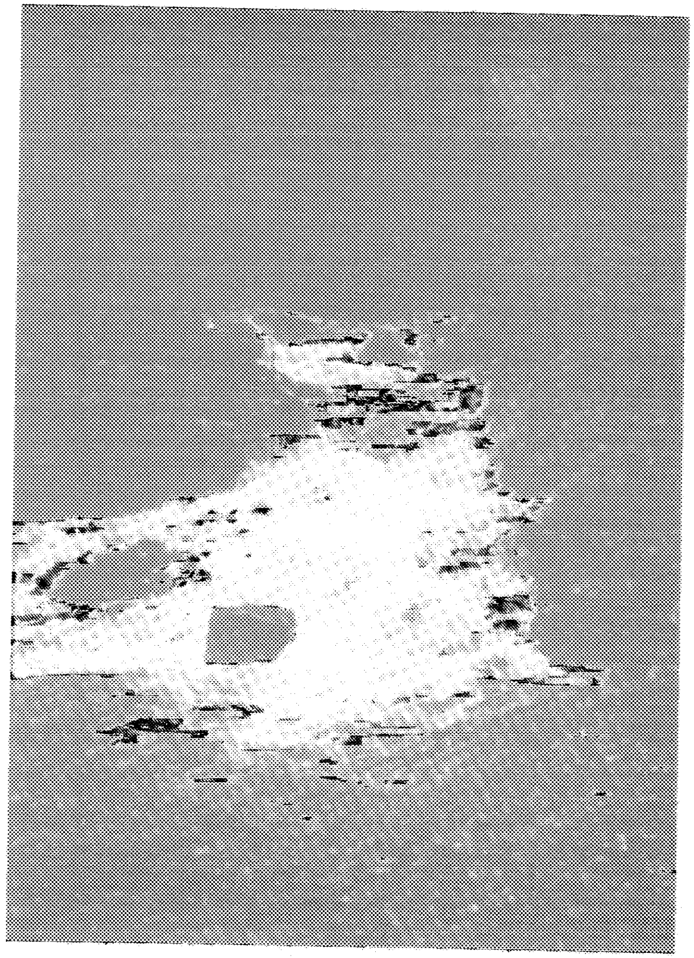


IV. SUMMARY:

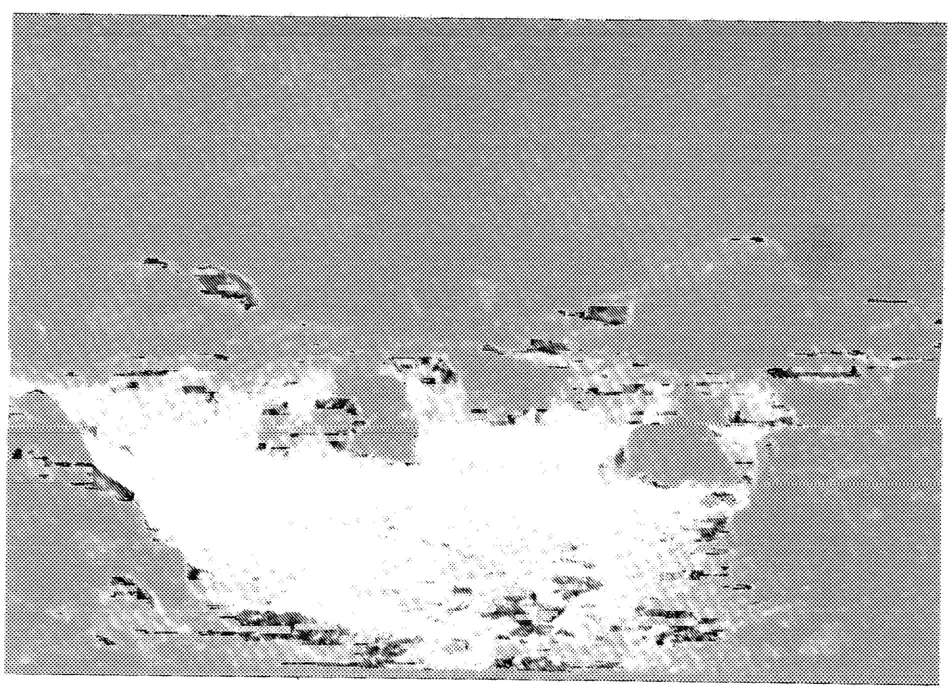
The overall objectives for restoring and maintaining an anadromous fishery in Eldorado Creek are nearly complete. These objectives include: habitat enhancement of main Eldorado Creek and selected tributaries, removal of four fish passage barriers, population augmentation of steelhead trout, and re-introduction of spring chinook salmon.

In 1985, three of these objectives were met. Habitat enhancement of mainstem Eldorado Creek was completed in the summer of 1985, at a cost of $26,000. The completed project resulted in the construction of 179 structures over 6.6 miles of Eldorado Creek. Also during the summer of 1985, all four migration barriers were successfully treated at a cost of $13,000 (refer to figures 7 and 9). In the spring of 1985, the U.S. Fish and Wildlife Service transported 1150 adult steelhead to Eldorado to seed all available spawning habitat. And in addition to the adult planting, 121,284 steelhead smolts were released 2 weeks later in Eldorado Creek (refer to figures 10 through 14). The existence of two age classes of steelhead in Eldorado Creek (reported by Stowell, pers comm, 1985) was confirmed (by Murphy and Espinosa, 1985) by snorkel diving.

Plans are currently being made to satisify the two remaining objectives for Eldorado Creek. The U.S. Forest Service will fund a 1986 project enhancing the habitat of the Eldorado Creek tributaries. Idaho Fish and Game currently plans to stock Rapid River spring chinook salmon in Eldorado Creek in the spring of 1986.



Figures 7 and 8. Upper and lower photos show the work at barrier site #3.



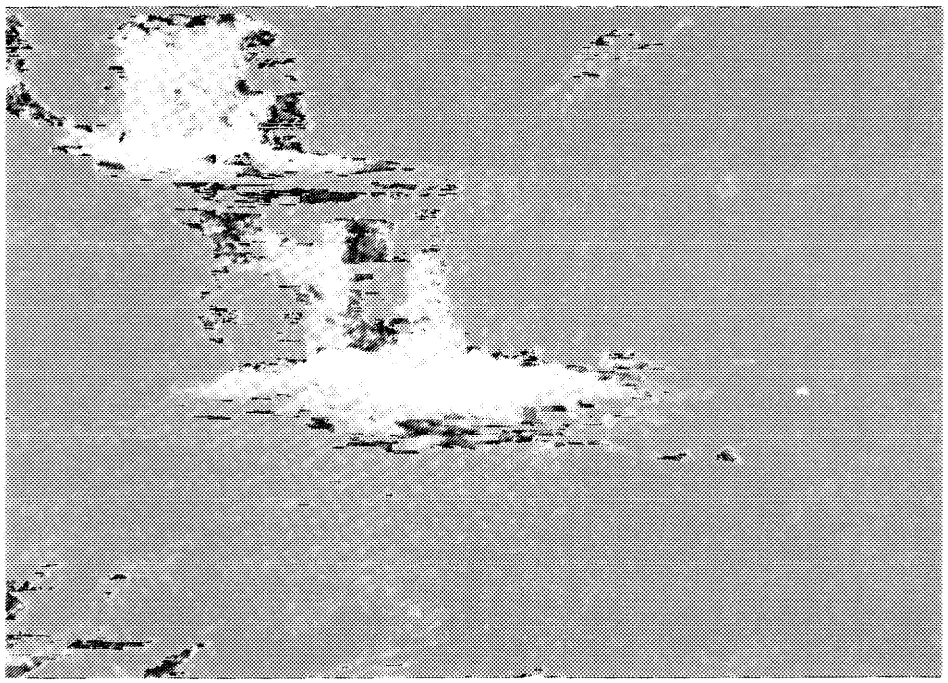
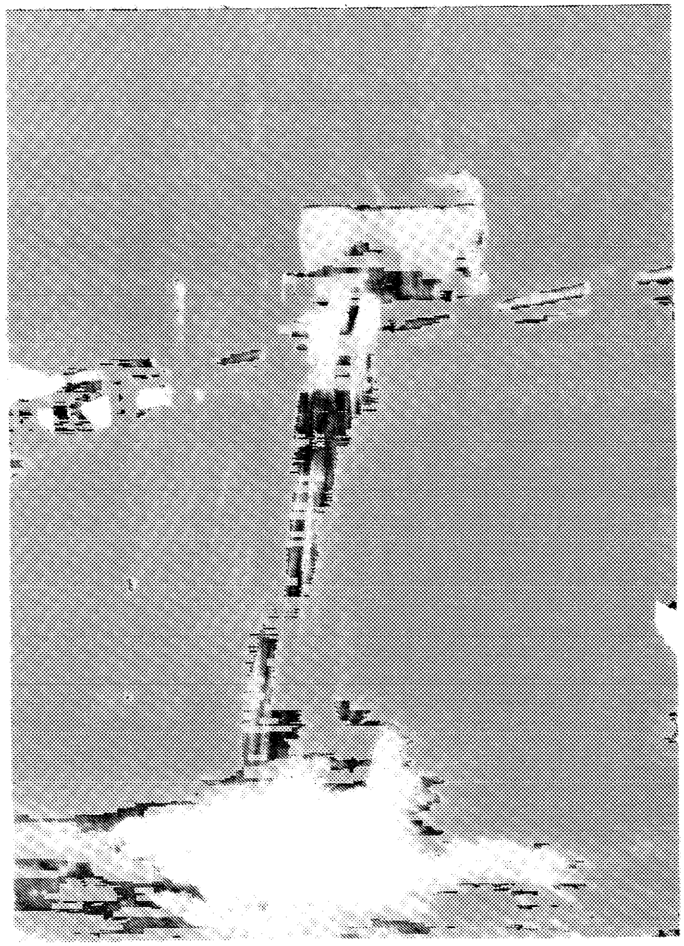
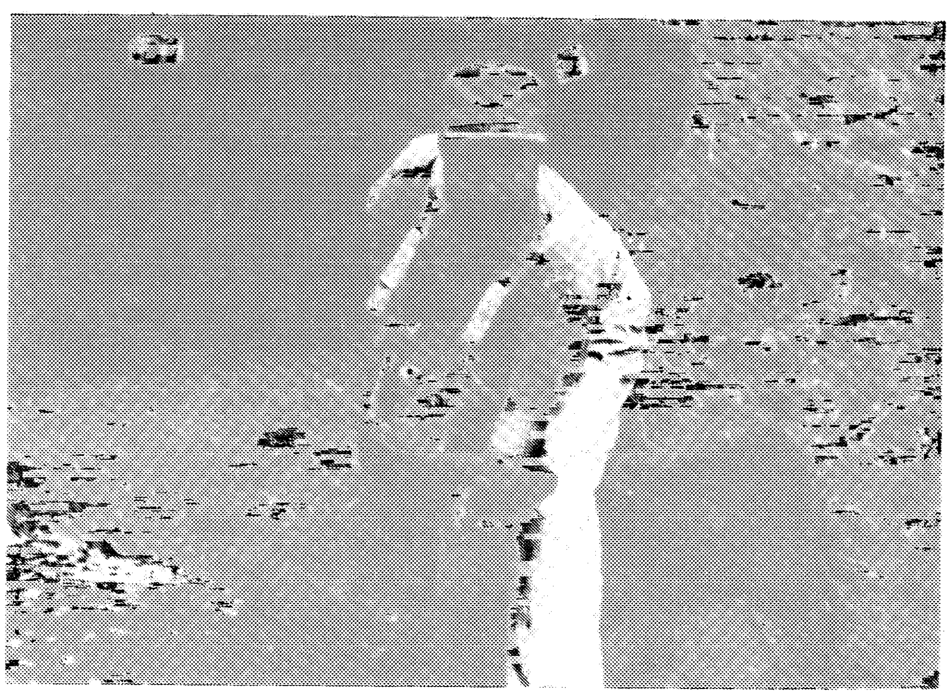
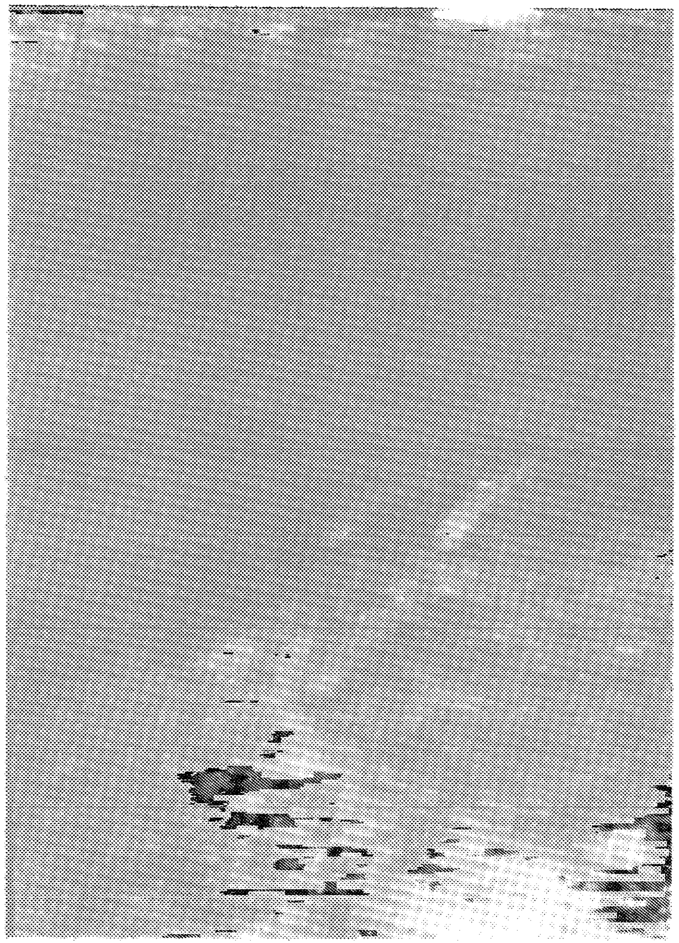


Figure 9. Photo shows barrier removal and pool construction at site #1.



Figures 10 and 11. Upper photo shows release of adult steelhead at Fan Creek Bridge, Eldorado Creek, spring 1985. Lower photo shows conservation officer with released steelhead.





Figures 12 and 13. Upper and lower photos show released adult steelhead in Eldorado Creek, spring 1985.

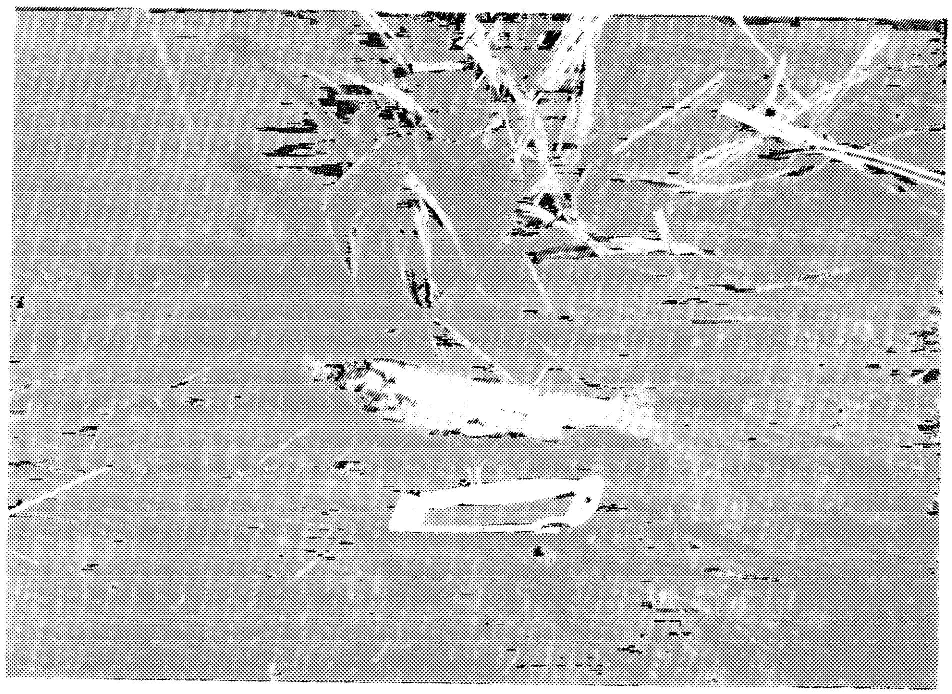


Figure 14. Photo shows one of the non-surviving smolts released in Eldorado Creek, spring 1985.

UPPER CROOKED FORK FISH BARRIER REMOVAL

Powell Ranger District
Clearwater National Forest
Region b

Columbia River Basin Fish and Wildlife Program
Northwest Power Planning Council
Northwest Power Act (P.L. 96-501)

by

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Funded by
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ABSTRACT

Crooked Fork Creek is one of the principal tributaries of the Lochsa River. It contains the bulk of the remaining high quality spawning and rearing habitats for anadromous fish on the Clearwater National Forest. It is estimated that 25 percent of the total chinook salmon and 25 percent of the total steelhead smolt production of the Clearwater National Forest emanate from this drainage. The long-term ability to restore anadromous fish runs to the upper Lochsa system is dependent upon increasing the available spawning habitat in the Crooked Fork drainage.

Stream and habitat surveys performed in 1983 on the Crooked Fork established that several natural waterfalls and rock chutes totally preclude upstream migration of spring chinook salmon during late summer flows. At some high flows summer steelhead are able to negotiate the barriers.

Seven major barriers and five partial barriers were drilled and blasted in the summer of 1984. Following evaluation in 1985, six of the major barriers and four of the partial barriers required additional work. Deep take-off pools, resting areas, and gentler gradients were created to increase fish passage. An additional barrier was identified on Hopeful Creek, a tributary of the Crooked Fork, and was removed.

INTRODUCTION

Crooked Fork Creek is one of the principal tributaries of the Lochsa River. It contains the bulk of the remaining high quality spawning and rearing habitats for anadromous fish on the Clearwater National Forest. It is estimated that 25 percent of the total spring chinook salmon and 25 percent of the total summer steelhead trout smolt production of the Clearwater National Forest emanate from this drainage. The long-term ability to restore anadromous runs to the upper Lochsa system is dependent upon increasing the available spawning habitat in the Crooked Fork Drainage.

During the summer of 1984 several natural waterfalls and rock chutes, previously identified as migration barriers, were drilled, loaded with explosives and detonated (Kramer et al., 1984). The sites were evaluated again during the summer of 1985 for additional modifications. Ten of the original eleven sites were still considered migration barriers and required further blasting.

A stream and habitat survey of Hopeful Creek, a major tributary of the Crooked Fork, identified a site as an upstream migration barrier at all flows. Removal of the barrier was begun in 1984 but early snows forced the postponement of its completion. In 1985, the debris jam was shot with explosives and the remainder of the debris removed by hand.

DESCRIPTION OF PROJECT AREA

Crooked Fork and White Sand Creeks reach confluence near Powell, Idaho (3,500 ft. elevation) to form the Lochsa River. Crooked Fork Creek is in fact a small river draining approximately 93,000 acres of the Bitterroot Mountains and covering some 24 miles.

The Crooked Fork drains a variety of landforms that include glacial valley trains, steep breaklands, colluvial drift slopes, and alluvial flood plains. Breaklands and alluvial plains dominate the watershed. Granite soils of the Idaho Batholith typify the geology of the area. The stream flows through dense, mixed coniferous stands of western red cedar, Douglas fir, Englemann spruce, white pine, ponderosa pine, and larch. A few deciduous species are present within the riparian zone.

The Crooked Fork has experienced extensive timber harvesting and road construction for the past two decades. Most of this activity has been concentrated in its lower reaches and in the Brushy Fork subdrainage. Impacts associated with sedimentation and over-harvesting in the riparian zones have been moderate. The upper reaches of the Crooked Fork are lightly developed and are in pristine condition.

The Crooked Fork watershed is under management of mixed ownership; the U.S. Forest Service and Plum Creek Timber Company. Crooked Fork is characterized by a checkerboard pattern with Plum Creek owning some 34,000 acres (23%).

The project area is located approximately two miles upstream from the confluence of Boulder Creek, T.38 N., R.14 E., sec. 14 (see Figs. 1 & 2). The area is accessible only by foot or helicopter. Within the project area, Crooked Fork displays a mean discharge of 221 c.f.s. during steelhead spawning (April and May) and 37 c.f.s. during the salmon spawning period (July 15 - Sept. 15). Crooked Fork shows a mean stream width and depth of 26 feet and 0.7 feet respectively (base flows). Within the project area, the creek had a mean gradient of 3.7 percent with a range of 2.0 percent to 6.2 percent.

The stream substrate within the project area consists of larger materials (Bedrock 21%, Boulder 26%, Rubble 41%). Above the project area, Crooked Fork displays a lower gradient and smaller substrate materials which provide good spawning areas. Most of the Crooked Fork barriers consist of long 15 to 30 foot, steeply inclined, granite rock aprons that contain no jump pools or resting areas. At low flows, only a thin layer of water flows over the aprons. Extensive rearing areas for juvenile salmon and steelhead exist above the barriers. Provision of access will open up 16 miles consisting of 78 acres of rearing and 0.93 acres of spawning habitats for anadromous fish. Assuming the availability of seeding stock or increased escapement to the upper Lochsa area, the project would increase the system's smolt production by 27,000 salmon and 27,150 steelhead.

Hopeful Creek is a 4th order stream that flows into the Crooked Fork at "Boogie Down Flats" (T. 39 N, R. 14 E, Sec. 3). At the confluence with the Crooked Fork, Hopeful Creek has a slightly larger drainage area than the Crooked Fork and is capable of supporting steelhead trout and chinook salmon. Except near the mouth where Road 595 and an outfitter's camp are located and near the upper reaches where a pack trail intersects the stream, the area remains unimpacted. The area burned in 1910 and is now stocked primarily with lodgepole and spruce.

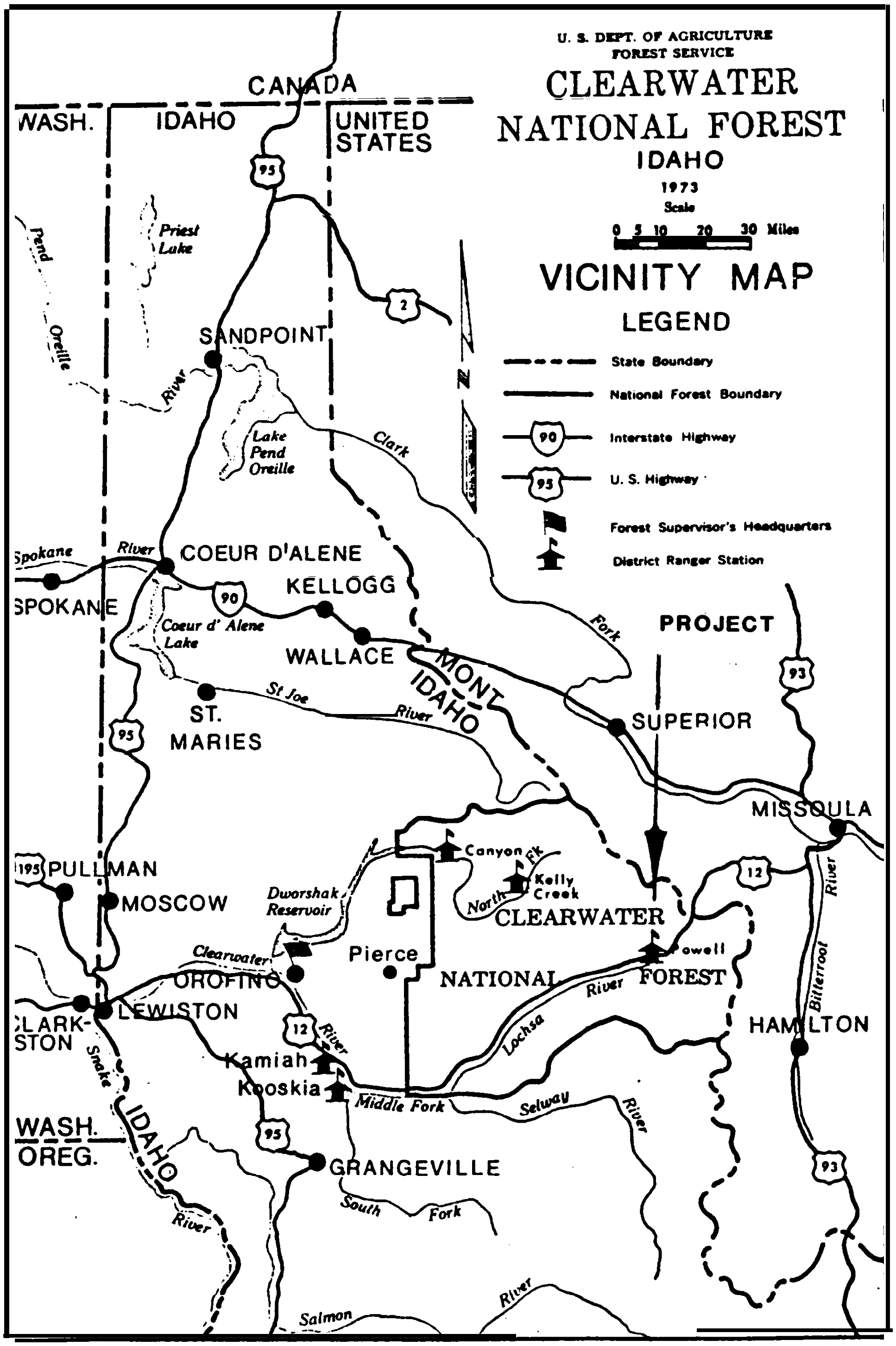

Figure 1. Vicinity Map.

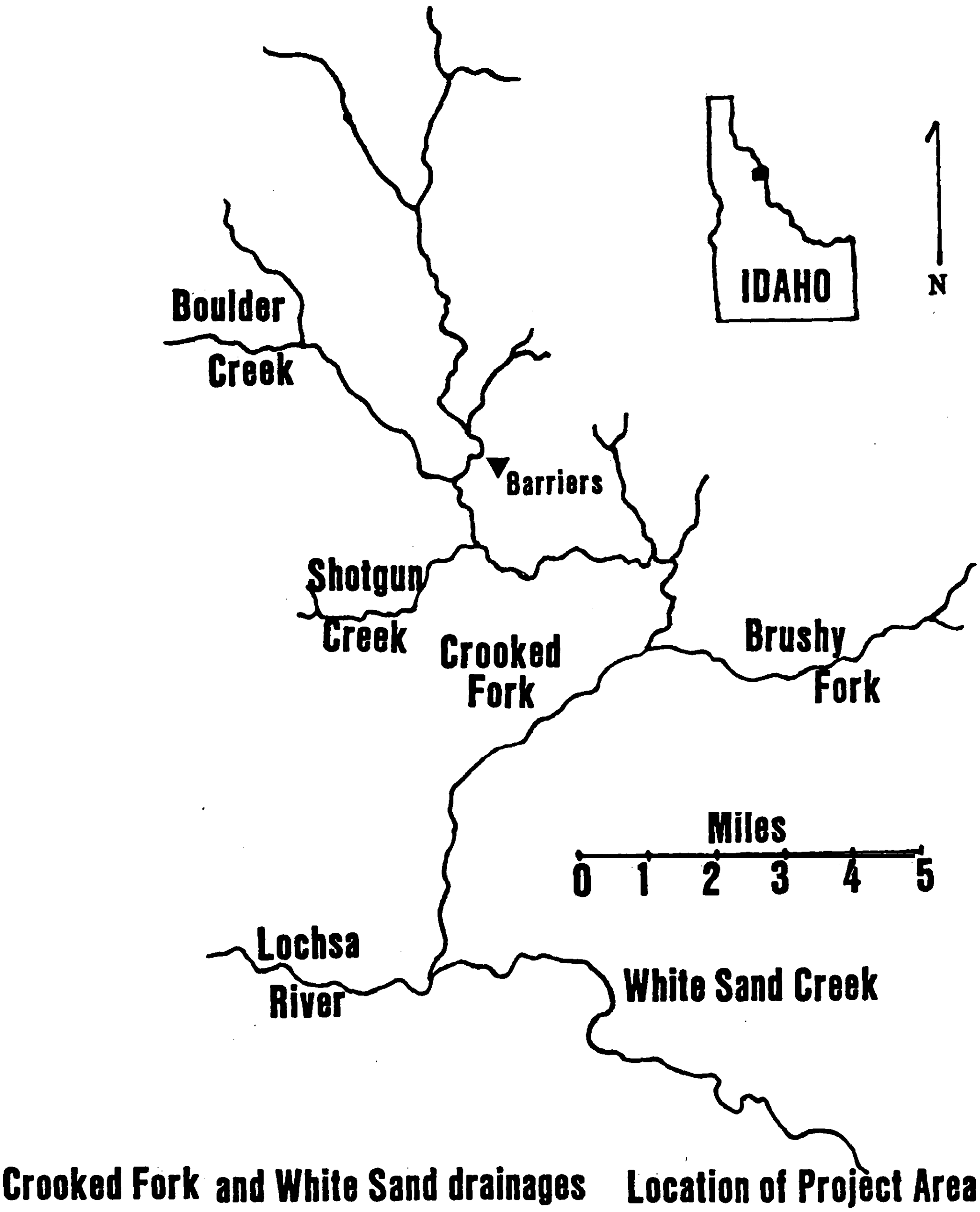

Figure 2. Project area map.

The project area is approximately one mile upstream from the mouth of the creek (Fig. 2). The barrier was composed of several large bedrock protrusions which trapped logs and created a debris jam that was 15 feet high, approximately 18 feet wide and stable with a large accumulation of sediment trapped above it. Based on the size of the material in the jam (greater than 18"dbh) and the amount of gravel trapped behind it, this barrier has been in place for a number of years. The 1910 fire completely removed the existing stands and the replacement stand consists of 70 year old lodgepole that is less than 12" dbh. Bank cover and stability in the project area are good and the mean gradient equals 2.4%. Removal of the barrier will make available 182 square yards of anadromous spawning gravel and 146 square yards of resident spawning gravel.

METHODS AND MATERIALS

Work was begun on Hopeful Creek in July. In late July the Crooked Fork project was evaluated to determine the success of blasting in 1984; modifications and placement of drill holes were discussed and ten of the original eleven sites were found to require additional work. Equipment and personnel were flown into the helispot. Part of the crew hiked in approximately one mile from the Crooked Fork Road (595), clearing the trail enroute to assure better access to the campsite over the duration of the project. Camp was set up and drilling began in the afternoon on site #3A. Drilling, blasting and redrilling continued throughout the month of August. Jack Orsborn, P.E., surveyed the project area to determine success of the modifications made and recommended further changes for optimal fish passage (see Appendices B and C). After blasting, the sites were re-evaluated and all migration barriers were considered passable. Data on the sites was gathered and the camp dismantled. The project was completed with the burning of the debris piles on Hopeful Creek in late October.

The Pionjar and other equipment were taken to the stream sites via backpack. Since there were no trails along the stream, all materials had to be transported from site to site by walking in the stream. This was difficult due to the weight of the packs, slippery walking surfaces, and debris. The Pionjar pack weighed aproximately 65 pounds, the weight of the other packs varied but averaged about 50 pounds. Aluminum "freighter" packs were modified: a piece of 1/4" plywood was cut to fit the back and bottom of the pack and holes drilled at regular intervals along the border to allow them to be laced onto the pack frames. The bottom piece had a 5" round hole cut in it through which the Pionjar chuck was placed. The freighter pack used for carrying bits, cheater bars, tools and explosives had a solid piece on the bottom. The backpack strapping and elastic cords were used to secure the cargo. The addition of plywood made for a more stable load.

Drilling was performed by a three person crew using a Pionjar 120 rock drill and "star" drill bits ranging in length from 1 1/2 feet to 4 feet (Fig. 3). Blasting holes were drilled into the bedrock at predetermined locations. After a site for a hole was identified the drill was "set" by two people, one person holding the pionjar, the other steadying it and both bracing the bit against the rock with their feet to prevent it from slipping down the face of the bedrock. On dry bedrock with an uneven face, one person could usually set the

Figure 3. Removing the Pionjar from a 1 1/2 foot long bit.

drill by themself. Once the drill was set, one person could run the Pionjar by steadying the drill, adjusting the needle valve and occasionally lifting the drill bit out of the hole to prevent sticking. Earplugs were required while running the drill to prevent loss of hearing.

The drill bit became imbedded periodically due to rock dust and chips bashing back into the hole and pinching the bit extension. This was especially common in fractured rock, previously blasted areas, or areas where there was not enough water flowing over the hole to wash out particulate rock. Partially dry rock powder had a tendency to form a cement-like mixture which would plug exhaust holes and result in "frozen" bits. A variety of methods were used to remove stuck bits such as up and down jarring, side to side twisting, and allowing the drill to vibrate while in the breaking gear. As a last resort, two large crescent wrenchs and cheater bars were used to twist the bit loose. Care had to be taken to avoid unscrewing the bit from the rod (reverse threads) . In some cases the extension had to be unscrewed from the bit, leaving the bit in the hole and at times the bit and extension could not be removed at all. An attempt was made to remove imbedded bits by blasting but this usually resulted in bent rods at the expenditure of much time and resources.

To avoid getting the bit stuck the following measures were taken: lifting, it up and down periodically while drilling in order to clean the exhaust hole, making sure that the hole for exhausting dust was clear on both the bit and extension. When drilling above the water's surface, the addition of water to the hole was avoided to prevent "cementing" of the exhaust hole. On the Crooked Fork project the four foot bit stuck frequently, usually due to rock chips washint, back into the drill hole and pinching the bar. Two bits remained stuck beyond all efforts to remove them - one remained imbedded even after blasting.

In the normal course of drilling, holes here begun with the shortest bit possible to use. Usually this is determined by the depth of the water. The bit was used until water came up to the casing of the Pionjar and then it was changed to a longer bit (Fig. 4). Once the desired depth was reached, an aider branch or some sturdy , visible marker was placed in the hole to help locate it later when settin;: the charges (Fig. 5).

On the Crooked Fork, blasting holes were drilled into the bedrock at predetermined locations. An average of six feet per hour were drilled and nine feet per tank of gas. Removable star bits were found to drill faster than the single point bit. However, special sharpening techniques required that they be sent away for resharpening while the single point bit could be sharpened on a hand Grinder. Generally, the star bits would drill approximately 40 feet before they needed resharpening After cleaning rock debris from the blast area, ail sites were re-evaluated and many were drilled and blasted again.

Removing the bit from the extension was difficult due to the continual tightening by the drill, the impregnated rock dust, and the loss of protect the grease as it was used under water. After several attempts it was determined that the easiest way to remove the bit from the extension was to canti the bit over a rock, hold the extension to the ground with a crescent wrench, tightly grasp the bit with a pipe wrench over which a cheater bar has been

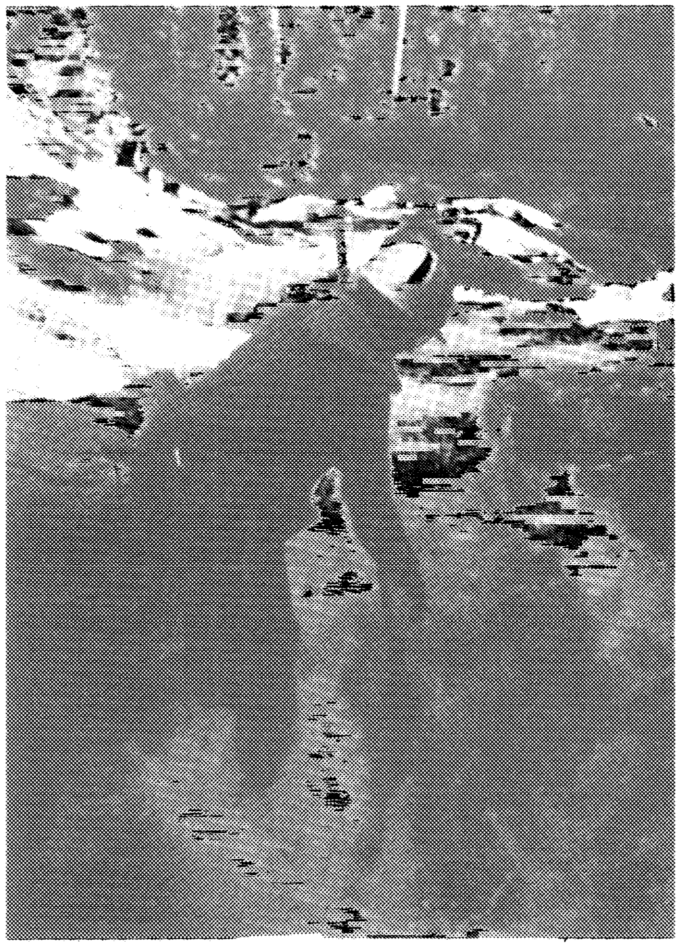

Figure 4. A crew member exchanges drill bits.

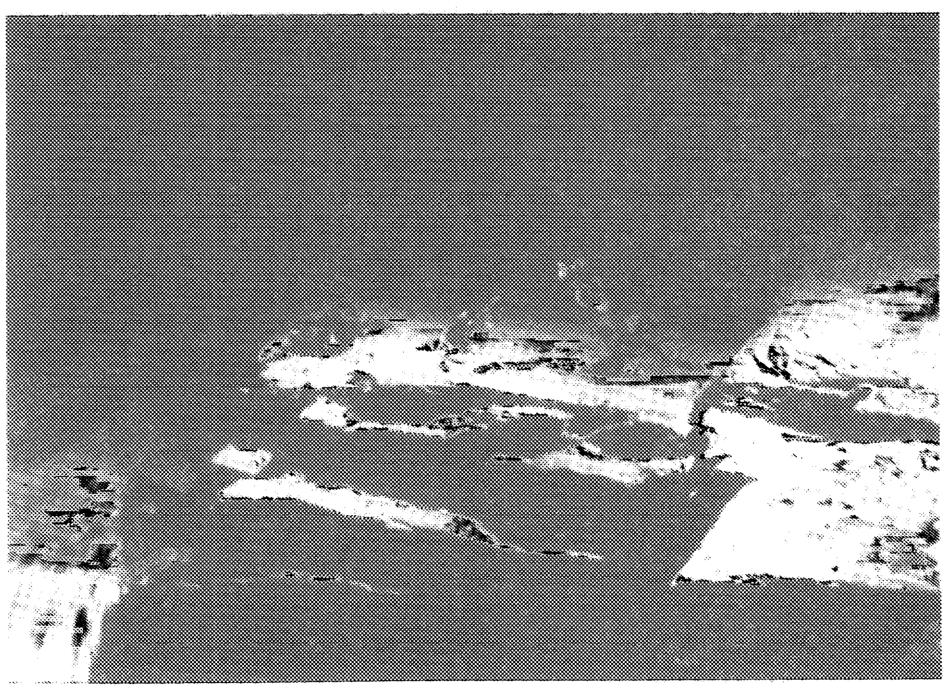

Figure 5. . der branches marking the drill holes.

placed and, with a small sledge hammer, hit the cheater bar to loosen the bit. When replacing the bit, clean the threads of the extension and the bit, grease the bit with a heavy grease, and screw the bit onto the extension. It is not necessary to get this more than finger tight as using the drill will tighten it.

