THE RESOURCES AGENCY OF CALIFORNIA
Department of Fish and Game

STREAM CLEARANCE PROJECT - COMPLETION REPORT NOYO RIVER, MENDOCINO COUNTY[1]

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Region 3, Inland Fisheries

SUMMARY

This report covers one of the first major stream clearance projects to be conducted in the State. Activities are described from the initial surveys to post project inspections.

A total of 36 miles of spawning and nursery areas of the Noyo River drainage were improved at a cost of slightly over $19,000. Clearance work was conducted by use of Conservation Camp personnel.

The project was deemed beneficial, although no satisfactory method was devised to evaluate results. Contrary to popular belief, the principal benefit of log jam removal is not removal of impassable barriers. It is improvement of habitat by permitting scouring winter flows to remove silt and gravel deposited behind log jams. It is believed that both spawning conditions and food production are thus improved for anadromous fishes.

After this initial success, it is anticipated that stream clearance work will be carried out on other drainages.

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Inland Fisheries Administrative Report No. 64-10.

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INTRODUCTION

Logging activities over the past few decades have caused severe damage to the fish habitat of our North Coast streams. Probably the most devastating feature has been excessive erosion, which comes as an aftermath of the land clearing and road building associated with logging. Debris from the logging also collects in the stream channels and acts as catchment basins for the eroded materials. Often the natural streambed is buried several feet beneath silt and mud. This destroys the area for use by fish life. Frequently the debris also form barriers that prevent the upstream migration of fishes. Silver salmon (Oncorhynchus kisutch) and steelhead (Salmo gairdnerii) are the principal fish species occupying these streams.

In an effort to rehabilitate such streams, the Noyo River stream clearance project was initiated. Logging damage is normally the responsibility of the landowner. However, most of the damage was found to be the result of logging which occurred 10 to 20 years ago. Persons who conducted the operations were no longer present in the area in most cases. It was therefore decided that the project would include all logging damage over five years old and an effort would be made to establish landowner-operator responsibility for more recent damage.

This pilot stream clearance project was first conceived in July, 1958, as the result of a combined field trip by Salmon Unlimited, State Division of Forestry, Union Lumber Company, and the Department of Fish and Game. At that time responsibilities were discussed and defined as follows.

1. The Division of Forestry was responsible for the removal of all log jams on the Noyo River drainage within Jackson State Forest.

2. The Department of Fish and Game was responsible for the stream clearance on the Noyo River outside of Jackson State Forest.

3. The Union Lumber Company was responsible on their lands for the cleanup of stream damage from logging within the last five years. They also pledged themselves to provide the use of heavy equipment, when required, to assist the Department of Fish and Game with stream clearance on their lands.

PRELIMINARY ACTIVITIES

Field Surveys

It became apparent at the outset that more information about the drainage was needed before a coordinated stream clearance project plan could be adopted. Field surveys were therefore conducted on all streams within the drainage. These surveys started during the summer of 1957, at which time fisheries workers walked out all streams within the drainage. At that time, basic surveys were made and general barrier information obtained (See Figure 1). During January and February of 1959 more detailed information on barriers was obtained and recorded on maps with corresponding data sheets (See Figures 2 and 3). This resulted in compilation of the information which follows.

1. General description of the drainage.

   The Noyo River is located in Mendocino County in the northern coastal area of California. The drainage involves approximately 80 miles of streams, of which 70 miles can be considered of present or potential fisheries value. The drainage is divided into three main units.

a. Main Noyo River.

This stream heads in the coastal hills about four miles west of Willits, flows generally west through redwood and Douglas fir forests for approximately 20 miles and enters the Pacific Ocean at Noyo near Fort Bragg. Vegetation of the extreme headwaters watershed is comprised primarily of open grassy glades and oak-brush covered hills. Farther downstream the river becomes more gradual in gradient and enters broad V-shaped canyons densely covered with second growth redwood and Douglas fir forests. Several minor areas adjacent to the streams have been cleared of forest trees and are used for cattle and sheep grazing.

b. Noyo River, South Fork.

The South Fork originates at Old Camp 19, approximately 20 miles west of Willits on Highway 20, flows generally northwest and enters the Main Noyo River at the settlement of South Fork. This fork in physical description is similar to the main stream except that less of the watershed is cleared of trees for cattle grazing. Nearly 90 percent of the South Fork drainage is located within the Jackson State Forest.

c. Noyo River, North Fork.

This fork originates on the southwestern slopes of Sherwood Peak and flows generally southwest to enter the Noyo River at North Spur. In physical description it is similar to the Main Noyo River.

