AUTHOR: SMITH, MATT 1994

REDWOOD NATIONAL PARK

BRIDGE CREEK LOG JAM MODIFICATION AND STABILIZATION PROJECT

CONTRACT NUMBER
CX 8480-9-0002

NORTH COAST FISHERIES RESTORATION
30,000 HWY 299
BLUE LAKE, CA 95525

MATT SMITH
CONTRACT MANAGER

1989-1994

50 PAGES

ABSTRACT

This report describes the methods and procedures used to modify a log jam barrier to chinook salmon, on Bridge Creek, a tributary to Redwood Creek, in Redwood National Park. A summary of periodic inspection and maintenance performed over a four year period following construction is included. The "Winter Inspection and Maintenance Summary" provides an assessment of the projects ability to meet its objectives, and describes the follow-up work that was required.

The goals of the project were to:

1. Modify the log jam by creating a fish passage around it, so chinook salmon could migrate upstream to the four miles of unavailable quality habitat.
2. Stabilize the log jam, therfore retaining the sediment stored above it, which would prevent unneeded sediment transport downstream.
3. Remove the woody debris accumulated upstream from the log jam to allow future mobile woody debris to pass over it and move downstream.
4. Improve salmonid spawning and rearing habitat adjacent to the log jam.

Both, private fisheries habitat restoration experts, and Redwood National Park physical scientists were involved in achieving the objectives of this project. This integrated effort which combined technical expertise, skilled labor, heavy equipment, fisheries habitat restoration techniques, and local materials, produced many positive results: Chinook salmon have successfully migrated upstream of the log jam, the stored sediment upstream of it has been retained, and spawning and rearing habitat for salmonids has been significantly improved.

The overall success of the Bridge Creek Project provides a model for others wishing to perform similar projects. The broad base of expertise drawn from to modify the Bridge Creek Log Jam, incorporated applications of innovative fisheries habitat restoration techniques to address the best possible solutions to the problems which existed. The successful results detailed in this project will be very useful not only for log jam modifications, but for all types of fisheries habitat restoration and enhancement.

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AUTHORS NOTE

This project resulted from a Request for Proposal (RFP) by Redwood National Park (RNP). Many potential contractors received this RFP; however, Trinity Fisheries Consulting (TFC) was the only contractor to submit a project proposal to RNP.

Ron Sonnevil, geologist, for RNP served as the Contracting Officers Representative (COR) until leaving the park in July, 1991. During the remainder of the contract, Randy Klein, Hydrologist, assumed the responsibility of COR.

TFC was the original contracting organization when the contract for this project (CX 8480-9-0002) was entered into on September 29, 1989. When TFC dissolved as a partnership in January 1991 the original Contract Manager, Matt Smith, continued the contract, doing business as North Coast Fisheries Restoration (NCF), until completion of the contract on April 30, 1994.

Since TFC was the original contractor, the text of this final report refers to TFC as the prime contractor.

Sincerely,
Matt Smith
NCFR

ACKNOWLEDGEMENTS

The Bridge Creek Log Jam Modification and Stabilization project has been a highly successful and rewarding contract which was made possible by the efforts of many dedicated people. All of the people involved should be proud that they were responsible for the restoration of Bridge Creek's habitat, and its run of chinook salmon.

Without the cooperation and understanding of the Redwood National Park personnel involved, this unique contract would probably not have succeeded as it did. Although TFC had considerable previous experience modifying a variety of fish migration barriers, TFC's review of similar RNP projects and discussions with RNP staff played a major role in shaping the design and implementation of the Bridge Creek project, as well as the preparation of this report. In addition, the considerable amount of data collected by RNP on Bridge Creek was invaluable to properly designing the modified log jam structure.

The Author wishes to sincerely thank the following individuals and agencies for their contributions to this project:

Randy Klein (Hydrologist), Ron Sonnevil (Geologist), and Tekla Vines (Contract Administrator) for Redwood National Park, lent advice and administrative assistance which was extremely valuable. Other RNP personnel who indirectly supported the project were Terry Hofstra, Dave Anderson, Vicki Ozaki, Terry Spreiter, Dave Best, Darcy Short, Greg Bundros, Lee Parkeson, and Cara Smith. In addition, several people from the RNP labor crew assisted the contractor during the Construction Phase.

Scott Downie, and Harry Vaughn of Eel River Salmon Restoration, were an integral part of the initial construction phase, and their in-stream structure and heavy equipment expertise was essential to the projects success. Scott and Harry were also involved with the project proposal and some administrative work.

