REDWOOD CREEK POOL COVER PROJECT

California Department of Fish and Game

Fisheries Restoration Grant Program

(Phase Two)
1991-1992
FG-1251

FINAL REPORT

North Coast Fisheries Restoration
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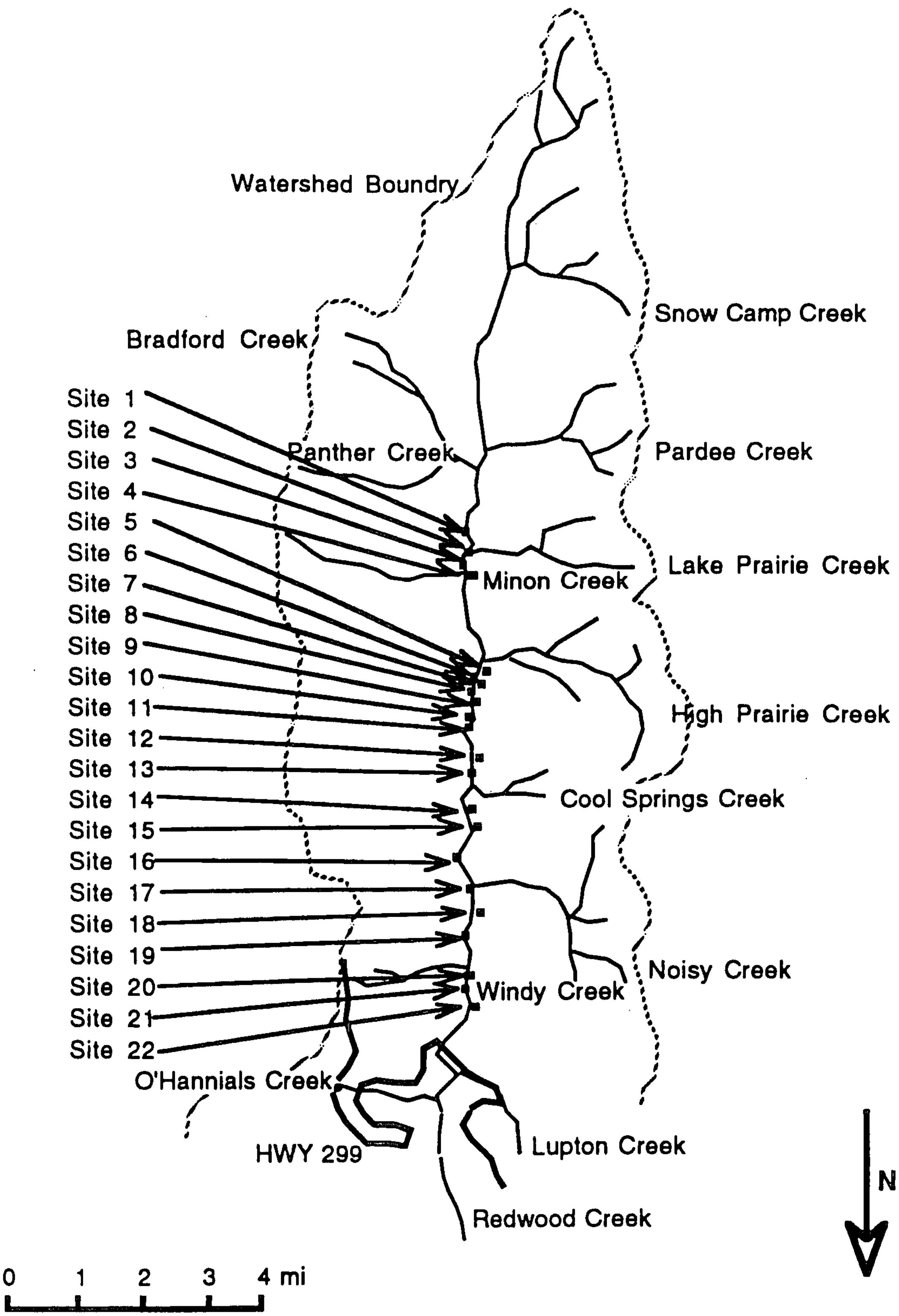