A minimum of two people were utilized while drilling as a preventive safety measure. Sharing the load of heavy equipment while packing it to the stream site, lending support while working with the drill on slick or uneven surfaces (Fig. 6), and generally being aware of the other crew members condition and whereabouts resulted in very few accidents under highly hazardous conditions. Other safety measures taken on the Crooked Fork project included: use of hard hats, gloves, earplugs, chaps and safety goggles (when using the chainsaw), checking the footing in an area prior to working on it, felt soles on waders, walking sticks (while traversing the stream), staying close together while hiking in the stream and an attitude of overall caution.

Blasting was achieved by using water gel, primacord and blasting caps. A certified Forest Service blaster loaded, set up and shot the drill holes. Assistance was given to the blaster by the crew while loading the holes. No two way radios were used near blasting equipment to prevent accidentally setting off the blasting caps. When the holes were loaded the crew departed while the blaster attached the blasting caps. At least one person was stationed a minimum of 500 feet in straight line distance upstream and one downstream from the blasting site to warn any people in the area and for personal safety. Once a safe distance was reached, crew members turned to face the blast site and watch for flying debris (Fig. 7). In the event no blast was heard, crew members were to remain 500 feet from the blast site while the blaster investigated the problem.

After blasting, crew members hand picked boulders and rock fragments out of the pools (Fig. 8). Chest waders, rain gear, shoulder length rubber gloves, and wet suits were used to protect the crew from the cold and deep water. The debris was either placed on shore, pushed downstream, or blasted again to make it small enough to move. Natural scouring in the spring will eventually dislodge any remaining materials.

After the sites were re-evaluated and the blasting determined to be complete, data was gathered on the sites. A Lietz BT Series Optical Plummet Transit was used to gater data on depth of pools and runs, height of jumps, and distance covered. The most logical migration route was determined and a series of measurements were made for a profile. All measurements were taken at low flows. The sites will be significantly different during migration of steelhead trout in high spring flows but gradients, height of jump and depth of pools have been significantly improved so that passage for steelhead trout should present no problems. Side channels that are not available to chinook salmon due to low flows will be available for steelhead during high water.

During the project, before and after shots were taken of each barrier. Additional photos showing crews working were also taken.

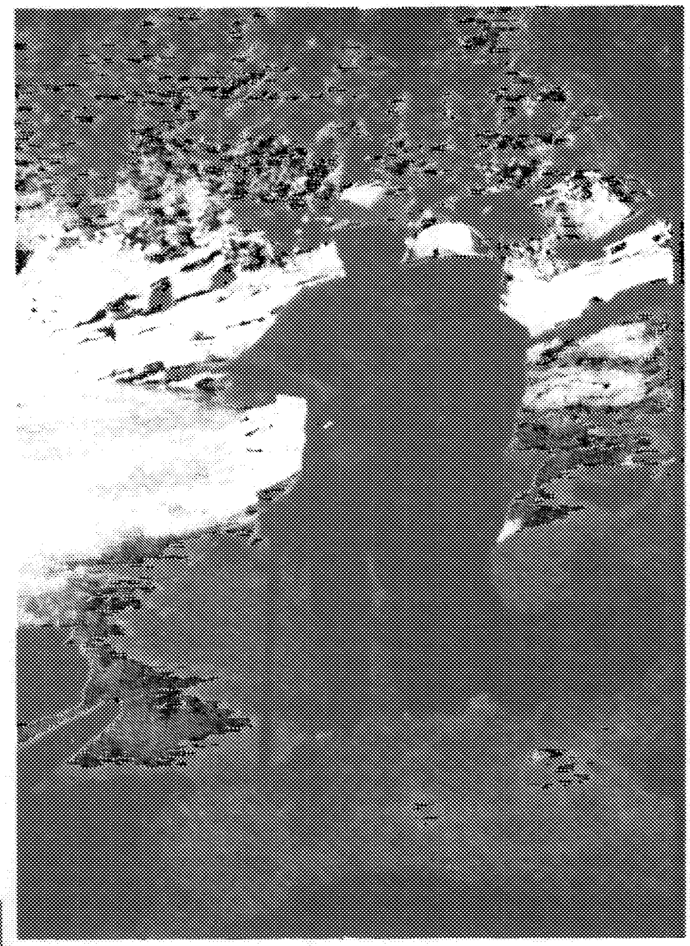

Figure 6. Crew members putting the Pionjar back on the 4 foot bit.

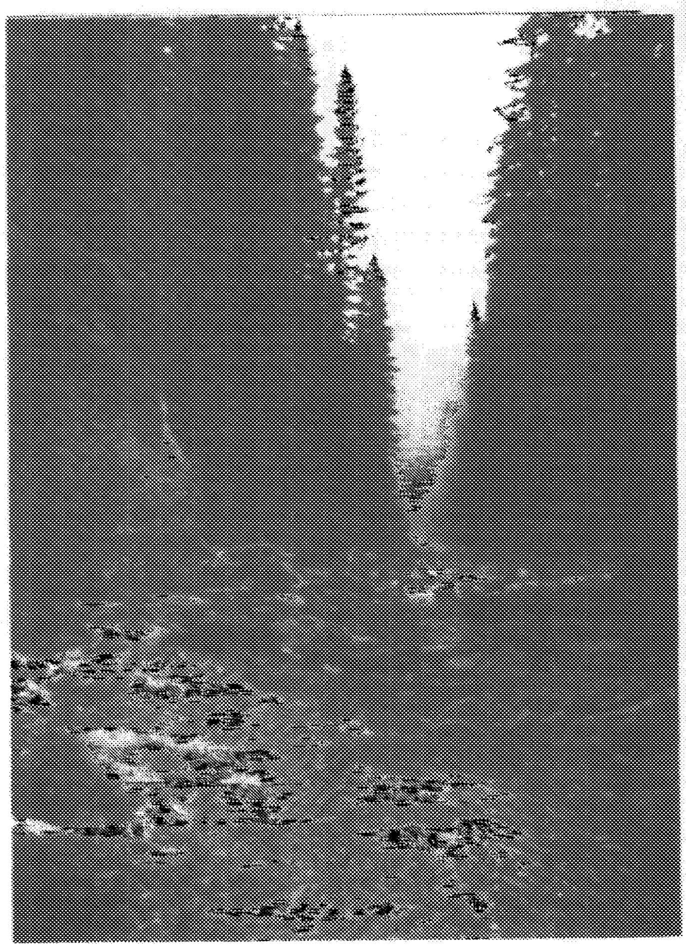

Figure 7. The blast at Site #1, upstream view.

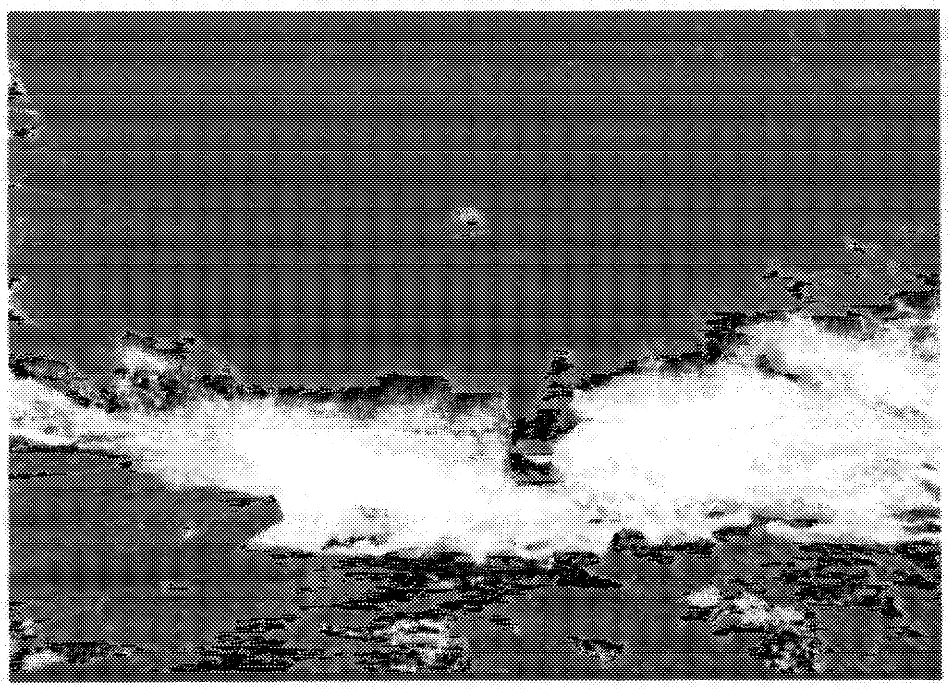

Figure 8. A crew member removes debris from Site #3, post-blast.

RESULTS AND DISCUSSION

In 1984, approximately 252 shot holes, ranging in length from 1 1/2 to 4 feet deep were drilled on 12 barriers. In 1985, 340 feet of bedrock were drilled and blasted on ten barriers. Three hundred fifty feet of water gel explosive and 2100 feet of primacord were used in 30 separate charges. After detonating the drilled holes, several sites were left with large boulders that required removal by blasting. Only one blast was necessary for successful modification of most sites (4 sites). The maximum number of blasts needed was four (1 site), with the remainder utilizing three blasts (3 sites) and two blasts (3 sites). Modification of jump pools and resting pools, gradient changes, or channel alterations were created at each barrier. In all, 3 resting pools, 5 jump pools, 6 gradient changes and 4 channel modifications were developed. Water depth, fluctuating water levels, and fractured bedrock with the resultant imbedded drill bits made it difficult to reach the desired goals. High water velocity and poor footing also made drilling very difficult. Though hand removal of debris was carried out, most pools will benefit from the scouring of winter ice and high spring flows.

The following narrative describes each barrier and the modifications made:

Barrier #1

In 1984 a two foot deep pool was created on the left side of this barrier and the channel cleared on the right side of the barrier (Fig. 9 & 10). Upon review in 1985, the lower pool was determined to be too shallow for the height of the jump. Twenty-six feet of bedrock were drilled and one charge set off to create a 35 cm deep jump pool below the barrier (Fig. 11, point A), a 35 cm jump (Fig. 11, point B) and a 35 cm deep resting pool above the barrier. Work on this barrier was deemed successful (Fig. 12). It is expected that additional scouring by spring flows will dislodge some material and deepen the pool.

Barrier #2

Two pools were created and an existing pool deepened in 1984 (Figs. 13 & 14). Evaluation of the site in 1985 still indicated problems. The lower jump pool was deepened to 60 cm (Fig. 15, point A). Above this a bedrock lip located in midstream and creating a narrow channel with high velocity was removed (Fig. 15, point B). The resting pool (Fig. 15, point C) above the jump was also deepened to 40 cm and a channel was created on the left side of the barrier for passage and also to lower the height of the jump, presently 50 cm (Figs. 16 & 17). A 30 cm deep pool was blasted four meters upstream on the right bank (Fig. 15, point D). One hundred fifteen feet were drilled and three blasts made. Scouring is expected to remove the fractured rock remaining in the lower pool.

Site #2 required the most drilling of all the barriers. The lower pool proved difficult to drill: the depth of the pool made it necessary to start the holes with a 2 1/2 foot long bit, bits repeatedly got stuck due to the layered, fractured rock and the turbulent water filled the holes with rock chips. A four foot bit became imbedded irreversibly in the lower pool, not even dislodging when the site was blasted.

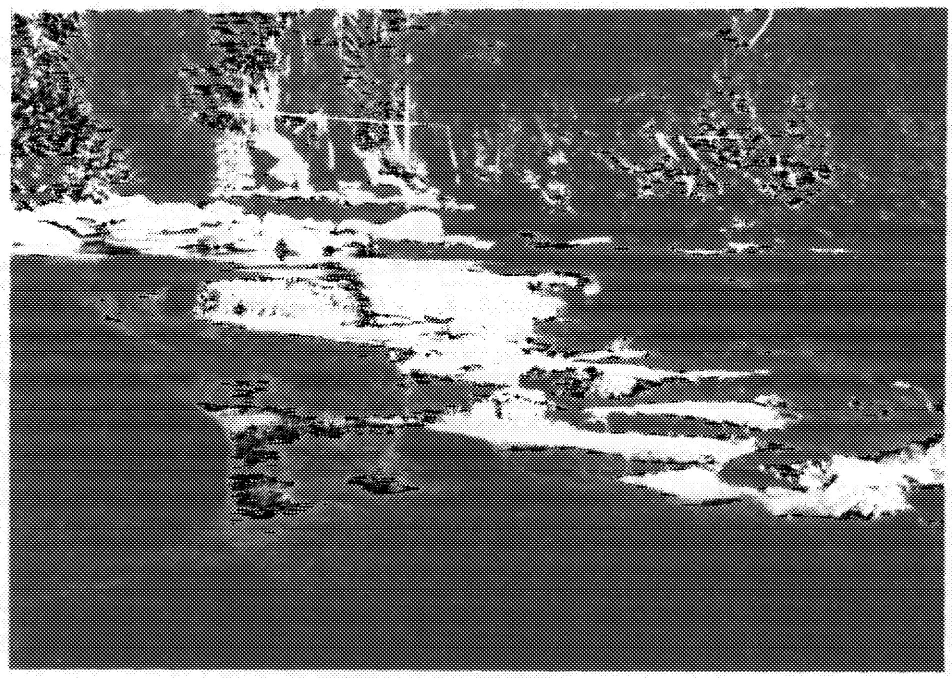

Figure 9. Site #1, preblast, 1985, upstream view.

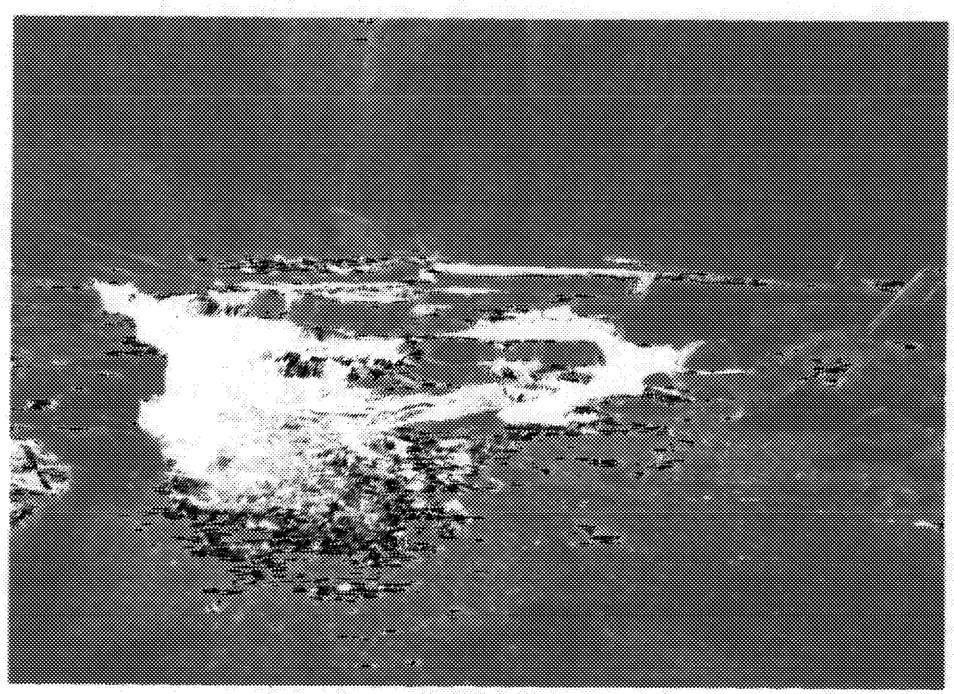

Figure 10. Site #1, preblast, 1985, upstream view.

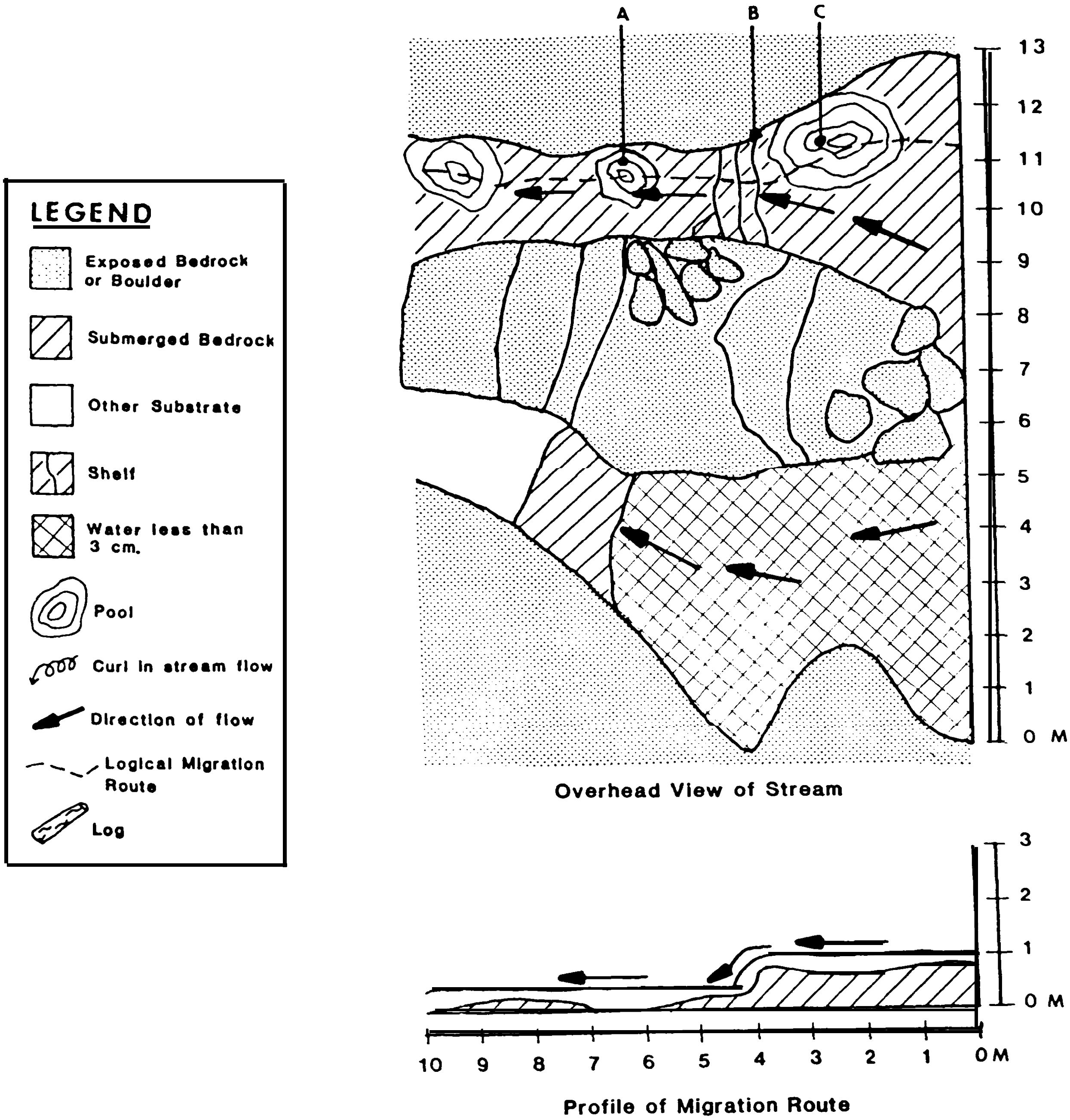

Figure 11. Post-modification diagrams, Site #1, Crooked Fork Creek, August 1985.

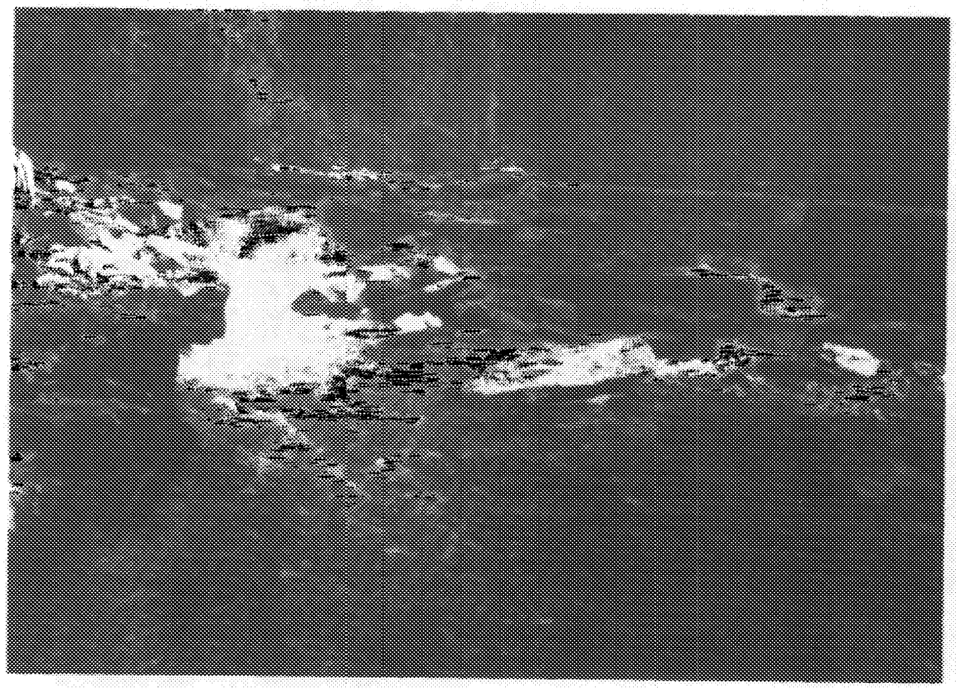

Figure 12. Site #1, post-blast, 1985, upstream view.

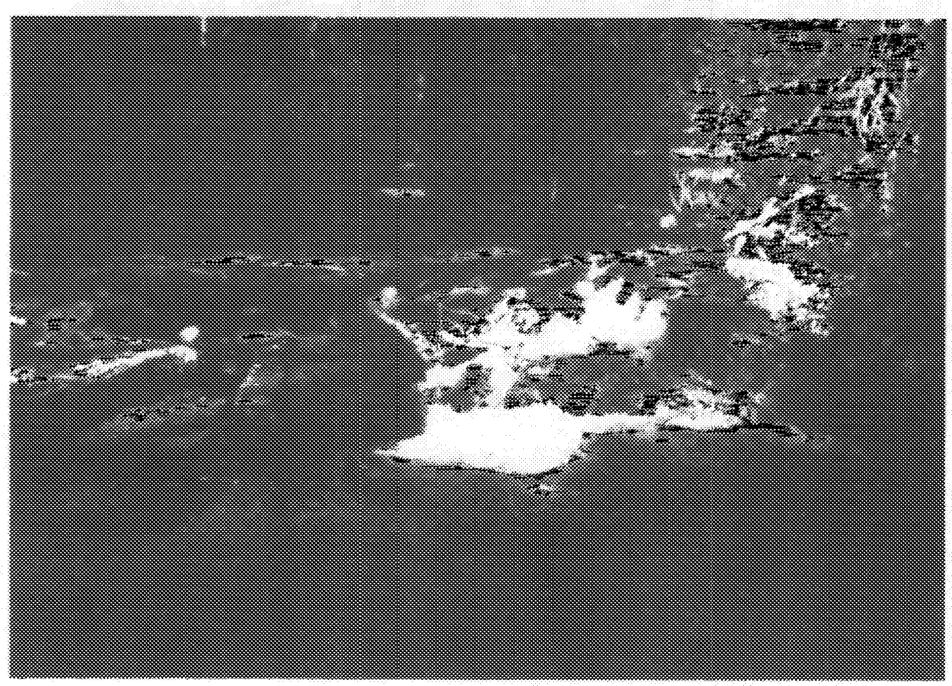

Figure 13. Site # 2, pre-blast, 1984, upstream view.

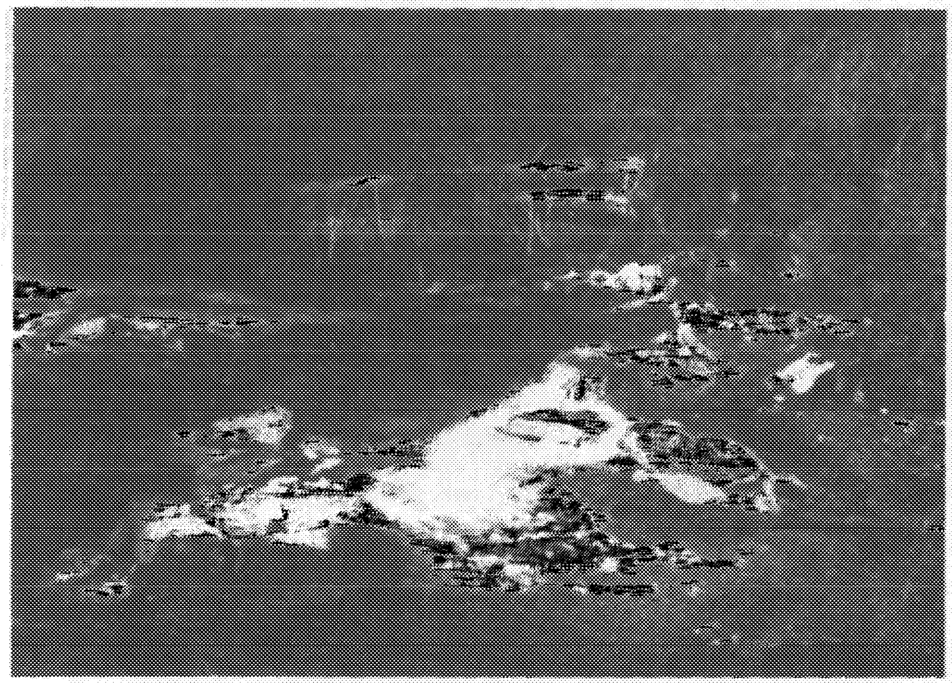

Figure 14. Site # 2, post-blast, 1984, upstream view.

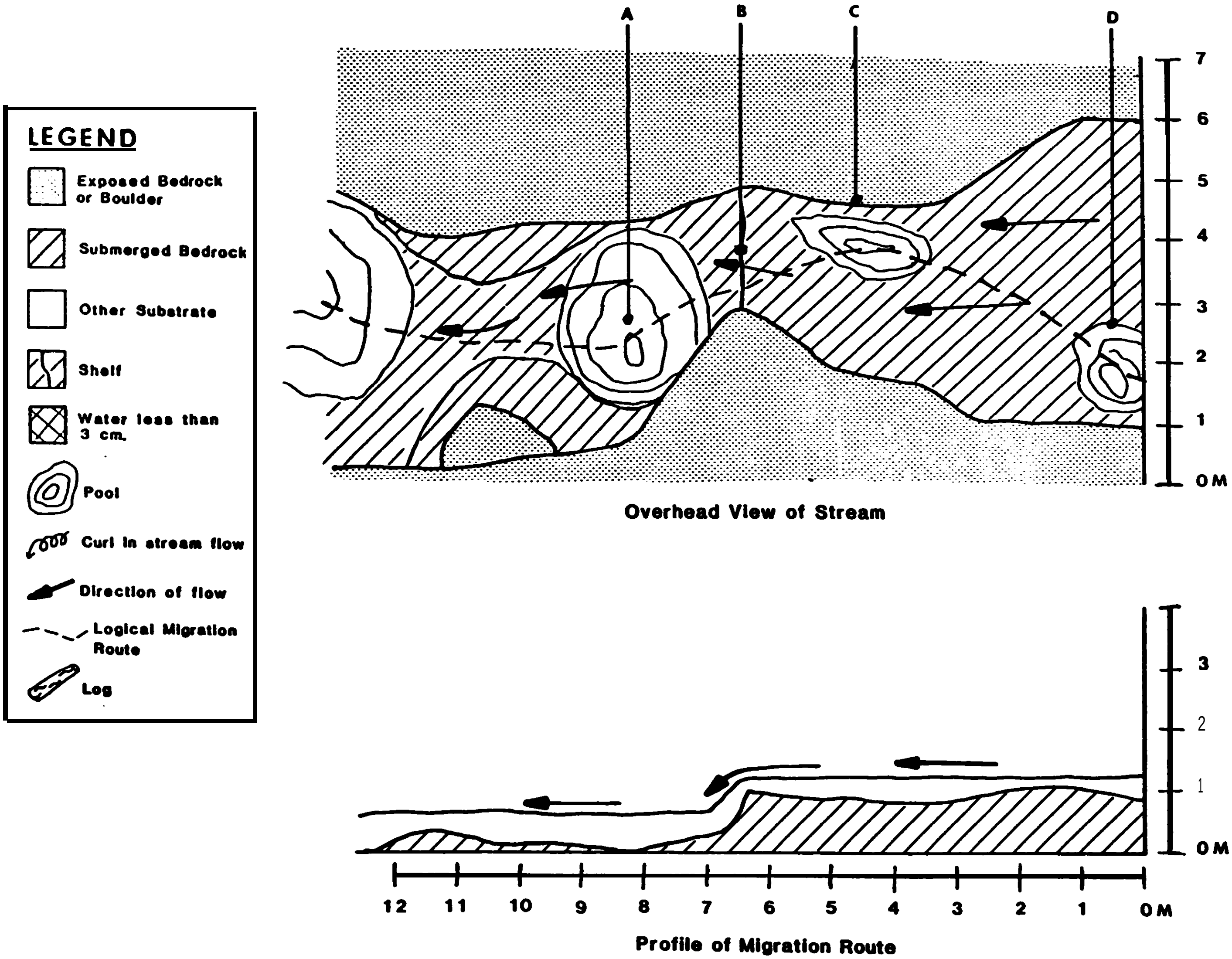

Figure 15. Post modification diagrams, Site # 2, Crooked Fork Creek, August 1985.

Figure 16. Site # 2, post-blast, 1985, upstream view.

Figure 17. Site # 2, post-blast, 1985. An upstream, close-up view of the lower pool and first jump.

Barrier #3A

Site #3A was considered a partial barrier. In 1984, a small pool was enhanced at the bottom of the run to improve passage (Fig. 18). In 1985, five feet of bedrock were drilled and one blast used. A large boulder was dislodged into the channel, creating a boulder weir with a 65 cm deep pool on the upstream side (Fig. 19 & Fig. 20, point A). A bedrock lip protruding out of the channel was removed, thus enhancing the pool and changing the gradient (Fig. 20, point B).

Barrier #3

In 1984, two jump pools were created at this barrier (Figs. 21 & 22). Upon review it was determined that the channel needed to be made deeper and wider to improve fish passage. Ten holes, a total of 23 feet were drilled and one shot made. The site presently consists of a 55 cm deep pool (Fig. 23, point A) and a 30 cm deep run (Fig. 23, point B) below a 25 cm jump (Fig. 23, point C). The resting pool above the jump was deepened to 40 cm (Fig. 24, & Fig. 23, point D).

Barrier #4

Efforts were made in 1984 to create two pools on the left side of the stream to help deepen the channel and slow the velocity (Figs. 25 & 26). The appraisal in 1985 concluded that the velocity was still too high and the pools too shallow. Thirty one feet of bedrock were drilled and four blasts made (Figs. 27 & 28). The pool at the base of the run is currently 40 cm in depth (Fig. 29, point A). into which flows a 30 cm deep channel (Fig. 29, point B). A 35 cm deep pool (Fig. 29, point C) was created in this run when the point of a boulder was removed. A 30 cm jump (Fig. 29, point D) into a 30 cm deep pool (Fig. 29, point E) complete the run. A secondary channel on the right side of the stream would have sufficient flows for steelhead passage in the spring but is too shallow for summer passage of chinook salmon.

Barrier
#5A
The smooth bedrock slope at this site proved difficult to blast (Fig. 30). The first two charges only fractured the surrounding rock. After redrilling, the third charge successfully lowered the gradient and deepened the channel (Fig. 31). Currently, the profile of the migration route is a 60 cm deep pool (Fig. 32, point A) downstream of a 30 cm deep run (Fig. 32, point B). Above this is a 20 cm rise (Fig. 32, point C) topped by 15 cm of water. A total of 18 feet of bedrock was drilled.

Barrier #5

In 1984, the jump pool and resting pool at Barrier #5 were deepened successfully. No further work was required at this site (Figs. 33 & 34).

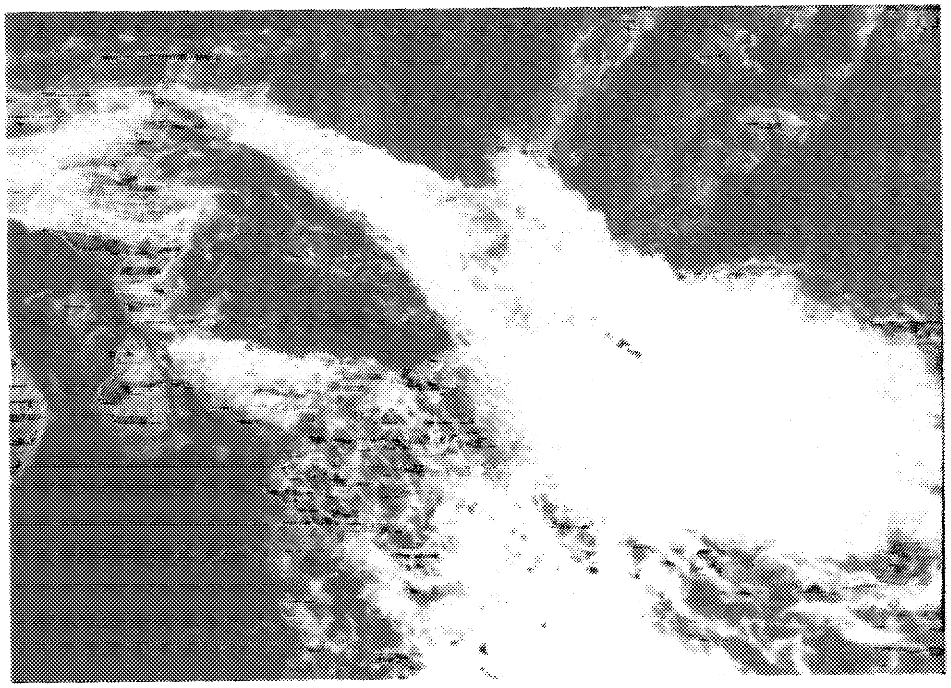

Figure 18. Site # 3A, pre-blast, 1985. An overhead view of the barrier.

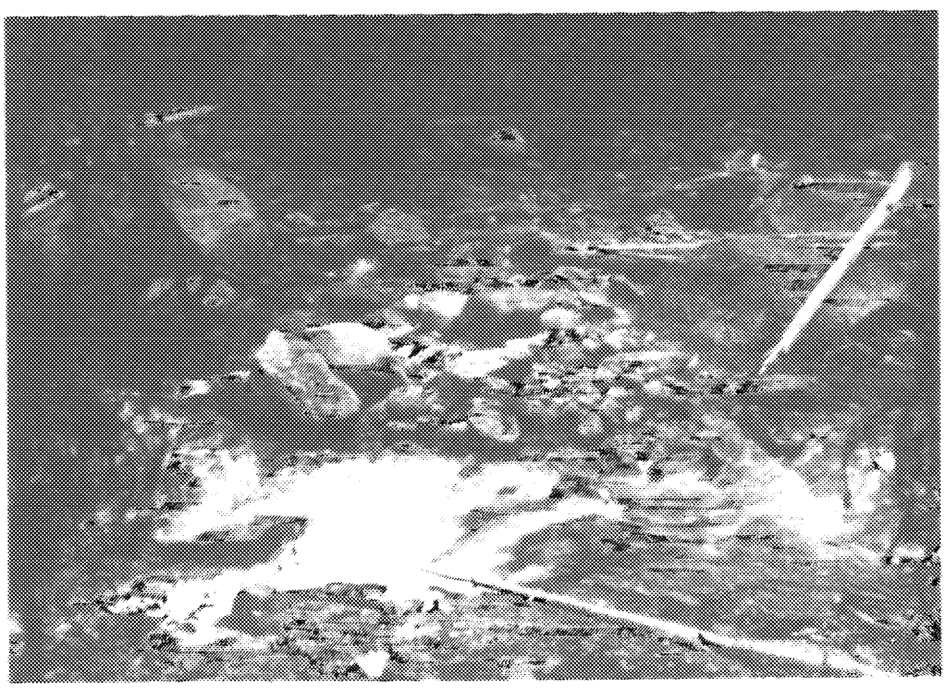

Figure 19. Site # 3A, post-blast, 1985. A downstream view from the right bank.