George Mullins of GM Construction was also essential because of his experience with heavy equipment work involving fisheries habitat restoration.

Aldaron Laird, Keith Barnard, and Dustin Escano-Smith of Trinity Fisheries Consulting, helped write the proposal, and administer the contract. Gary Bentjen, Jeff Jones, and Don Allen who were laborers with Trinity Fisheries Consulting, also contributed essential skills to the project, both during initial construction, and the winter maintenance phase. Bill Trush of Trinity Fisheries Consulting, provided the hydraulic parameters for the project structures.

Carl Harral, Habitat 1 Supervisor with the California Department of Fish and Game contributed design recommendations which were very helpful.

Zeak Grader with Pacific Coast Federation of Fishermen's Associations, Inc., provided support by securing bonding for this contract. Eel River Salmon Restoration is one of the fisheries restoration groups affiliated with PCFFA.

INTRODUCTION

Bridge Creek has been studied intensively through a comprehensive watershed rehabilitation and monitoring program established by Redwood National Park (RNP). As a result, previous alterations of the Bridge Creek stream channel from natural and man-made causes have been well documented, including the negative effects of log jam removal on native fish stocks. Some of these log jams, at times, did block salmon migration to their spawning habitat upstream, but most did not prevent salmon or steelhead from passing them. In fact, log jams provide essential components of fish habitat, and their removal can alter stream channels, significantly degrading fish habitat (Beschta 1979, Bilby 1984).

However, the previous misconception that all log jams were fish barriers led to the widespread removal of woody debris accumulations from Bridge Creek prior to inclusion into RNP. Evidence of the impacts from the woody debris removal on Bridge Creek have been well documented by RNP staff. The extensive removal of woody debris from Bridge Creek has reduced the structural complexity of this stream channel. Consequently, its ability to recruit and retain suitable spawning gravel, or to create other habitat types has been reduced.

Since the benefit of log jams has been recognized, the management goal for the BCLJ was to stabilize it, retain the gravel wedge upstream of it, and preserve its woody debris structure intact. Prior to this project the BCLJ was a partial barrier, allowing only steelhead trout to negotiate it. A fish passage around the BCLJ was necessary to provide passage for chinook salmon to the upstream four miles of unavailable habitat. While providing passage around the BCLJ was the main objective, it was also necessary to maintain and increase the stability of the log jam, to prevent the release of the stored sediment and the resultant downstream impacts.

Another goal of the project was to facilitate future woody debris passage over the BCLJ. This was accomplished by clearing a high flow channel through the center of it. The final goal of the project, to improve the degraded habitat adjacent to the BCLJ was accomplished by allowing some of the fine sediment upstream to flush out, exposing the spawning gravel which had been buried underneath it. Additionally, large woody debris cover structures were constructed to improve rearing habitat upstream of the BCLJ.

The initial goals of the contract have been met. The first chinook salmon migration upstream of the BCLJ in 8 seasons was possible because of constructing a fishway around it. Constructing a channel for passage of debris over the BCLJ was accomplished, and has functioned as planned. Anchoring systems employed on the BCLJ have made it substantially stronger than prior to modification. It is anticipated that the structure will stay intact for decades, but only time and the flood events of Bridge Creek will dictate its longevity.