Redwood Creek Pool Cover Project Map

REDWOOD CREEK POOL COVER PROJECT
FINAL REPORT
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BACKGROUND

Contractor: North Coast Fisheries Restoration Formerly Trinity Fisheries Consulting (phase one).
Contract Representative: Matt Smith
Agreement Number: FG-1251
Budget Amount: $26,507.00

Project location: Nine sites on main channel Redwood Creek from 1/4 mile upstream of Highway 299, upstream 10 miles, in Humboldt County, in Township 6 North, Range 3 East, in sections 14, 23, 26, 25, and 36, and in Township 5 North, Range 3 East, Section 7. (Please see project map). Redwood Creek is a fourth order stream draining into the Pacific Ocean, and has a 280 square mile watershed.

Acknowledgements:
Without the cooperation and support of the landowners in this project could never have been implemented. Their participation in the restoration of Redwood Creek's fisheries is extremely valuable and much appreciated. Some of the landowners donated logs which helped to make the project more cost effective. The following private landowners allowed access through their property or provided materials or labor:
Simpson Timber Company Allowed access across their property, donated cull logs and rootwads.
Joe Massei Allowed access across his property, provided lodging, donated logs and labor time.
Ken Bareilles Allowed access across his property.
Michael Deering Allowed access across his property and donated logs.
Jim O'Hanen Allowed access across their property, donated 2 cubic yard boulders. Mr. O'Hanen was hired to operate his loader and cat to place boulders and stockpile logs.
Forest Tilly Allowed access across his property and donated logs.
Tim Mason Allowed access across his property.
Jack Mason Allowed access across his property and donated cull logs.
Vernon Harling Allowed access across his property. Mr. Harling was hired to stockpile logs.

Contract History: During 1988 and 1989 an extensive inventory was performed to determine which pools in this project reach were lacking cover the most. Out of 50 pools 25 were targeted for pool covers. The first phase of this contract was awarded in 1989 to construct 13 pool covers. Contract FG 8451 funded for $31,416.00 was completed December 1991 (Please see final report for contract FG8451). Boulders, logs, and rootwads were yarded into pools devoid of rearing and escape cover. One pool had three boulders placed in it to provide cover. Twelve other pools had multiple logs or rootwads placed in them. The project took two seasons to complete. Thirteen sites were completed during the first year's work. Flashy high flows during the winter of 1989-90 displaced site thirteen and site eleven lost two of the eight logs that were present. Other sites had some cables fail due to poor rock composition (rock broke apart and cables pulled out) resulting in loose logs on the structures. Most of the 1990 season was spent repairing and adding cables to the previously constructed structures. Much of this work was required due to the poor quality of the bedrock present. Extra cables with extra deep holes were added to insure structure longevity. Logs were also added to four of the structures to increase their complexity. Site thirteen was relocated downstream at the mouth of Noisy Creek where channel morphology and pool orientation made the structure less vulnerable to displacement in high flows.

A year was allowed to pass to assess project effectiveness before submitting a phase two proposal to treat the remaining pools identified for habitat improvement. The winter flows of 1990-91 did not displace the structures which was a concern in a large drainage such as Redwood Creek. Heavy duty anchoring techniques used for this project had never been employed before, making an assessment period prudent.

A proposal was submitted in 1991 to complete the second phase of this project and was funded for the 1992 work season. Ten pools had log covers placed in them, and six of the existing sites had threaded rebar, cable and clamps, and extra logs added. Site seven from the first phase had logs added to it to increase its complexity. The first phase project was located in the uppermost accessible anadromous reach of Redwood Creek. The second phase completed the pools from the first phase reach downstream to Highway 299. All the pools in the entire reach now have good to excellent cover, whereas 50% were virtually devoid of cover prior to project implementation.