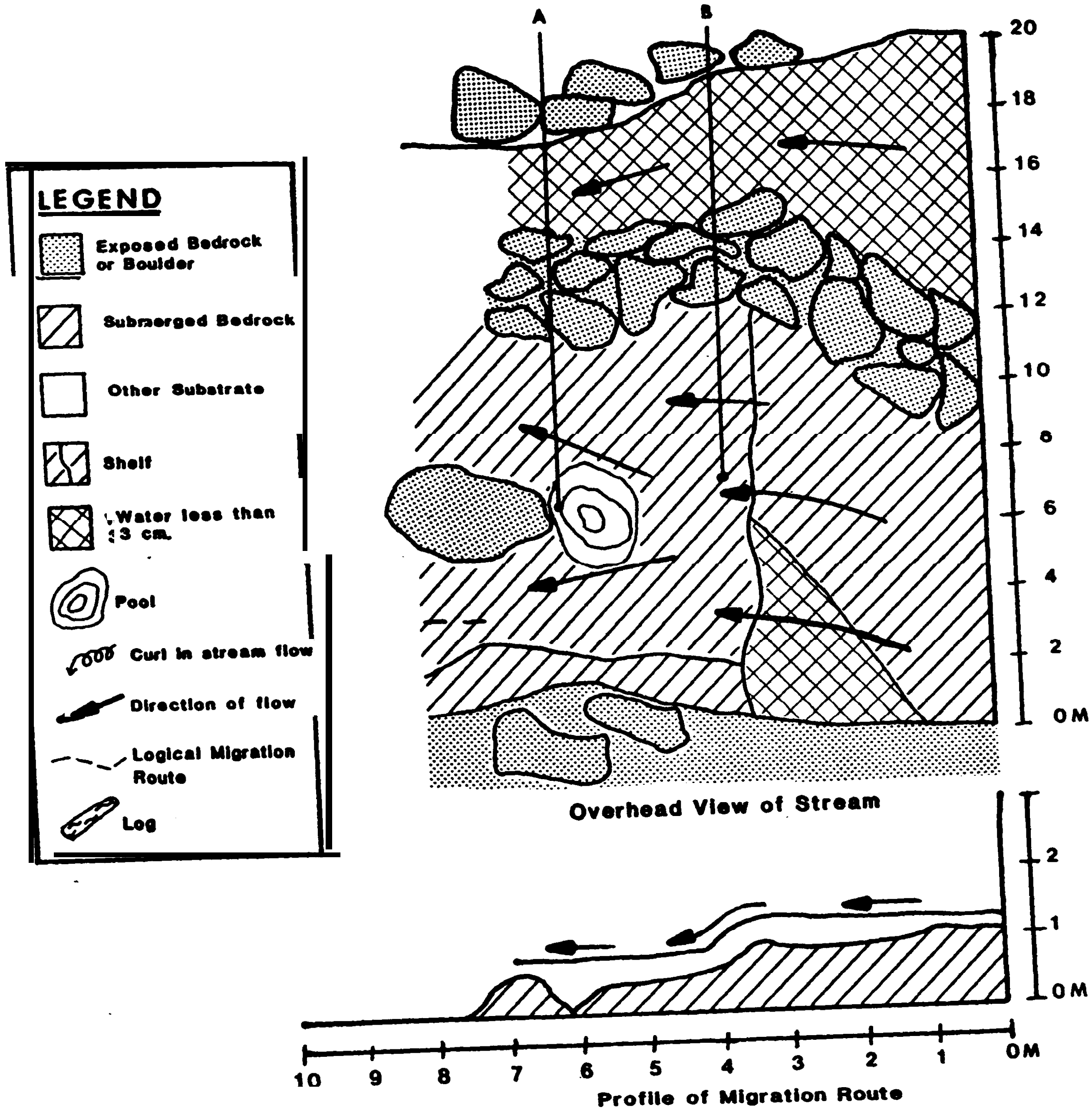

Figure 20. Post-modification diagrams, Site # 3A, Crooked Fork Creek, August 1985.

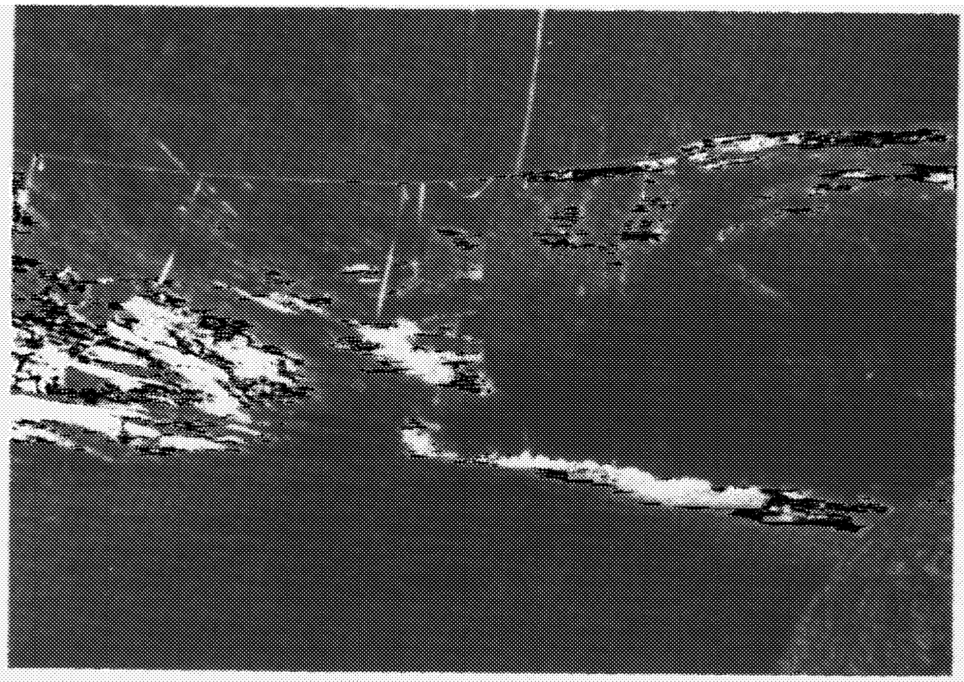

Figure 21. Site # 3, pre-blast, 1984, upstream view. The red paint on the rock on the left bank is the area to be blasted.

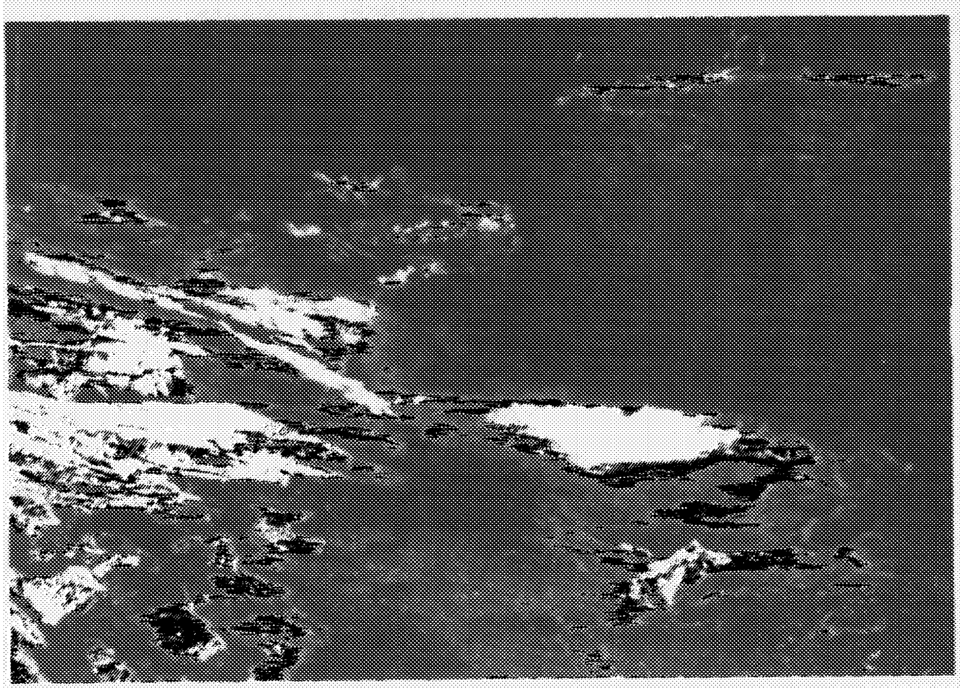

Figure 22. Site # 3, pre-blast, 1985, upstream view.

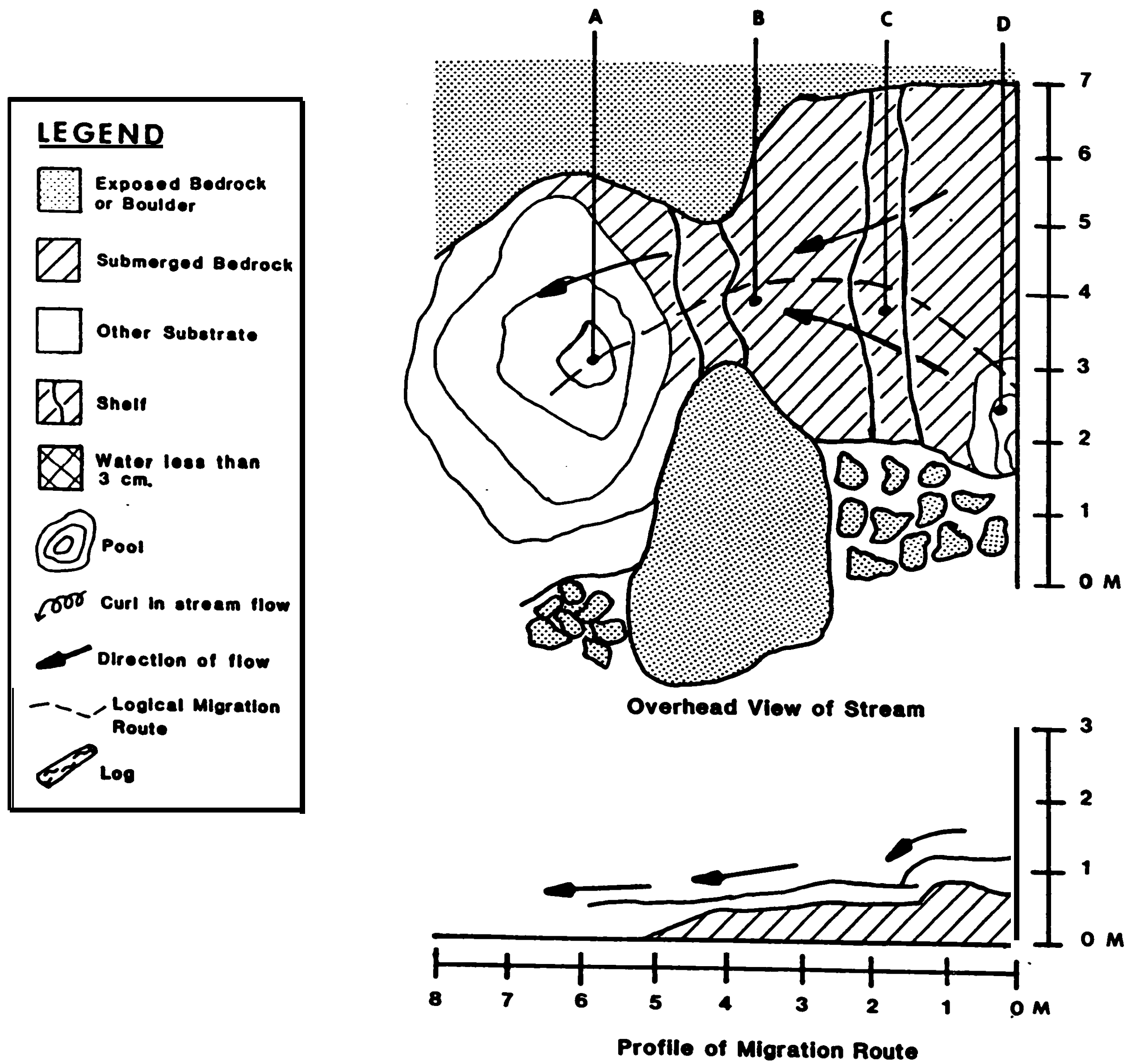

Figure 23. Post-modification diagrams, Site # 3, Crooked Fork Creek, August 1985.

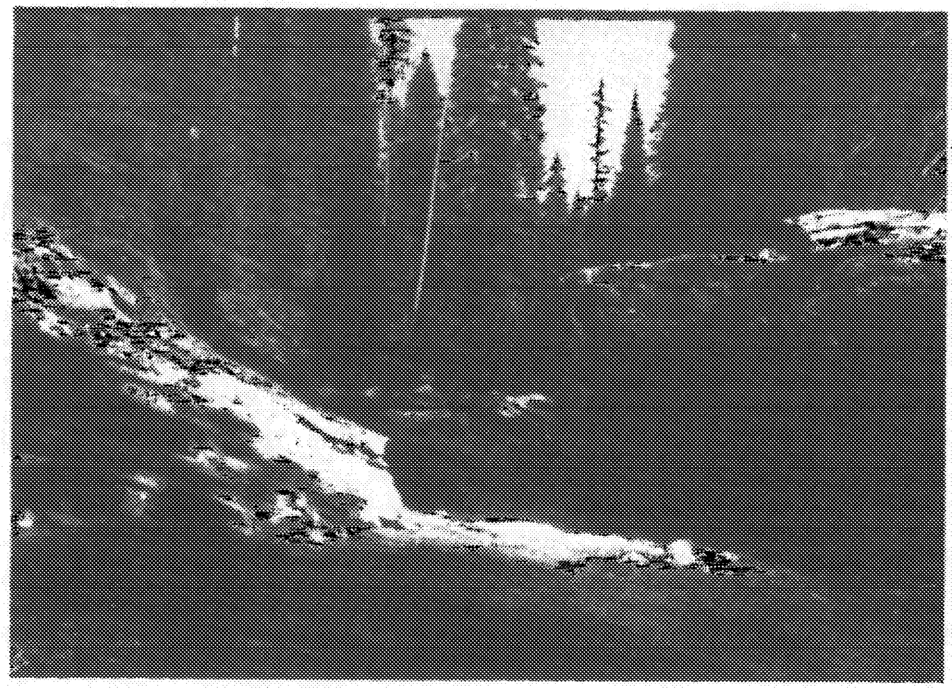

Figure 24. Site # 3, post-blast 1985, upstream view.

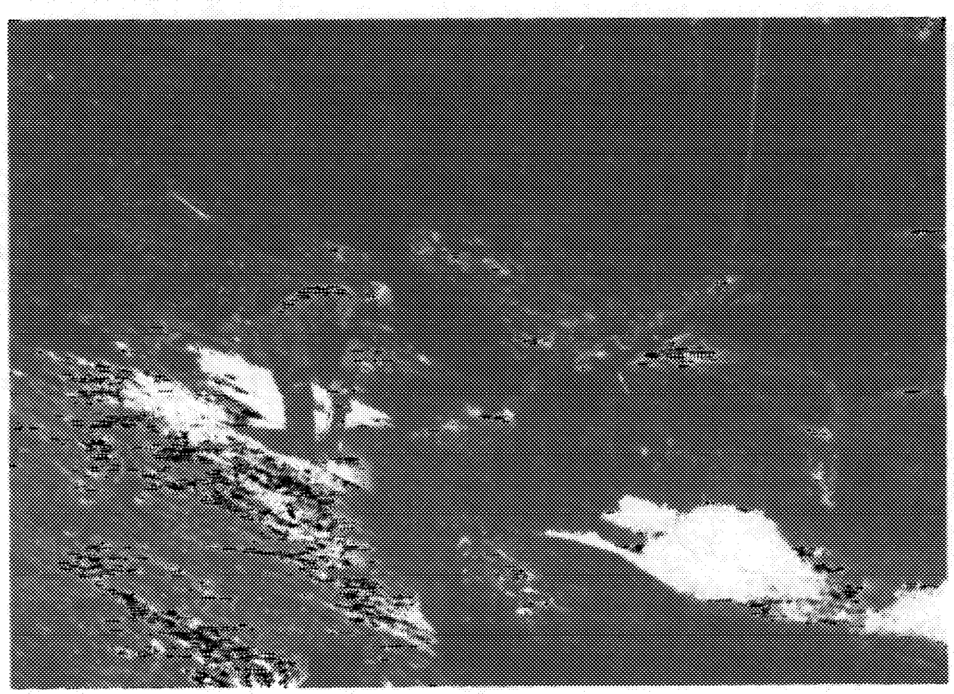

Figure 25. Site # 4, pre-blast, 1984, upstream view.

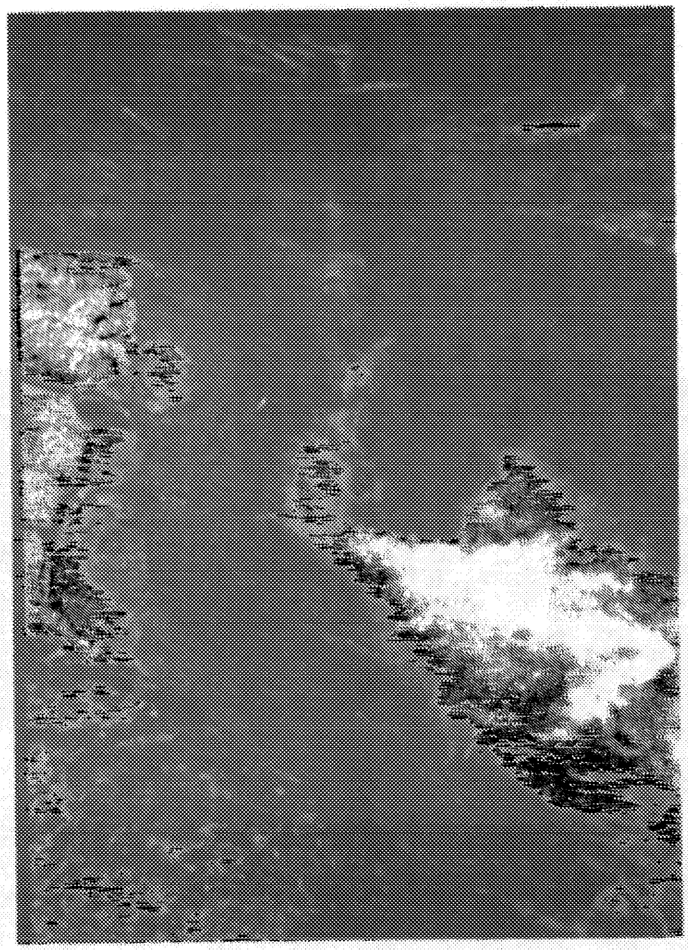

Figure 26. Site # 4, pre-blast, 1985, upstream view. The red dot marks the area that was blasted in 1984.

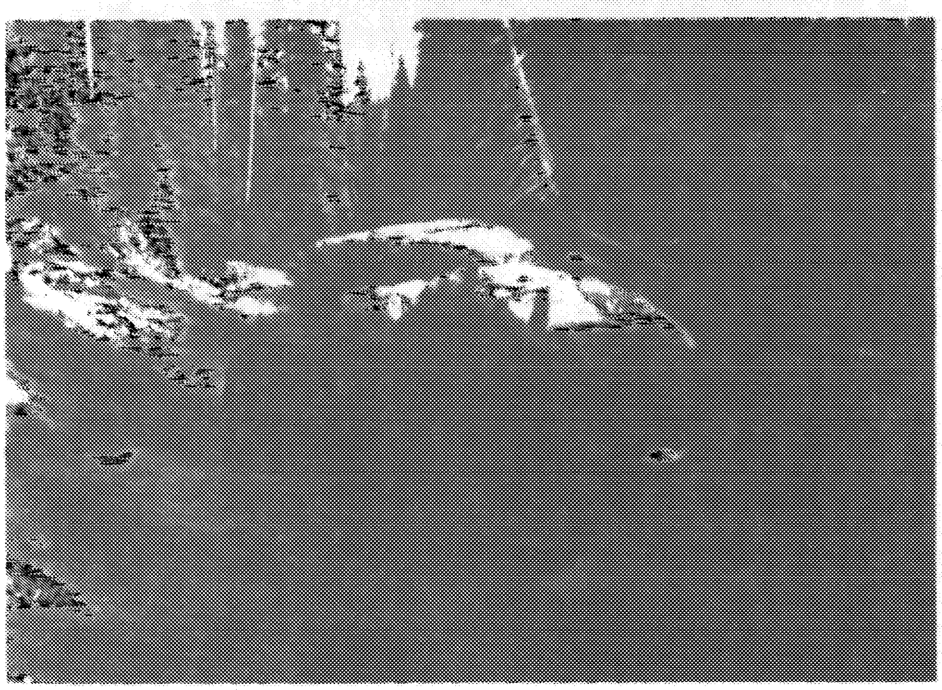

Figure 27. Site # 4, post-blast 1985, upstream view. Site # 3 is in the background.

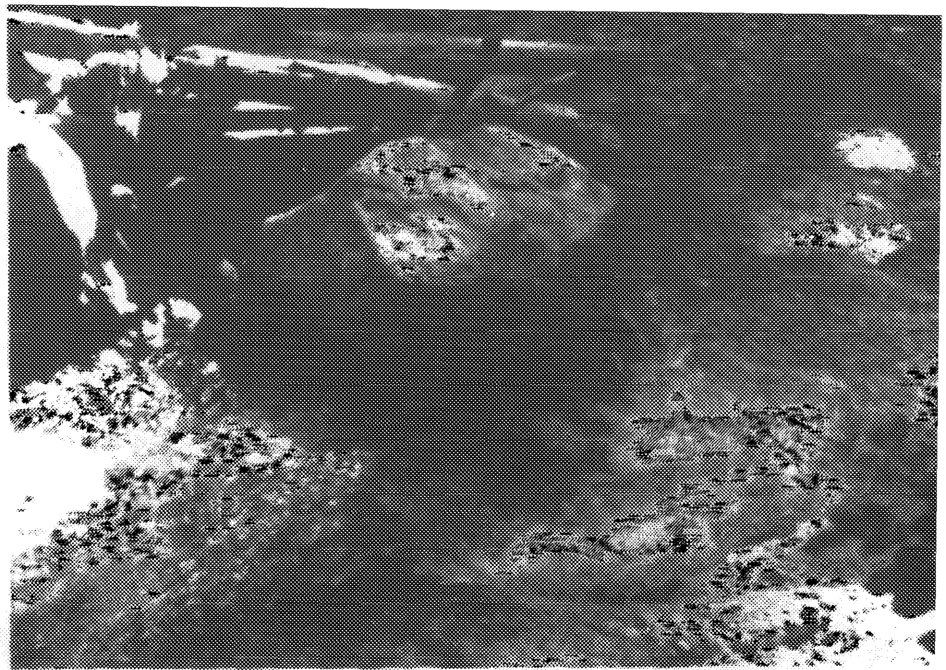

Figure 28. Site # 4, post-blast 1985. An overhead, downstream view.

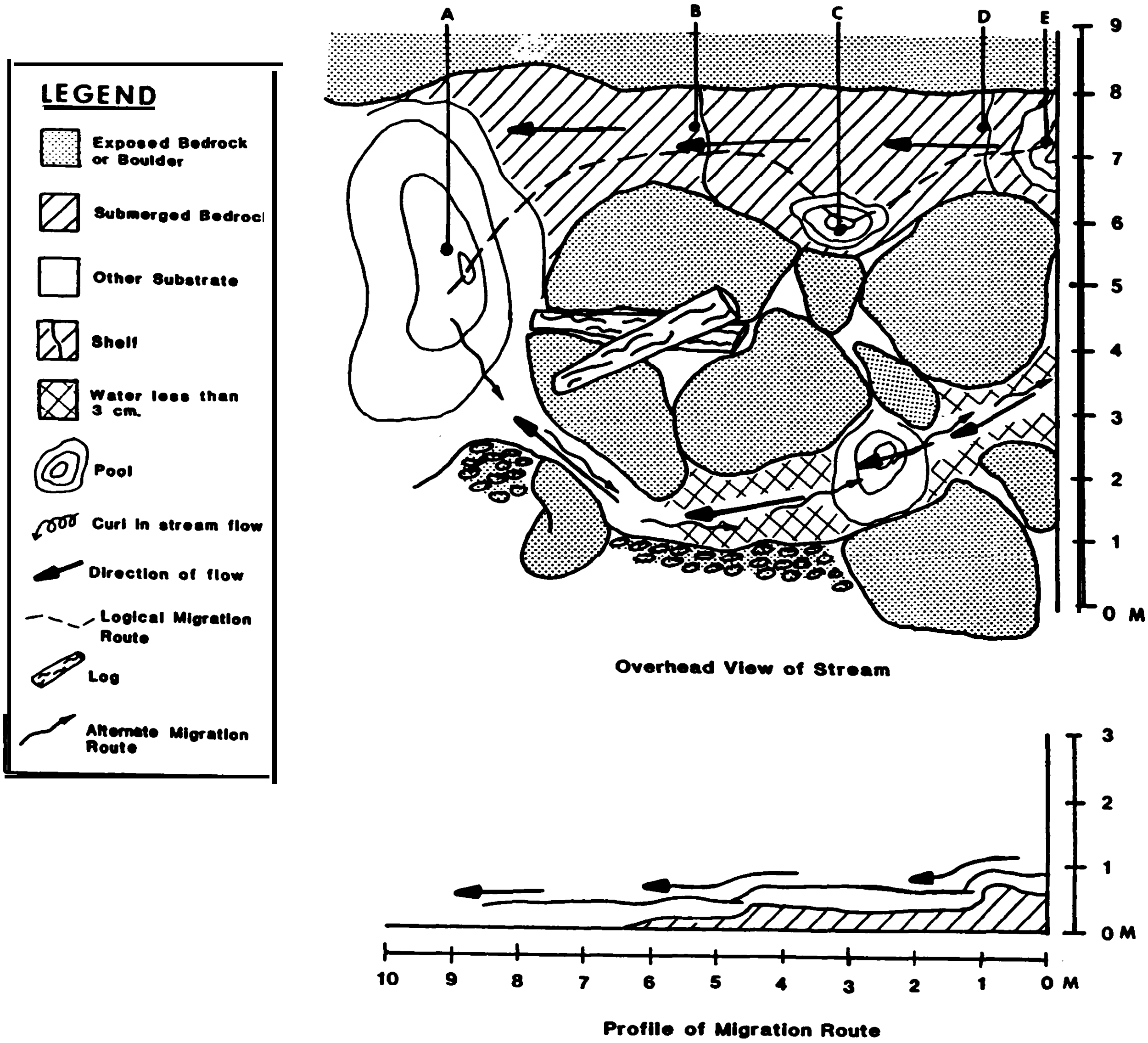

Figure 29. Post-modification diagrams, Site # 4, Crooked Fork Creek, August 1985.

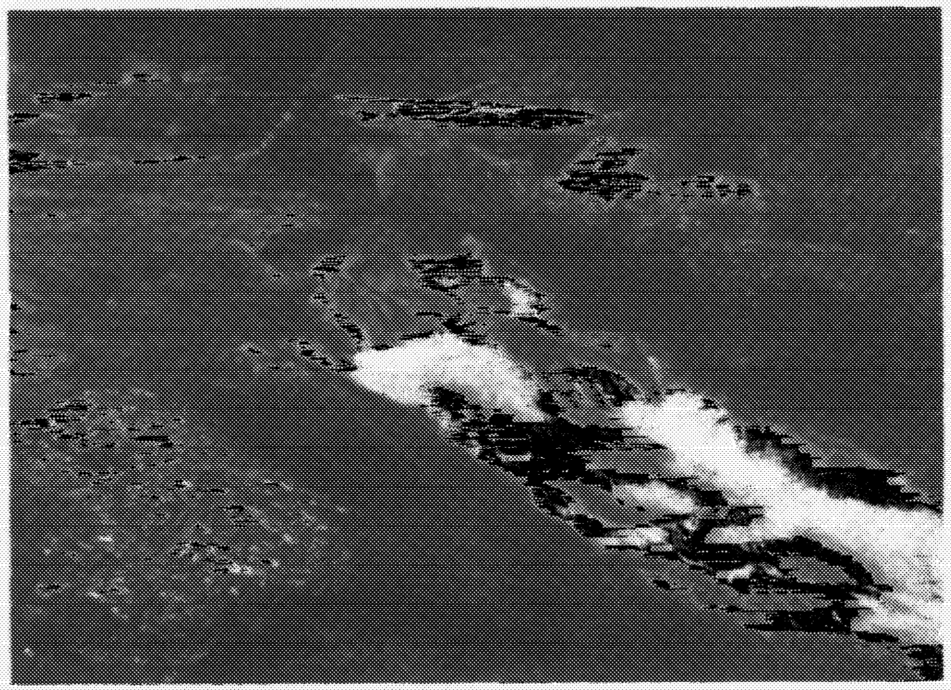

Figure 30. Site # 5A, pre-blast, 1985, upstream view.

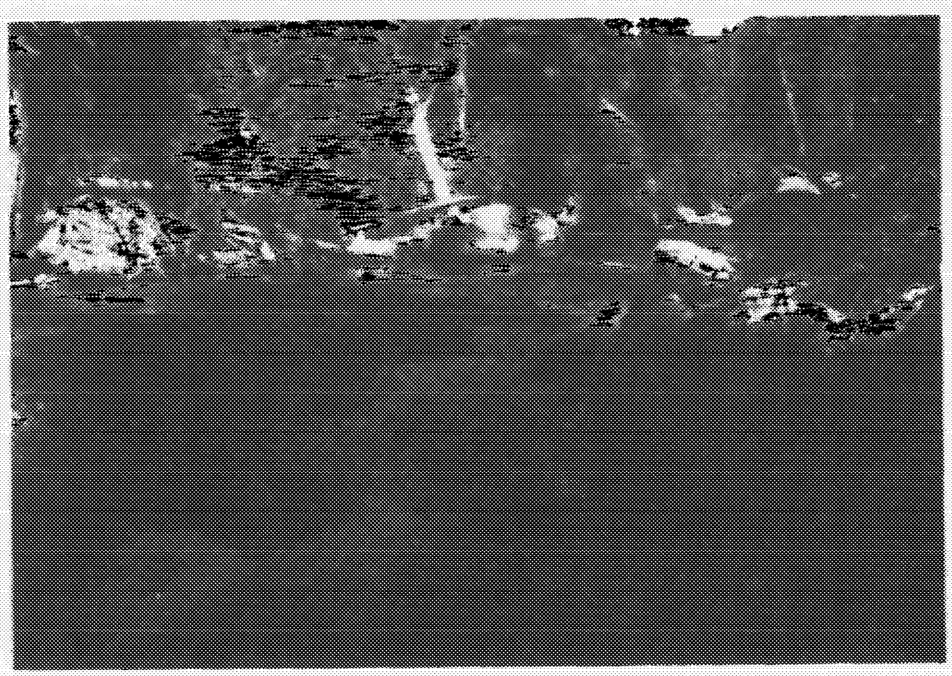

Figure 31. Site # 5A, post-blast, 1985, upstream view.

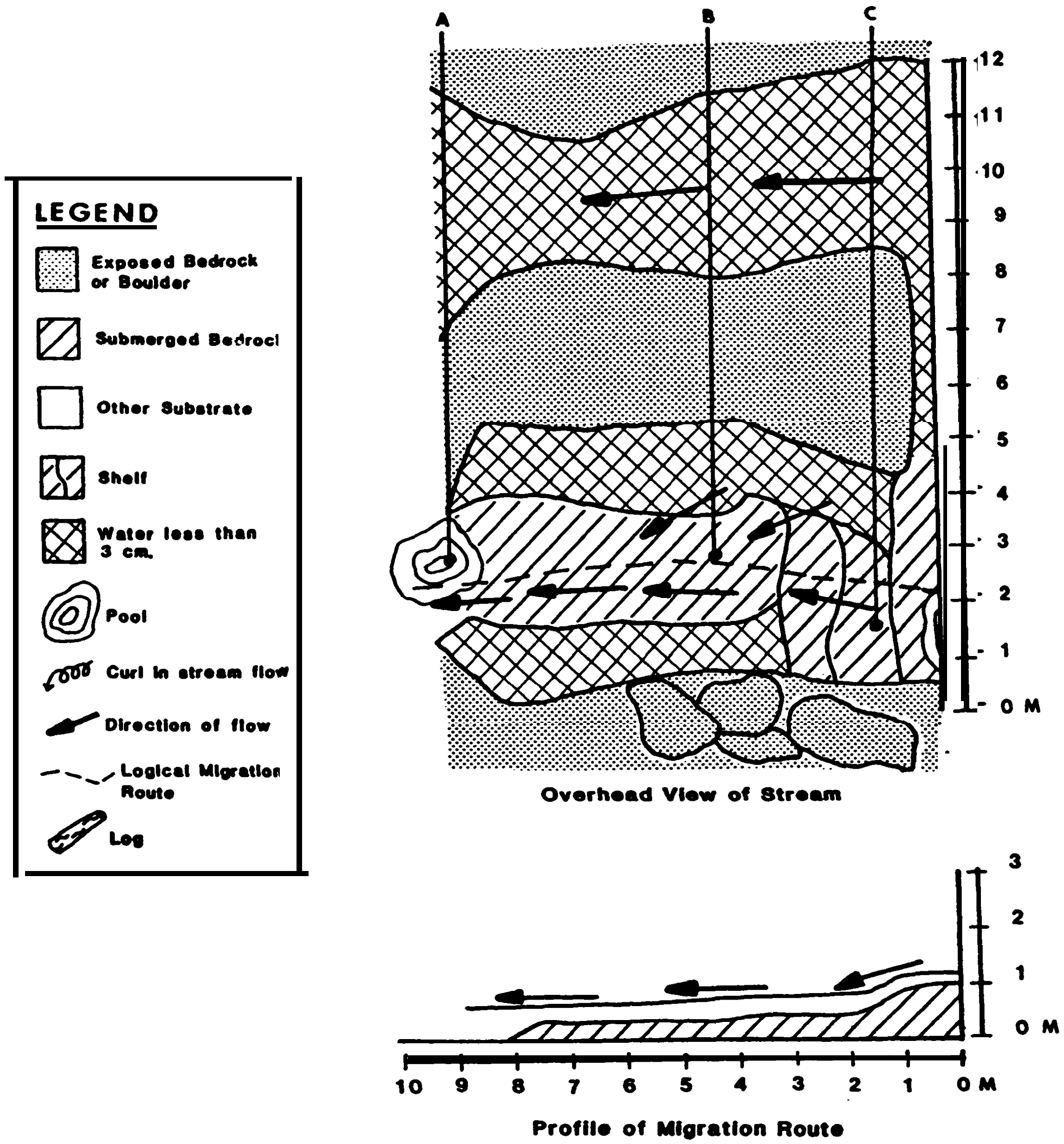

Figure 32. Post-modification diagrams, Site # 5A, Crooked Fork Creek, August 1985.

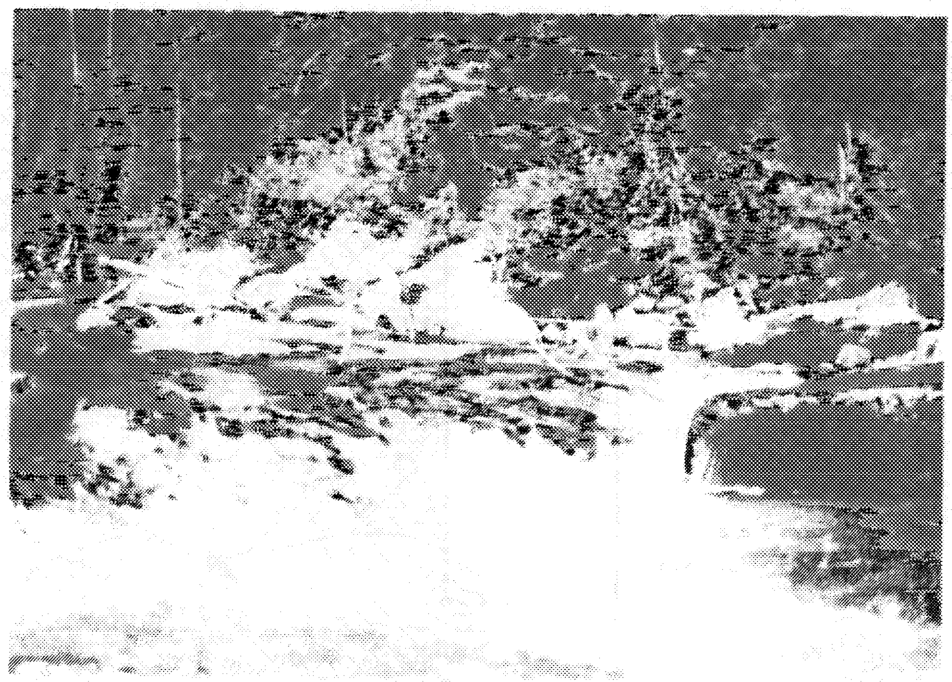

Figure 33. Site # 5, pre-blast, 1984, upstream view.

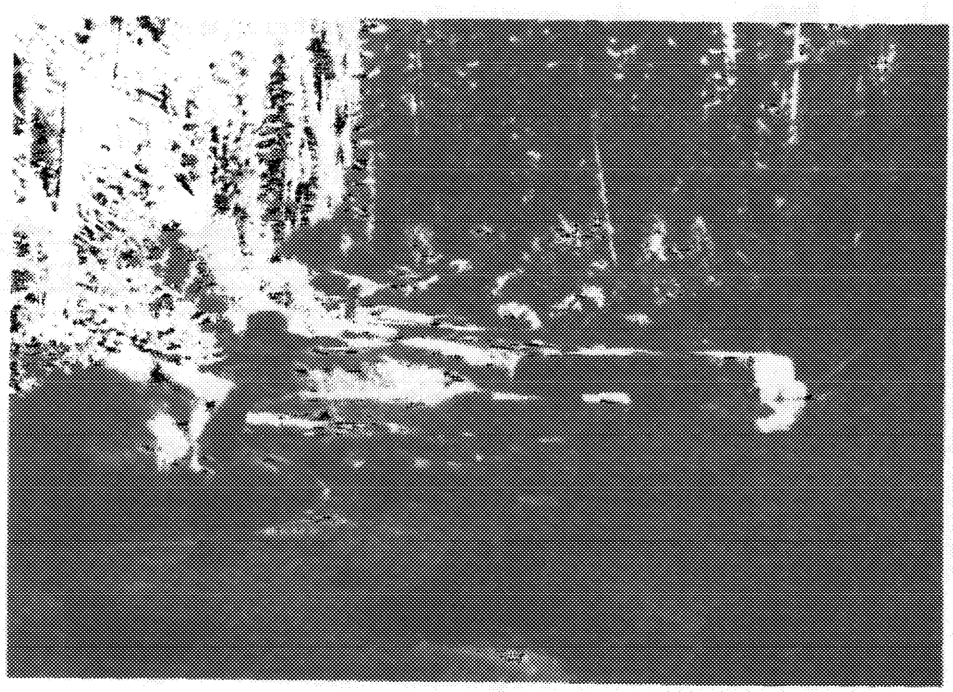

Figure 34. Site # 5, post-blast, 1984, upstream view.

Barrier #6A

The downstream pool in this partial barrier was deepened to 40 cm (Fig. 35 & Fig. 36, point A). Upstream and to the right of this pool a bedrock shelf was drilled and blasted to reduce the height of the jump, currently 20 cm (Fig. 37 & Fig. 36, point B), and to create a deep migration channel. A deep pool (55 cc) was created in 1984 in the upstream portion of this barrier (Fig 36, point C). Three holes were drilled and shot along the upper rim to help deflect more water into the pool. Nine feet of bedrock were drilled and one blast detonated.

Barrier #6

In 1984, a large pool was blasted in the center of the barrier but the blast also removed the retaining wall of rock thus lowering the depth of the pool. The upper pool and trench were also lowered to deflect the flow of water to the right bank (Figs. 38 & 39).

In 1985, it was found that this site required extensive changes as the gradient was very steep and no migration route was evident. A step pool was created on the face of the bedrock slope and efforts were made to create a large resting pool above the slope. The charge, however, removed the retaining wall of rock that would contain the pool and a channel with a lesser gradient was formed.