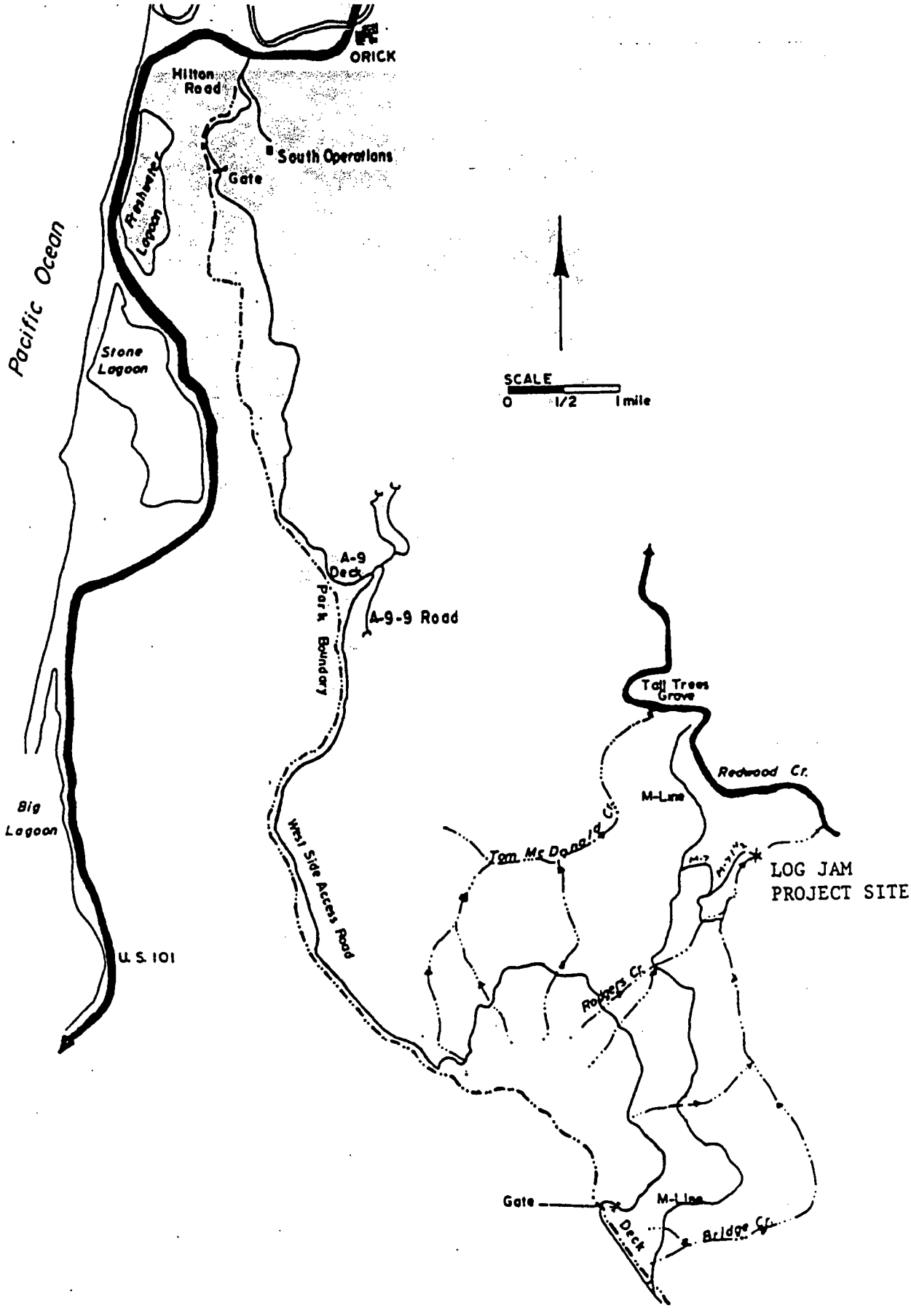


Figure 2. Map showing location of Bridge Creek, access roads, and project site

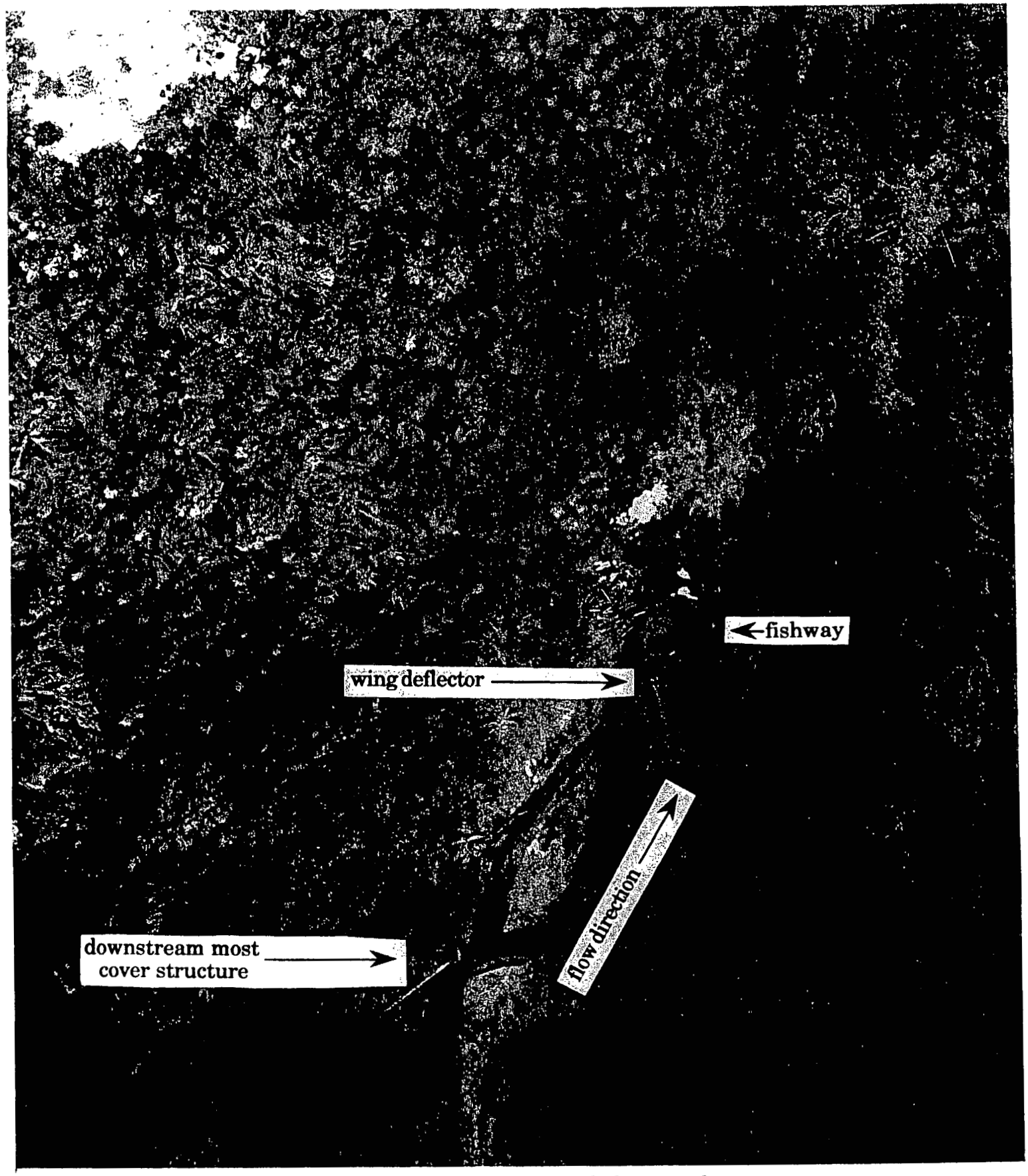


Figure 4. Post-project aerial photograph

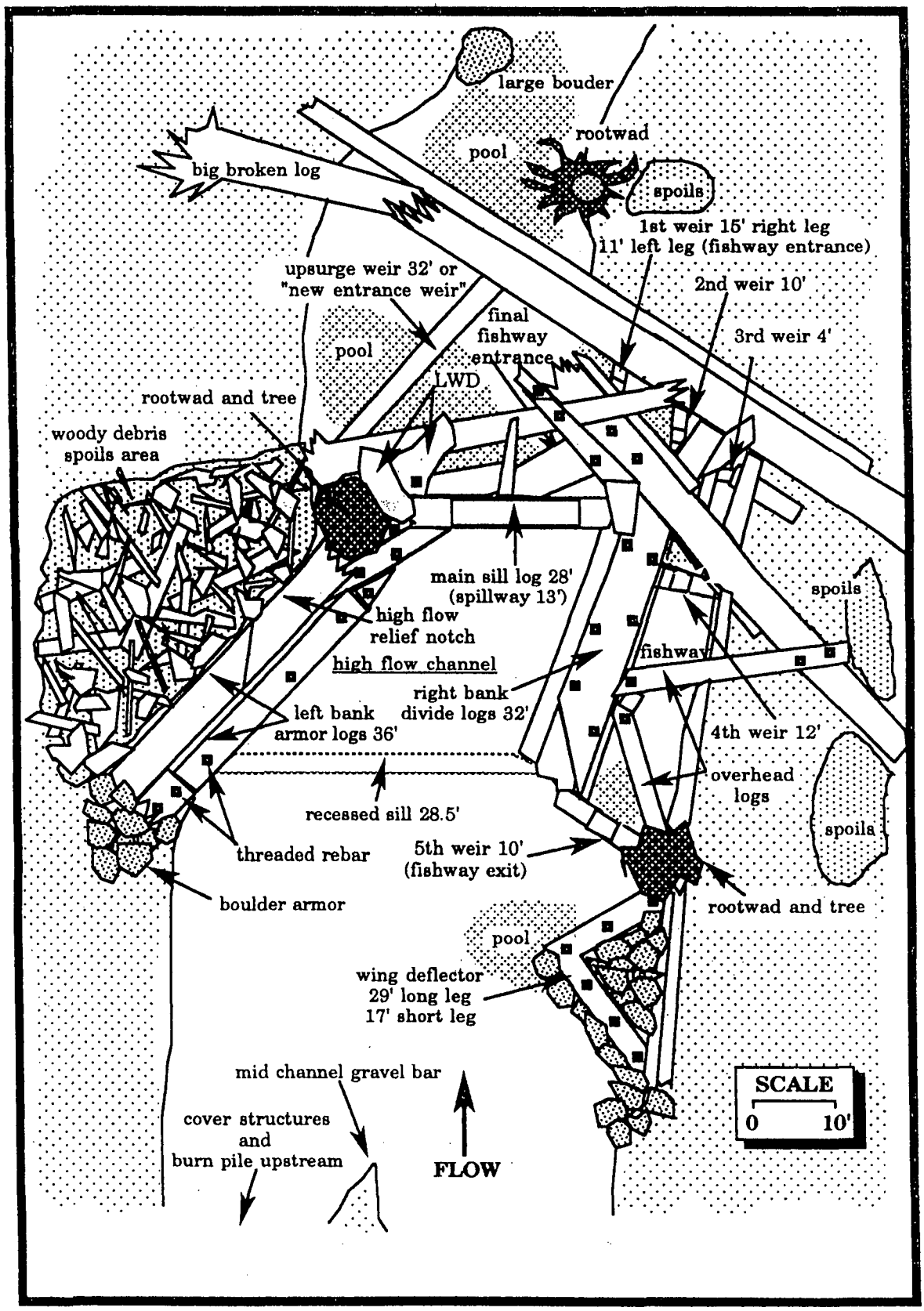


Figure 5. Completed structure illustration

I. SUMMARY

A. TIME TABLE

Due to the unique nature of the Bridge Creek Log Jam Stabilization contract, additional correspondence compared with the usual contract requirements was necessary. The ability to determine exact construction requirements was not possible until the contract was in progress. Utilizing on site material to reduce costs played a major role in the final design of the project. The additional design and contract work required was valuable for determining the best