2. Principal land uses.

The principal use of lands within this drainage is logging of the vast redwood and Douglas fir forests, most of which lie on private lands. A large portion of the drainage lies within the 52,000-acre Jackson State Forest. This land is utilized to demonstrate forest management practices, as well as to harvest the timber stands. Some cattle and sheep ranching is carried out in the headwater areas of the drainage. Recreational use is limited to winter salmon and steelhead fishing in the lower part of the river, and hunting and camping within the Jackson State Forest.

3. The fisheries resource.

Although actual numbers are unknown, thousands of adult silver salmon and steelhead migrate out of the ocean each winter and enter the river mouth near Fort Bragg. They then scatter throughout the entire river system, returning in most cases to the stream of their birth. Here they reproduce and deposit their eggs in the gravel bottoms of selected riffles. The adult salmon then die while many of the steelhead return to the ocean.

If conditions are favorable, the eggs hatch in about two months. The young then remain in the streams for at least one year before migrating downstream to the ocean.

Principal use of the silver salmon is by the ocean sport and commercial fishery. They are also harvested during the winter then they enter the main river. Juvenile silver salmon are seldom caught by summer anglers, since they are still quite small by the time they return to the ocean.

CALIFORNIA DEPARTMENT OF FISH AND GAME

STREAM SURVEY FILE FORM No.

NAME OLDS CREEK COUNTY Mendocino

STREAM SECTION FROM Mouth To Headwaters LENGTH 3 miles

TRIBUTARY TO Noyo River TWP. R. SEC.

OTHER NAMES None RIVER SYSTEM Noyo

SOURCES OF DATA General observation

EXTENT OF OBSERVATION
Include Name of Surveyor, Date, Etc.
LOCATION
RELATION TO OTHER WATERS
GENERAL DESCRIPTION
Watershed
Immediate Drainage Basin
Altitude (Range)
Gradient
Width
Depth
Flow (Range)
Velocity
Bottom
Spawning Areas
Pools
Shelter
Barriers
Diversions
Temperatures
Food
Aquatic Plants
Winter Conditions
Pollution
Springs
FISHES PRESENT AND SUCCESS
OTHER VERTEBRATES
FISHING INTENSITY
OTHER RECREATIONAL USE
ACCESSIBILITY
OWNERSHIP
POSTED OR OPEN
IMPROVEMENTS
PAST STOCKING
GENERAL ESTIMATE
RECOMMENDED MANAGEMENT
SKETCH MAP
REFERENCES AND MAPS

EXTENT OF OBSERVATION - Stream was observed from a point adjacent to its headwaters all the way to its mouth where it enters into the Noyo River by John Gallagher on August 13, 1957.

LOCATION - About 8 miles west of Willits and right at Irmulco.

RELATION TO OTHER WATERS - It flows northwest into the Noyo River.

GENERAL DESCRIPTION:

Watershed - Steep terrain, plenty of shade, low vegetation, dried up tributaries to it. Water has milky color.

Immediate Drainage Basin - Noyo River.

Altitude -

Gradient - Slight.

Width - 3 to 4 feet.

Depth - 7 inches to 2 or 3 feet. Average about 1 foot.

Flow - 1¼ to 2 c.f.s, estimate.

Velocity - Slow.

Bottom - Sand and gravel.

Spawning Areas - Poor.

Pools - Some present but small.

Shelter - Shelter and shade abundant.

Barriers - Log jam right off bridge 80 feet long, 50 feet wide, 6 feet high. Partial obstruction. Lower end of creek near river full of small jams and little logs and debris.

Diversions - None.

Temperatures - Water 56 to 58 degrees F. Air temperature range 64 to 68 degrees F.

Food - Fair.

Aquatic Plants - None.

Winter Conditions - Extreme high waters. Severe fluctuations.

Pollution - None.

Springs - None.

ISHES PRESENT AND SUCCESS - Steelhead and salmon 1 to 4 inches scarce upstream half, more oundant downstream.

THER VERTEBRATES - Frogs and salamanders.

ISHING INTENSITY - None.

THER RECREATIONAL USE - None.

CCESSBILITY - Irmulco road runs parallel to Olds Creek.

WNERSHIP - G. R. Twitchell.

OSTED OR OPEN - Posted.

PROVEMENTS - Stream needs a lot of sluicing out of sand and silt before it can be uitable for fish production.

AST STOCKING - None.

ENERAL ESTIMATE - Good spawning and nursery area if improved.

COMMENDED MANAGEMENT - Remove log jams and encourage flushing out of silt.

ETCH MAP - See attached.

FERENCES AND MAPS - Forestry map south half of Mendocino County, 1948.

FIGURE 1

STREAM SURVEY SUPPLEMENT

STREAM: OLDS CREEK

COUNTY: MENDOCINO

EXTENT OF OBSERVATION - This stream was surveyed from its mouth upstream approximately 3 miles by Gerald Holman on January 16, 1959.