The profile of the migration route is a deep downstream pool of 70 cm (Fig. 40, point A) into which flows a 30 cm deep run (Fig. 40, point B). At the top of the run is a 20 cm jump (Fig. 40, point C). Above this, the lip of a pool was lowered on the right side of the stream to help channel more water to the jump (Fig. 40, point D). A 30 cm resting pool (Fig. 40, point E) lies just above this lip. There is a rise of 1.60 meters over 7 meters for a gradient of 23%. Seventy three feet of bedrock were drilled and two blasts made to achieve the results at this site (Fig. 41 & 42). This site was one of the most difficult at which to achieve the desired results due to poor footing and extensive drilling.

A report by Murphy and Metsker (1962) describes a cataract area on Crooked Fork Creek, approximately 2.2 miles upstream from the mouth of Boulder Creek. The cataract was considered a partial migration barrier and removal by blasting recommended. A photograph of the site, along with the description, suggests that this area is site #6 of the Crooked Fork Project.

Barrier #7A

The pool on the upstream edge of this barrier was deepened to approximately 1 meter in 1984. Upon review in 1985 it was decided to reduce the velocity in Barrier #7A by widening the channel (Figs. 43 & 44). Twenty feet of bedrock were drilled and two charges set at this site. Presently there is a 60 cm deep pool (Fig. 45, point A) and a 30 cm deep run (Fig. 45, point B) with an upstream jump of 50 cm (Fig. 45, point C), Another GO cm deep jump pool (Fig. 45, point D) was deepened when a point of bedrock, jutting into the stream (Fig. 45, point E), was removed. There is a 10 cm jump and a 40 cm resting pool (Fig. 46 & Fig. 45, point F) at the top of the run.

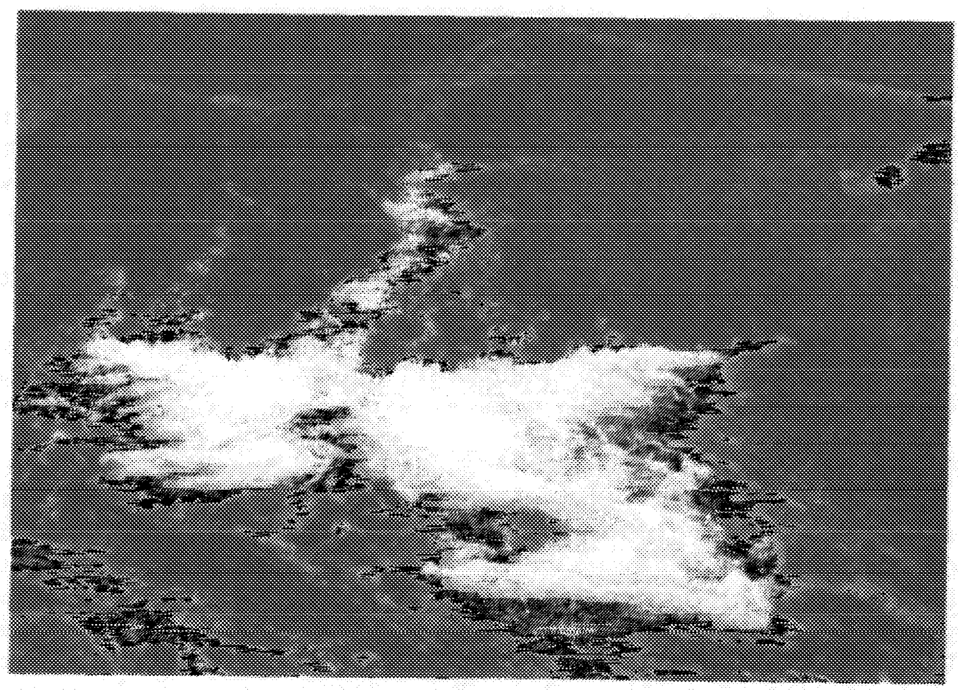

Figure 35. Site # 6A, pre-blast, 1985, upstream view.

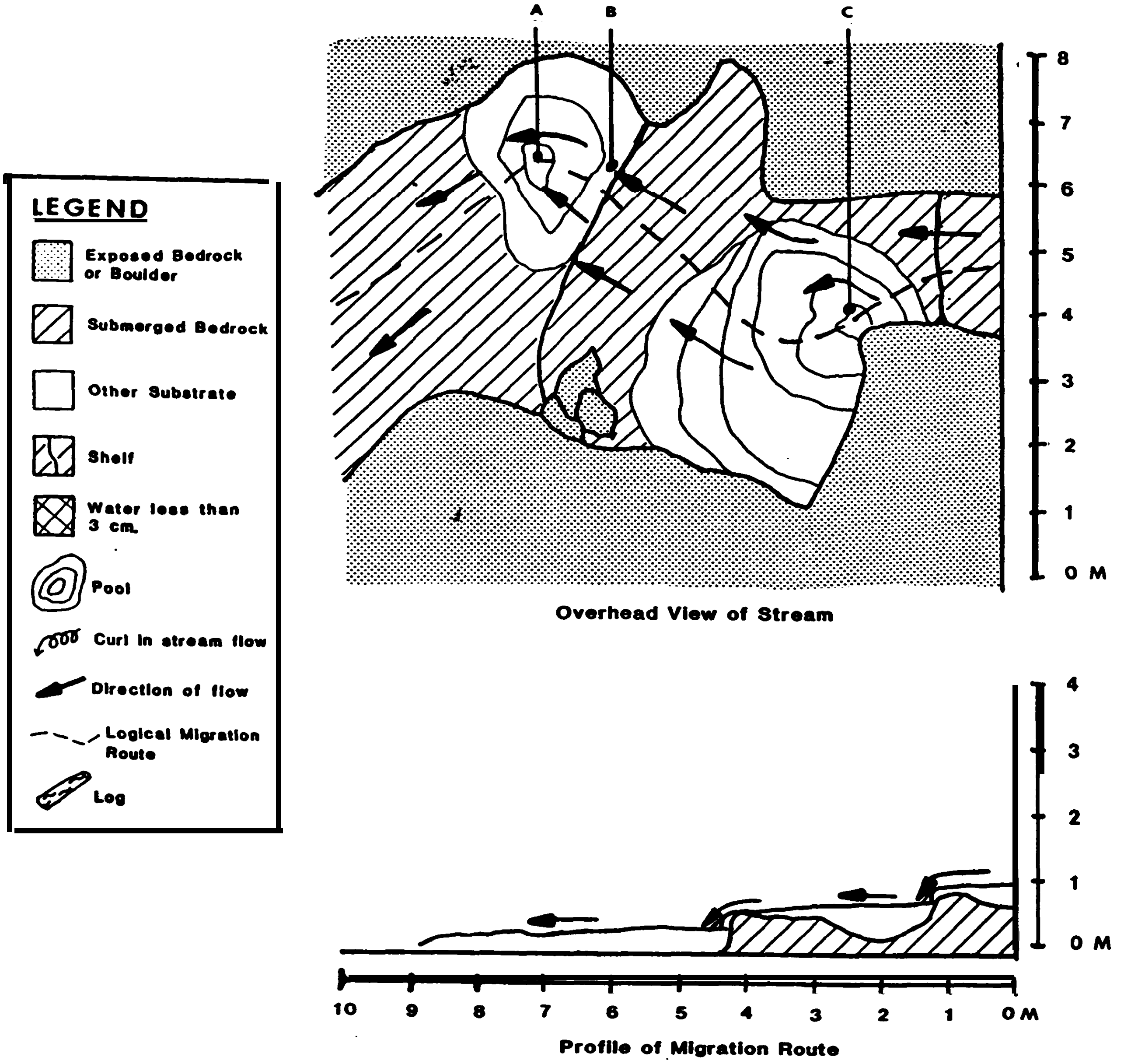

Figure 36. Post-modification diagram, Site # 6A, Crooked Fork Creek, August 1935.

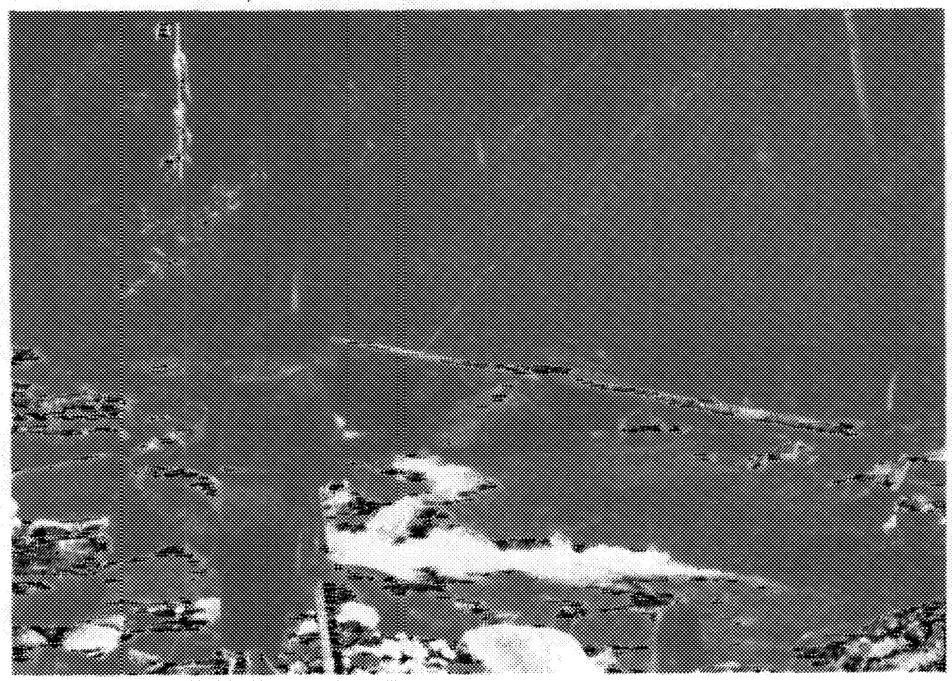

Figure 37. Site # 6, post-blast, 1985, upstream view.

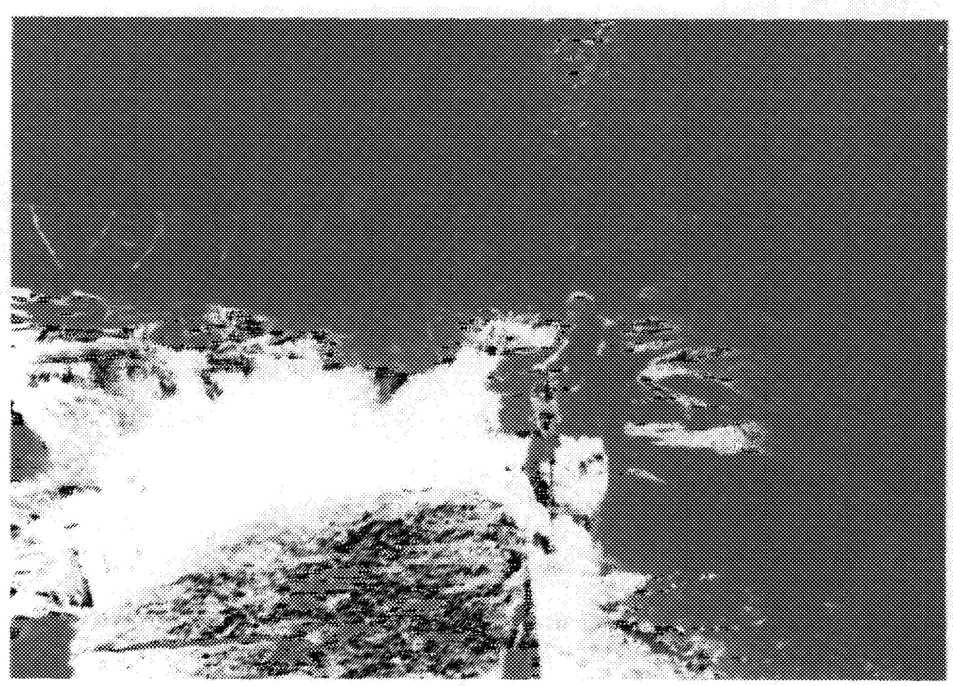

Figure 38. Site # 6, pre-blast, 1984, upstream view.

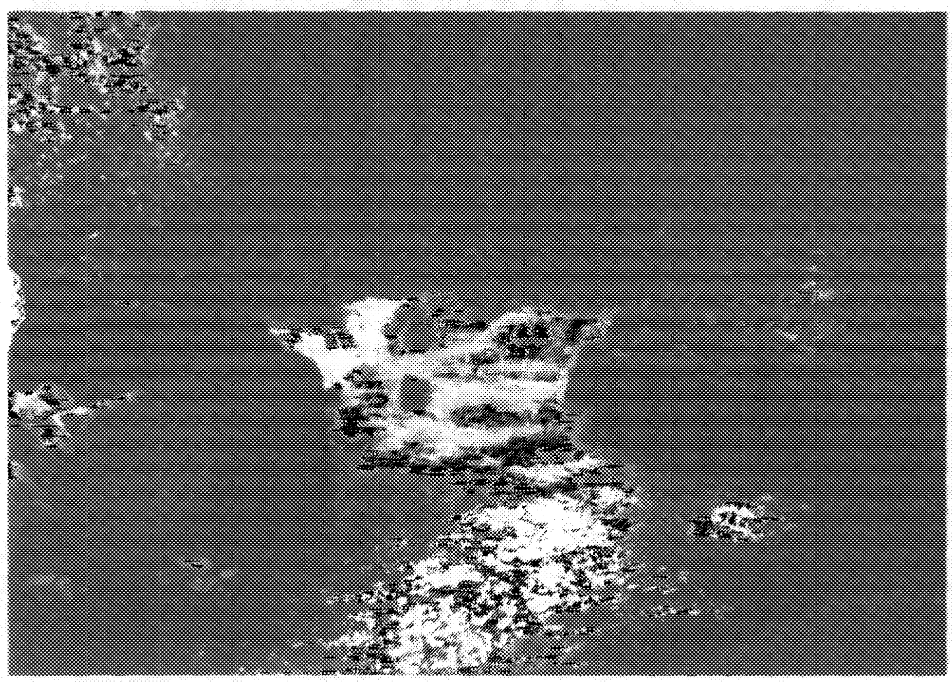

Figure 39. Site # 6, post blast, 1984, upstream view.

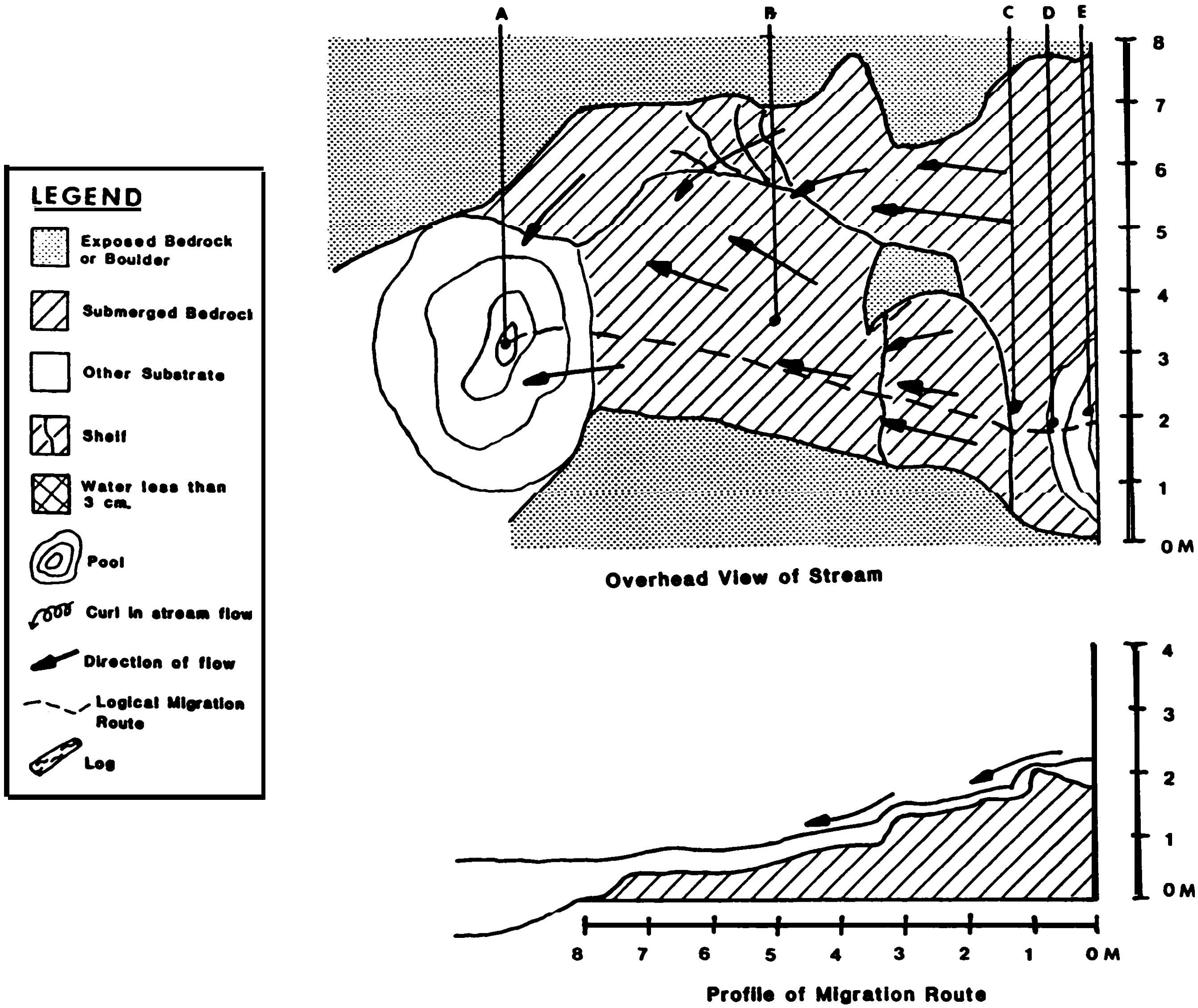

Figure 40. Post-modification diagram, Site #6, Crooked Fork Creek, August 1985.

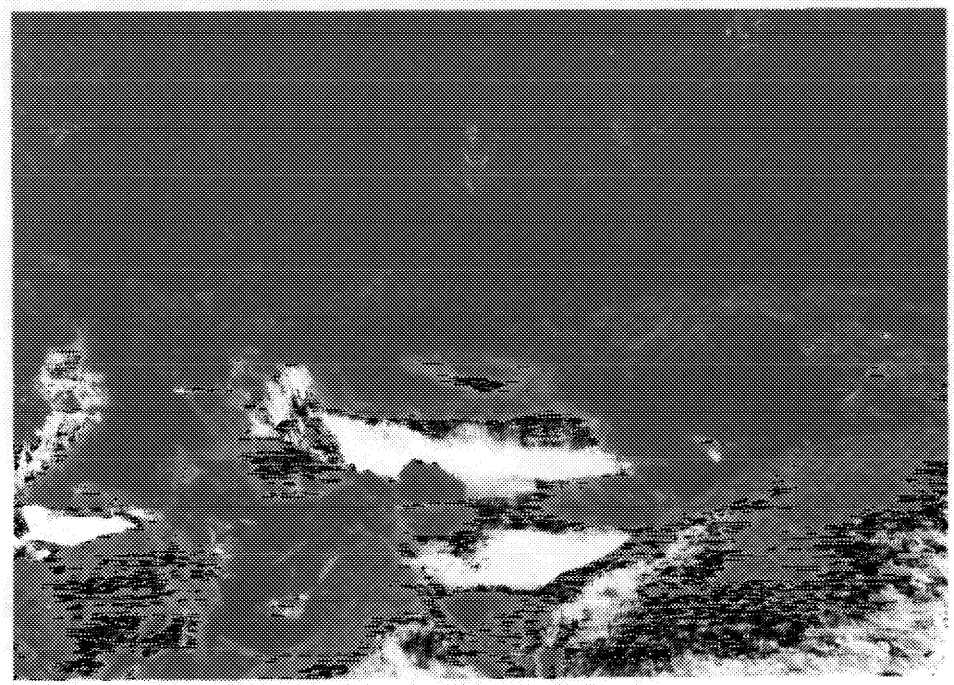

Figure 41. Site # 6, post-blast, 1985, upstream view.

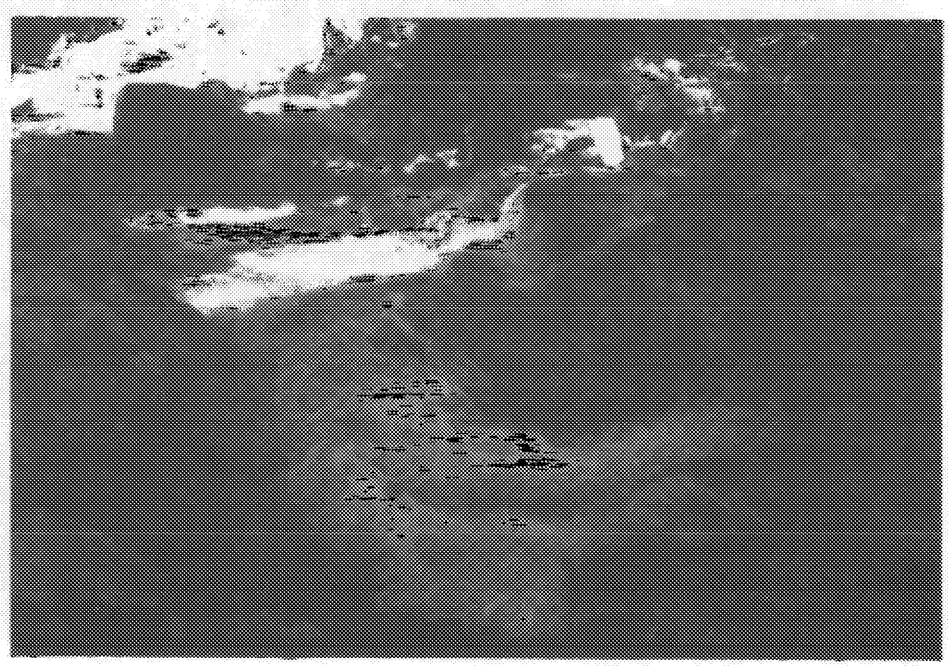

Figure 42. Site # 6, post-blast, 1985. A downstream view of the channel created.

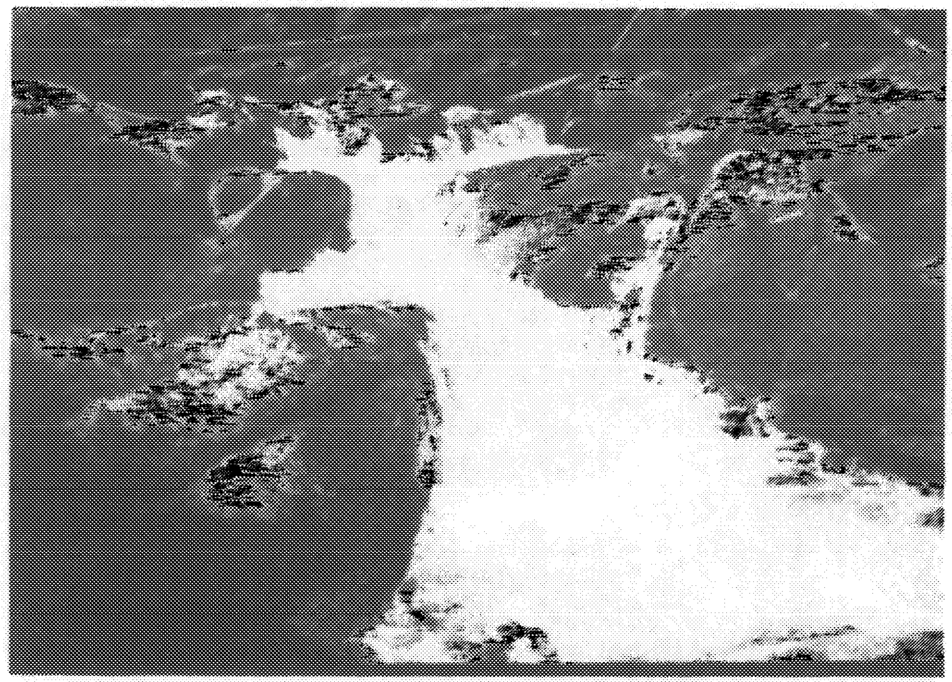

Figure 43. Site # 7A, pre-blast, 1985, upstream view. The smooth bedrock face on the right side of the creek was blasted.

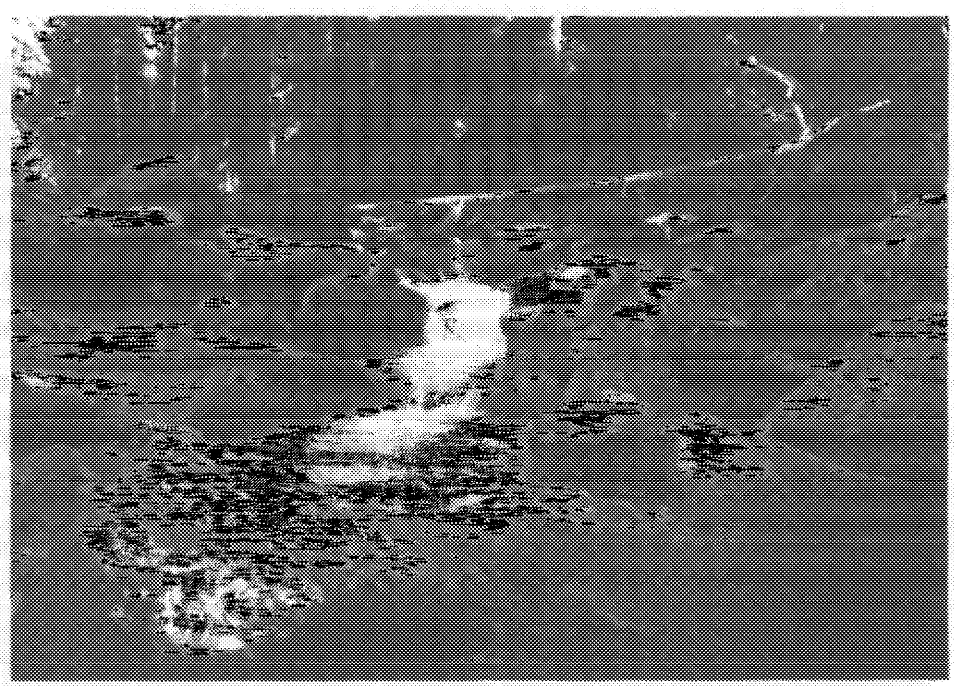

Figure 44. Site # 7A, post blast, 1985, upstream view.

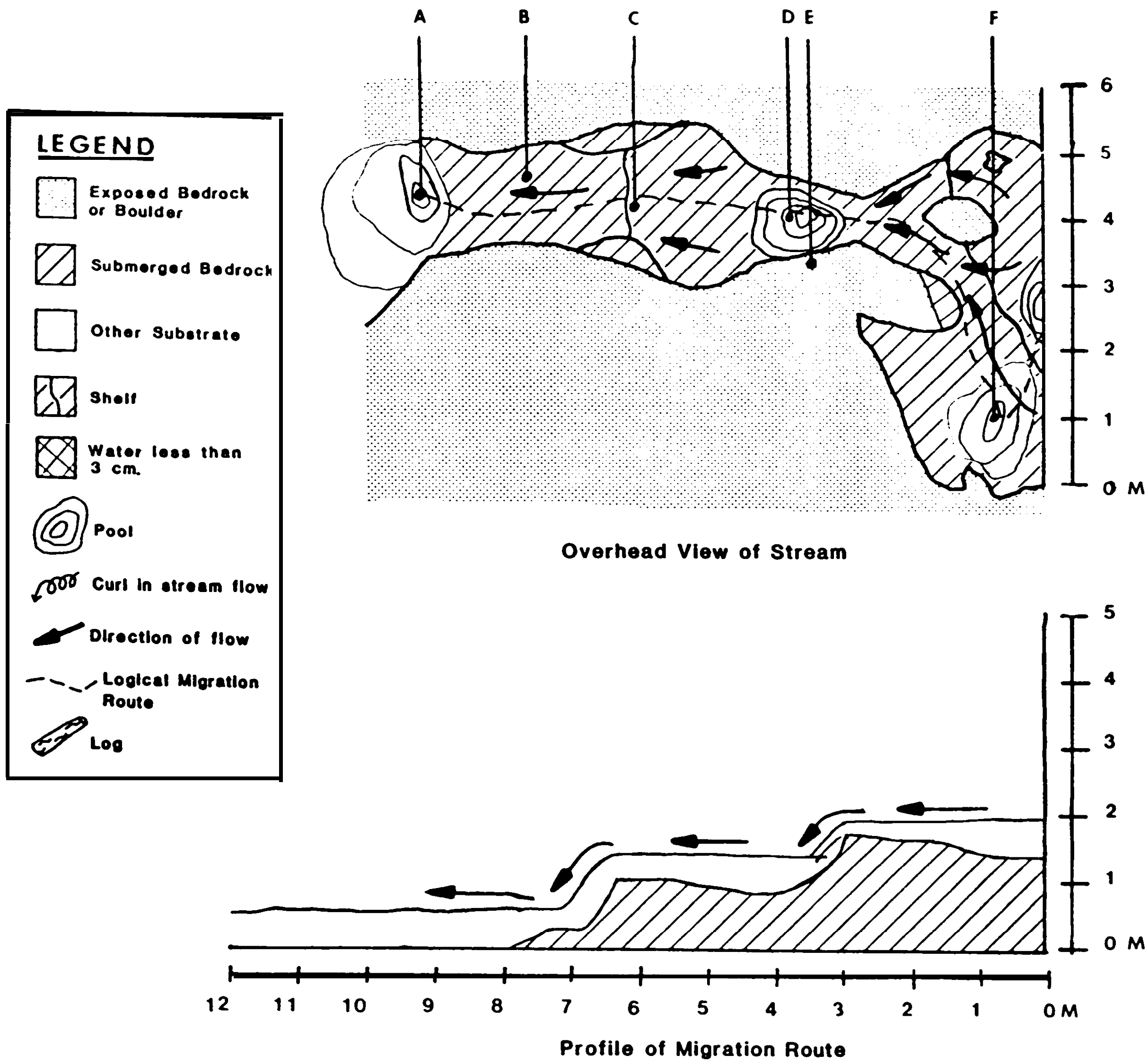

Figure 45. Post modification diagrams, Site # 7A, Crooked Fork Creek, August 1985.

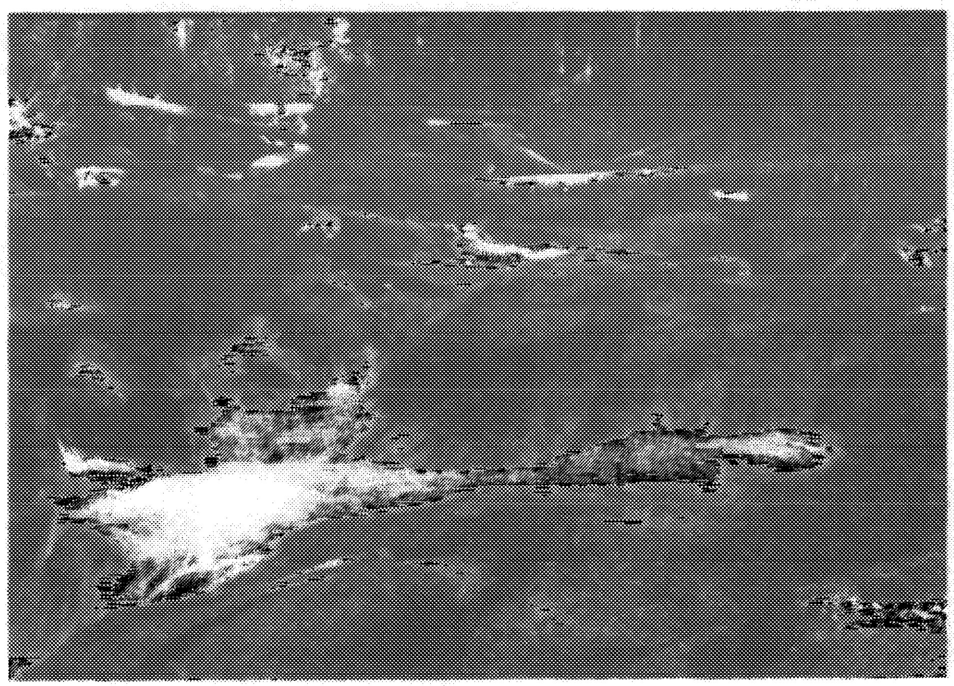

Figure 46. Site # 7A, post-blast, 1985. A view of the upstream pool that was blasted in 1984. The fractured rock i the lower left hand corner was blasted last year.

Barrier #7

Extensive changes were made at this site in 1984 (Figs. 47 & 48). A rock face was removed, three pools deepened and a rock "V" berm constructed. The rock berm, however, did not withstand the spring flows. Significant changes were still needed in 1985 to improve the sight for migration (Fig. 49). A deep pool existed downstream of this site (Fig. 50, point A). At the downstream edge of the barrier was a high velocity channel where water flows were deflected and then constricted by a submerged bedrock shelf in midstream and a bedrock point on the right side of the stream. The river right edge of the submerged bedrock was drilled and blasted creating a wider channel. A curl of water (Fig. 50, point B) deflected off the point of bedrock onto the remaining submerged bedrock shelf provides a low velocity chute for the fish to "walk" up (Fig. 51). The jump pool (Fig. 50, point C) for the upper 40 cm jump (Fig. 50, point D) was deepened to 60 cm and should develop more after scouring by spring flows.

Barrier #7 was the most difficult site at which to achieve the desired results. Water depth, fluctuating water levels, and fracturing bedrock with the resultant imbedded drill bits frustrated efforts to reach the required modifications. Twenty-two feet of bedrock were drilled and 2 blasts made.

Hopeful Creek Debris Jam

In 1984, crews began cutting and hand removal of the debris jam and succeeded in opening a channel on the left side of the stream before snows forced the postponement of the project (Figs. 52 & 53).

In 1985, crews again began cutting and hand removal of the debris jam. Due to the size of the jam and time required to remove it by hand, charges were set and the right side of the jam blasted from the stream. With the opening of this channel a considerable amount of sediment was released downstream and the width of the upstream channel was reduced significantly. Cutting and hand removal continued after the blast and the majority of the debris was removed from the stream and piled for burning. A bedrock boulder in midstream was drilled and blasted to prevent reoccurence of a debris jam (Fig. 54). To preclude the wash out of slash into the stream, debris piles were burned in late October. Major changes are anticipated at this site as spring flows cut at the banks of sediment.

SUMMARY AND CONCLUSIONS

The Crooked Fork Creek Passage Project made available additional spawning and rearing areas for salmon and steelhead. The modifications provided deep take off pools and resting areas and should increase the percentage of fish migrating upstream. Additional scouring of pools is anticipated during spring flows. The Hopeful Creek debris jam was successfully removed and, with the blasting of a bedrock boulder in midstream, should not present any future problems. All sites were developed to the point where they no longer constitute migration barriers. Results of the project will be monitored to provide field verification.

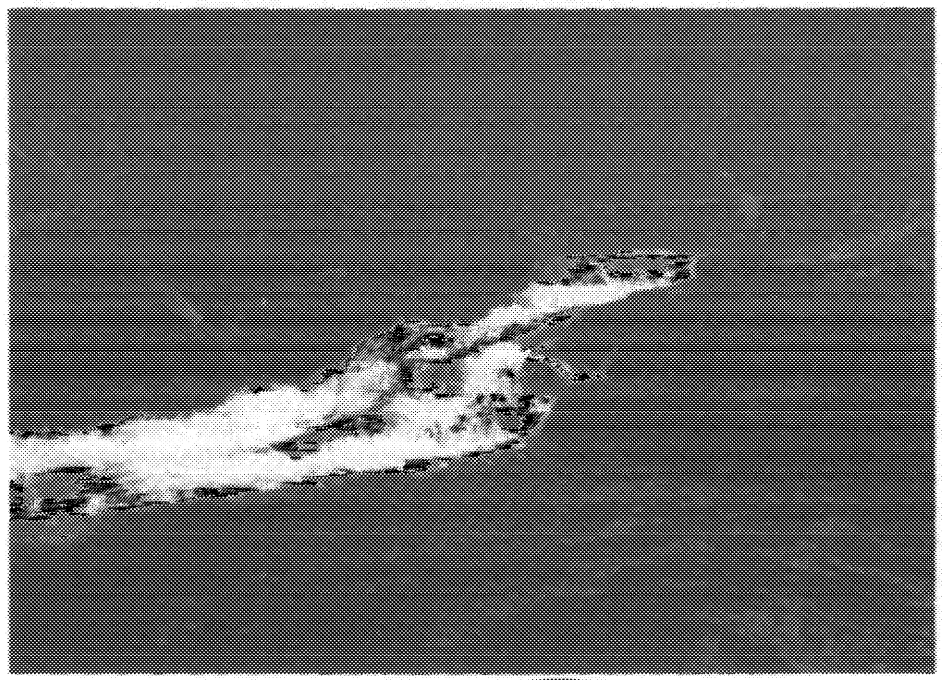

Figure 47. Site # 7, pre-blast, 1984, upstream view.

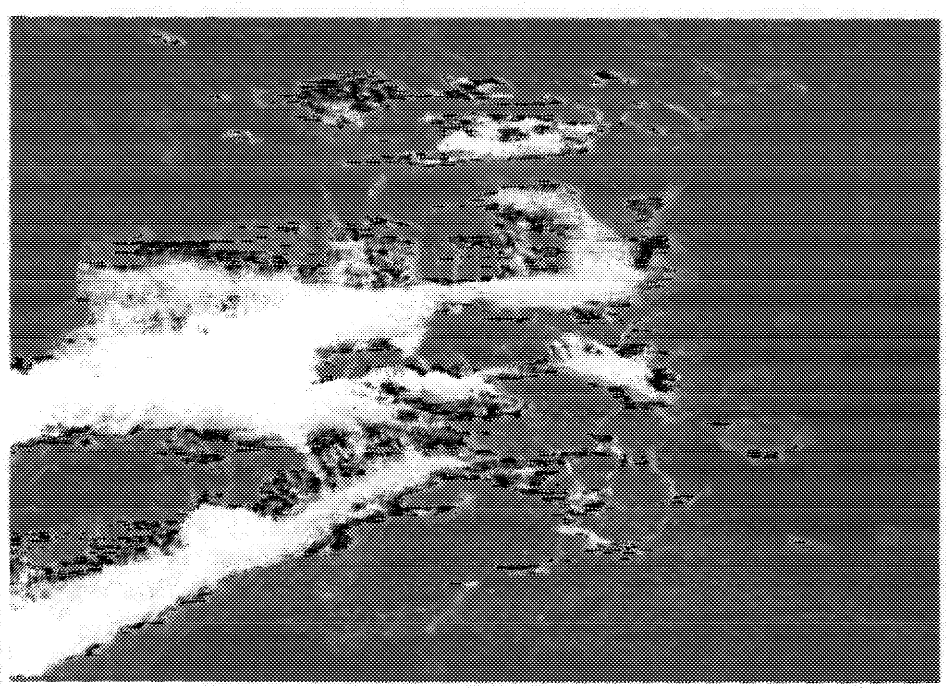

Figure 48. Site # 7, pre-blast, 1985. An upstream view of the upper jump.