possible design for the project. The working relationship between Trinity Fisheries Consulting (TFC), Eel River Salmon Restoration (ERSR) and Redwood National Park was excellent. Park personnel were very helpful which facilitated a smooth and trouble free contract period. The schedule of pertinent dates associated with the Bridge Creek Log Jam Modification and Stabilization Project is as follows:

Table 1. Schedule of Contract Dates

RNP log jam rehabilitation solicitation	June 8 1989
RNP solicitation amendment	July 21 1989
RNP bid opening	July 11 1989
TFC 1st proposal addendum	Aug. 7 1989
RNP 1st request for additional information	Aug. 11 1989
RNP 2nd request for additional information	Aug. 15 1989
TFC 2nd proposal addendum	Sept. 11 1989
RNP request for best and final offer	Sept. 14 1989
RNP contract award	Sept. 29 1989
TFC 1st contract modification request	July 30 1990
RNP pre contract meeting	Aug. 9 1990
TFC start construction	Aug. 15 1990
RNP contract modification #1	Aug. 17 1990
TFC contract modification request	Sept. 3 1990
RNP contract modification #2	Sept. 7 1990
TFC initial construction phase completed	Sept. 10 1990
RNP contract modification #3, contract extension	Mar 21 1991
TFC contract modification #4, change of name	Sept. 29 1991
NCFR contract modification #5, change of address	July 7 1991
NCFR contract modification #6, contract extension	April 30 1992
NCFR contract modification #7, contract extension	April 30 1993
NCFR winter inspection and maintenance phase completed	April 28 1994
BCLJ contract expired	April 30 1994