GENERAL DESCRIPTION:

Watershed - Generally, the watershed is of steep terrain heavily covered with second growth redwood and fir.

Immediate Drainage Basin - Stream is confined in a very slight gradient, broad valley densely covered with second growth redwood and fir with alder along the stream banks.

Barriers - There are many log jam barriers throughout the 3-mile section none of which can be considered fish barriers. Near the mouth exist a concrete dam with a vertical drop of approximately 6 feet which can be considered a barrier except during higher flows.

GENERAL ESTIMATE - The stream in its present condition cannot be considered a good salmon or steelhead stream because it has a heavy overburden of sand and silt over most of the stream. State Highway 20 and the Irmulco Road are probably the cause of this heavy siltation. The concrete dam near its mouth as well as being a partial barrier is also contributing to the siltation problem by holding back a heavy silt deposit above the dam.

RECOMMENDED MANAGEMENT -

1. Removal of the concrete dam.
2. Removal of all log jams and debris to approximately 1/2 mile above the Irmulco Road crossing. By this removal the heavy overburden of gravels and silt will be allowed to flash downstream and the streambed will become more stable.

FIGURE 1 -- Continued

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FIGURE 1 -- Continued

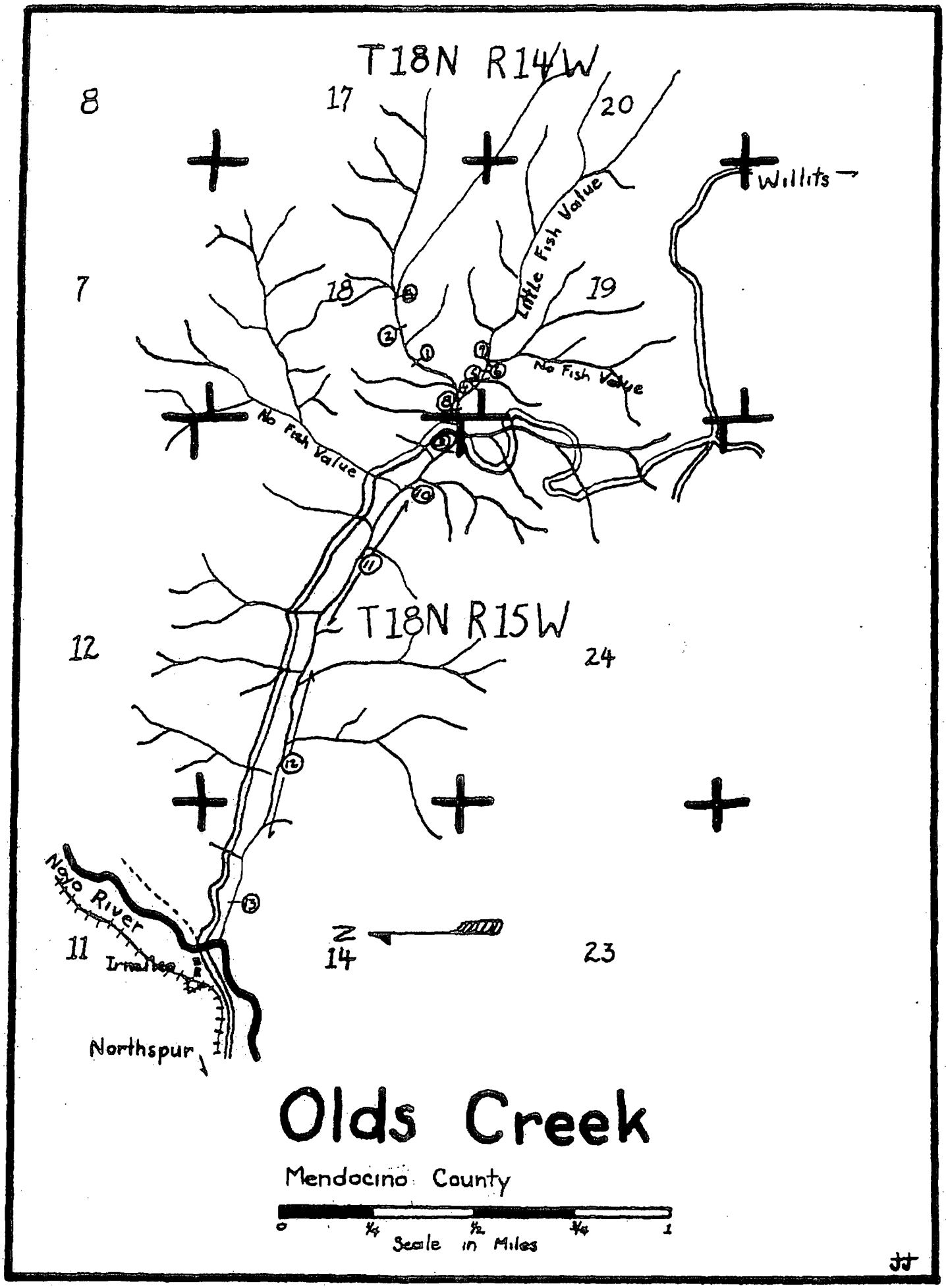
T18N R14W
8
17
20
Willits
Little Fish Value
7
18
19
No Fish Value
No Fish Value
T18N R15W
12
24
Noyo River
11
Irmaleo
14
23
Northspur
Olds Creek
Mendocino County
0
¼
½
¾
1
Scale in Miles
JJ