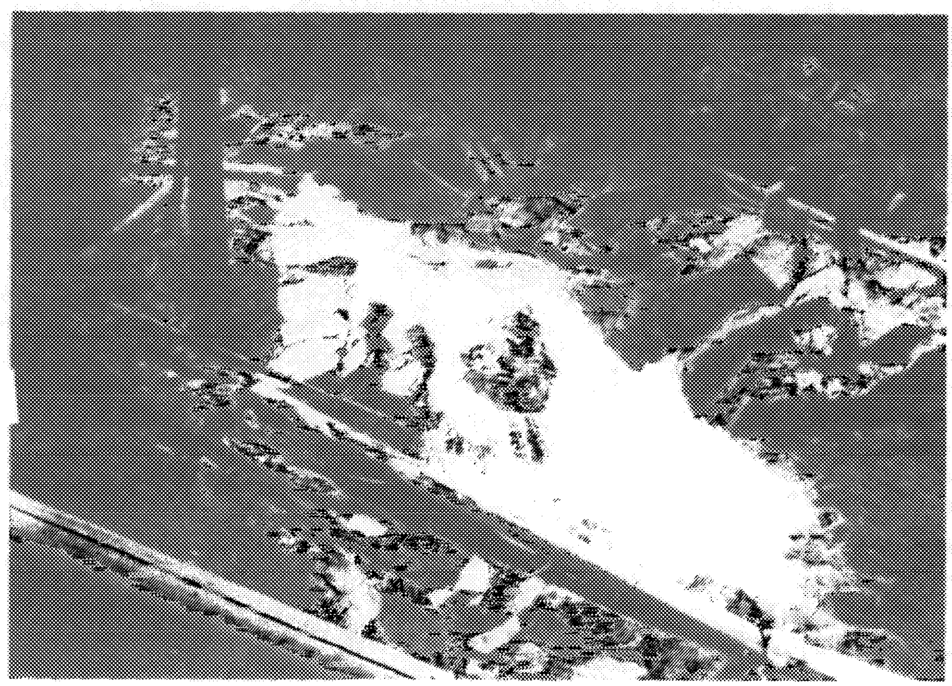

Figure 49. Site # 7, pre-blast, 1985. An overhead view of the barrier.

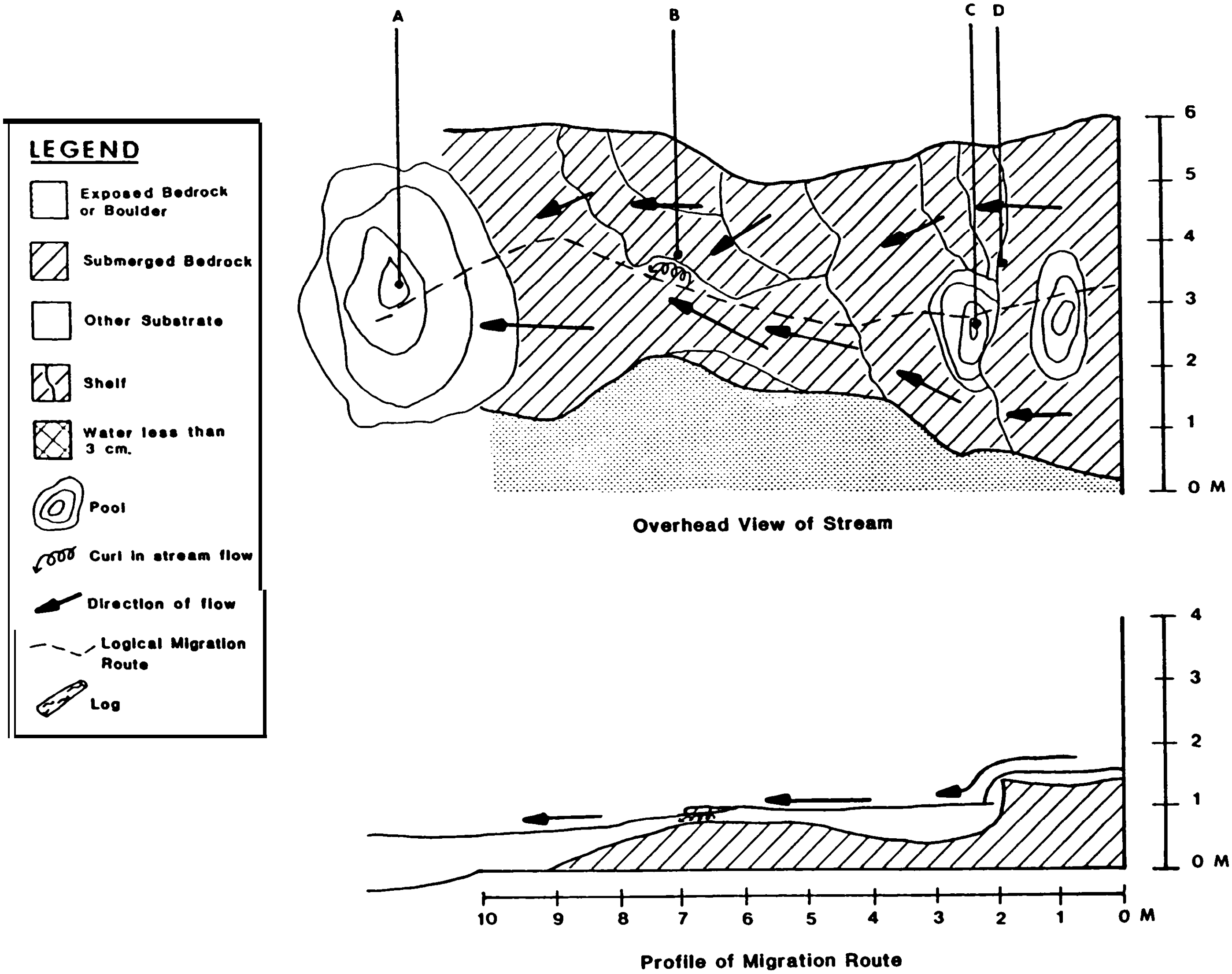

Figure 50. Post modification diagrams, Site # 7, Crooked Fork Creek, August 1985.

Figure 51. Site # 7, post-blast, 1985, upstream view. The curl of water that fish will be able to swim up is shown in the lower right-hand corner of the downstream jump.

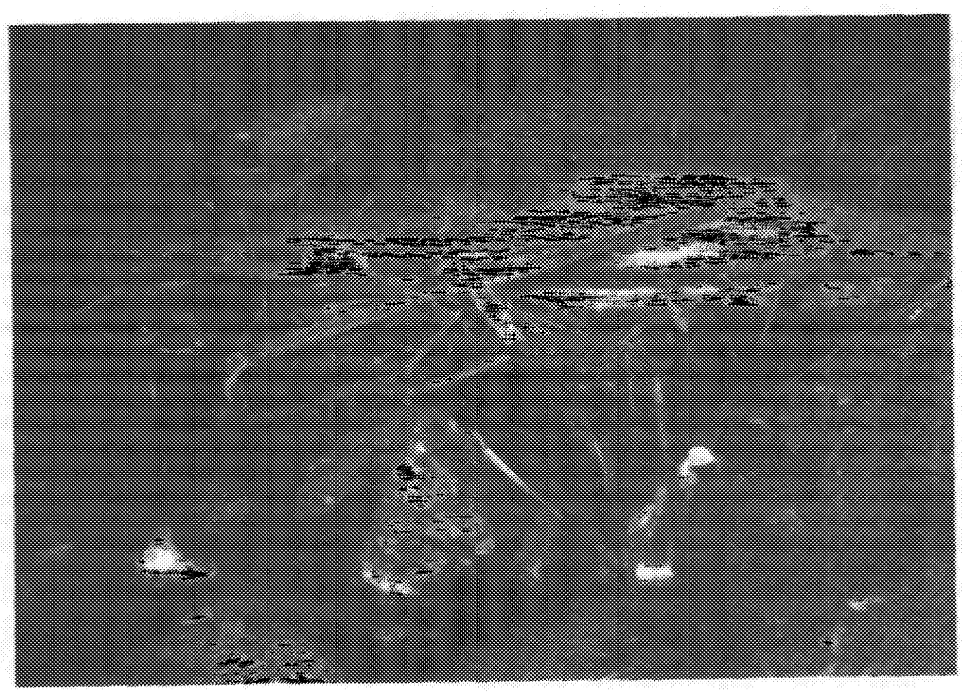

Figure 52. Hopeful Creek debris jam prior to blasting in 1984.

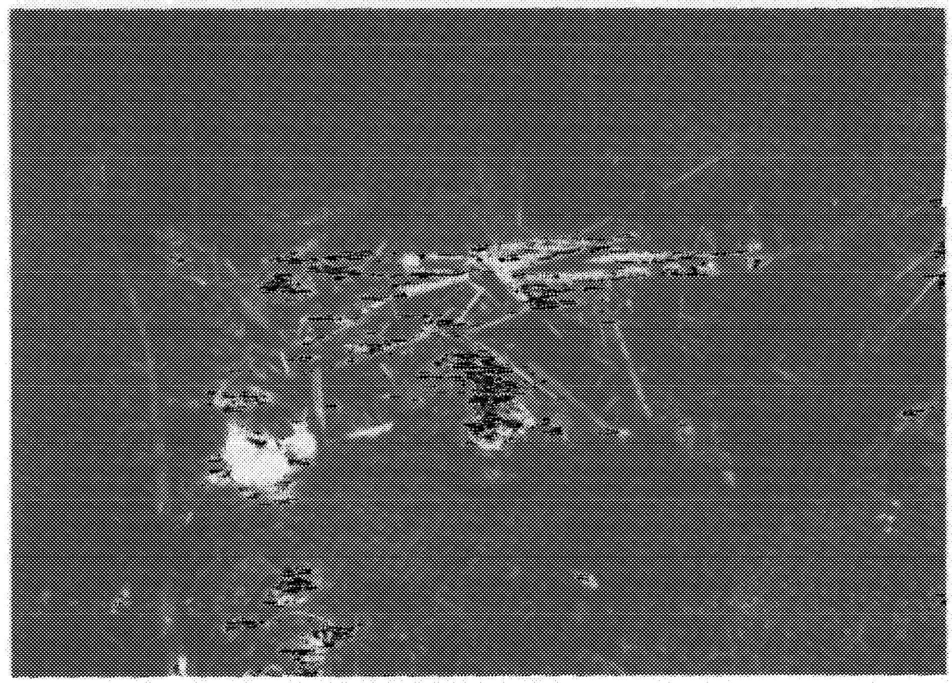

Figure 53. Hopeful Creek debris jam. Note the partial hand removal begun on the left side of the stream channel.

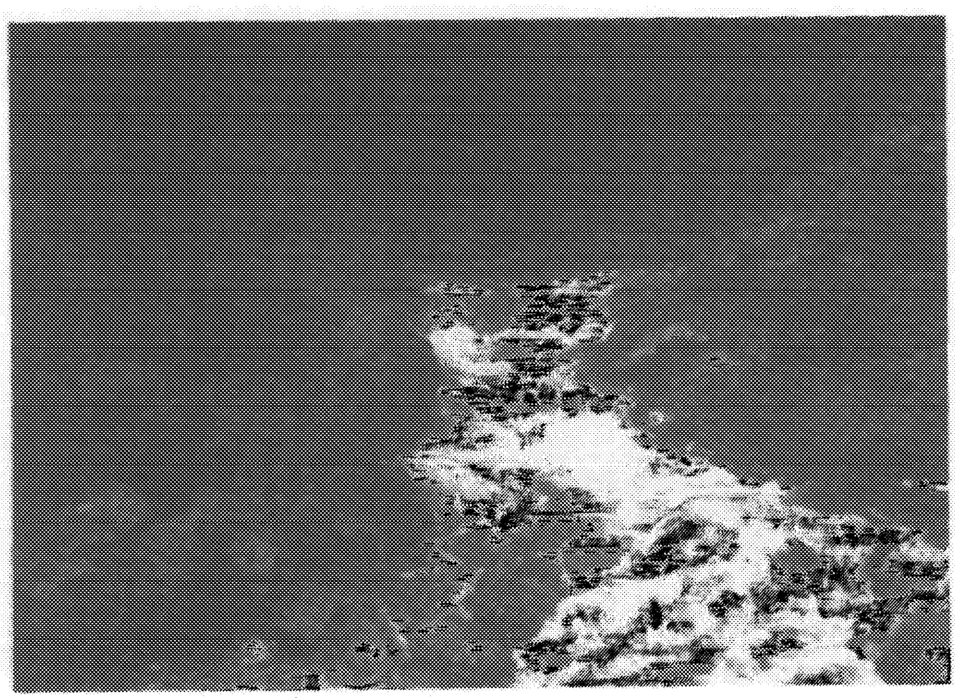

Figure 54. Hopeful Creek after removal of the debris jam. The bedrock boulder in midstream was blasted and the debris piles burned.

In the past, runs of both steelhead trout and chinook salmon have been severely depressed. In 1985, the largest run of chinook salmon in many years was observed on the Crooked Fork. A total of 47 redds and 55 adults were observed in a two mile reach of the Crooked Fork below the confluence of Shotgun Creek. No fish were observed near the barrier sites. Unfortunately, full utilization of the expanded habitat will not be realized until fish runs of both chinook salmon and steelhead trout are greatly increased. It is highly recommended that disease-free -juvenile salmonids be released above the barriers to accelerate the recovery and expansion into this area.

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Murphy, L.W., and H.E. Metsker. 1962. Inventory of Idaho streams containing anadromous fish including recommendations for improving production of salmon and steelhead, part II Clearwater River drainage. State of Idaho, Dept. of Fish and Game. 197 pp.

ACKNOWLEDGEMENTS

Special thanks are given to Phil Day for his hard work and safety consciousness during the hazardous and sometimes uncomfortable conditions of the project. Jim Norwood and Burt Currence, our blasters , deserve recognition for completing this project in a safe and professional manner. Thanks also to Teresa Seloske for her assistance on the diagrams.

APPENDICES

APPENDIX A

Summary of Expenditures

Salaries	18,467
Travel and transportation	1,214
Nonexpendable equipment and material	----
Expendable equipment and material	2,500
Operations and maintenance	964
Overhead*	----
Total	23,145

* Withdrawn at Supervisor's Office

APPENDIX B

BARRIER ANALYSIS ON ELDORADO CREEK, CROOKED FORK AND SKULL, QUARTZ AND ISABELLA CREEKS

CLEARWATER NATL. FOREST

Prepared for:

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Prepared by:

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August 31, 1985

REGISTERED PROFESSIONAL ENGINEER
4865
STATE OF IDAHO
JOHN F. ORSBORN

John F. Orsborn

Work conducted under Purchase Order No. 40-0276-5-477

WATERFALL ANALYSIS ON: (Barriers to migration)

1. Crooked Fork of the Lochsa River;
2. Eldorado Creek; and
3. Skull, Quartz and Isabella Creeks.

INTRODUCTION

This work was accomplished in two phases:

1. A review of the blasting and waterfall modifications made at the sites on Crooked Fork and Eldorado Creek in 1984; and
2. The recommendations for modifying the barriers (potential) to upstream migration by kokanee in Skull, Quartz and Isabella Creeks.

Field visits were made to the Eldorado Creek sites on Aug. 12, 1985 and the Crooked Fork sites were visited on Aug. 13, 1985. The Skull, Quartz and Isabella Creek Sites in the Canyon Ranger District were visited on Aug. 30, 1985.

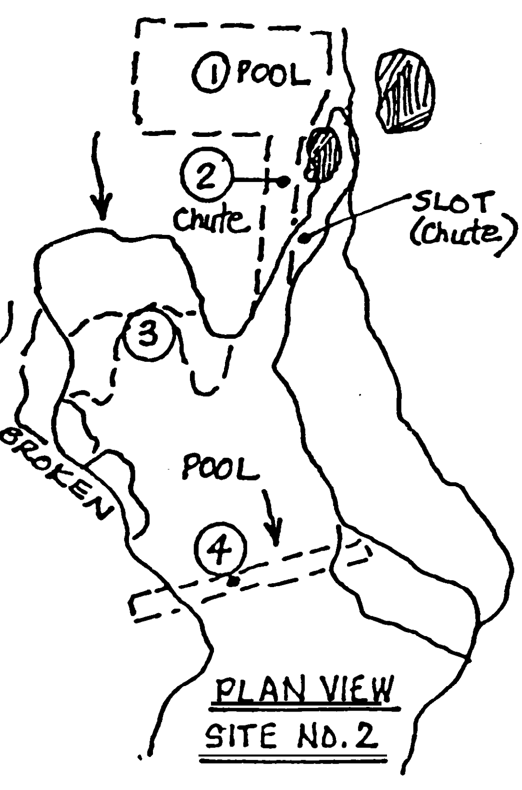
At SITE No. 4, where the barrier has been created by large boulders rolling into the stream from the road fill, most of the work has been completed. The main pool depth needs to be increased and the overall size of the pool increased.

CROOKED FORK SITES - Powell District

Complications due to unusual rock breakage at some sites in 1984 was the main reason for visiting sites (Barriers) 2-7 in 1985.

At SITE No. 2 (No. 1 not visited) four (4) separate alternative steps were discussed:

(1) Excavate upstream pool;
(2) Enlarge the existing chute;
(3) Square the downstream (d/s) rock face in the middle pool and deepen it;
(4) Install a log weir at the d/s end of the pool to raise the pool and reduce the jump height.



Priorities were set on the alternative modifications, with observations of flow conditions to be made after each modification. Unnecessary modifications were to be eliminated from further consideration. The priority was:

(1) upstream pool; (A1)
(2) square the falls face; (A3)
(3) deepen the downstream pool; (A3)
(4) install the log weir; and (A4)
(5) enlarge the chute. (A2)

SITES 3-7 had been modified in 1984, and for the most part just needed some further adjustments. SITE No. 5 (p.12 in Orsborn report*) was completed according to plan in 1984 and did not need to be adjusted. At SITE No.6 (p.12, also) the central pool slab did not hold due to thin layers and weakness in the granite. Redrilling had been accomplished and the overall plan of adjustment looked adequate.

---

* Appendix B in Kramer, R.P., P.K. Murphy and F.A. Espinosa. n.d. Upper Crooked Fork Fish Barrier Removal Project. Annual Report. BPA Project DE-AI79-84BP-16535. (1984-JFO)

At SITE No. 7 (p. 11) the modified blasting (drill) holes had been drilled and marked. Pool deepening was needed in the central pool (Pt. B in figure on p. 11 of App. B), but several planned charges were eliminated to maintain correct flow conditions and maintain structural integrity.

The V-Rock Berm installed downstream was partially washed out by high flows this past spring because only hand-placed rock was used and not keyed. It was recommended that the berm be rebuilt using several, interlocking rows of rock, only one rock high. This berm will raise the lower pool and improve leaping conditions at the first step in SITE No. 7.

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APPENDIX C

Report on

CORRECTION OF FISH PASSAGE BARRIERS ON ELDORADO CREEK AND CROOKED FORK

—

CLEARWATER NATL. FOREST

—

Prepared for

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Prepared by

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Work Conducted Under

PURCHASE ORDER No.
43-0276-4-0361 (6/4/84)

AUGUST 7, 1984

PART 1. FOUR BARRIERS ON ELDORADO CREEK;

PART 2. BARRIERS ON CROOKED FORK OF THE LOCHSA RIVER NEAR POWELL, IDAHO.

DESIGNS PROVIDED IN THE FIELD 8/1/84.

REGISTERED PROFESSIONAL ENGINEER
STATE OF
JOHN F. ORSBORN

CROOKED FORK

These barrier sites consist mostly of sloping layers of bedrock which cause depth and velocity barriers for Chinook during lower flows in July and August.

In addition, many of the barriers provided poor jumping conditions at their bases because: (1) the jets splash on rocks and are diffused; (2) the jets strike the pool at a flat angle which disorients leaping fish; or (3) no adequate pool is available from which to leap.

Large boulders and irregular rock structure complicated many of the passage problems by: (1) not providing adequate landing conditions for leaping fish; (2) causing discontinous flow paths of adequate depth to negotiate high velocities; and (3) providing unstable conditions for modifying the barrier (some solutions may have developed into other passage barriers.

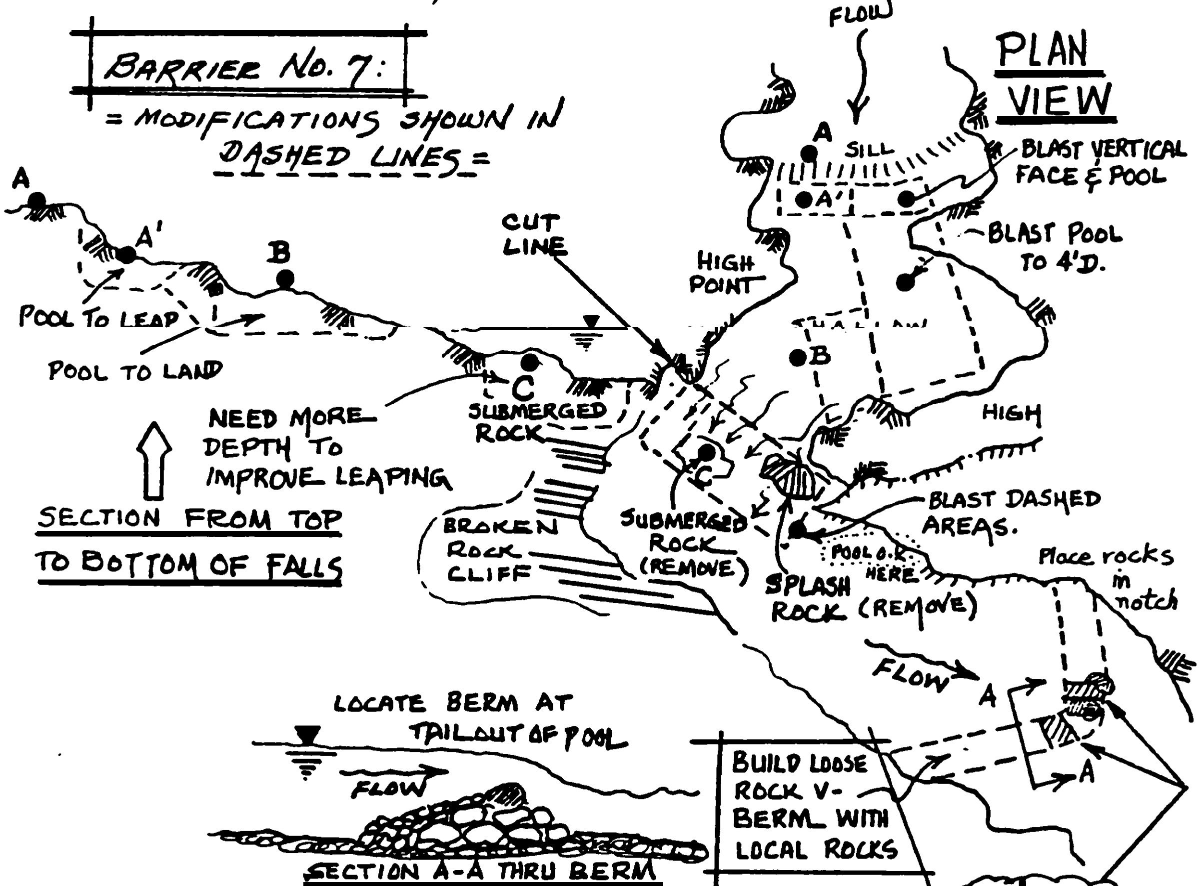
The sites on Crooked Fork were visited on 8/1/84. Late departure by helicopter only allowed enough time to visit 5 or the 7 designated barriers (Nos. 7-3 starting at the downstream end). Barriers 1 & 2 were observed from the air during the return flight to Powell Ranger Station.

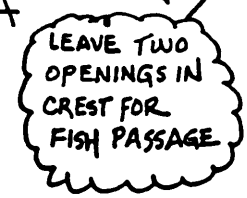
As the site investigation team progressed upstream from the lowest barrier (No. 7), each barrier was discussed, alternative solutions were considered and recommended modifications were marked and noted in field books. Numerous smaller and less obvious barriers were noted, discussed and marked for correction besides the major barriers Nos. 3-7. Also, initial modifications of the barriers sometimes necessitated upstream modifications in the channels to match the flow patterns with the flow path of the modified barrier.

A summary analysis of each of the barriers visited is presented with a plan view sketch and sectional view(s) showing areas which should be excavated or modified in order to assist Chinook past these barriers during lower flow periods.

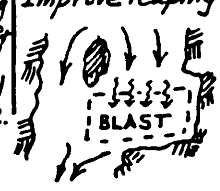
BARRIER No. 7:

= MODIFICATIONS SHOWN IN DASHED LINES =

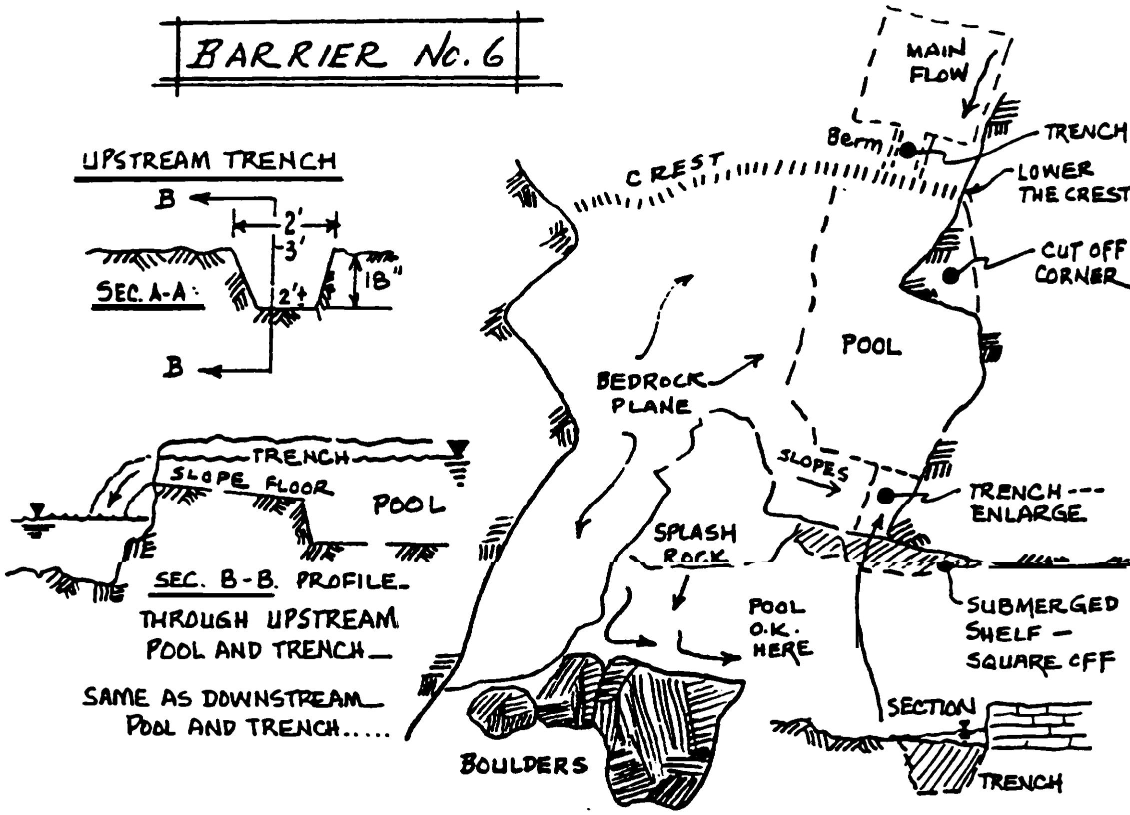




Beginning at the downstream end of the pool, the following modifications should be made to improve passage conditions at Barrier No. 7:

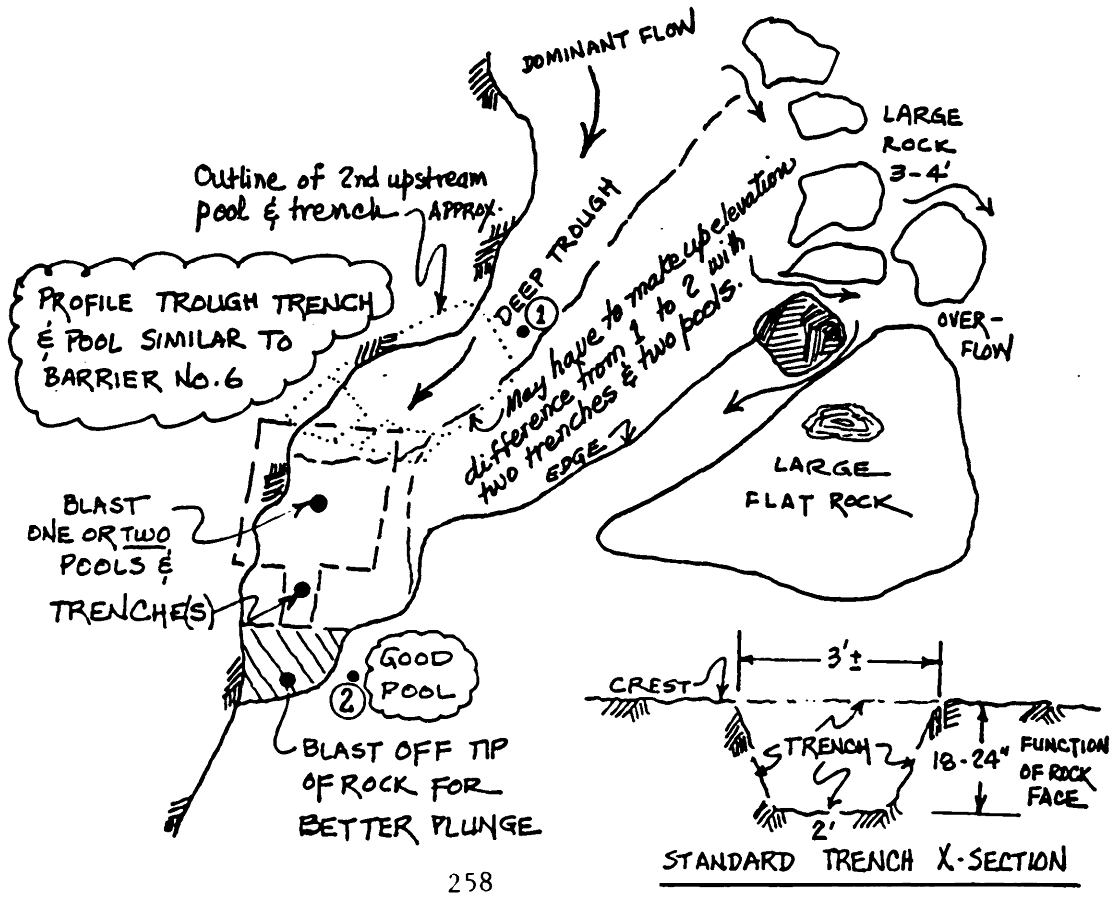
LOCATION	CHANGE	REASON	LOCATION	CHANGE	REASON
• C - SPLASH BEDROCK(S) AT BASE OF FALLS AND SLOPING FACE.	CUT AWAY ALONG CUT LINE ON RT. BANK	PROVIDE BETTER JUMP ANGLE & POOL.	• B - A'	EXCAVATE POOL	REST AND LEAP POOL ALONG LEFT SIDE AND ACROSS FACE TO A'.
• BUILD LOOSE ROCK BERM AT CHANGE IN GRADE.	RAISE POOL	REDUCE DROP IN FALLS BY 1 FT ±. INCREASE POOL DEPTH.	• A'	CUT FACE VERTICAL	TO PROVIDE EASIER LEAP TO A.
• B - TOP OF FIRST (LOWER) FALLS	EXCAVATE POOL TO 4'	PROVIDE DEEP LANDING	Cascade just above Barrier No. 7	Cut off long yellow finger of rock and enlarge pool on left side.	Improve leaping. 

BARRIER No. 6



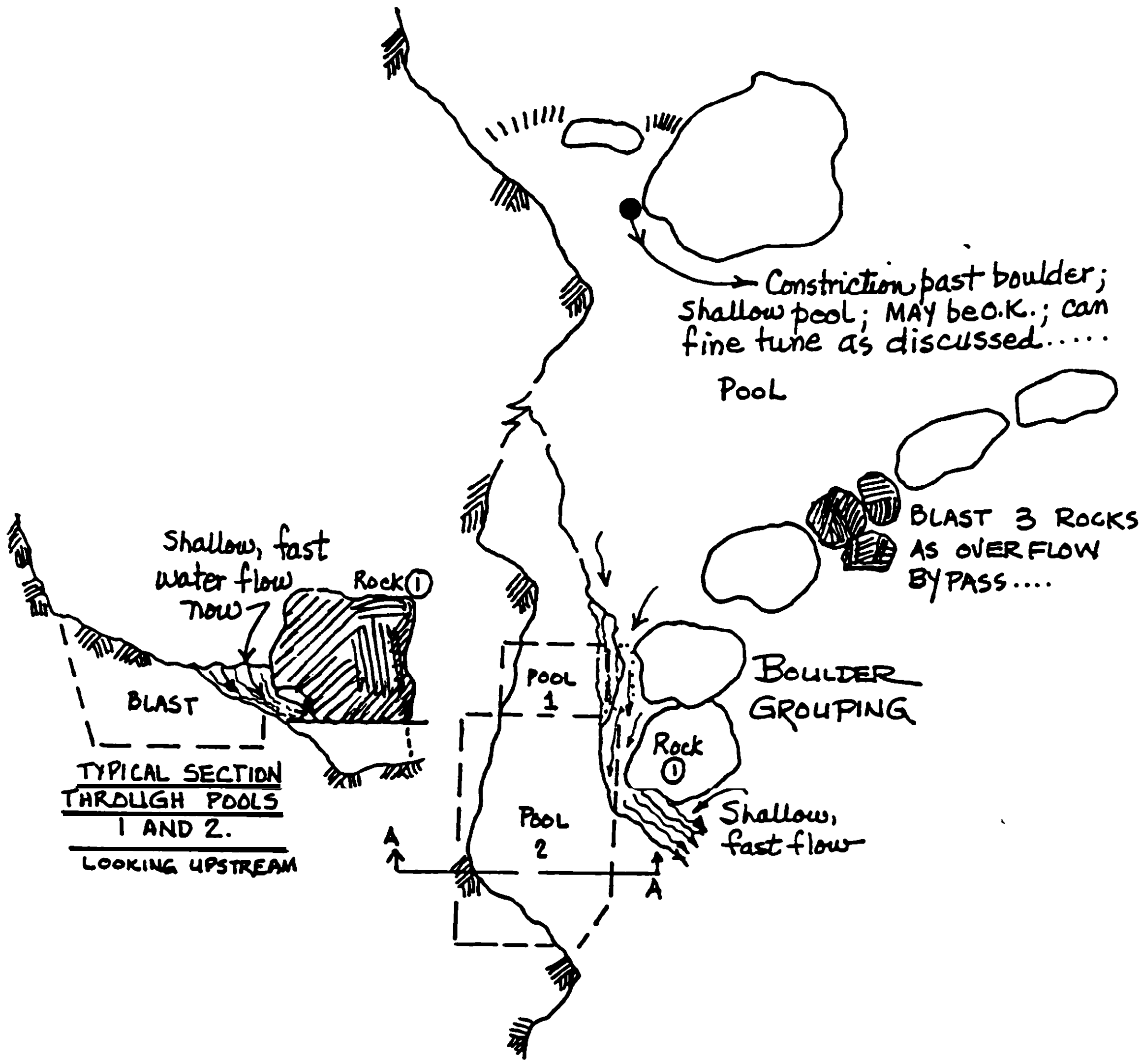
BARRIER No. 5

DIAGONAL CHUTE WITH LARGE TRIANGULAR TABLE ROCK ON LEFT -



BARRIER NO. 4

LOWER BOULDER GROUPING
— AND —
UPSTREAM CHUTE
AROUND LARGE BOULDER



Site No. 3 was documented and marked in place by the District biologist, as were numerous intermediate, lesser barriers.

Sites 1 & 2 were not visited on the ground, but were observed from the air and discussed as to the modifications to be made.

Slides of Barriers 4-7 are appended.

SOUTH FORK CLEARWATER RIVER

HABITAT ENHANCEMENT

ANNUAL REPORT - 1985

BY
Don Hair, Project Biologist
and
Rick Stowell, Project Coordinator
U.S.D.A. Forest Service
Nezperce National Forest

Prepared for

Lorry B. Everson, Project Manager
U. S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife

Agreement No. DE-A179-84BP16475
Project No. 84-5

March, 1986

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TABLES AND FIGURES

INTRODUCTION

In 1927 a dam was constructed on the South Fork of the Clearwater River at Harpster, which totally eliminated anadromous fish runs into this important spawning and rearing habitat. In 1935 a fish ladder was constructed at the dam but was reportedly only minimally successful. In 1962 the dam was completely removed. By this time, however, the anadromous runs had been eliminated from the drainage. Additional activities in the drainage that have had impacts on the anadromous fish habitat include mining (both dredge mining and hydraulic mining for gold), grazing (especially on private lands in Red River), and timber harvest and road construction which have increased sediment loads in the streams.

Idaho Fish and Game began a program of re-introduction of anadromous salmondis in 1962. Hatching channels were constructed on Red River at the Red River Ranger Station and on Crooked River near Orogrande. These were stocked annually with eyed eggs. Species stocked varied and included coho salmon, chinnook salmon and steelhead. The Crooked River channel was abandoned several yeare ago when the lease on private land terminated; however, the Red River Channel has continued in operation. Host of the recent use (1978-1983) has been with steelhead. In 1977 Idaho Fish and Game constructed a rearing pond at Red River which is used to rear 200,000-300,000 spring chinook salmon annually. The pond is stocked with fry in the spring. After rearing in the pond over the summer, a portion are marked end all are released into Red River at the pond site.