Both phases of this project have seen an evolution in anchoring techniques with the end product resulting in a combination of anchoring materials and techniques preventing large woody debris displacement. During the "drought ending" winter of 1992-1993, the highest peak discharge the structures were tested by was 5,256 CFS on January 20th, followed by six additional peak flows. Floating old growth fir logs were observed battering some of the structures but only one anchor failure occured resulting in a 95 percent success rate The anchoring techniques developed for this project were found to be very successful and are becoming the state of the art for instream structure anchoring in California (described in technical information).

A "wait and see" follow-up on this project was adopted because the drainage was so large and the drought was not providing adequate testing flows for the structures. Large woody debris cover structures such as the ones employed here have typically been placed in smaller first and second order streams where high flows are less of a concern. The buoyancy associated with these structures, and the difficulty in anchoring them has prevented their use in larger streams and rivers. This project has been an excellent study case for the potential of success in future projects of this type. The winter of 1992-1993 proved that anchoring on this scale is possible. Only one of the twenty-two structures was displaced. This failure occured because it was placed in a trench pool through a bedrock constriction with no floodplain. As the flow increased, the water was not allowed to spread out and disipate energy, increasing depth and turbulence which floated the structure up, leveraging the Hilti anchored cables in turn disintegrating the bedrock. The flow was ten feet over the top of the structure when this happened. The rest of the structures were completely submerged by three to six feet. The upper watershed of Redwood Creek received over seventy inches of rain subjecting the structures to one high flow after another until remaining at an average flow of 1100 CFS until May.

WORK PERFORMED

All of the work was covered by the original budget amount requiring no add-on of additional funds. The 22 sites completed over the two phase project required a total of 96 logs or rootwads and 23 boulders. The average number of logs per structure was four, and one structure had eleven logs. Sixty-one logs or rootwads and three boulders were used in the first phase and 35 logs or rootwads were used in the second phase. Twenty boulders were also placed in the second phase as well as adding threaded rebar and clamps to six of the sites from the first phase.

These logs and rootwads were used to construct large woody debris "spider logs". Large woody debris material was yarded into the pools usually with the aid of heavy equipment, and in some cases with a portable hydraulic winch, or a truck mounted winch. The material was then winched into place one log at a time and temporarily held in place with chains and binders. The main support logs were anchored to bedrock or large house size boulders with the Hilti anchoring system. In some cases, off-channel anchoring was achieved by constructing a threaded rebar anchor through the center of a large diameter tree. When ever possible an in-channel boulder or point of bedrock was used to anchor the apex of the structure down in the water, preventing the structure from floating. All of the wood to wood joints were then anchored together with three quarter inch threaded rebar. The first phase of the project utilized all cable anchors.

One of the structures upstream of Noisy Creek was designed to provide both bank armorment and cover habitat. Six to eight foot diameter boulders were placed along an eroding bank on the outside of a bend. Bank erosion was prevented and cover habitat was provided between and under the boulders where they are submerged.

The following page is a listing of what type of structure was developed at each site for both phases of the project. The location of each site is shown on the project area map. Also provided is the landowner and years in which construction and subsequent maintenance was performed (please see figures for examples of the structures).