B. LOGISTICS

Trinity Fisheries Consulting and Eel River Salmon Restoration (ERSR) a subsidiary of Pacific Coast Federation of Fishermen's Associations (PCFFA) performed this contract as a joint effort. A total of six people were on site every day of the initial construction period; one project supervisor, two heavy equipment operators, and three laborers. Trinity Fisheries crew consisted of the project manager, Matt Smith, and two laborers, Gary Bentjen, and Jeff Jones. Eel River Salmon Restoration consisted of two heavy equipment operators and one laborer. Scott Downie operated the D4E cat and George Mullins operated the Case 680 backhoe. Harry Vaughn was ERSR's laborer. A low bed for heavy equipment transport, and a dump truck for boulder mobilization were also subcontracted too. The construction phase of the contract required 3.5 weeks. The

total number of hours required for heavy equipment and labor to complete the project is as follows:

Table 2. Construction Phase Contract Hours

Type	Hours
Laborers	745.5
D4E Cat	137
680 Backhoe	128
10 Yrd dump truck	38
Total	**1,048.5**

II. BACKGROUND

A. FISH OBSERVATIONS AND MIGRATION

Fish observations in Bridge Creek from 1980 to 1987 indicate spawning access to upper Bridge Creek was prevented by the BCLJ. The overburden material was not allowed to pass over the jam due to several vertically oriented support logs which protruded above the upstream channel bottom. During high flows, water was backed up upstream of the log jam causing the woody debris to float, then settling out when the flows subsided. This movement of the woody debris each winter had not allowed the log jam to form an adequate fish passage. Instead, fish passages migrated back and forth through the jam creating very sketchy windows for passage through the years. This inadequate fish passage limited migration only to steelhead trout.

Steelhead trout have passed through the jam as they have been observed above the log jam in significant numbers. Steelhead trout have an uncanny ability to negotiate log jams during high flows. When the woody debris upstream of the BCLJ were floating, steelhead were able to swim through the material. However, chinook and coho salmon have much less leaping and swimming ability (Orsborn1985). Steelhead trout have been observed intermittently above the BCLJ since 1983 with a large number of juveniles during the 1989 summer season.

The Bridge Creek log jam was modified primarily for chinook salmon because steelhead trout already were populated above the log jam. Chinook salmon are also the higher priority species for restoration in the Redwood Creek basin because of their reduced populations compared with steelhead trout. Adult chinook salmon had not been observed above the BCLJ since 1983. Large numbers of chinook salmon had been observed in the pool below the BCLJ, unable to pass upstream to the higher quality spawning habitat there.

B. BCLJ CHARACTERISTICS

The BCLJ was a 17' high log accumulation which prevented most upstream migration by salmonids. The actual height of the BCLJ which fish negotiated was 8 vertical feet from the pool below the jam to the riffle above the BCLJ. The BCLJ consisted of approximately 15 support pieces of large woody debris (LWD) and a large mass of LWD and small woody debris (SWD) overburden (approximately 2,015 cubic yards). Most of the logs within the log jam were in the twelve to eighteen inch diameter range and some logs were four to six feet in diameter. One 30 foot, 6 foot diameter log was large enough to require both the backhoe and cat to move it. Prior to modification the log jam was approximately 80 feet wide and 40 feet long. The present dimensions of the log jam are substantially different from pre modification. Virtually all the woody debris overburden

has been removed from the right bank and center portion of the log jam and was either burned or placed on the left bank portion of the log jam. The width of the jam remains the same but the length is now 15 feet in the center, and 40 feet on the sides where the right bank fishway and the left bank armor logs now are.

The 80 to 100 foot wide channel upstream of the log jam stores approximately 33,000 cubic yards of sediment. The log sill which was constructed at the center of the log jam now determines the height at which the gravel aggrades to. The top of the sill was placed at the same elevation as the pre-existing upstream channel bottom. This was to limit the amount of down cutting that could potentially occur. Although some down cutting through this sediment wedge was expected due to the lowering of the log jam top elevation. Further down cutting has been, and should be mainly from the thalwag being incised within the channels stored sediments.

Water flowed through the top one-third of the jam mainly on the right bank. The water fall that was present was misaligned with the rest/jump pool below the jam. Some of the woody debris material on the left bank of the BCLJ had been displaced during high flows, signalling potential for lateral channel migration to that side and consequent destabilization of the BCLJ. The maximum flow that the modified BCLJ was designed to withstand is a 25-year peak discharge of 2800 cfs. The fishway through the BCLJ was designed to facilitate fish passage at a minimum of 150 cfs.