FIGURE 2

CALIFORNIA DEPARTMENT OF FISH AND GAME
Region 3
Ferry Building, San Francisco 11, California

LOG JAM SURVEY DATA

STREAM: OLDS CREEK

SECTION: Entire

DRAINAGE: Noyo River

Miles: Three

Number	Barrier	Size in feet			Void area (Percent)	Cubic feet of wood material	Man days for removal
		Long	Wide	High			
				Whittaker Property			
1	No	15	50	6	75	1,125	11.5
2	No	10	10	5	50	250	2.5
4	No	10	15	4	80	120	1.0
5	No	10	15	6	50	450	4.5
6	Part	100	20	7	75	3,500	35.0
7	Part	20	30	6	80	720	7.0
8	Part	100	30	6	75	4,500	45.0
9	No	50	15	4	60	1,200	12.0
10	No	20	30	4	60	960	9.5
11							
				McGuire Property			
12	No						
Total						12,825	128.0

FIGURE 3

Steelhead adults, on the other hand, are seldom taken in the ocean, but are harvested by sportsmen in a winter fishery as they enter the main river. Summer fishing for trout throughout the river drainage consists largely of catching the young steelhead which have not yet migrated to the ocean. Since many of them do not leave these streams until their second or third year, they provide some angling. In headwaters areas there are also some resident rainbow trout populations.

Of the 70 miles of streams in the Noyo River system, the 15 miles of the South Fork drainage appear to be the mainstay of the silver salmon resource. This is possibly due to the fact that the South Fork has been relatively undisturbed by logging since the turn of the century.

4. The effects of logging upon the drainage.

a. Past logging.

Except for small isolated areas, the entire drainage has been logged at one time or another. The presence of old logging spur railroad grades in nearly all of the tributaries and the size of the second growth trees indicate that most of the logging activity occurred at least 50 years ago. There are some areas of fairly recent logging (10 years ago or less). However, these involve only about 10 percent of the drainage.

The effects of past logging upon the drainage and the fisheries resources must have been quite destructive and no doubt has a direct influence upon present day fisheries. Although most of the watershed has regrown with timber and has become stabilized, it is evident that the vast amounts of logging debris and silt that resulted have created undesirable conditions that exist even today. Present day log jam barriers, areas of broad, flat, unstable gravels, and areas of heavy silt deposits are the results of past logging.

In determining the extent of damage upon the fisheries from past logging, the following factors should be considered:

(1) Creation of log jam barriers impassable to migration of fish life.

(2) Siltation of streambeds destroying bottom organisms utilized as fish food and smothering fish eggs that have been deposited in redds.

(3) Compaction of spawning gravels through spaces being filled with silt and sand.

(4) Destruction of streamside cover.

Through action of one or more of the above factors, all of the 70 miles of potentially important fisheries streams in the drainage have been adversely affected by logging at one time or another. Logging carried on about 10 years ago has directly harmed about five miles of the drainage and indirectly harmed possibly twice that amount by siltation.

b. Present logging - within the past five years.

There has been little logging in the drainage in recent years. Most of this has been confined to areas of steep terrain and all of it away from stream edges.

c. Future logging.

Future logging in this drainage will largely utilize second growth timber. Cutting will probably occur when growth stands are 60 to 80 years old. Streams will therefore have a "breathing spell", so to speak, of 20 to 40 years in which little or no logging will occur in many parts of the drainage.

Under future second growth, logging for less damage to streams is anticipated. This is based primarily upon optimism that future logging methods will improve and cause less soil erosion. Also, removal techniques on second growth should not require use of heavy equipment along the immediate stream margins. Therefore, the opportunity for these streams to remain in good condition after rehabilitation is encouraging.

5. Status of stream barriers.

It was found that 296 log jams, one natural bedrock barrier, and a small abandoned concrete dam existed on 16 streams within the drainage. A few were complete barriers to upstream migration of anadromous fishes. Streams such as the Main Noyo River, as well as the North and South Forks, were free of obstructions except in their extreme headwaters. All of their tributaries contained many log jams ranging in size up to 200 feet long and 50 feet wide.

The natural bedrock barrier on Hayworth Creek completely blocked from use two miles of good potential steelhead spawning and nursery areas.