The U.S.F.S. began a program of active habitat inporvement in the Red River, Crooked River, and Newsome Creek drainage systems in 1980. These are continuing on an annual basis utilizing Forest Service funding. Since the B.P.A. project proposal has been approved, the Red River District has directed its emphasis to the South Fork of Red River, and the Elk City District has concentrated on Newsome Creek. These projects will complement the B.P.A. work being carried out in Red River and Crooked River. The U.S.F.S. contribution to the rehabilitation of the South Fork Clearwater system was $7,800 in 1983, $30,157 in 1984, $96,347 in 1985, and is projected to be $120,000 in 1986.

DESCRIPTION OF PROJECT AREAS: The projects are on the Red River and Elk City Ranger Districts of the Nezperce National Forest (Figures 1 & 2).

The Red River project area consists of approximately 19 miles of stream with 50% on U.S.F.S. land and 50% on private land. Stream reaches involved include both meandering meadow reaches and timbered valley bottoms. Fish habitat problems are the result of overgrazing and previous dredge mining for bold.

The Crooked River project area covers 10 miles of stream with more than 90% on U.S.F.S. land. Fish habitat problems are associated with past dredge mining activities, for gold, which channelized the stream channel and eliminated the riparian meadow.

METHODS

Because of the scope of these projects, and multiple land ownership pattern, it was necessary to develop a systematic approach for evaluation, design and execution of the projects. The first step was to separate the streams into reaches with similar characteristics. On Crooked River each reach was considered a project segment while on Red River each reach was separated into individual project segments based on ownership.

After stream reaches have been identified, each reach is evaluated for fish habitat problems and potential habitat improvement projects. The resulting project proposals undergo continuing review and revision until a final project design is selected.

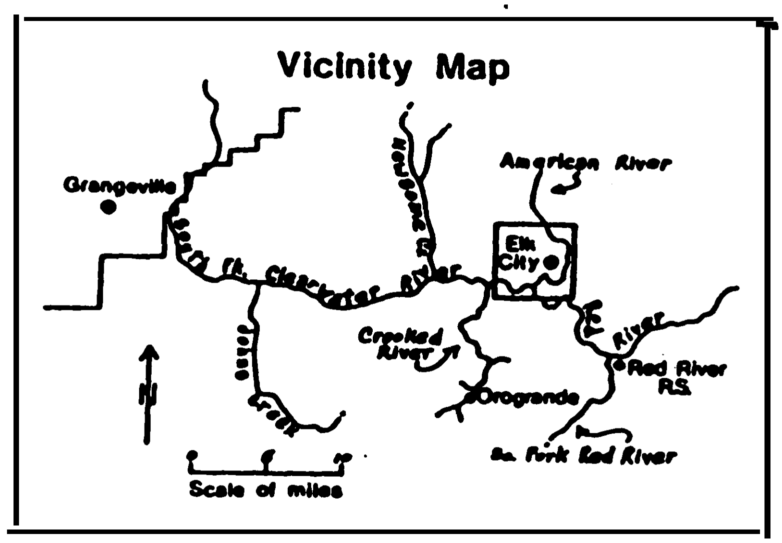
Methods used in 1983, 1984, and 1985 were standard fish habitat improvement projects including log weirs, deflectors, bank overhangs, bank stabilization structures, riparian fencing, boulder placement and riparian vegetation planting.

Descriptions of the habitat problems identified, and various treatments of the problems, were presented in the 1984 annual report which is available from BPA. This progress report wil l deal with additional treatments which were not covered previously.

Specific activities to be discussed in this report include: 1) flood plain construction, 2) connection or construction of ponds and/or side channels, 3) vegetation “clump” plantings, and 4) test plantings of various shrub species.

FIGURE 1

Crooked River Fish Habitat Improvement Project



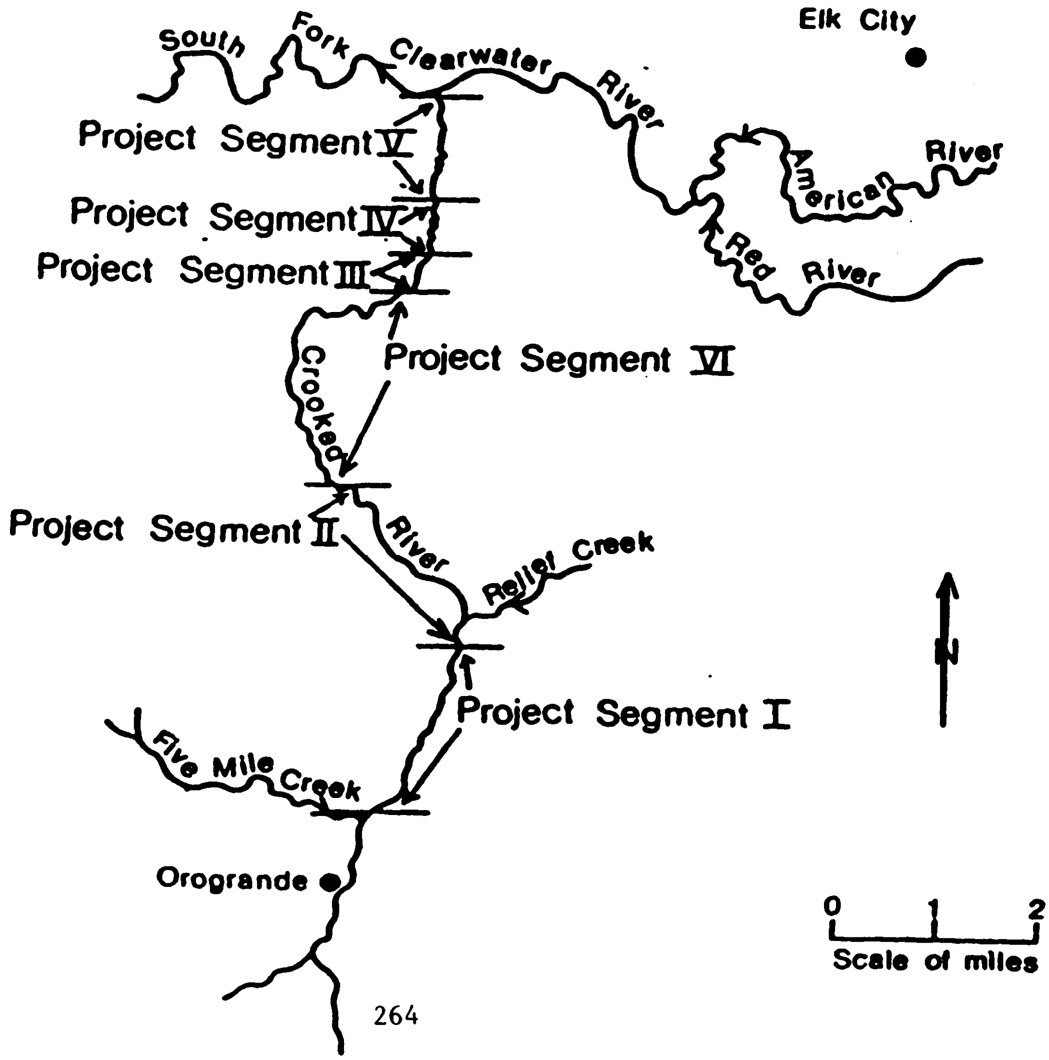
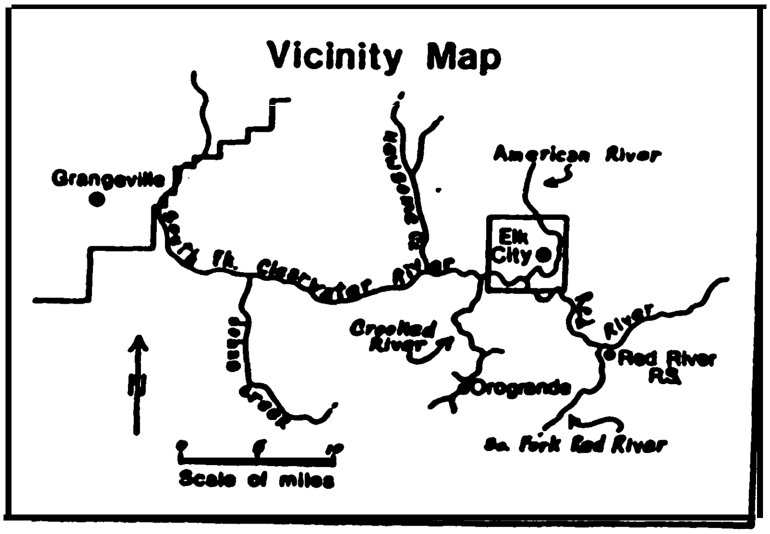
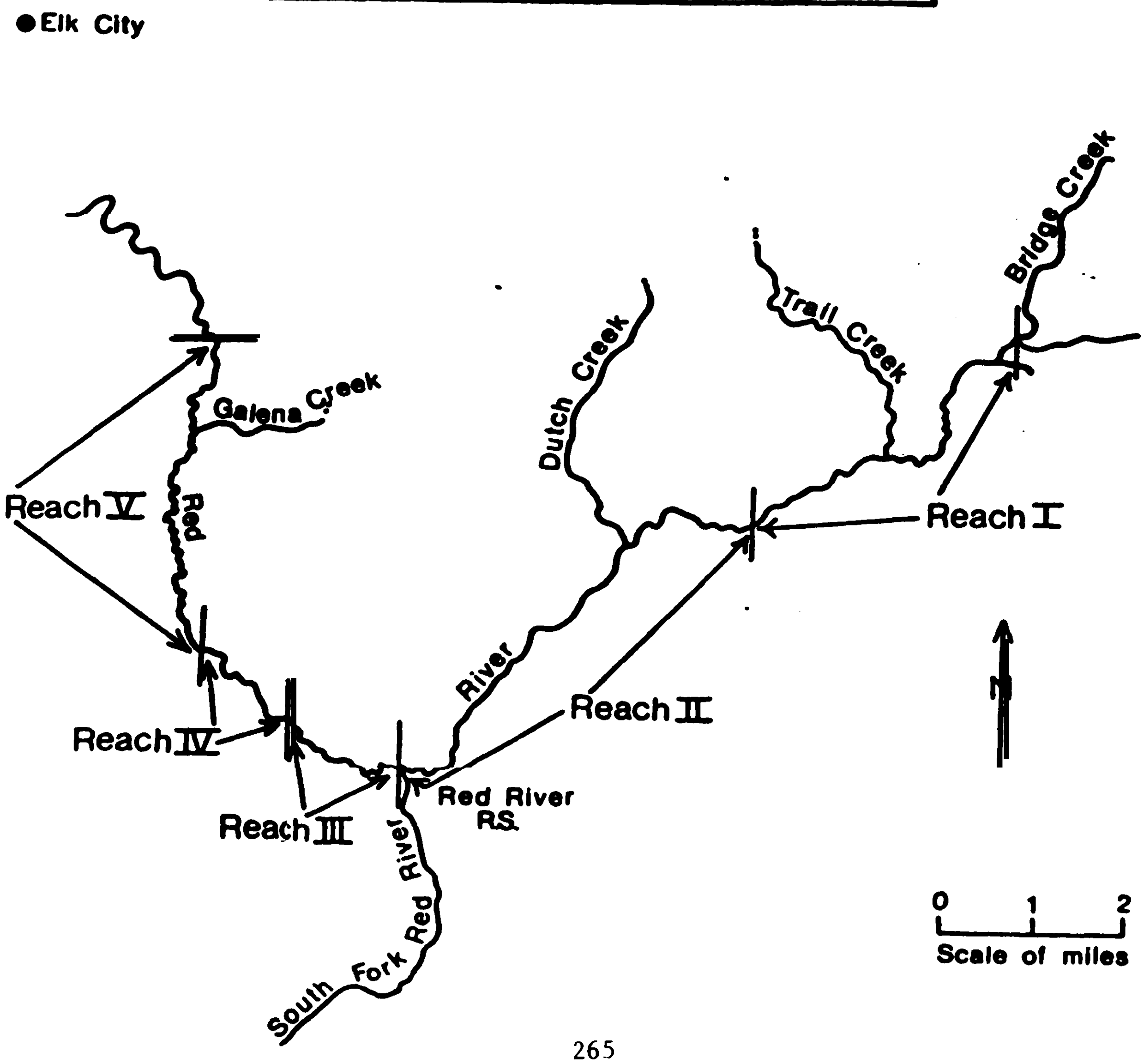


FIGURE 2

Red River Fish Habitat Improvement Project





Flood plain construction. Along Crooked River in areas where dredge tailings have created an unnatural channel, especially at high flows, we attempted to create a flood plain. The objective is to provide conditions which more naturally duplicate a meadow type stream. Activities began early in the spring when a D-7 cat was used to create small access roads across the dredge tailings, and to lower and level tailings piles adjacent to the stream. The next step was to install planned instream structures. Finally, a hydraulic excavator was used to move the remaining tailings to a level where the stream would over top the bank during spring runoff (See Figure 3). For the initial trial of this technique, we excavated down to the level where vegetation was growing on the tailings piles. After monitoring for a season, and completion of cross section surveys, we will attempt to refine this technique for future use. Things we hope to accomplish with this technique are: 1) enhanced revegetation success, 2) deposition of fine materials on the flood plain during spring runoff and 3) reduced scouring during floods.

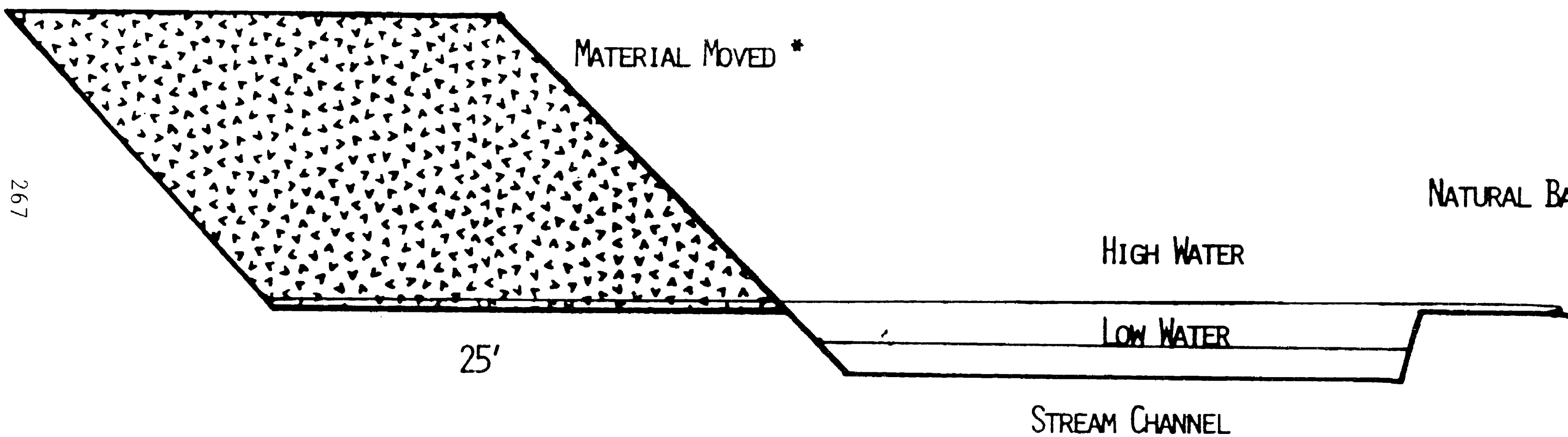
Ponds and side channels. This type of activity was used in both Crooked River and Red River. In Crooked River, existing ponds at three sites were connected to the stream. At two of the sites, the ponds were connected at both the upstream and downstream ends of the ponds so that a small portion of the stream is flowing through the ponds (See Figures 4 and 5). At the other Crooked River site, one pond that has a considerable amount of intergravel flow was connected only at the lower end (See Figure 6). The objective here was to provide an off channel refuge during spring runoff. All of these connections were made using the hydraulic excavator. Finishing touches to the connecting channels (placing rip rap, planting, installing log drop structures) were completed by hand.

In Red River four sites were treated , three by opening existing side channels, and one by excavating a new channel. This work was done using a small track mounted backhoe (John Deere 555-D). It is anticipated that Idaho Department of Fish and Game monitoring will take place on these side channels next season (1986) and will provide information on the extent these add to rearing habitat.

Clump plantings. This technique was observed on the Umatilla National Forest and it appeared to be very successful. We tried incorporating it into our flood plain construction areas on Crooked River. It is done by excavating a hole in the dredge tailings down to water level. Whole clumps of shrubs (several plants) are then dug up away from the site by the excavator and placed in the hole. Our concern is for survival of these plants since it was done during the hottest part of the summer (Kid-late August).

FIGURE 3

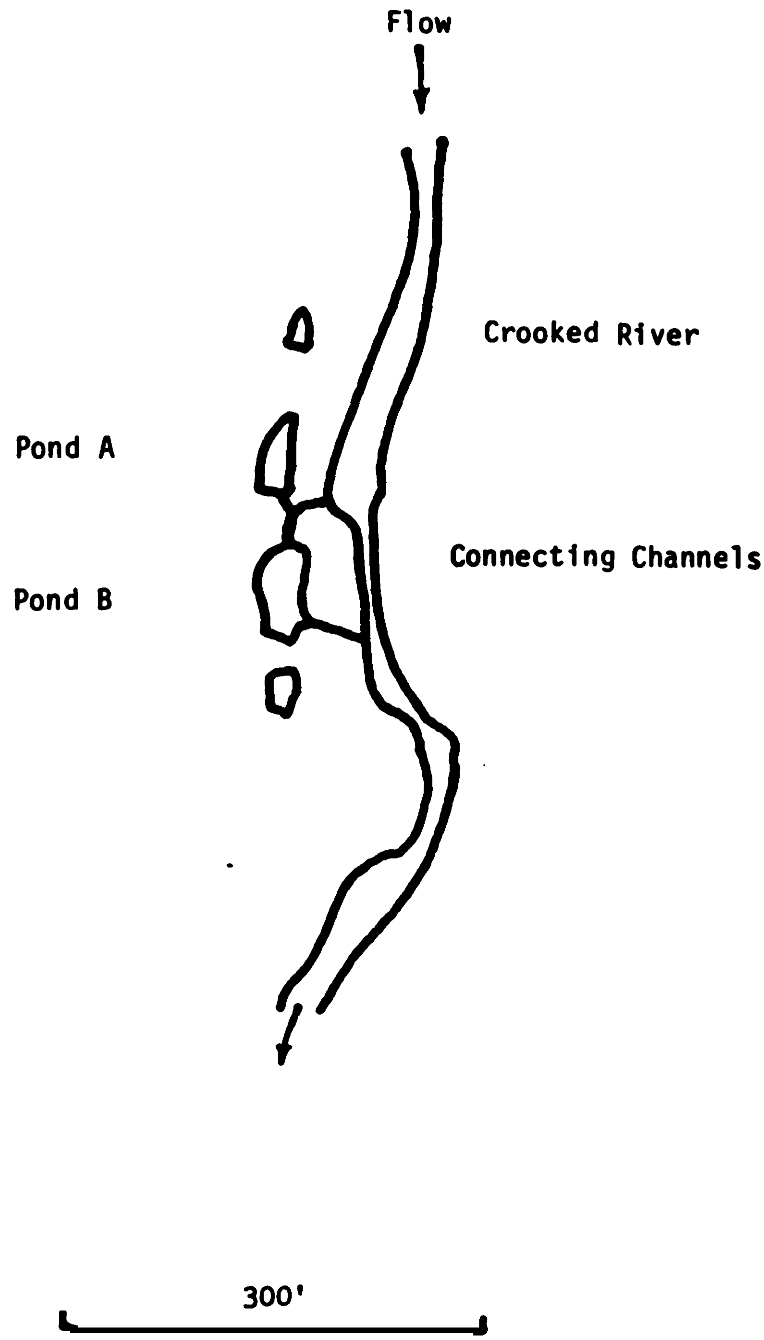
SCHEMATIC OF FLOOD PLAIN CONSTRUCTION



*TREATING 930 LINEAR FEET OF STREAM BANK REQUIRED MOVING APPROXIMATELY 10,300 YD^3 ROCK AND RUBBLE MATTERIAL.

FIGURE 4

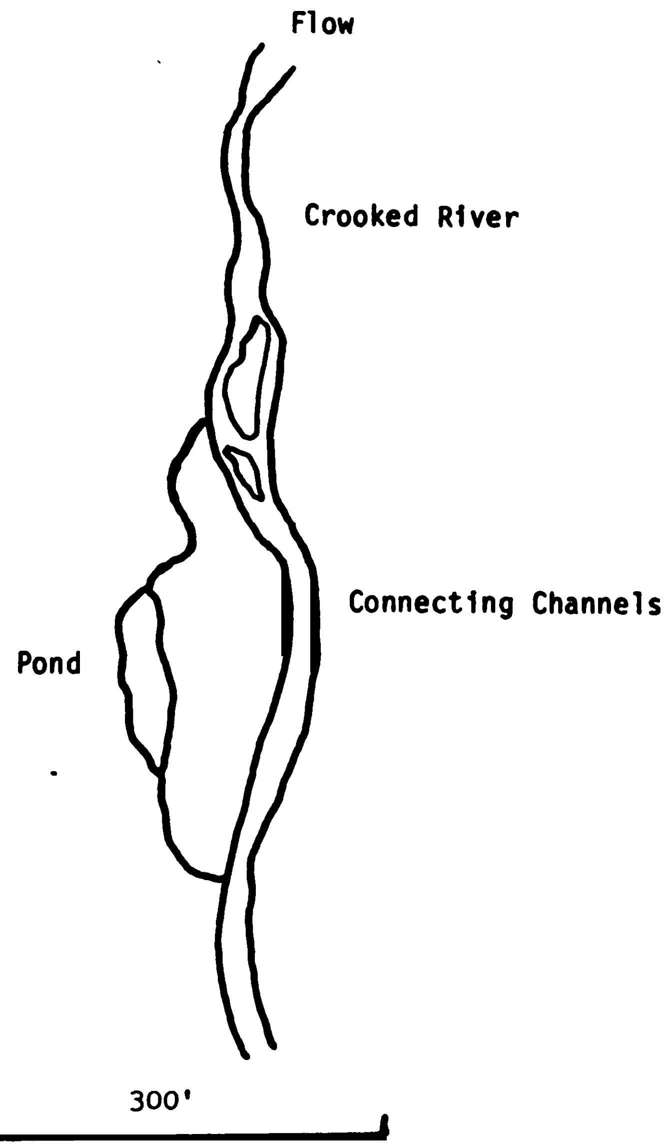
Site 1 - Ponds Connected to Crooked River



Pond A = 53' x 18' = 954 $ft.^2$
Pond B = 70' x 26' = 1820 $ft.^2$
Channels = 100' x 3' = 300 $ft.^2$

FIGURE 5

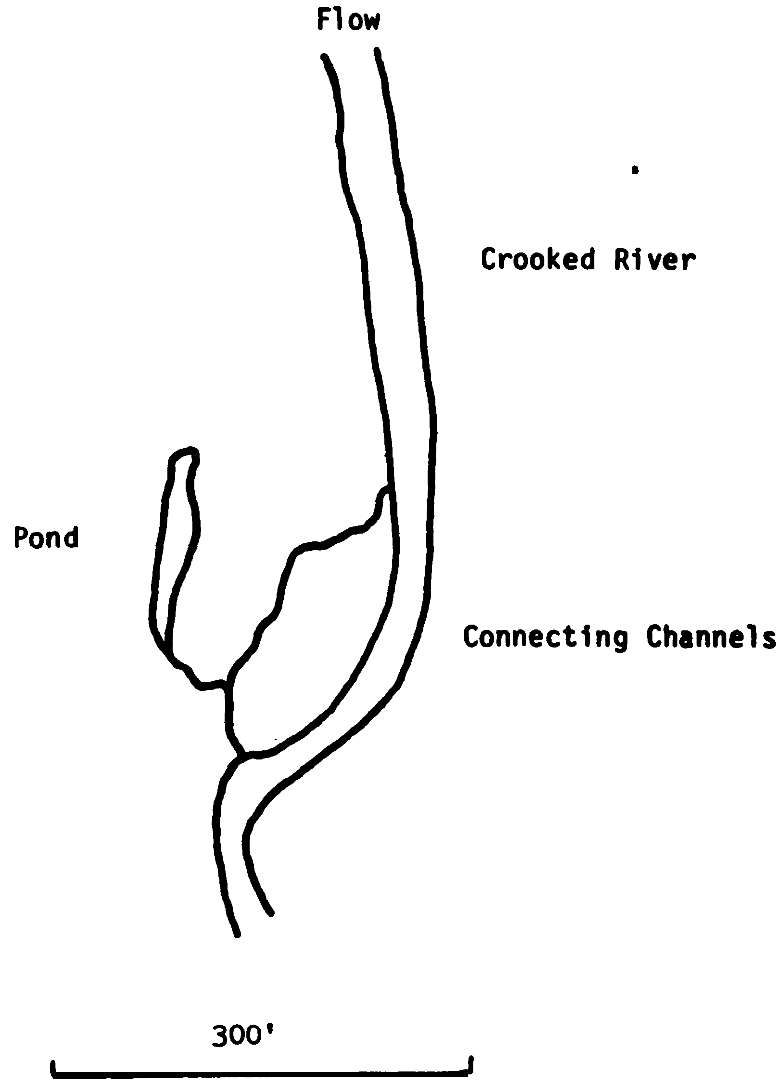
SITE 2 - POND CONNECTED AT BOTH UPSTREAM AND DOWNSTREAM ENDS



Pond = 142' x 28' = 3976 ft.^{2}
Channels = 200' x 3' = 600 ft.^{2}

FIGURE 6

SITE 3 - POND CONNECTED AT DOWNSTREAM END ONLY



Pond = 130' x 18' = 2340 $ft.^2$

Channels = 95' x 3' = 285 $ft.^2$

Trees placed for cover structures. This activity entailed identifying areas where we could get to the stream and operate without disturbing structures already in place. A hydraulic excavator was moved to the site. It then crossed the stream, accessed pre-selected trees and moved them to the stream where they were placed for cover. Whole trees (including roots) were used instead of cutting trees and cabling them to the banks or leaving large portions of the tree on the banks.

Test plantings - To better evaluate survival of plantings in the dredge tailings, we set up test plots. These included both local cuttings and rooted nursery stock. Plantings were on a 2' x 2' spacing on tailings piles with six rows of four plants in each test plot. The planting plots were marked with metal fence posts at the corners and 1/2 the plantings were protected with vexar tubes held up with bamboo stakes.

Instream structures (described in 1984 annual report).

Results and Discussion

Accomplishments -

Crooked River - During 1985, treatments were carried out in two stream reaches. In Reach I (treated last year) additional instream cover was added in the form of trees, root wads and boulders. In Reach II treatments included use of pool forming structures, cover structures, boulder placements, bank stabilization activities and connecting ponds to provide additional habitat. See Table 1 for a summary of structures used in each reach.

Red River - All improvement activities were carried out in Reach II this year. improvements were designed to enhance pools habitat, instream cover, bank stability and provide additional rearing habitat by opening side channels. (See Table 2).

Monitoring (Results and Needs)

Revegetation Efforts - In Crooked River three test sites were marked with metal fence posts and various containerized shrubs and Local cuttings planted on a 2' x 2' spacing. Observations in the fall indicated very low survival. See Appendix 1 for a summary report of the planting activities. A systematic survey of the plots will be carried out in the spring of 1986 to determine 1st year survival.

Additional activities which need to be carried out include planting additional test plots and then treating these with some type of regular irrigation system. This may be critical for establishment of trees and shrubs on the rubble tailings piles.

Table 1. Summary of accomplishments, Crooked River, 1985.

Treatment	Number
Upstream V Boulder Weirs	8
Upstream V Log Weirs	1
Downstream V Boulder Weirs	6
Diagonal Log Weirs	14
Deflector Logs	12
Treated Cut Banks	3 (3,750 square feet)
Root Masses	6
Random Boulders	104
Ponds Connected	4 (9,090 sq. ft. surface area)
Trees or L.W.D.	59
Fish House	1
Newly Created Side Channels	7 (395' total length)
Existing Side Channel Opened	1 (100' total length)
Flood Plain Created	3 Sites (21,145 sq. ft.)
Transplanted Brush Clumps	
Willow 12	
Snow Berry - 4	
Alder 17	
Service Berry - 1	

Shrubs Planted

Cottonwood	50
Red Osier Dogwood	125
Siperion Pee	25
Hybrid Poplar	300
Golden Willow	25
Arctic Blue Willow	25
Alder	500
Red Osier Dogwood (cuttings)	2,150
Willow (cuttings)	- 12,150

Table 2. Summary of accomplishments, Red River, 1985.

Treatment	Number		
Log Weirs			
Perpendicular			
With filter cloth	2		
Without filter cloth	1		
Diagonal			
With filter cloth	3		
Without filter cloth	5		
Boulder weirs[a]			
Perpendicular	1		
Upstream V	2		
Downstream V	1		
Rock weirs			
Perpendicular	1		
Diagonal	1		
Upstream V	4		
Boulder clusters[a]	4		
Rock deflector	1		
Log deflectors	5		
Anchored debris			
Cabled logs or trees	8		
Hoot wads	2		
Bank cover	5		
Instream cover	7		
Bank stabilization	4		25 m^2
Bank stabilization and bank cover	2		18 m^2
Off channel rearing			
Channel opened	3		175 m total length
Entire channel dug	1		98 m total length
Seeding, fertilizing, and mulching[d]	35	sites	10,500 m 440 m
Boulders hauled from Crooked River			
Used in 1985	125		
Mot used in 1985 section of stream	42		
For use in 1986 section of stream	82		
Additions to structures built in 1984	3		
Shrub plantings			
Rooted stock			
Red-osier dogwood	115		
Utah honeysuckle	120		
Russian olive	50		
Willow cuttings	500		

a Granite boulders

b Instream rock and boulders

c Includes only root wads as independent structures. Two other root wads are part of structures.

d A few sites in Reach II were seeded, but not mulched becaused the areas were small, the site was level, and the straw supply was nearly gone. The bank in Reach IV was not mulched because much of it was too steep, and seeded in spring.

Another revegetation technique used in Crooked River that will be monitored for success is "clump plantings". These are vegetation mate including shrubs that were transplanted using the hydraulic excavator. We anticipate potential problems because of the time of yeor that the plantings were done. If survival is low we will want to redo them either in the early spring or late fall and monitor results.

Both Red River and Crooked River received large numbers of planting6 of local unrooted cuttings of willow and Red Osier dogwood. as many of these sites as possible will be reviewed for survival after spring run off. If successful this technique will be used more in the future because it is realitively inexpensive compared to purchasing rooted nursery stock. Initial observation indicated good survival the first season of plantings in both Red River and Crooked River.

__Instream Structures__ - observation of previously installed structures indicated failure of only one type of structure, a downstream V shaped rock wier failed, and that may have been caused by vandalism. All other structures were functioning as designed. Maintenance was minimal for structures installed in 1986. The true teat of these structures will come with a 20 year recurrence, or greater, flood even t. Condition of structures will be monitored annually and maintenance scheduled as needed to assure that the structures continue to function as designed. Specific conditions we will check for this season include undercutting of the structure causing flow to percolate through the structure, erosion at end6 of the structure and downstream erosion.

__Food plain__ - The constructed flood plains sites will be checked to determine if they are functioning as designed i.e. overflowing the banks and depositing fine material during spring runoff, reducing erosion during highflows and providing good sites for revegetation. Additional work scheduled includes a site survey with flood plain and channel cross sections each 25 feet. The information resulting from this survey will be analyzed to estimate velocity and water depths at various flows. This information can then be compared to the calculated flow duration curves for Crooked River and will allow us to improve our design of flood plains for future projects in dredged areas.

__Fish__ - population monitoring ie being carried out by Idaho Department of Fish and Game under another contract with BPA. New or additional monitoring which would be helpful to this project includes monitoring use of ponds connected in 1986 and 1985 in Crooked River and density of fish in side channels opened in Red River. It would be especially useful to have seasonal (spring, summer and winter) density information. It would also be extremely helpful to have fish density and numbers for each age class presented by habitat type (pool, riffle and run). This would give us some clues on how effective we are at providing habitat for all age classes.

Maintenance - If structures show as little deterioration as last year the amount of maintenance required will be minimal, and will be incorporated in the seasons normal work load with no additional funds required. If maintenance becomes a major need the structure designs will be re-evaluated prior to maintenance to determine if design changes are required. All previously completed project activities will be reviewed early in the 1986 season.

Design

Flood plains areas in Crooked River to be constructed in 1986 will be surveyed and designed based on flow data rather than by "gut feel" as done during 1985. The success of these two approaches can then be compared and refined in the future. During 1985 the flood plain was excavated by eye to a level where vegetation was growing on the stream banks (approximately the height of the "natural" stream bank on the other side.

Problems Encountered

Coordination and Easements - Coordination with other agencies, minerals claimants and the general public went well this year. We had a potential conflict with one miner, but we managed to avoid major difficulties.

Red River

Idaho Department of Fish and Game was not able to obtain easements for working on private lands along Red River. Consequently we had to shift our efforts to placing instream structures in Reach II which is all Forest Service land. We have requested that these easements be obtained for the 1986 field season. If the easements are not obtained by the field season, there is still enough work to do in Reach II that we can shift our activities one more season. After that, it is doubtful that the project can continue except at a minimal maintenance level in the future. The Forest Service and Idaho Department of Fish and Game are continuing their efforts in this area.

Crooked River

We had a problem with a proposed engineering design contract that was advertised for a portion of the Crooked River project. The contract was to design a project segment which requires connecting several ponds to the stream channel. The contract was threatened with appeal, under the Brooks Act, by an an engineering group in Boise. Because of this appeal, the Forest withdrew the contract and we are now re-evaluating the best way to accomplish this project segment.

APPENDIX 1

SPRING - FALL PLANTING 1985
CROOKED RIVER FISHERIES HABITAT IMPROVEMENT
BONNEVILLE POWER ADMINISTRATION
U.S. FOREST SERVICE

In late April, a four-person crew was hired to begin the task fo revegetating the dredge tailings along Crooked River. Willow and red osier dogwood cuttings were taken along Highway 14 near the mouth of Crooked River. The cuttings were 14-16 inches long, bundled in groups of fifty and stored overnight in a snow bank.

Planting sites on Crooked River were concentrated in Reach I where in-stream structures had been installed the summer of 1984. Planting was concentrated between access I and III. A re-bar planting tool was used to plant the cuttings In the tailings. The willow and red osier dogwood word planted at water level or slightly below.

Rooted planting stock was ordered from a commercial nursery to determine what species would grow in this altered environment. Four test plots were established to aid in this evaluation. Each plot contains a row of six different species. The spacing used was 2' x 2' and 50% of the plants were protected by 18" vixar tubes held in place with bamboo stakes. Green metal fence posts were driven to mark the corners.

After the test plots were established, the remaining stock was planted throughout Reach I. In all 50 cottonwood (rooted), 125 red osier dogwood (rooted), 25 Siberian Pea (rooted), 300 Hybrid Poplar (non-rooted), 25 Golden Willow (non-rooted), 23 Arctic Blue Willow (non-rooted), 12,150 willow cuttings and 2,150 Red Osier Dogwood cuttings were planted.

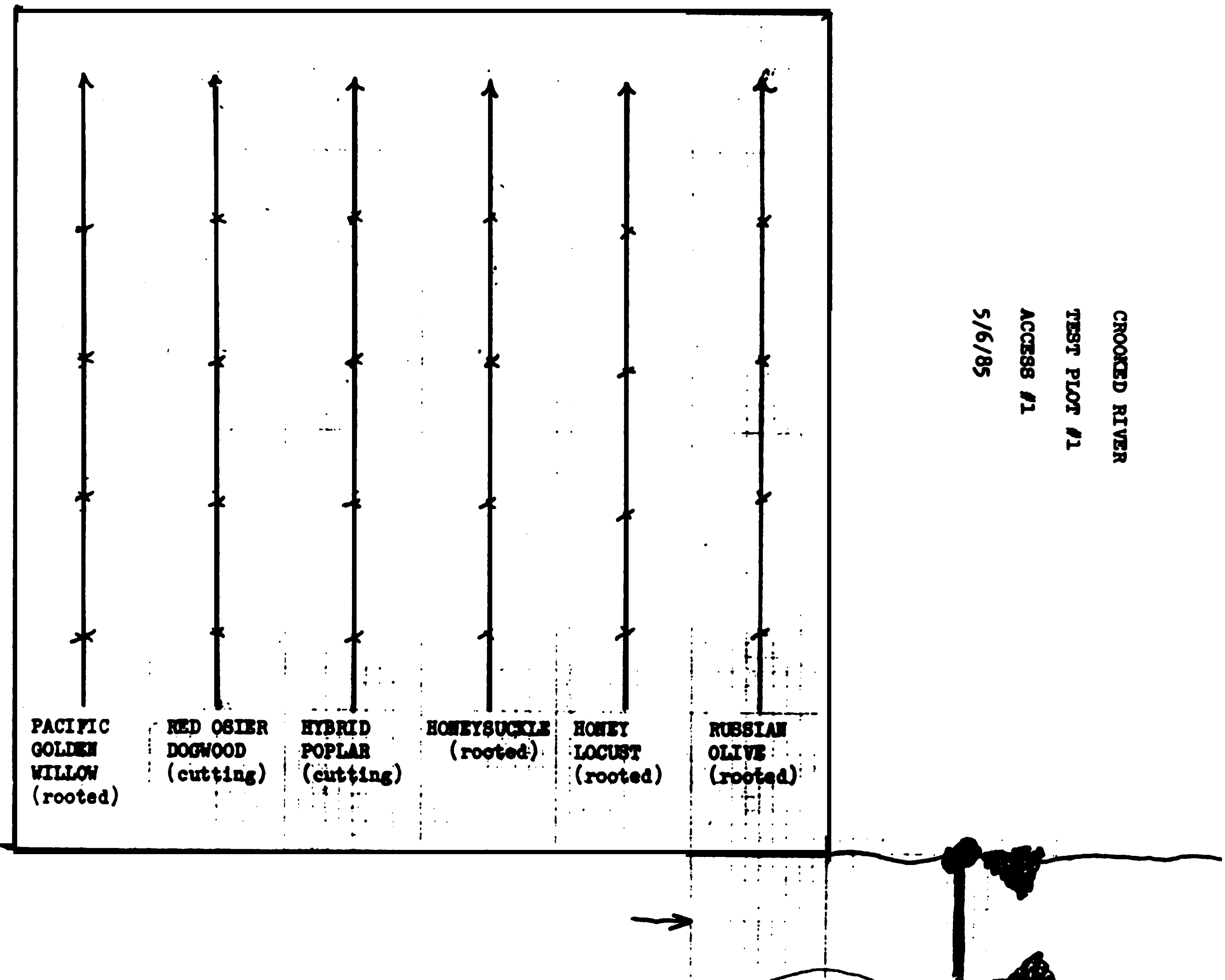
Due to the drought conditions through the month of July, it is estimated that 80% of the plantings died. The willow and dogwood cuttings along the stream did well and some of the rooted stock planted on the east bank where there is more shade and better soil, also did well. It may be necessary to have an Irrigation system, using floation pump, available for use during these dry periods. Hauling in top soil has also been discussed.