Structure Types

Site #1	Three boulders cabled together on bottom of pool. Simpson 1989.
Site #2	One large fir log in a digger configuration, two smaller logs forming a spider on the right bank. Simpson 1989-90-92.
Site #3	One fir log and rootwad is cabled to large boulders on the right bank extending into the middle of the channel. Simpson 1989-90-92.
Site #4	Six large fir logs, two with rootwads, forming a spider in a digger configuration on the left bank. Simpson 1989-90-92.
Site #5	Five fir logs and one rootwad forming spider with digger configuration on left bank. Main support log sixty feet long. Joe Massai 1992.
Site #6	Five large fir logs, two with rootwads forming a spider on the right bank. Joe Massai 1989-90-92.
Site #7	Four logs ,one with a large rootwad forming a spider on the left bank. Joe Massai 1989-90-92.
Site #8	Two oak logs, one with a rootwad cabled to bedrock on the right bank Second phase added two fir logs in digger configuration angling down from cliff and extending to bottom of pool. Main digger log is sixty feet long. Joe Massai 1989-92.
Site #9	Seven fir and oak logs, two with rootwads forming a spider on the left bank. Joe Massai 1989-90-92.
Site #10	Three logs forming a spider with a digger configuration spanning from the bank to the center of the channel. Joe Massai 1989-90-92.
Site #11	One large fir log with rootwad and one oak log with rootwad forming a spider on right bank. Joe Massai 1989-92.
Site #12	Eleven fir logs, one with a large rootwad forming a spider in a digger configuration on the left bank in trench pool. Ken Bareilles 1989-90.
Site #13	Ten logs, two with rootwads forming a spider on the right bank. Ken Bareilles 1989-90.
Site #14	Four fir logs forming a spider on a left bank bedrock outcrop. Michael Deering 1992.
Site #15	Four fir logs forming a spider with a digger configuration on a left bank bedrock outcrop. Main support log over sixty feet long. Michael Deering 1992.
Site #16	Boulder armorment placed on right bank. Twenty 6 to 8 foot diameter boulders placed. Jim O'Hanen 1992.
Site #17	Six large fir logs cabled together in a digger configuration on the left bank at mouth of large tributary. Jim O'Hanen 1990-92.
Site #18	Four fir logs forming a spider with a digger configuration on left bank house sized boulders. Main support log has a rootwad, is fifty feet long, and is four feet in diameter. Jim O'Hanen 1992.
Site #19	Three fir logs forming a spider with a digger configuration on right bank house sized boulders. Structure extends from bank to middle of channel. Forest Tilly 1992.
Site #20	Four fir logs forming a spider with a digger configuration on right bank bedrock cliff. Tim Mason 1992.
Site #21	Two fir logs in a digger configuration extending from the top of a house sized boulder on the right bank to the bottom of the pool. The main digger log is four feet in diameter, 45 feet long with a rootwad. Jack Mason 1992.
Site #22	Six fir logs forming a spider with a digger configuration on left bank house sized boulders. Main support log seventy feet long providing cover over entire pool length. Vernon Harling 1992.

BENEFIT

1. Species benefitted are steelhead trout, coho salmon and chinnok salmon. Steelhead trout and coho salmon juveniles utilize the pool shelters during the summer months for escape cover and steelhead use them for velocity cover in the winter.
2. Adult chinook salmon use the shelters during winter for escape and velocity cover.
3. The shelters act as filter nets, providing a benefit by supporting food organisms.
4. The log ends protruding from the structures catch small woody debris recruiting additional cover through the years.
5. Pool depth is increased due to the hydraulic influences created by the log cover structures.
6. The log structures provide resting and feeding places for wildlife and birds.
7. Land owner awareness of fisheries has been increased.

TIME FRAME

First phase of construction was performed during the field seasons of 1989 and 1990. In 1989, work started in early August after receiving a notice to proceed from the department on July 5th. Work was discontinued in mid October when an unusually high discharge storm raised water levels. The 1990 construction began July 18th, and was completed July 31st. Sixteen hundred person hours including administrative time, was required. The second phase took 43 days to complete from July 7th to October 16th of 1992. Including administrative time, this phase required 779 person hours

EVALUATION

The project has been successful in reaching the restoration goals originally proposed. These goals were to increase carrying capacity by increasing escape and velocity cover for salmonids. Although limited, biological monitoring has shown increased carrying capacity for the targeted pools. Another goal of any restoration project is to provide as long a life to the project benefits as possible. The soundness of the large woody debris material and the anchoring techniques employed have provided for structure longevity, thus insuring the projects benefits will be realized for many years to come.