The abandoned six-foot high concrete dam on Olds Creek once served a sawmill at Irmulco. Only under certain flow conditions could silver salmon or steelhead ascend this dam.

Land Ownership and Related Problems

The land ownership of this drainage is divided into two classifications: State Forest and private landowners. Jackson State Forest includes nearly the entire drainage of the South Fork of Noyo River. This area represents approximately 30 percent of the entire drainage.

Several logging companies and private ranches comprise the remaining land holdings in the drainage.

In order to conduct this project it was necessary to obtain written permission from each landowner to enter upon his lands and carry out stream clearance work. This involved the following steps:

1. Determining land ownership.

The landowners and the location of their properties were obtained from records of both the Union Lumber Company and the Mendocino County Assessor's Office.

2. Preparing agreement forms.

The next step was the preparation of a permit form acceptable to all parties concerned (See Figure 4). Personal contact was then made with each landowner to explain the project and obtain his signature on the permit.

Out of ten required contacts, signed permits were obtained from all but one landowner. This landowner controlled about one-half mile of land in the headwaters section of Olds Creek. Since this was of minor importance, the area was eliminated from the project.

Computation of Cost Estimates

As a result of the surveys, location of all logging debris in the streams was delineated and the volume of material estimated. Removal costs were then estimated on the basis that all material would be either burned or cut and removed from the streambed.

The labor force planned for was from the Conservation Camps within Jackson State Forest. These camps, operated jointly by the Department of Corrections and Division of Forestry, consist of State prison inmates who are available to carry out conservation projects. Inmate labor is contracted for at a given rate per hour, which includes the necessary supervision.

The original cost estimates were based upon using privately contracted equipment and labor. However, when the Conservation Camp labor became available, these original estimates were revised.

The field measurements of the log jams were recorded in cubic feet of wood material. To convert this figure into man-days of inmate labor it was estimated that one man could remove 100 cubic feet of wood material in one day. As the cost of this labor was $3.50 per man-day, the cost of removing individual log jams was obtained. The sum of the individual log jam removal costs was thus computed for each stream (See Figure 5).

The total cost for the entire project was estimated at $18,000 to be expended over a two-year period. With the aid of the Legislature, these funds were made available to the Department of Fish and Game in 1959. It later became necessary to extend the project period for one year and add $1,000 to cover the entire cost. Thus, the Noyo River Stream Clearance Project covered a three-year period from 1959 to 1961 and cost a total of $19,041.38.

Figure 6 indicates the miles of stream satisfactory without improvement, miles improved, and the total mileages involved. Also, these areas are shown in Figure 7 on a general map of the drainage.

With this work, a total of 36 miles of streams was improved for silver salmon and steelhead.

STREAM CLEARANCE OPERATIONS

Stream Clearance Crews

All stream clearance activity involving labor was based upon utilization of Conservation Camp personnel from Parlin Fork and Chamberlain Creek Camps. These camps are located in the Jackson State Forest on State Highway 20 between Willits and Fort Bragg. The workers are honor inmates from the various State prisons assigned to these minimum security camps for the primary purpose of forest fire suppression. During periods of the year when they are not needed for fire suppression, they do work for other State agencies, as well as work on the Jackson State Forest. Stream clearance fits nicely into this off-season work which can be best carried out during the fall, winter and spring months of low fire hazard when burning is permissible.

A crew consisted of 15 to 18 Conservation Camp workers supervised by one Division of Forestry Project Foreman. They were equipped with a truck or bus for transportation, two or more chain saws, a grip hoist and other small hand tools such as axes, shovels, etc. Crews so equipped were relatively free to move about without being encumbered with heavy equipment.

Planning Stream Clearance Activities

Four phases of activity were required:

1. Development of an operational plan.

   This plan, developed by the Division of Forestry Chamberlain Creek Camp Superintendent and the Department of Fish and Game representative (the senior author), consisted of general planning of work activities. Time schedules were prepared with reference to winter and summer access to the individual tributaries. The type of work to be done on each tributary and the time required were included in this operational plan.

2. Field inspection of streams.

   The work was reviewed at streamside by the Division of Forestry Camp Superintendent and the Department of Fish and Game field man prior to stream clearance. Problems of access, locked gates, equipment needs, restrictions by the landowner, and special problems were reviewed at this time.

3. Stream clearance.

   The major portion of this work consisted of log jam removal. These were removed by two methods:

   a. Cut and pile the wood material on either bank above high water mark, or

   b. Cut, pile and burn in the streambed.

   Each method was employed under different situations.

   On streams characterized by scattered debris and small jams, the wood material was cut into 3 to 10 foot lengths and stacked above high water mark. Grip hoists (a type of portable hand winch) were also used to pull some of the logs out of the streambed.