C. MONITORING

A detailed physical monitoring program has been conducted on Bridge Creek by Redwood National Park (RNP) personnel since 1983. This has allowed characterization of the physical nature of Bridge Creek, including the BCLJ. The volume of sediment storage in the study reach below the BCLJ has decreased dramatically due to LWD removal in 1971. An estimated 33,000 cubic yards of sediment have accumulated in the reach immediately above the BCLJ, as a result of this one LWD structure. Stored sediment in the stream reach from the base of the BCLJ to the mouth of Bridge Creek has decreased to 17% of the 1971 volume, excluding terraces near the mouth of Bridge Creek. This decrease in spawning gravels below the BCLJ had increased the need to provide access to the quality spawning habitat above the BCLJ.

Under a separate contract TFC performed physical monitoring in the form of habitat and stream typing during the summer and winter of 1989. This detailed habitat inventory will be valuable in determining changes in habitat after modifying the BCLJ. Included was a woody debris inventory which will be helpful in tracking future woody debris migration through Bridge Creek. Future fisheries habitat restoration up and downstream of the BCLJ will also benefit from this inventory. Together,the habitat and woody debris inventories will provide important planning tools for future habitat restoration work in Bridge Creek.

A biological monitoring program of lower Bridge Creek has been conducted since 1980. Lack of access over the BCLJ had restricted chinook salmon to the limited spawning areas downstream, which provide only 31% of the total estimated spawning area available in Bridge Creek. A portion of the available spawning area for chinook salmon is located on the sediment wedge upstream of the BCLJ. Natural structures such as BCLJ serve two important functions. They provide stable gravel bars for spawning

salmonids as well as providing shelter from predators and resting places away from high velocities and turbulence. A food net is created by floating invertebrates being strained out, concentrating food in association with LWD. The decaying wood also drops other insects into the water

D. SEDIMENT STORAGE HISTORY

The BCLJ and another debris accumulation upstream were burned in the fall of 1984. Large piles of debris were left on the gravel bars which mobilized during the winter of 1986 and backed up upstream of the BCLJ. Woody debris had continued to accumulate upstream of the log jam since 1986. The overburden material was not allowed to pass over the jam due to several vertically oriented support logs which protruded above the upstream channel bottom. After the burning was performed some gravel was released downstream from the BCLJ. A larger amount of sediment was released from the upstream debris accumulation with some sediment being retained behind the BCLJ and the rest released downstream. Debris from this accumulation floated downstream during different winters and lodged on the BCLJ

E. TFC HISTORY

Trinity Fisheries Consulting had been involved in the restoration of fish habitat in the lower five miles of Bridge Creek since 1987. In 1988 a multi-phase proposal was submitted by TFC to the California Department of Fish and Game (CDF&G) to:

1) Analyze the fish habitat availability and needs of Bridge Creek.
2) Restore structural diversity and thereby improve the fish habitat of lower Bridge Creek.
3) Modify the BCLJ.

The proposal was evaluated, prioritized and slated for partial funding with matching funding from RNP. CDF&G budget reductions for fiscal year 1988-89 prevented the implementation of the project.

TFC's proposal package was adopted for funding solely by RNP and the first phase, Bridge Creek woody debris and habitat inventory, was awarded to TFC in April of 1989, under contract number RFQ 8480-9-0003. Monument establishment, woody debris inventory, and habitat typing were performed. Recommendations for habitat restoration were included with the final report. One recommendation was to develop rearing and velocity cover structures which became a secondary objective of the BCLJ contract.

In 1990, the second phase was initiated with an RNP contract for constructing woody debris structures in the reach downstream of the BCLJ with labor supplied by the California Conservation Corps. Contract CX-8480-0-0002 Bridge Creek Log Jam Stabilization was awarded to TFC and the initial construction phase was completed in 1990.

Trinity Fisheries Consulting subcontracted with Eel River Salmon Restoration creating a joint effort to implement this project. Eel River Salmon Restoration is an association of the Pacific Coast Federation of Fishermen's Associations. The two groups united for two reasons. First, TFC and ERSR are leaders in the field of fisheries habitat restoration and felt that by combining efforts the best possible solution would be found to solve the unique problems which existed because of the BCLJ. Secondly, TFC's

specialty in barrier modification and in-stream structure design combined with ERSR's experience in heavy equipment manipulation of stream channels, created an excellent team to address the unusual modification of the BCLJ.