Pre and post project physical and biological monitoring was volunteered by the contractor to assess the structures hydraulic influences on channel morphology and to determine if increased numbers of fish are utilizing them. Baseline documentation of pool dimensions were recorded and then again the following year. The winter of 1989-1990 increased pool depth due to hydraulic influences created by the woody debris structures was documented. After the 1991-1992 winter, pool depth was dramatically increased creating the deepest pools since the 1964 flood filled the entire Redwood Creek channel with sediment

Direct observation diving was performed to determine species composition, abundance, and habitat preference. In both phases of the project a 50 to 60 percent increase in steelhead and coho juvenile utilization has been observed. On many occasions this increase was observed only one to two days after structure placement, indicating increased carrying capacity and not just fluctuations in population numbers from one season or year to another. The fish were nearby in riffles and pocket water areas, but not using these pools. As soon as cover was provided, the fish moved to the pools from their previous habitat niches. While riffle areas provide some cover in the form of bubble curtains and interstitial spaces, they also can make juveniles vulnerable. Water snake predation and cut off side channels that dry up are examples of this.

Another observation worth noting is the usage of the cover structures depending on complexity. Structures having less complexity with single or double logs while providing increased carrying capacity did not provide as much as more complex ones. Structures with multiple logs or rootwwads provided many micro habitat niches on all sides of the structures, whereas single logs usually provided niches on two sides.

Due to difficult conditions for observing adult salmonids, structure benefit is not determined.

Cost effectiveness is quite good considering the complexity, size, and potential benefit of the structures. Cost per structure for phase one was $2,461.00, and $2,409.00 for phase two.

The threaded rebar anchoring material used for the second phase of the project has proven to be invaluable in anchoring woody debris. Its qualities make it much more desirable than the previous alternative of cable and clamps or standard rebar (Pleases see technical information for more information).

In the four years implementing this project, different placement of the structures has been tested. Initially it was assumed that by placing the structures closer to backwater eddy areas, downstream or behind rock points, this would reduce the structures vulnerability to displacement by high flows. While this is true, this placement does not allow for beneficial hydraulic influences by the structure on channel morphology. When structures were placed too far out of the main thalwag or highest energy spot of the pool, bed aggradation was caused. Placement of the structures in these high energy spots created optimum scour increasing pool depth and size. Therefor, it became more important to target pools where structure placement of this type could be performed and at the same time not cause undue vulnerability. Corner pools with exposed bedrock facing directly at stream flows were avoided. Lateral scour pools located in straight wide channels are the most ideal.

Follow-up work is recommended but not required. Maintenance of the structures could be performed if loose anchors occur. Clamps or threaded rebar nuts could be tightened to prevent structure movement. Further monitoring could reveal future physical and biological changes associated with the structures

TECHNICAL INFORMATION

Matt Smith has nine years habitat improvement construction experience. Many unique techniques have been developed during that time. A few techniques which were used on this project are described in detail.

Cabling

Large diameter steel cable is extremely stiff which resists bending. This can cause problems in creating tight enough anchor points. If cable is wrapped by hand around two logs and clamped together the cable will have slack. Slack creates flexibility at an anchor point, allowing the logs to twist and move. When this happens the cable can become frayed. Also, the cable can cut into the log creating additional slack, ultimately resulting in structure failure. To prevent this from happening the cable must be cinched tight. We have retrofitted standard cable clamps, welding hooks onto them (see figure #4) to provide a means of hooking a come-a-long to the cable ends. Clamps are attached to different places on the cable depending on the way in which the cable is wrapped. A come-a-long with its yarding cable extended is hooked to one cable hook, wrapped around the logs and then hooked to the second cable hook. The come-a-long is then ratcheted in, tightening the cable. Before the cable is all the way tight, two cable clamps can be put around the two cables where they are to be anchored. Leave the clamps loose so the cable can pull through them. Cinch the cable tight the rest of the way and then tighten down the cable clamps securing the anchor point. The come-a-long can now be released and the cable will stay tight.