NOYO RIVER PROJECT
STREAM CLEARANCE COST DATA

Stream	Estimated labor cost	Actual cost[1]	Cost per mile
Burbeck Creek	$ 187.50	$ 116.50	$ 116.50
DeWarren Creek	80.50	681.25	340.62
Duffy Gulch Creek	957.00	312.25	208.17
Hayworth Creek	6,513.50	497.87	248.93[2]
Kass Creek	390.25	1,977.39	988.69
Marble Gulch Creek	1,767.50	3,333,04	1,666.52
McMullen Creek	735.00	909.32	909.32
Noyo River	No estimate	823.78	274.59
Noyo River, North Fork	52.50	1,503.53	1,000.23
Noyo River, South Fork	140.00	985.70	328.57
Olds Creek	437.50	2,201.36	1,467.57
Redwood Creek	1,916.25	5,699.39	2,279.76
Subtotal	$13,177.50		
Equipment rental	2,000.00		
Contingency	2,822,50		
Totals	$18,000.00	$19,041.38	

1/ Includes all costs including labor and equipment rental.

2/ Removal of natural falls only.

Average cost per mile (21.5 miles) = $885.62.

FIGURE 5

CALIFORNIA DEPARTMENT OF FISH AND GAME
Region 3
Ferry Building, San Francisco 11, California

PERMIT

The undersigned, being the owner(s) of the land hereinafter described, and desirous of having the barrier(s) or obstruction(s) described below removed from such land, do(es) hereby request and permit the Department of Fish and Game of the State of California, its agents and employees, to remove such barrier(s) from my (our) property pursuant to Section 1501 of the Fish and Game Code by any means and at any time whatever, said property being situated in the County of _____, State of California, and described as follows:

The said barrier(s) is/are generally known as _____ _____ and is/are located on _____ and its/their removal by the Department of Fish and Game is the consideration to me/us for signing this permit.

Dated this _____ day of _____ 19____

_____	_____
Witness	Permitter
_____	_____
Address	Address
_____	_____
Witness	Permitter
_____	_____
Address	Address

FIGURE 4

NOYO RIVER DRAINAGE
SPAWNING AND NURSERY STREAM MILES

Stream	Satisfactory before project	Miles improved	Total
Outside Jackson State Forest			
Burbeck Creek	0.0	1.0	1.0
DeWarren Creek	0.0	2.0	2.0
Duffy Gulch Creek	0.0	1.5	1.5
Hayworth Creek	2.0	2.0	4.0
Kass Creek	0.0	2.0	2.0
Marble Gulch Creek	0.0	2.0	2.0
McMullen Creek	0.0	1.0	1.0
Noyo River	23.0	3.0	26.0
Noyo River, North Fork	5.0	1.5	6.5
Noyo River, South Fork	1.0	1.5[1]	2.5[1]
Olds Creek	0.0	1.5	1.5
Redwood Creek	0.0	2.5	2.5
Totals	31.0	21.5	52.5
Within Jackson State Forest			
North Fork of the South Fork Noyo River	1.0	5.0	6.0
Parlin Creek	0.0	3.0	3.0
South Fork Noyo River	0.0	6.0	6.0
Camp 6 Gulch	0.0	0.5	0.5
Bear Gulch	0.0	0.5	0.5
Totals	1.0	15.0	16.0

[1] Six miles additional within Jackson State Forest.