III. OBJECTIVES

1) To improve access for migrating adult chinook salmon (Oncorhynchus tshawytscha) to 3.7 miles of under utilized anadromous habitat, containing approximately 69% of the estimated spawning habitat of Bridge Creek.
2) To increase the stability of the BCLJ in order to prevent the release of the stored sediment upstream of the BCLJ which could adversely impact lower Bridge Creek and Redwood Creek through the tall trees grove. The large gravel wedge also provided valuable spawning habitat.
3) To reduce woody debris recruitment upstream of the BCLJ which could possibly add to fish passage problems around the BCLJ and the potential for its destabilization during high flows.

Habitat restoration projects are often difficult to develop exact designs for. This is due to the uniqueness of every stream channel, and the in-stream structural components influencing it. Every project is very site specific, requiring adjustments and modifications in order to produce the final product. Some of the design aspects of the BCLJ were unknown until the project was actually underway. Until the BCLJ overburden was removed, the main structure logs and other debris could not be properly assessed for appropriate manipulation. The proposed design was basically adhered to for this project, but modifications were necessary.

A. FISH PASSAGE

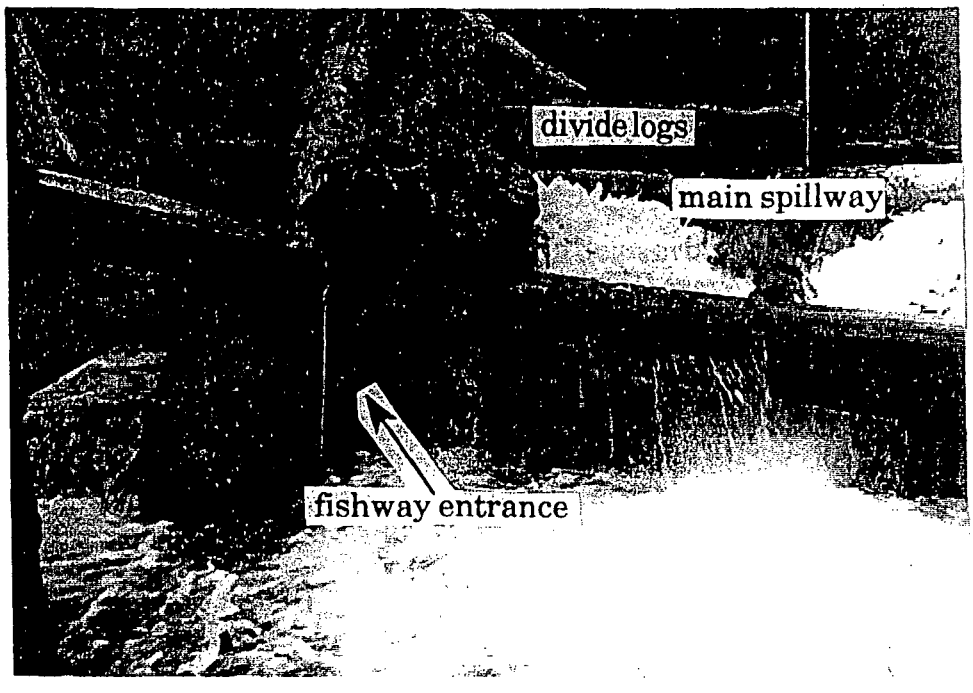
This objective of the project is extremely important as the spawning habitat for chinook salmon is limited both in the reach below the BCLJ and in other tributaries within the Redwood Creek basin. Most of the available spawning habitat is in the mainstem Redwood Creek due to the limited accessibility to the tributaries. The spawning habitat above the BCLJ is of higher quantity and quality than that below the BCLJ.

Fish passage requirements for chinook salmon are much greater than those of steelhead trout. Jump heights must be lower than for steelhead trout. A 14 inch jump is appropriate for chinook salmon. Pool size, pool depth, and resting area must also be greater. Constructing a weir height to twelve inches during the low flow season will result in wave over the same weir at high flow when chinook salmon are migrating. This is desirable because chinook salmon will swim over an obstacle before attempting to leap over it.

Steelhead trout have much greater leaping capabilities than chinook salmon as evidenced by the steelhead which effectively negotiated the BCLJ before it was modified. Not only can steelhead trout leap over extreme distances in elevation, they can also swim through turbulent, high velocity water underneath a barrier. This appears to be what has happened at the BCLJ where spaces under and through the BCLJ are where the fish traveled. This was apparent because the jump pool below the BCLJ was inadequate for steelhead to leap over the total height of the BCLJ.

Figure 11.
MAIN SILL

Before project looking upstream from downstream of BCLJ



After project completion during high flow (same photo point)