Drilling

When cable is wrapped around a log and clamped off to secure it, if the cable is not run through a drilled hole first, the cable will work itself loose. This twisting movement abrades the log, creating slack which eventually allows the log to slip out of the cable loop. A hole must be drilled through the middle of the log where the cable is to be wrapped around it. The cable is run through the hole and then wrapped around the log which prevents the log from twisting. Even if the log becomes abraded and loose, it will not be allowed to slip out of the cable loop. Twisting of the logs must be prevented as this can cause the greatest amount of abrasion. This can be achieved by clamping the cable on either side of the log where the cable enters the drilled hole. By clamping the cable in this fashion the log is prevented from twisting, because the cable clamps keep the cable from pulling through the drilled hole. In some situations two holes are drilled into bedrock on either side of log to secure it. The cable runs from one hole in the rock around the log, through a drilled hole and back to the second hole in the rock. If one of the rock holes fails, then the cable is allowed to pull through the log. To prevent this, cable clamps must be placed on either side of the log. If one rock hole fails, then the opposite clamp will still keep the log secure.

FIGURE #1
Spider log examples

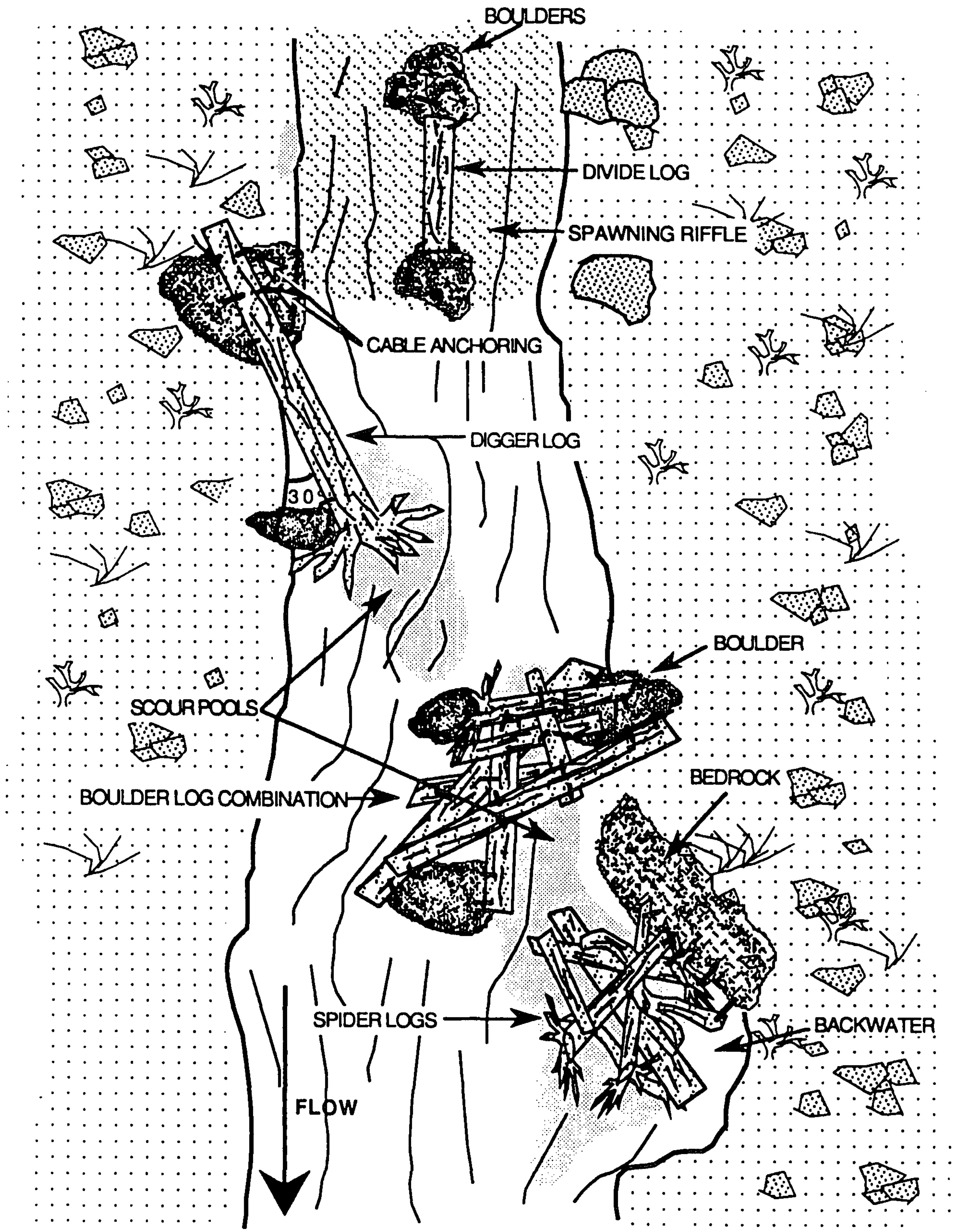


FIGURE #2
Structure photographs

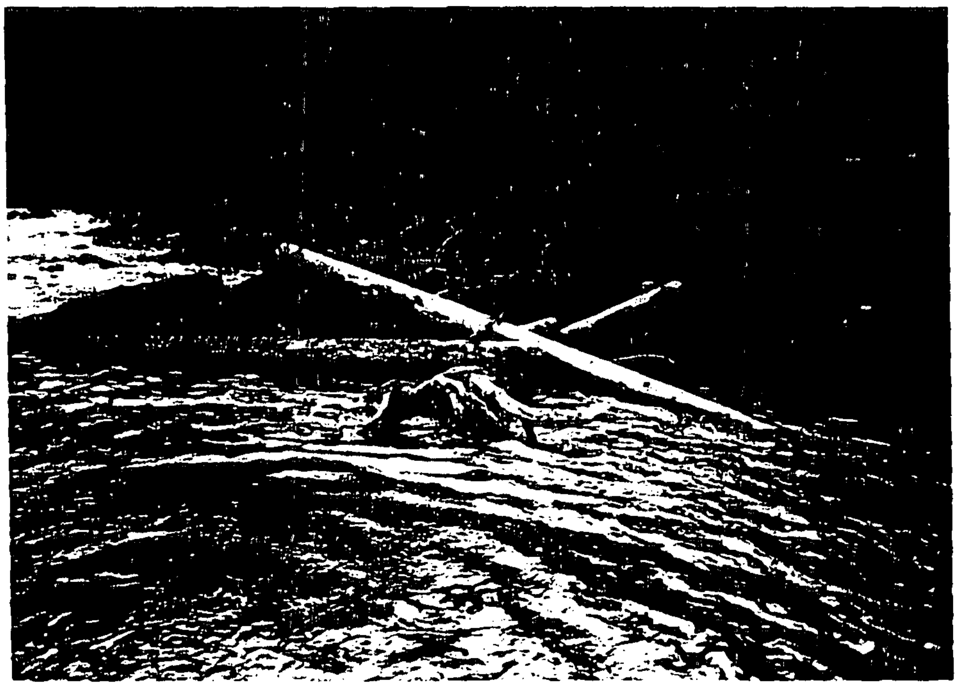
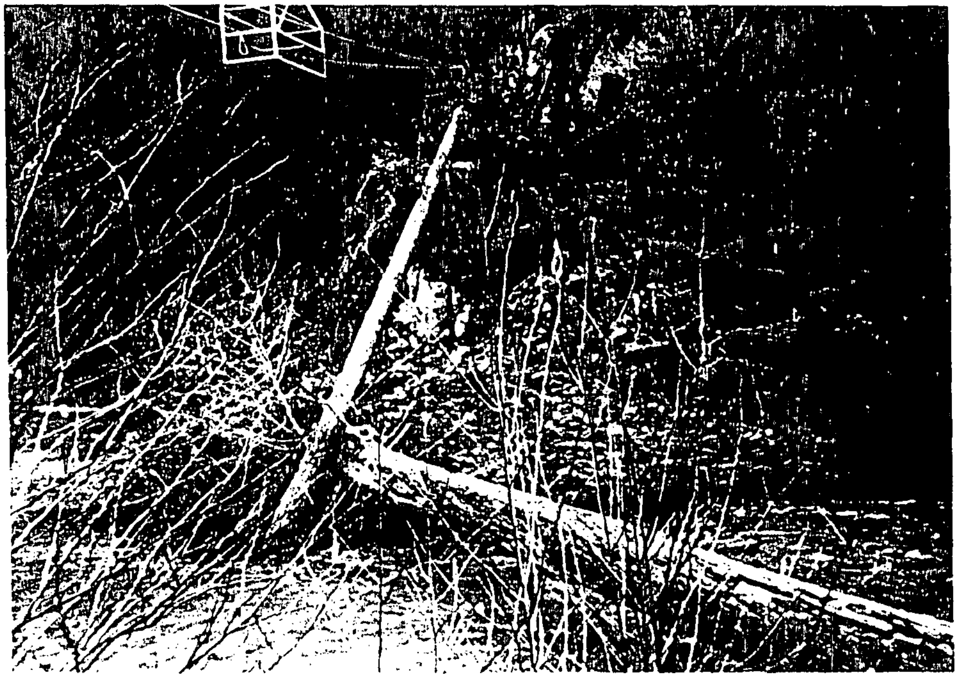