FIGURE 6

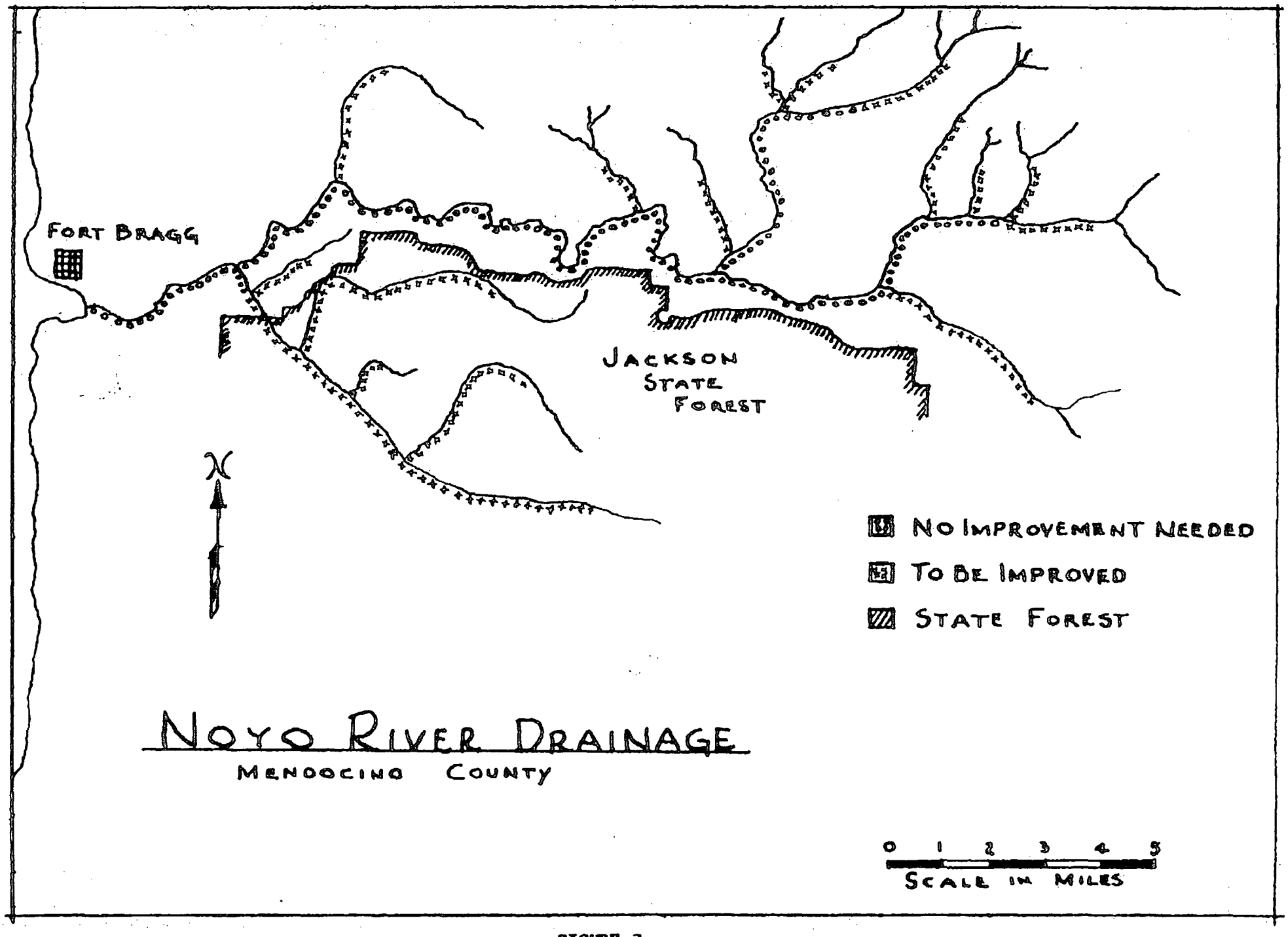
FORT BRAGG
JACKSON
STATE
FOREST
N
NO IMPROVEMENT NEEDED
TO BE IMPROVED
STATE FOREST
NOYO RIVER DRAINAGE
MENDOCINO COUNTY
0 1 2 3 4 5
SCALE IN MILES

FIGURE 7

FIGURE 8. Crews clearing debris from Olds Creek, 1/2 mile above mouth. Photo by Gerald Holman, January 6, 1960.

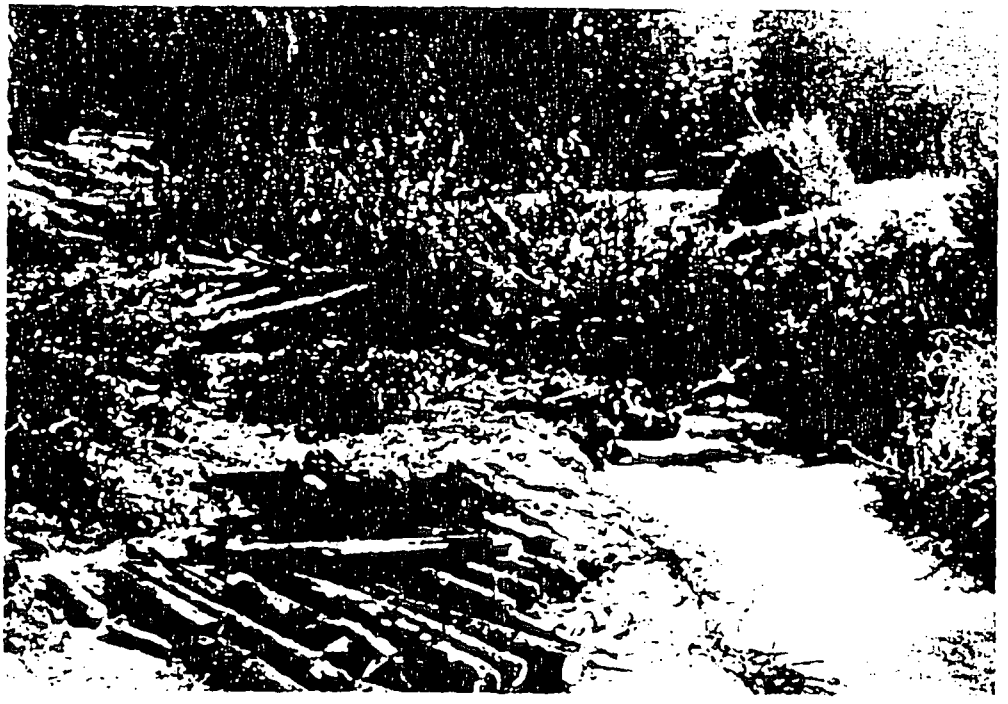

FIGURE 9. Contrast between cleared and uncleared area of Olds Creek, approximately 1/2 mile above mouth. Photo by Gerald Holman, January 6, 1960.