FALL PLANTING

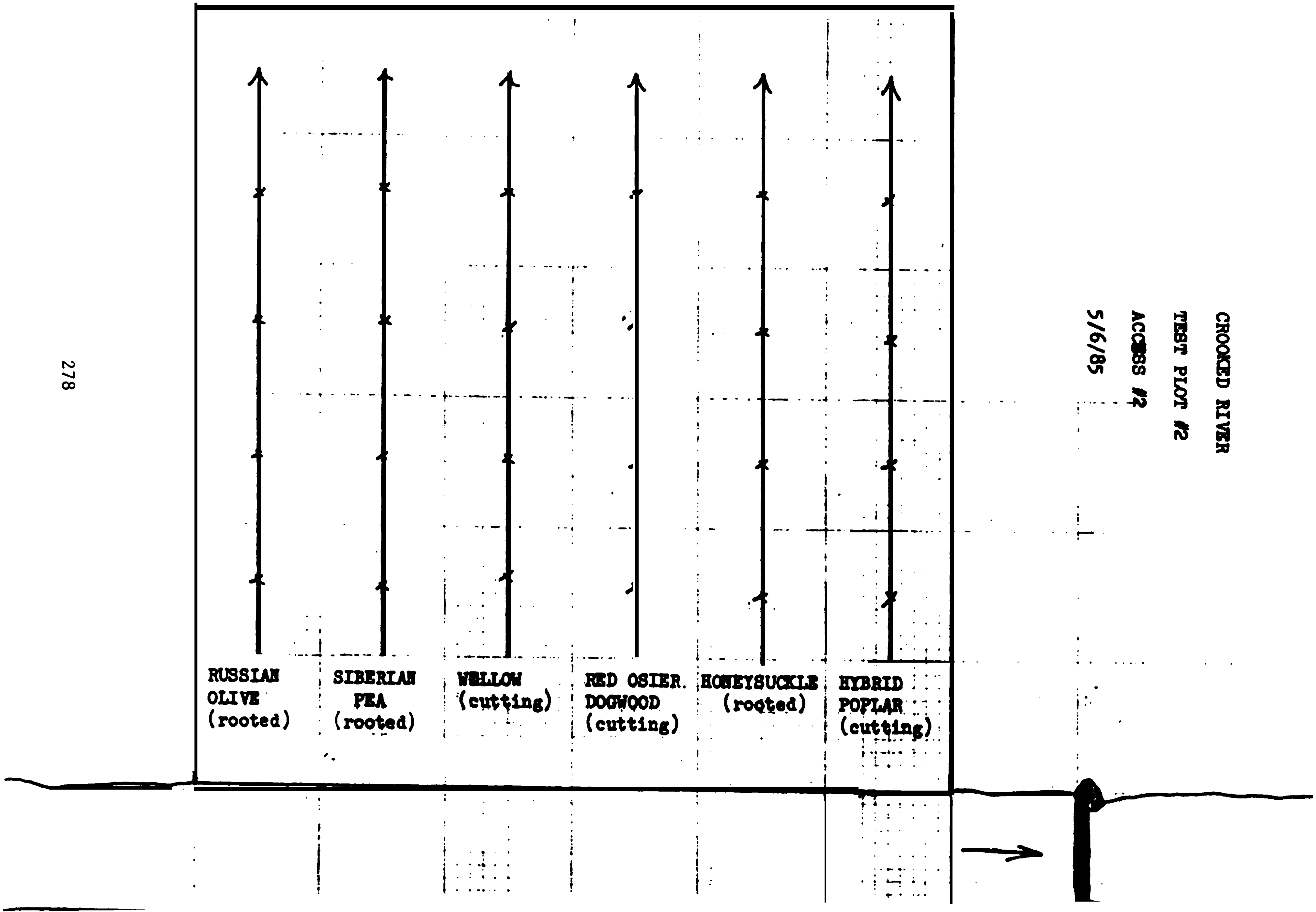
500 rooted elder were planted October, 1985 along newly created channels - Reach II, Crooked River.

WAYNE PARADIS
BIOLOGICAL TECHNICIAN

CROOKED RIVER
TEST PLOT #1
ACCESS #1
5/6/85



CROOKED RIVER
TEST PLOT #2
ACCESS #2
5/6/85



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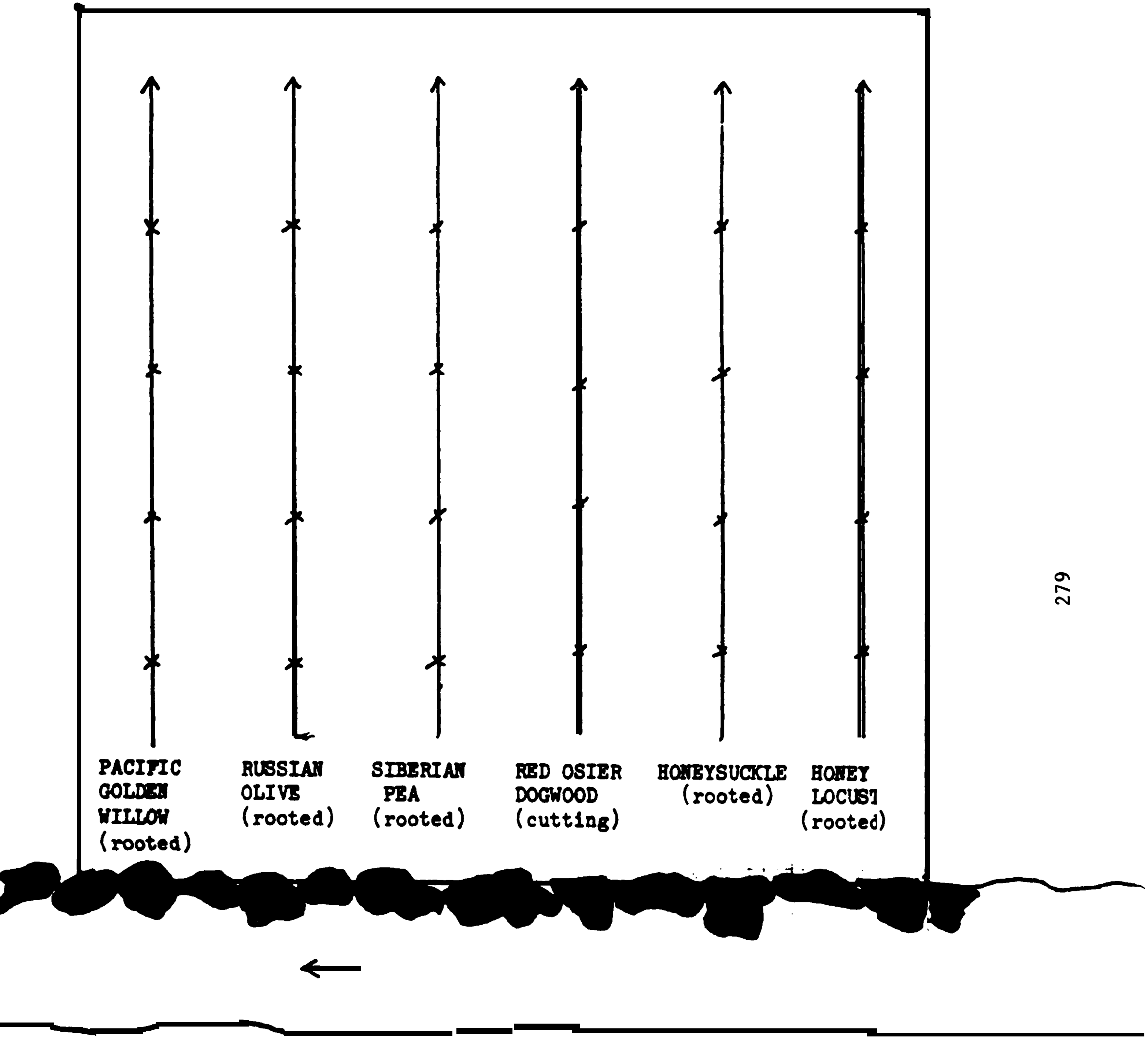
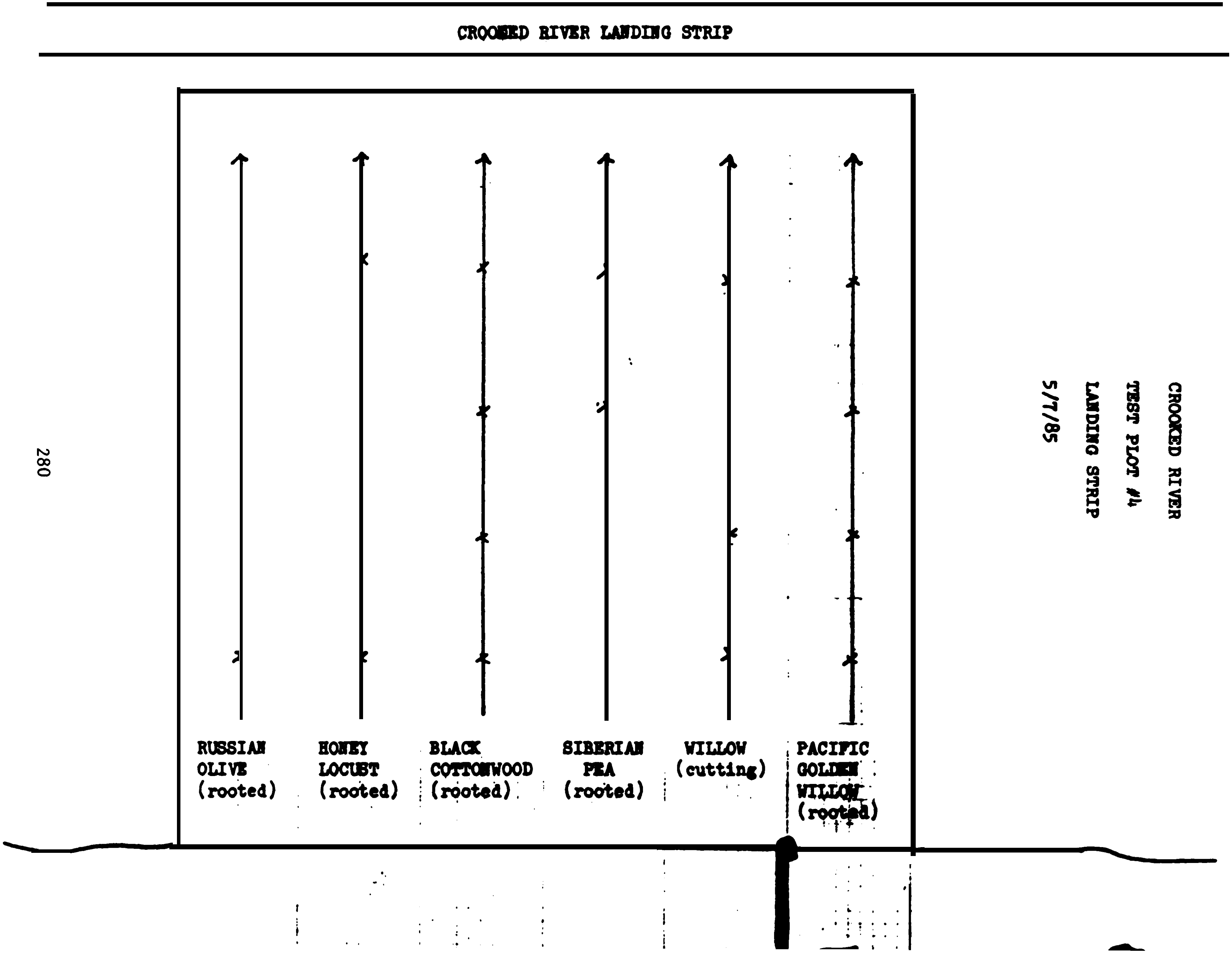
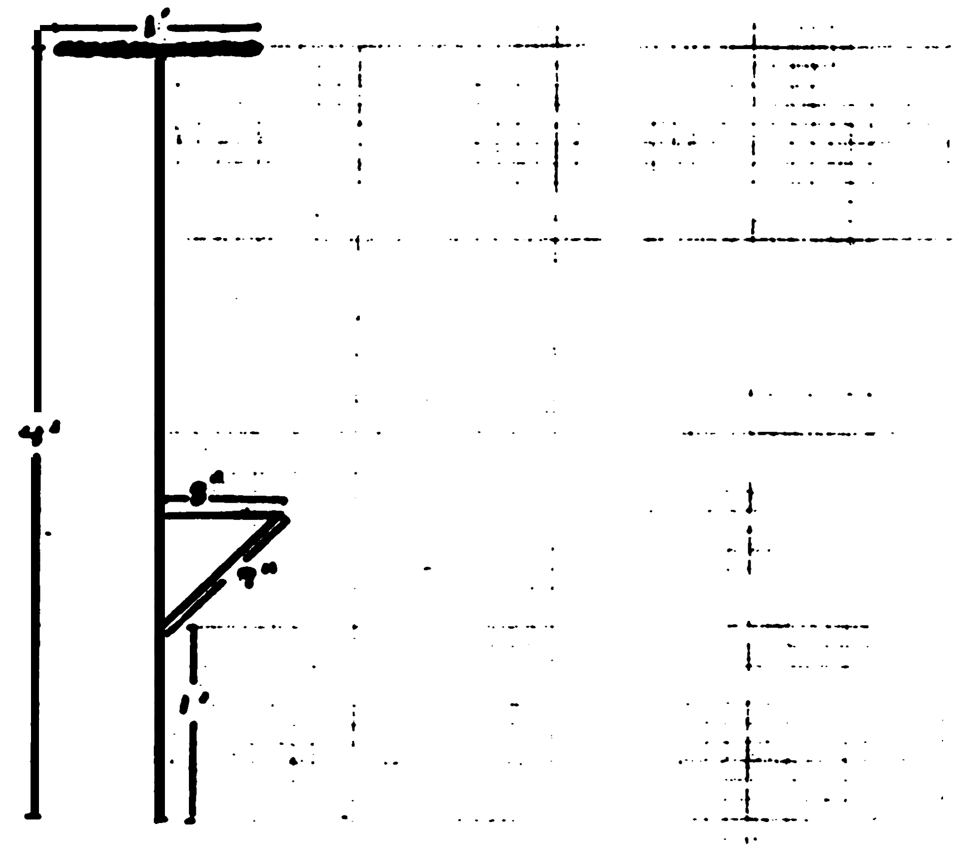
TEST PLOT #3
ACCESS #3
5/7/85



CROOKED RIVER
TEST PLOT #4
LANDING STRIP
5/7/85



5/8 DiameterRE-BAR PLANTING TOOL



CAMAS CREEK (MEYERS COVE)

ANADROMOUS SPECIES HABITAT IMPROVEMENT

PLAN

FINAL REPORT

by

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and

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USDA Forest Service

Salmon National Forest

Funded by

U.S. Department of Energy

Bonneville Power Administration

Project No. 84-23

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Introduction

This report represents an analysis of potential enhancement and management options designed to improve instream and riparian zone conditions in the Meyers Cove area of Camas Creek. The efforts expended will contribute to improvement of anadromous species spawning, incubation and rearing habitat. Potential production increases would provide some compensation for hydropower effects in other areas of the Columbia River basin.

The overall project has been divided into two separate but interrelated phases. This first phase was designed to provide an assessment of enhancement options, potential schedules, and costs associated with the enhancement options. The second phase will involve implementation of actual enhancement measures and associated monitoring to verify fish response. The combined phases are intended to meet the stated project goal.

Goal: To improve riparian and instream conditions of Camas Creek in the Meyers Cove area to increase spring chinook and steelhead trout spawning and rearing production potential.

To assist in achieving the above goal, this feasibility and design phase was funded, in part, by the Bonneville Power Administration (BPA). The authority for BPA funding is associated with Section 700 [specifically Sec. 704(d)(l) (Table 2)] of the Columbia River Basin Fish and Wildlife Program adopted by the Northwest Power Planning Council in accordance with the Northwest Electric Planning and Coordination Act of 1980. The project is a cooperative effort involving the U.S. Forest Service (USFS), Idaho Department of Fish and Game (IDFG), and the BPA.

Project Area Description

In order to have an adequate understanding of the importance of the Camas Creek (Meyers Cove area) drainage, it is important to highlight the significance of the Middle Fork of the Salmon River as a producer of chinook salmon and steelhead trout. The Middle Fork is the largest major tributary in the Salmon River drainage; it is also the most significant producer of wild anadromous fish. The basin drains 2,830 square miles and has 685 miles of habitat accessible to anadromous species. For most of its length, the drainage flows through the Frank Church-River of No Return Wilderness, and the aquatic habitat conditions have remained in a relatively pristine state (Fig.1). The few perturbations that have resulted from man's activities are generally small, in relation to drainage size, and are located in specific areas. Most disturbances have resulted from past mining activity (Marble and Big Creeks) and from development of road access.

The topography within the Middle Fork drainage is very rugged and steep. Road access is available to the headwaters of the main stream and additional entry

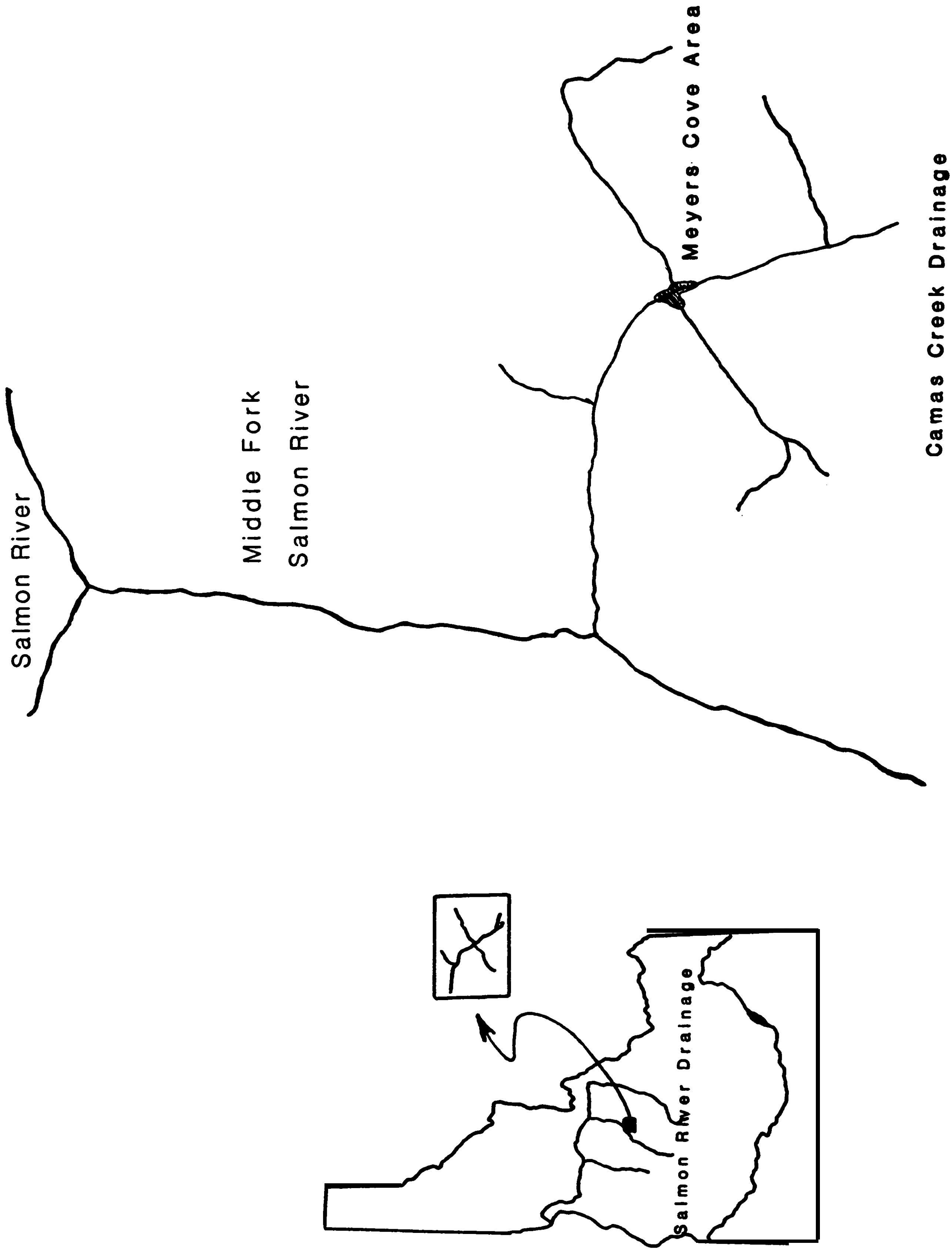

Figure 1 Map of study location in Central Idaho.

points exist to the headwaters of most major tributaries. A detailed description of the geology and vegetation can be found in Minshall et al, 1981. Climate varies considerably by elevation with temperatures ranging from below freezing to above 90°F. and precipitation amounts ranging from 15 to 39 inches. Most of the precipitation occurs as snow and stream flow characteristics reflect this influence. Peak discharge occurs during a 2-6 week period in early May to mid-June, followed by flows decreases throughout summer and winter months. Mean annual discharge for a five-year period equaled approximately 1,549 cfs. with values ranging from 567 to 9,010 cfs (Thurow, 1982).

Stream habitat features within the Middle Fork drainage are consistent with the rugged topography. Most streams have moderate to high gradients and are confined in drainage basins with steep side slopes. Pool type habitats within the Middle Fork range from large deep slow water areas to small pocket water areas. These pool habitats provide a significant amount of rearing habitat, particularly for chinook salmon and cutthroat trout, and, to a lesser extent, steelhead trout. The faster water areas, with large substrate materials, form pocket water holding areas and provide rearing habitat for steelhead trout. Water quality is characterized by low concentrations of dissolved ions (Minshall, 1981).

In general, the Middle Fork of the Salmon River is in a relatively pristine state with all aspects of the anadromous habitat in generally excellent condition.

The production potential of chinook salmon (both spring and summer) and steelhead trout within the Middle Fork drainage is high. Idaho Department of Fish and Game management objectives for 1985 to 1990 call for the following production values:

	Spawning Escapement	Adult Production	Smolt Production
Steelhead Trout	6,000	15,000	750,000
Spring Chinook	9,000	22,500	1,406,000
Summer Chinook	2,000	5,000	312,000

The values expressed in the State's Management Plan may vary somewhat with production estimates developed as part of other research (i.e., Thurow, 1985), but all estimates serve to show a relatively high production potential. Thurow (1985) discussed options available for estimation of production potential; his analysis placed steelhead smolt production at 350,000 based on anticipated density levels in the tributaries and the main stem of the Middle Fork.

In addition to the values associated with high production potential, the Middle Fork drainage contains anadromous stocks that are wild and indigenous to the area. The State's species management plan for the coming years recommends that the drainage be managed for production and preservation of wild, indigenous anadromous stocks. The advantages of this management direction have been identified and reviewed (Horrall, 1981; Richer, 1972; Stock Concept International Symposium, 1981; Wagner, 1979). It is anticipated that recovery of the depressed nature of anadromous populations in the Middle Fork will be a slow, deliberate, and unspectacular process tied with harvest regulation, improvement in downstream passage, and habitat restoration and maintenance (Loftus, 1981; Thurow, 1985).

Camas Creek

The Camas Creek drainage (Fig. 2), including the Meyers Cove area, was in an essentially natural undeveloped condition prior to 1900. A minor amount of mining and mineral prospecting had occurred in Yellowjacket and Silver Creeks, but no significant development occurred in areas immediately adjacent to Camas Creek. The lower Camas Creek corridor provided a popular route for early travel into the interior regions of Idaho.

In 1901, a Mr. Andrew Lee settled on the land where Camas Creek and Silver Creek converge. Over a 16 year period, from 1901 to 1917, Mr. Lee cleared 120 acres and established a small ranch. The majority of this area was used for hay production and grazing (late fall and winter). The Meyers Cove area remained in agricultural use from the early 1900's until the late 1960's. Land ownership changed several times during this period but basic land use remained essentially the same. The final private owner was Mr. James Strickler who established Hidden Valley Ranches, Incorporated. The corporation used the land as a base for outfitting in the Idaho Primitive Area. Hay production and some grazing continued to be the primary land uses.

Removal of the riparian vegetation and the subsequent agricultural use of the land immediately adjacent to Camas Creek initiated influences to the stream channel which are in effect today. The natural revetment and channel control provided by large woody vegetation was altered and substantial changes occurred as stream energies began to exert influences on the stream's bed and banks. In 1970, the United States Government purchased 463 acres of private land in the Meyers Cove area under the authority of the Land and Water Conservation Fund Act of 1964. Benefits attributed to acquisition of the property included maintaining access to a vast area of Forest Service administered land (100,000 acres), opportunity to develop a recreational site, and to provide management control for protection of fishery resources.

Domestic livestock use of the Camas Creek drainage has been ongoing since 1918, with early use being very heavy. Through the years changes in grazing have occurred and livestock numbers have been reduced. At present, the area is managed as one allotment with a permitted use of 655 animal unit months. This use level represents approximately 11 percent of the original levels that

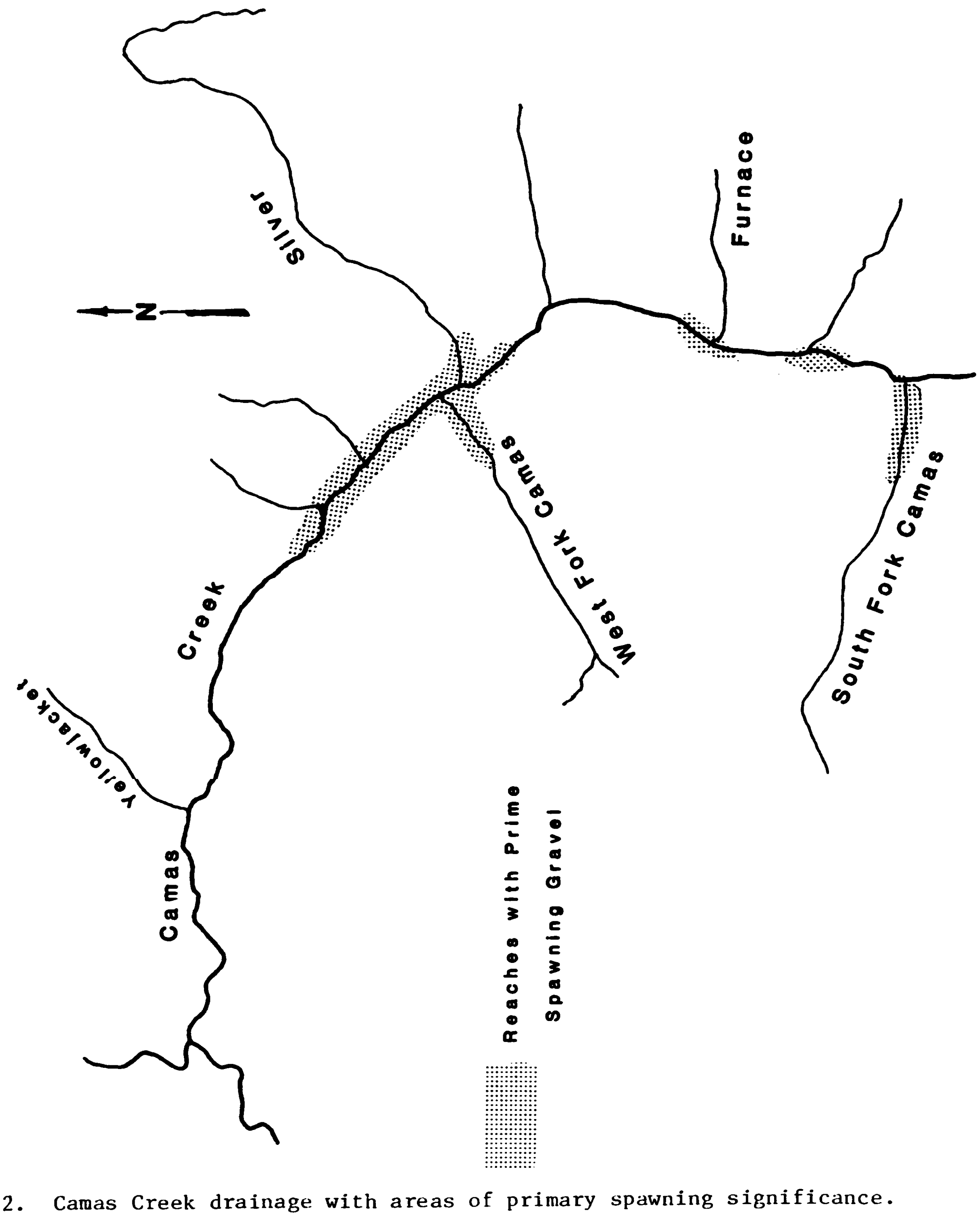

Figure 2. Camas Creek drainage with areas of primary spawning significance.

occurred during the early 1920's. Range condition varies greatly over the allotment. The preferred grazing areas have been utilized in excess of their potential. These areas for the most part are the old irrigated hay meadows and the riparian areas along Camas Creek at Meyers Cove. The remainder of the allotment is in fair to good condition. Future management direction for this allotment as contained in the Forest Plan emphasizes protection and enhancement of the anadromous fish habitat, reduction of riparian zone conflicts, and increased coordination of multiple uses.

Camas Creek is approximately 38 miles in length and enters the Middle Fork Salmon River near river mile 35. The Meyers Cove meadow area is located from Camas Creek river mile 11.5 to 15.5. A major tributary, the West Fork, is approximately five miles in length, and enters Camas Creek at Meyers Cove. Below Meyers Cove, Camas Creek delineates the boundary between the Salmon National Forest to the north and the Challis National Forest to the south. Due to improved access, administrative responsibilities for the Meyers Cove meadow area, including the lower reach of the West Fork of Camas Creek, have been assigned to the Salmon National Forest.

The project area (Meyers Cove) (T. 17 N., R. 17 E., Sections 6 and 7) lies at approximately 5,100 feet elevation in low gradient, wide, flat-floored bottomland bordered by steep volcanic and quartzite canyonlands rising to over 9,000 feet. Dominant vegetation includes Idaho fescue (<u>Festuca idahoensis</u>) and other grasses in bottomlands, with black cottonwood (<u>Populus Trichocarpa</u>), willow (<u>Salix</u> sp.), and occasional Douglas-fir (<u>Pseudotsuga menziesii</u>) comprising the riparian woody species. Stands of Douglas-fir and lodgepole pine (<u>Pinus contorta</u>) occupy suitable sites of upper elevation sideslopes.

<u>Fisheries Resource and Aquatic Habitat</u>

The Meyers Cove area of Camas Creek contains abundant spawning gravels (Fig. 2) with sufficient associated rearing habitat to support a relatively large number of anadromous fish, as well as resident populations of westslope cutthroat trout (<u>Salmo clarkii</u>), rainbow trout (<u>Salmo gairdneri</u>), bull trout (<u>Salvelinus confluentus</u>), and mountain whitefish (<u>Prosopium williamsoni</u>). Several non-game species (<u>Catostomus</u> sp., <u>Cottus</u> sp.) are also found in the stream.

The Idaho Department of Fish and Game has conducted annual chinook salmon redd counts since 1972, and has compiled five year average counts since 1951 (Table 1). Steelhead redd counts are not generally feasible due to turbidities during spring runoff.

Thurow (1982, 1983, 1985) made a concerted effort to delineate steelhead spawning within Camas Creek using both ground and aerial observation techniques. This effort met with some success as several redds and spawners were located and observed. Mr. Mel Reingold observed five spawning steelhead

Table 1. Annual (1960-1985) and Five-Year Average Chinook Salmon Redd Counts in Camas Creek[1/] [2/]

Year	Annual Redd Count	Year	Count	Average Redd Years	Count
1960	112	1972	211	1951-55	127
1961	142	1973	358	1956-60	119
1962	124	1974	172	1961-65	170
1963	252	1975	128	1966-70	180
1964	279	1976	61	1971-75	198
1965	51	1977	84	1976-80	65
1966	212	1978	148	1981-85	33
1967	256	1979	15		
1968	251	1980	17		
1969	94	1981	65		
1970	86	1982	33		
1971	120	1983	38		
		1984	11		
		1985	21		

and counted eight redds in the Meyers Cove area during April 1985. Population surveys, using snorkling techniques, have also been conducted within the Meyers Cove area. Results of these efforts have indicated a light to moderate use by juvenile salmon and steelhead.

Aquatic habitat assessments of Camas Creek and tributaries in the Meyers Cove area have been made periodically in an effort to describe condition and identify land use coordination needs. An initial review of habitat conditions occurred in 1979; this evaluation was tied to an allotment management appraisal and development of an updated allotment management plan. The information collected at that time reflected less than optimum aquatic/riparian habitat conditions. Pool habitats were limited in both quantity and quality. Streamside cover provided by vegetation was limited to less than 25% and streambank instability was evident at many locations. All streams reflected conflicts resulting from livestock use of riparian areas. Stream conditions also reflected the influence of a high intensity runoff that occurred in 1974 and resulted in major channel alterations.

A second major assessment was conducted in 1981 by the U.S. Fish and Wildlife Service for e Army Corps of Engineers as part of the lower Snake River enhancement[3/] effort. The Fish and Wildlife Service's study also focused on habitat conditions in the Meyers Cove area. Their approach was to assess habitat quality using a Habitat Quality Index (HQI) model (Binns and Eiserman, 1979). Habitat Quality Index values and measurements indicated that instream cover, eroding streambanks, water velocity and stream width factors were all rated very low. Riffle areas with large adjacent barren gravel bars were the dominant instream habitat condition. Streambanks were rated as generally unstable and sparsely vegetated with the erodible materials being deposited within the stream channel. Aggregation and channel instability had caused Camas Creek to widen, velocities to increase and instream cover to be scarce. Riparian shading was estimated to provide only 6 percent of the cover along the streambanks. Both studies indicated that substrate conditions were less than optimum as a result of moderate to high levels of fine material being incorporated in the desirable spawning gravels.

In general, both habitat evaluations reflected similar findings. Current habitat conditions of the streams and riparian zones within the Meyers Cove area were due, in part, to land use activities that occurred prior to government purchase in 1970, the 1974 runoff event, and recent land use management associated with the current cattle allotment. To supplement information gained in 1979 and 1981, this present study was initiated to further define significant habitat deficiencies and to describe suitable options necessary to effect enhancement of stream conditions.

Methods and Materials

Inasmuch as the previous studies described general aquatic habitat conditions in the Meyers Cove area, efforts associated with project 84-23 were limited to a more thorough analysis of habitat characteristics in most need of improvement. Field sampling efforts conducted during 1984 and 1985 were limited to analysis of streambank and channel conditions in sufficient detail to develop an enhancement plan. To accomplish this the entire length of stream channel within Meyers Cove was inventoried. Lengths of unstable bank were measured and corrective measures identified. Enlargements of aerial photographs, with a 1:24,000 scale, were used to map and display channel characteristics.

Allotment administration and management was also closely scrutinized to determine solutions to multiple use resource conflicts that are presently occurring. Field work associated with this effort included a review of present allotment facilities (i.e., fences, stream crossing, salting areas, etc.) and identification of additional facilities and management changes necessary to eliminate or minimize use conflicts.

Time was also spent in reviewing improvement options applicable to the problems encountered at Meyers Cove. Literature was reviewed, personal contacts made and actual experience evaluated. Cost estimates were also initiated and evaluated.

Findings and Discussion

In order to adequately describe existing stream channel and riparian conditions and to identify appropriate management remedies, stream channels within the Meyers Cove area were subdivided into reaches. Each reach was walked and the amount of unstable channel measured and general riparian conditions noted.

Allotment areas within the Meyers Cove were also inventoried to assess potential changes in livestock management and allotment administration that would expedite riparian and streamside recovery.

Camas Creek

The lower reach on Camas Creek comprised approximately 3,437 feet of stream channel. This reach originated in the area near a lower gate and proceeded upstream to a point just above an upper gate (Fig. 3). The lower portion (site l-l) of this reach was characterized by relatively heavy willow and cottonwood stands. Channel conditions reflected the influence of high bedload movement from past runoff periods. Point bars and channel bars predominated through the 2,417 feet of this lower section of the reach. Above this section there were four sites with obvious streambank cutting and/or sloughing attributable to stream energies and land management influences (Table 2). Livestock influences were most noticeable on the right banks in areas where willow and grass species were the dominant vegetation.

The middle reach inventoried on Camas Creek was approximately 2,790 feet in length (Fig. 4). This area included the junctions of both Silver Creek and the West Fork of Camas Creek with main Camas Creek and contained a large remnant meander of the main drainage. Several channel and point bars were observed and channel conditions reflected the influence of runoff from the West Fork. Revegetation of the old meander was proceeding at a very slow rate; livestock use and limited soil were primarily responsible for the slow recovery. Older cottonwoods dominated as the larger woody riparian vegetation and younger cottonwoods were noticeably absent. Channel conditions reflected the influence of runoff conditions and livestock use of the streamside areas (Table 3). A portion of the stream side area from sites 2-5 through 2-10 had been fenced to exclude cattle use and provide protection to riparian vegetation and streambanks.