FIGURE #3

Stucture photographs (Two upper photo's at 800 CFS flow. Two lower photo's same sites at 4,000 CFS flow.)



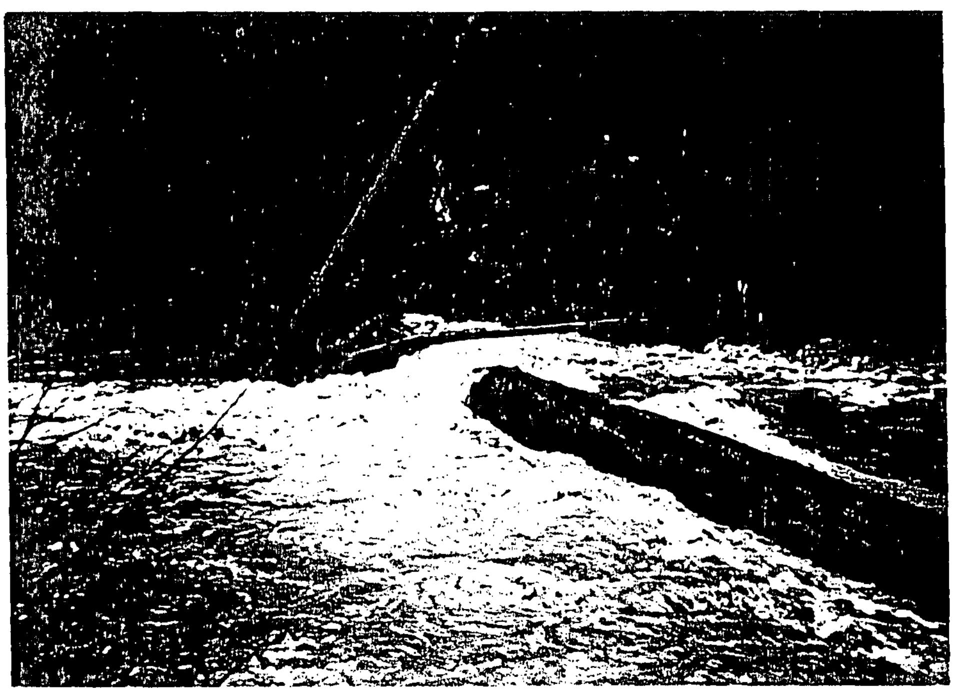


FIGURE #5
Structure photographs