The upper reach on Camas Creek in the Meyers Cove area (Fig. 5) extended from just above the confluence of Silver Creek upstream to a point where the jeep trail crossed Camas Creek. The length of this reach was approximately 2,792 feet and the stream channel was characterized by braided sections, wide shallow sections, and an area where the channel had divided forming a vegetated island. The immediate streamside zone is presently protected by a fence installed during 1984 and 1985. This reach of stream also has an old bridge designed to convey animals and equipment across Camas Creek during periods of high water. At present the bridge structure is in a state of disrepair and

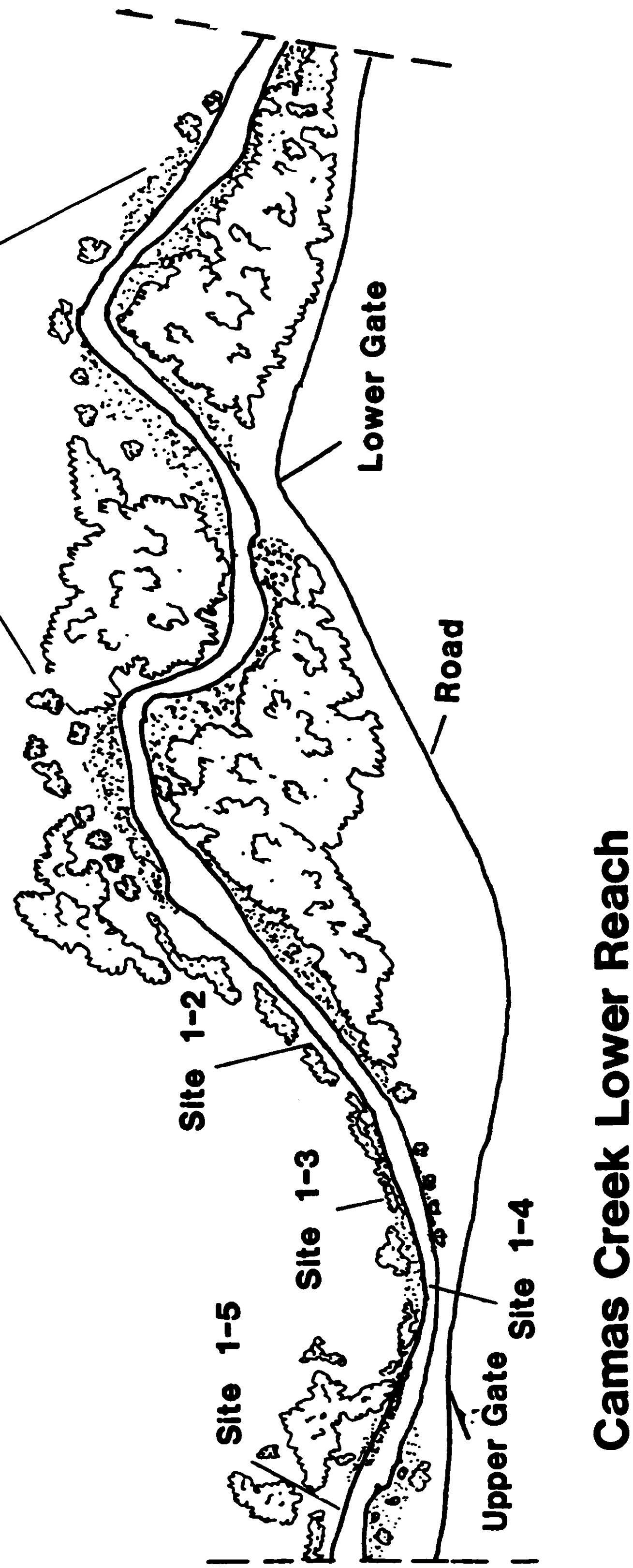

Figure 3. Location of major instability identified in the lower reach of Camas Creek in Meyers Cove area.

Table 2. Camas Creek lower reach stream channel condition and riparian zone inventory. Bank location is referenced facing upstream. Reach length was approximately 3,437 feet.

Site	Location	Length (ft)	Height (ft)	Comments
l-l	Extreme lower portion of reach - both banks	2,417	--	point and channel bars predominate; riparian vegetation composed of willow, cottonwood with various grasses and forbs; livestock conflicts light to moderate in nature; low bank with minimal cutting
l-2	Right bank	10	2-3	small bank rock with sod vegetative cover, cutting likely being influenced by livestock use and past agriculture activity on adjacent meadow
l-3	Right bank	6	3	conditions similar to section l-2
l-4	Left bank	180	2-10	gravel bar with adjacent channel bank having small bank materials; limited vegetation on channel bank; would be influenced during high water
l-5	Right bank	492	--	This section reflects the influence of post cutting; present conditions have interspersed areas of cutting and gravel bars.

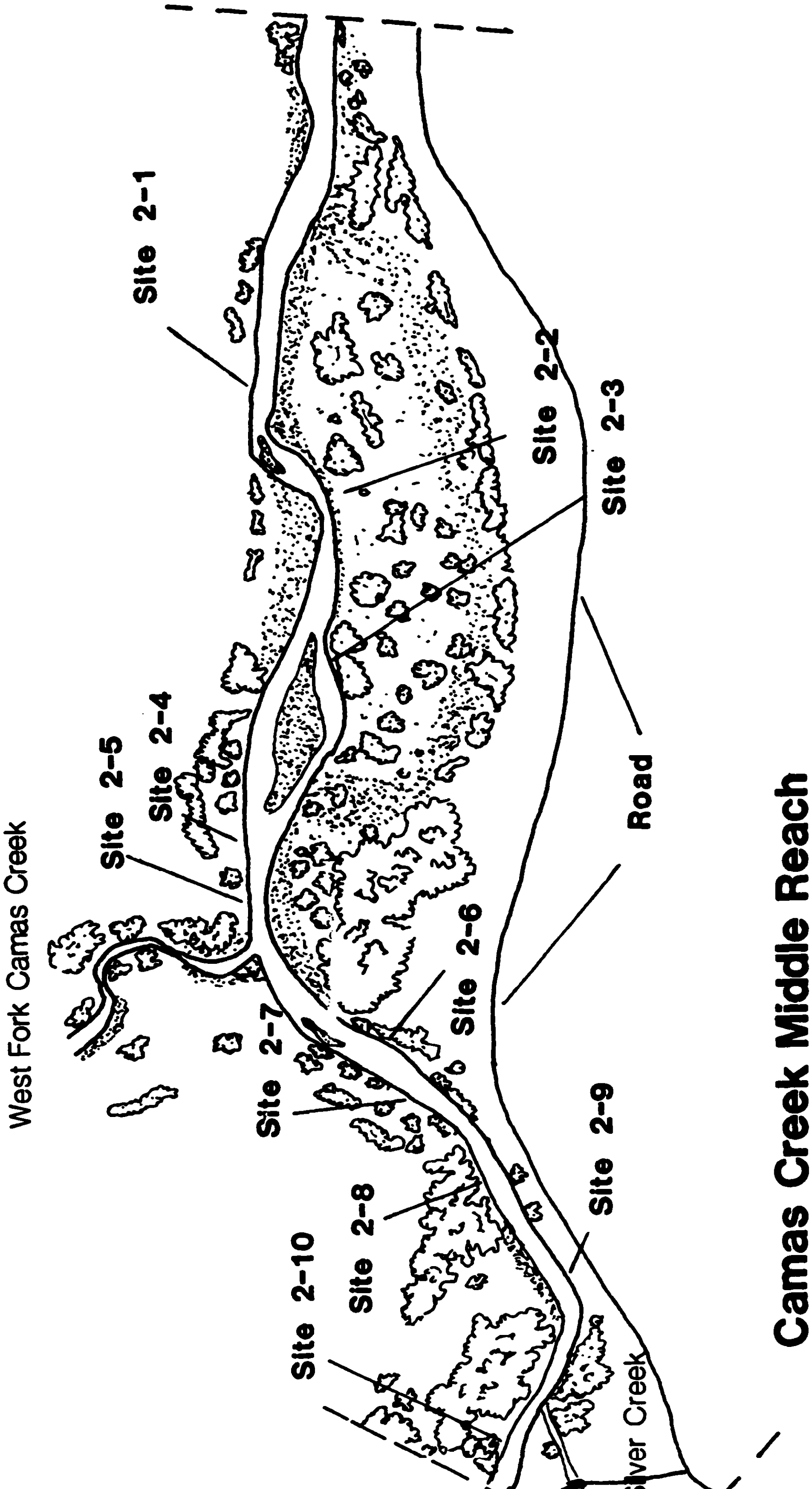

Figure 4. Location of sites with major instability in the middle reach of Camas Creek, Meyers Cove area.

Table 3. Camas Creek middle reach stream channel and riparian zone inventory. Reach length was approximately 2,792 feet. Bank location referenced facing upstream.

Site	Location	Length (ft)	Height (ft)	Comments
2-l	Right bank	190	2-3	streambank with cutting and sloughing; small bank materials; vegetation primarily bluegrass and forbs. Very limited amount of larger woody riparian vegetation; livestock influence evident.
2-2	Left bank	120	2-3	braided channel site; primarily a juvenile rearing area with low stream energies; old cutting that is naturally healing
2-3	Left bank	75	1	located just upstream of 2-2 on the braided side channel; old cutting evident that is naturally healing
2-4	Right bank	100	4	section of bank with cutting and sloughing evident; smaller bank rock materials present; vegetation dominated by occasional willow and other smaller materials
2-5	Right bank	27	6	just upstream of 2-4 and with similar streambank conditions; a fence has been installed to provide protection of this site.
2-6	Left bank	126	2-4	section of bank located on an outside bend; cutting is evident but site is stabilizing as a result of large bank materials and large cottonwood root masses; presently protected by fence
2-7	Right bank	--	--	minor area of sloughing and cutting; small forbs and a minor amount of willow provide some bank protection; presently protected by fence
2-8	Right bank	--	--	section with gravel bar with developing streambank; sparsely vegetated and with small to moderate bank rock materials; presently protected by fence

Table 3. (continued)

Site	Location	Length (ft)	Height (ft)	Comments
2-9	Left bank	70	3	unstable streambank area associated with large pool with back eddy currents; old beaver activity on opposite bank may have been responsible for directing flows and causing instability; presently protected by fence
2-10	Right bank	180	2-5	This site has substantial length of bank that is unstable and exposed to stream energies at high flows; at low flows gravel bar is exposed; opposite bank has substantial amount of debris; also Silver Creek enters immediately downstream; presently protected by fence

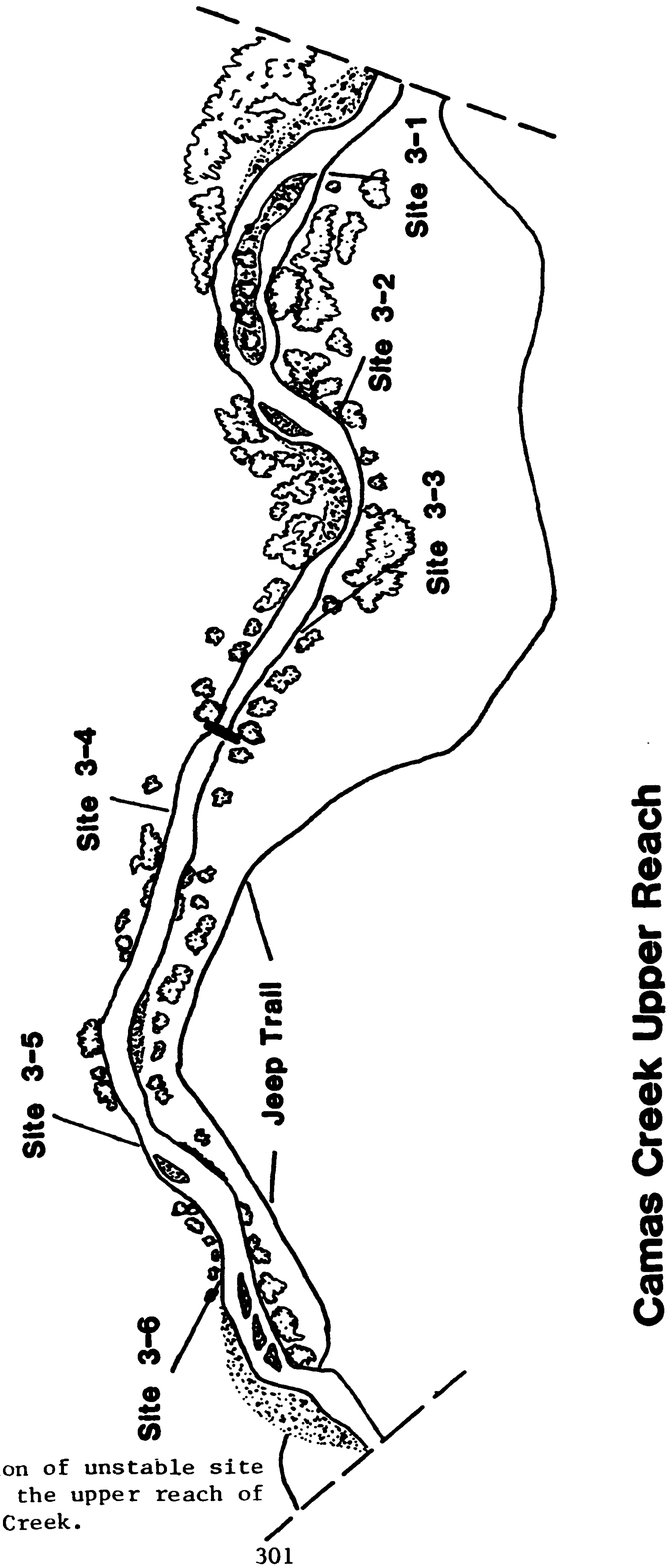

Figure 5. Location of unstable site within the upper reach of Camas Creek.

will have to be removed. General stream side and channel conditions reflected heavy livestock use and the influence of high runoff stream energies (Table 4).

Camas Creek stream and channel banks within the Meyers Cove area were characterized as unstable along approximately 2,230 feet of the 9,021 feet of channel inventoried. This represented 24.7 percent of the channel length and was felt to be conservative because only major unstable sites were recorded. Numerous smaller sites (less than 3 feet in length) were observed. The vegetative condition of the riparian zone adjacent to Camas Creek reflected the influence of intense use both from past agriculture activity and from the more recent grazing use. Most larger woody types, such as willow and cottonwood, were present predominately as older mature clumps or stands. Few seedlings or saplings were observed throughout the reaches inventoried. Bluegrass dominated as the major sod forming grass type and forbs were present on the drier sites. All of the grass and forb areas were in poor condition and reflected the influence of heavy livestock use.

Channel and streambank conditions observed along Camas Creek can be attributed to several interrelated factors. Past agricultural activity in the Meyers Cove area has encroached upon the riparian zone adjacent to Camas Creek resulting in removal of much of the larger woody vegetation types (i.e., cottonwood, alder, and willow). This influence has been further compounded by heavy livestock use of the area resulting in lower vegetative vigor and reduced ground cover. The types of vegetation present and their abundance has been insufficient to provide adequate natural revetment to withstand influences occurring during high runoff periods. Stream cover was also limited by the lack of adequate riparian vegetation.

<u>West Fork Camas Creek and Silver Creek</u>

The West Fork was a major tributary that flowed into Camas Creek in Meyers Cove area. To aid in the inventory process, this stream was divided into two reaches; the lower being 2,900 feet in length (Fig. 6), and the upper reach extending an equal distance upstream (Fig. 7). Within these two reaches, 19 separate sites having unstable bank conditions were identified (Table 5). These areas of instability were basically similar to those encountered in Camas Creek, with the exception that channel conditions along the West Fork showed the influence of channel scour to a much greater degree. The high intensity runoff event of the early 1970's forced the West Fork channel into a condition of disequilibrium. The resulting condition was typified by areas of channel bank cutting and gravel aggregation. Riparian vegetation recovery has been retarded to a degree as a result of heavy livestock use. Present vegetative condition and abundance along the West Fork has been insufficient to provide adequate natural revetment of the stream channel. The cover component of the habitat in the West Fork was also being impacted by the lack of adequate riparian vegetation.

Table 4. Camas Creek upper reach stream channel and riparian zone inventory. Reach length was approximately 2,792 feet. Bank location referenced facing upstream.

Site	Location	Length (ft)	Height (ft)	Comments
3-l	Left bank	180	4	This area is below a diversion in the channel which forms a vegetated island; this site is an outside bend with active cutting and sloughing; stream bank materials are small and streamside vegetation is primarily sod forming grasses.
3-2	Left bank	75		This site is at a watering area associated with a corral area; the stream has recently uprooted several willows; there is silt being deposited in the slower water areas immediately below.
3-3	Right bank	95	4	active stream cutting below bridge; area has some vegetation in the form of willow and alder which may provide revetment in time.
3-4	Left bank	210	2-4	major section with active cutting; this is just above present bridge and the instability is threatening the bridge; larger bank rock materials
3-5	Right bank	48	2	small section of bank with intermittent sections of bank cutting; there is also some sloughing that has occurred
3-6	Right bank	46	5	This site has a section of bank that is cutting as a result of flows being deflected off of several channel bars; at present several large willows are providing some protection.

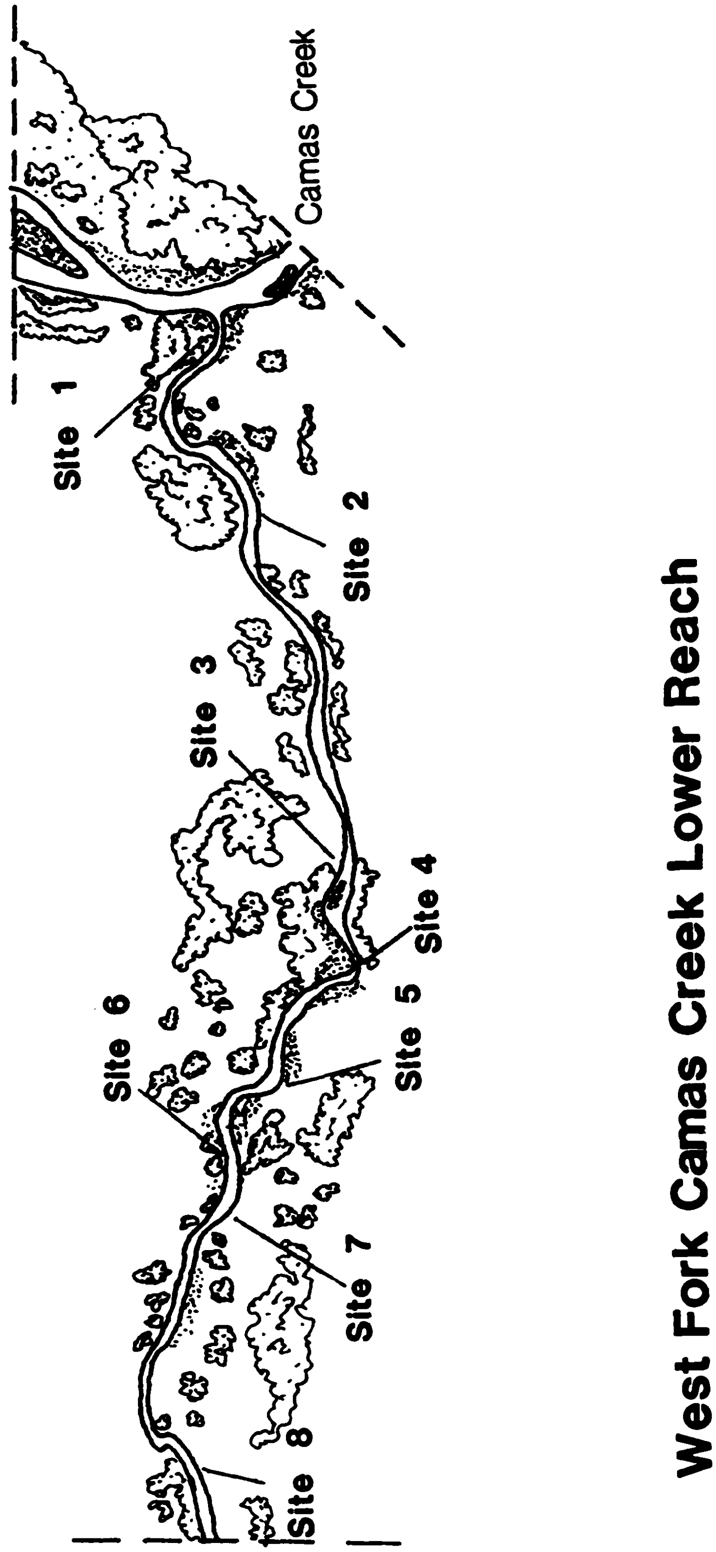

Figure 6 Lower reach of the West Fork Camas Creek with unstable sites

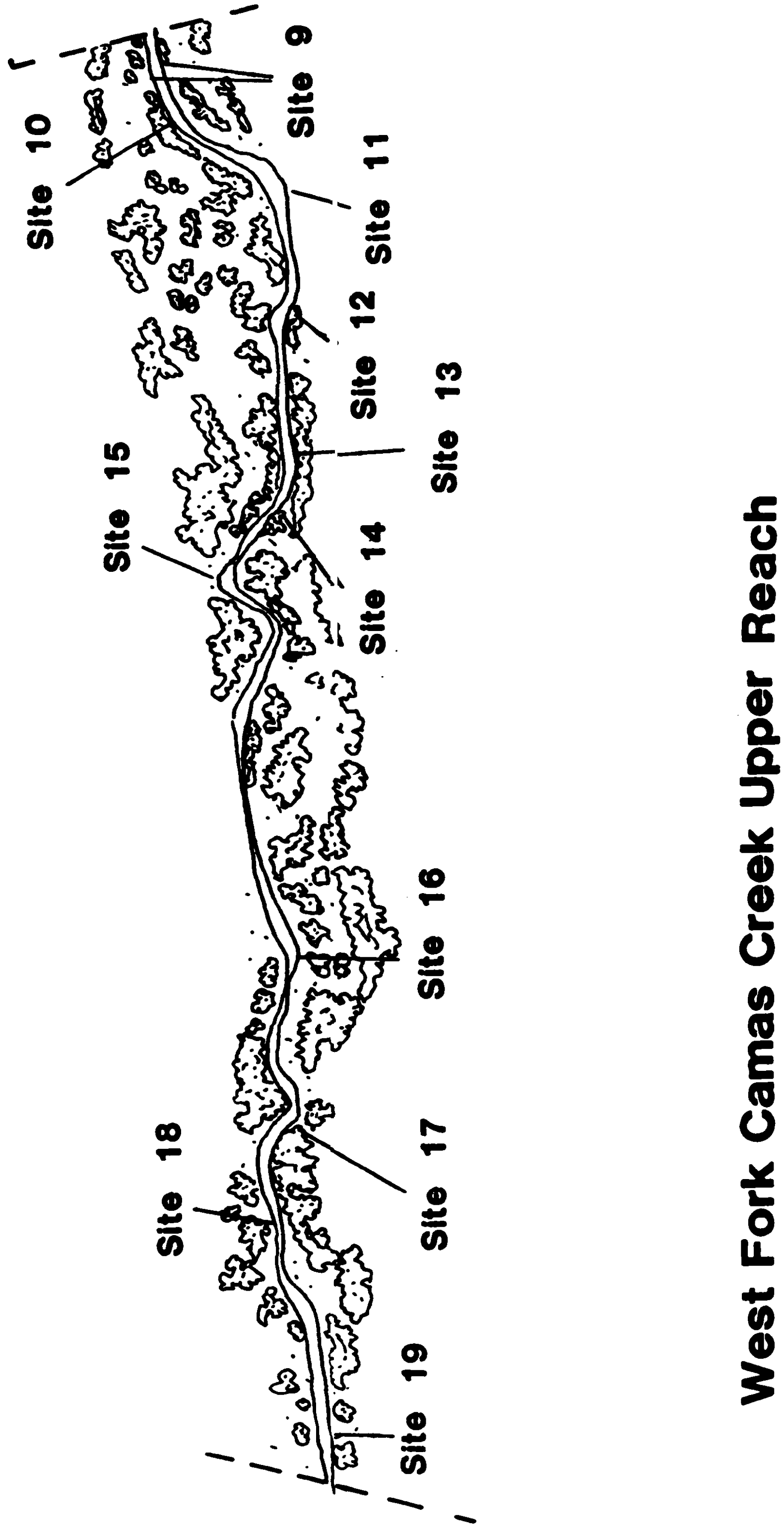

Figure 7. The upper inventoried reach of the West Fork of Camas Creek with 11 sites identified as unstable.

Table 5. West Fork Camas Creek stream channel and riparian zone inventory. Each reach was approximately 2,900 feet in length with the total inventoried area being 5,000 feet. Bank location referenced facing upstream.

Site	Location	Length	Height	Comment 8
Lower Reach				
l-l	Mouth of the West Fork	204	9	left bank at mouth with substantial cutting; gravel deposition evident and resulting in 2-3 braided channels; bank materials generally small and easily eroded; limited riparian vegetation
l-2	Left bank	264	4-7	major unstable bank area on stream bend; area of cut is vertical in nature
l-3	Right bank	120	--	This site has an area of old channel cutting; recovery is in process and the bank is being influenced by a channel bar that is diverting the stream flow.
l-4	Left bank	27	10	cutting streambank at an approximate 45° angle; limited revetment being provided by old cottonwoods
l-5	Left bank	44	3	unstable area that is in the process of recovery; large fallen cottonwood is parallel to channel and is providing protection from livestock
l-6	Right bank	67	4	Bank is primarily gravel with very little vegetation.
l-7	Left bank	84	5	Banks are nearly vertical with minimal vegetation; stream is flow along toe of canyon slope.
1-8	Left bank	200	--	area of old cutting; stream flow is being diverted away from channel bank by gravel bar; area is slowly recovering.
l-9	Right bank	21	6	45° cut slope; channel braids through this area; some bedrock is present.
	Left bank	58	--	

Table 5. (continued)

Site Location	Length (ft)	Height (ft)	Comments
l-10 Right bank	155	4-6	This site is comprised of both past and present cutting,
l-11 Left bank	12	5	This site is just upstream of l-10 in a relatively straight section of stream; has been influenced by livestock crossing.
1-12 Left bank	18	--	Livestock and vehicle crossing area; very gentle slopes
1-13 Left bank	210	up to 25	significant section of unstable bank; 45-60° slope
1-14 Left bank	56	--	unstable site with much livestock use
1-15 Right bank	23	2-4	heavy livestock use area; much woody debris evident as a result of past beaver activity
l-16 Left bank	108	3	area of old channel cutting; bank is presently isolated away from stream flow; recovery taking place
1-17 Left bank	400-500	7	area of old channel cutting; only a portion of flow is influencing this area; some stability is returning
l-18 Right bank	300-500	5-7	site has isolated channel section that was cutting; recovery in progress; bedrock channel control evident
1-19 Right bank	8	8	small section with active cutting

Silver Creek also enters Camas Creek within the Meyers Cove area. The riparian zone associated with Silver Creek within this area is composed of dense willow stands and many areas of standing water resulting from beaver activity. Habitat conditions were considerably improved over those in main Camas Creek and the West Fork. Specific measurements were not taken as part of this assessment.

Enhancement Recommendations

Enhancement of instream and riparian zone conditions within the Meyers Cove area of Camas Creek will center on options and activities needed to increase riparian vegetation, increase streambank and channel stability, reduce recruitment of fine sediments, and to effect beneficial changes in instream rearing habitat. Three basic areas of enhancement will be addressed in detail and cost evaluations associated with the enhancement activities presented in Table 6. The three enhancement areas include (I) Multiple use resource coordination, (II) Riparian/streamside zone enhancement, and (III) Instream enhancement.

I. Enhancement of multiple use resource coordination -- A major influence on existing riparian/streamside conditions within the Meyers Cove area has been past agricultural activity and present livestock grazing. Influences associated with recreational use of the area were also evident and include the effects of recreation pack stock and vehicle use. Coordination of multiple uses has been and continues to be a major concern of the Salmon National Forest. A focal point of Forest planning was identification of anadromous fish habitats and the decision to protect these resource areas during multiple use management.

Enhancement Activity 1 -- Isolate riparian/streamside zone from grazing areas by fencing (Fig. 8). This option would allow vegetation to become established in greater abundance. Direct bank disturbance would also be eliminated and habitat conditions would improve. It is anticipated that additional abundance of vegetation within the streamside zone would serve to lessen sediment delivery to the stream. cost estimates include materials, labor and administration.

Inplace	Proposed	Total
1.5 miles	2.8 miles	4.3 miles

costs:

2.8 miles @ $3,500 to $5,000/mi. = $ 9,500 to 14,000

Table 6. Summary of enhancement activities and cost estimates associated with improvement of habitat in Camas Creek near Meyers Cove.

Enhancement	Amount	cost	Comment 8
Multiple Use Coordination			
Activity 1 Fencing	2.8 Miles	$ 14,000	- Complete isolating all riparian zones from livestock, 1.5 miles in place
Activity 2 Coordination			
Water Development	2 Each	$ 6,000	- Compensation for reduced access
Stream Crossings	2 Each	$ 1,750	- Construct two fords with gravel revetment
Reseed Upland Meadows	200 Acres	$ 16,000	- Improve forage to compensate for reduction in acres
Riparian Areas			
Activity 1 Bank Reshaping	700 to 1150 Feet	$ 6,900	- Potential sites: Camas 1-4, 2-4, 2-5, 3-6; West Fork l-l, l-4, 1-9, 1-13, l-17, 1-19
Activity 2 Reseeding Riparian Area	16 to 26 Acres	$ 1,560	- Plant grasses and forbs to accelerate recovery
Plant Seedlings	0 Acres	$ 6,800	- Accelerate recovery of large woody vegetation
Activity 3 Bank Stabilization	1150 to 1600 Feet	$ 8,000	- Potential sites: Camas l-2, 2-1, 2-3, 2-10-3-4, 3-5; West Fork l-2, 1-3, 1-6, l-8, l-10
Instream Habitat			
Activity 1 Rock Placement	30 to 50 Each	$ 2,500	- Placement of large boulders for additional cover
	Total	$ 63,510	

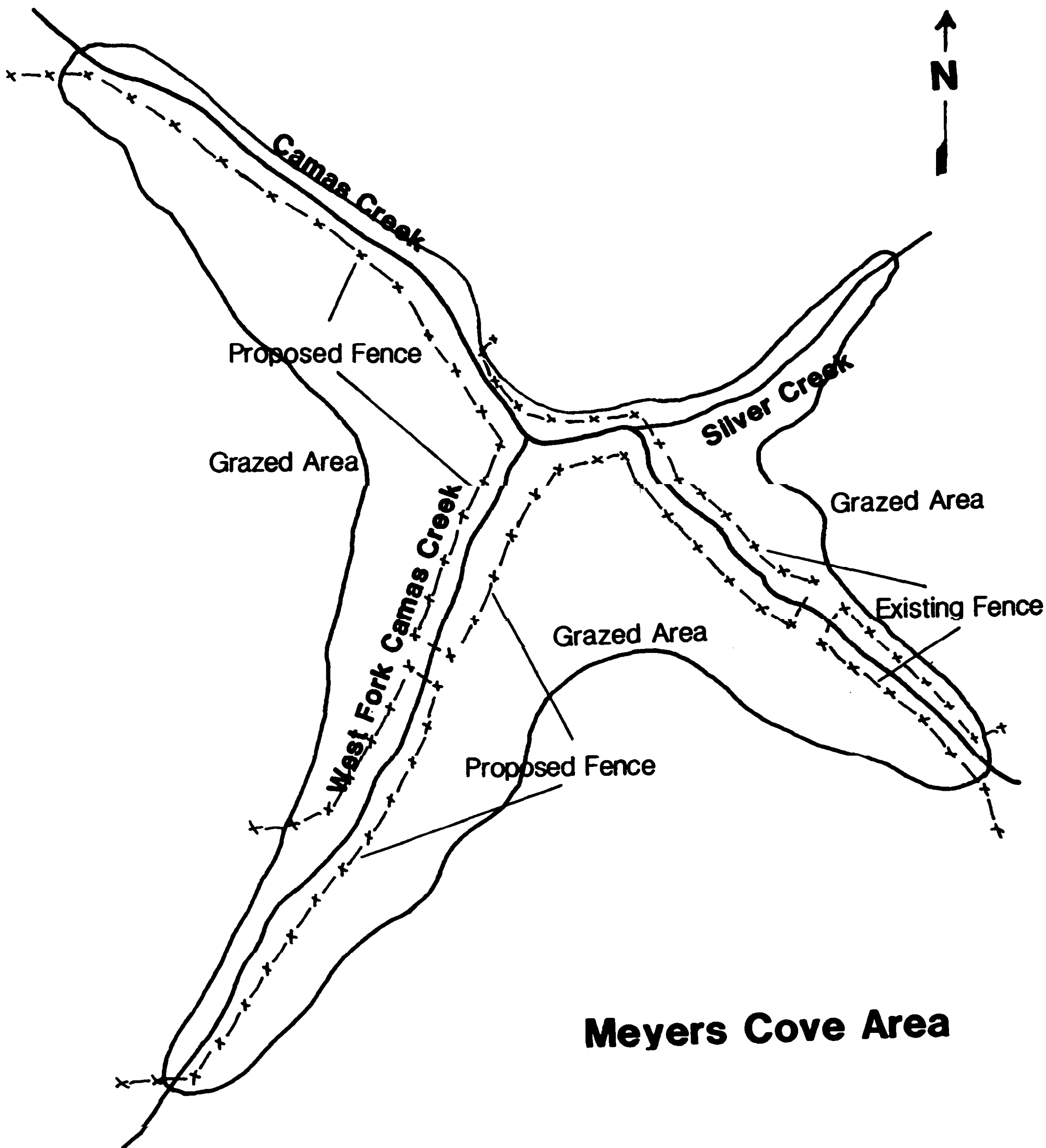

Figure 8. Proposed and existing fencing in the Meyers Cove area needed to coordinate grazing use and protect riparian resources.

Enhancement Activity 2 -- Coordinate riparian and stream enhancement with allotment use. In order to effect positive changes in livestock use of the Meyers Cove area, certain improvements, in addition to fencing, will be necessary.

1. Construct two water developments to compensate for lost access to Camas Creek and the West Fork. cost estimates include tanks, delivery lines and installation.

   Cost $3,000 ea. = $ 6,000

2. Construct livestock crossings on West Fork Camas Creek and main Camas Creek to lessen bank damage and sediment delivery to the streams. Cost estimates include revetment, shaping and sloping and labor. = $ 1,750

3. Reseed upland meadows with more productive grasses to compensate for forage in riparian acres that will not be available to grazing. Cost estimates include seed mix, land preparation and application, and administration.

   costs:
   200 acres treated 8 $50 to $80/ac = $16,000

II. Enhancement of riparian/streamside areas -- Isolation of the riparian area adjacent to the stream channels is expected to allow for a gradual recovery. This recovery is anticipated to be very slow requiring a considerable length of time for fishery benefits to be realized. Options identified for riparian enhancement were designed to expedite recovery, making fishery benefits available in a shorter time period.

Enhancement Activity 1 -- Reshaping and resloping of vertical channel and streambanks. It is anticipatedthat between 15 to 25 percent of the 4,605 feet of unstable banks could benefit. Reshaping would reduce sediment delivery and accelerate vegetative recovery. cost estimates include backhoe rental, travel time, setup and administration of activities.

costs:
Reshaping 700 to 1,150 ft. 8 $6/ft. = $ 6,900

Enhancement Activity 2 -- Reseeding and seedling planting to expedite vegetation recovery. Replanting 30 to 50 percent of the 52+ acres enclosed within the fence would accelerate vegetative recovery and expedite enhancement of fishery values. Cost estimates include hand seeding, seed, and administration.

costs:

Reseeding 16 to 26 ac @ $60/ac ($45 seed/at and $15 labor) = $ 1,560

Planting seedlings (willow, cottonwood, alder) 10 ac 8 1,700 seedlings/at and $.40/seedling. Three years anticipated to complete project. = $ 6,800

Enhancement Activity 3 -- Stabilization of bank sections having excessive cutting or sloughing. It is expected that 25 to 35 percent of the 4,605 feet of unstable streambank could benefit from stabilization (i.e., rock or brush revetment, log structures, etc.).

costs:

Stabilizing 1,150 to 1,600 ft. @ $5/ft. =$ 8,000

III; Enhancement of Instream Cover -- Under optimal conditions a substantial amount of instream cover is provided to external sources. Large organic debris is added as trees and brush enter the stream, root masses provide cover in undercut areas and stream cover is provided by the vegetation canopy. It is anticipated that these habitat components will increase as the relative health of the riparian zone improves. Rearing habitat is also provided by large substrate materials.

Enhancement Activity 1 --Increase rearing cover by placement of large rocks.

Costs:

Add 30 to 50 large boulder-size rocks 8 $50/rock = $ 2,500

Total Project Cost:

Estimated Maximum Cost = $70,010

The Forest Service at present has contributed between $15,000 to $20,000 toward enhanced coordination and improved riparian and fish habitat in the Meyers Cove area. Another $12,000 is budgeted for additional work during this fiscal year (FY 1986). Participation in all future enhancement options under the Columbia River Basin Fish and Wildlife Program is encouraged. Cooperative funding of the proposed enhancement will greatly improve the probability of success and expedite efforts for recovery of anadromous fish within the Middle Fork of the Salmon River.

Fishery Benefits

The benefits derived from accomplishment of the proposed enhancement items and the influence on anadromous salmon and steelhead production potentials are presented in Table 7. This information was taken from the U.S. Fish and Wildlife study (FWS) which was previously footnoted. The benefits were assumed to increase habitat utilized equally by chinook salmon and steelhead trout.

Greater benefits are anticipated under a combined implementation of all enhancement activities. These benefits would project an increase of 76 returning adult steelhead and 128 returning salmon. These increases would be about 77 percent greater than estimated returns from the Meyers Cove habitat in its present state.

The economic returns generated from the production increase can be calculated in several different ways. The initial analysis of economic values completed by FWS estimated a net average annual worth increase of approximately $58,000 associated with the enhancement. This amount was obtained using escapement values of $271 and $294 for steelhead trout and chinook salmon, respectively.

A benefit-cost analysis using a 4 percent discount rate would yield a 12.94 B/C ratio when carried for 25 years or 16.4 if the project life was extended to 40 years. The analysis was based on a one-time expenditure with benefits beginning in subsequent years. A 9 percent discount rate would yield 8.14 and 8.91 respectively, for the two project lifetimes. Under any of the analyses, the project would appear to have merit because of high potential returns.

Table 7. Predicted increases in steelhead trout and chinook salmon as a result of habitat enhancement in the Meyers Cove area of Camas Creek.

Condition	Smolts		Steelhead Adults		Chinook Adults	
	Steelhead	Chinook	Total	Enhanced	Total	Enhanced
Present	5,966	31,959	98	--	166	--
Enhanced	4,586	24,570	174	76	294	128

FOOTNOTES

1. Camas Creek from Hammer Creek to South Fork.

2. Idaho Department of Fish and Game, personal communication, 1985.

3. 1982. Lower Snake River Enhancement Study Stream Report. Camas Creek, 11 pp.

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