It was found that large log jams could be removed readily using hand labor to start several fires on top of the jam. Small debris was added to the fires until they became well established. Attention by a few members of the crew was necessary to maintain the fires, but vast volumes of wood material were removed in this manner.

Fire was also used to clear streams confined in narrow deep canyons. Where no space was available to place the wood material above high water mark, it was necessary to burn it. Burning was carried on only during periods of low fire hazard.

Correction of one natural bedrock barrier, 12 feet high, was also undertaken by the stream clearance crews. This work consisted of drilling and blasting a falls in such a manner as to create several pools for fish passage.

4. Field inspection of completed work.

Field inspections were made jointly by the Division of Forestry Camp Superintendent and the Department of Fish and Game field man to review the stream clearance work completed. If additional work was found to be necessary, plans were then made to carry this out.

Special Problems

Each stream posed individual problems, most of which were solved at the field level. For example, use of private roads for access required arrangements with landowners for repair and maintenance of the road after work was completed. The restoration of drainage ditches and grading were required in one case.

Training of crew foremen as to the required degree of debris removal was necessary. There was a tendency to be over meticulous in the clearing of small unimportant debris. Also, there was initially an insufficient number of chain saws available for the crew to function efficiently. To adjust to this, an excessive amount of hand sawing, axe work and use of explosives were employed on certain streams, such as Redwood Creek.

On Olds Creek the stream clearance crew removed a six-foot high concrete dam by blasting, in addition to the normal logging debris clearance (See Figures 10 and 11).

Hayworth Creek, worked on a cooperative basis, was divided into two phases. A 12-foot high natural bedrock barrier to fish life existed about one-quarter mile above the confluence of the North Fork Hayworth Creek. Above this falls were two miles of stream with many log jams to be removed. This damage was created by Union Lumber Company logging operations of fairly recent origin (less than 10 years). Through negotiations, it was agreed that Union Lumber Company would be responsible for the clean-up of the log jams and our Department would correct the falls. The falls was corrected by drilling and blasting in such a manner as to create several pools for fish passage (See Figures 12 and 13). Part of the stream clearance work by the Union Lumber Company has also been completed.

Access to Duffy Creek could only be made via the California Western Railroad. Through cooperation of the Union Lumber Company, arrangements were made to transport the crew and their equipment daily to and from this stream.

RESULTS

This stream clearance project removed an estimated 388,119 cubic feet of wood material to improve 21.5 miles of spawning and nursery streams for silver salmon and steelhead. The actual total cost of this project was $19,041.38, which consisted of salaries of the stream clearance crews and the rental of their equipment (See Figure 5). In addition, the Division of Forestry at their expense also removed 182,570 cubic feet of wood material to improve 15 miles of stream within Jackson State Forest (See Figure 6).

The cost per mile ranged from $116.50 to $2,279.76, with the average cost being $880.97. The wide range in cost per mile can be attributed to several causes:

1. Variation in amounts of debris present and work required on different streams.

2. Differences in travel distance from base camp.

3. Streams cleared during the crew training period, which required more time.

EVAULATION OF RESULTS

On each stream where clearance work occurred, an endeavor was made to assess the results. This was primarily accomplished by making visual observations throughout the cleared area.

The difficulty of evaluating the benefits derived by stream clearance became quite evident at the outset of the project. Most of the log jams removed were not total barriers to fish life. Many, no doubt, stopped upstream migration of the adult silver salmon and steelhead at various flows. They also posed the threat of becoming total barriers at a later time.

Except in such cases where definite barriers were removed and the stream became fish producing again, it is most difficult to demonstrate increases in actual fish production as caused by stream clearance. Factors such as normal fluctuation of fish population, lack of adequate stream flows, high summer temperatures, etc., also could have influenced variations in fish populations, as much or more than our clearance work.

In general it was concluded that the streams were improved as a direct result of the stream clearance project in the following ways:

1. Definite barriers to upstream migration of fish life were removed.

   It is estimated that about 5 percent of the project work fell into this category.

2. Removal of partial barriers which hindered upstream migration of fish life.

   Any barriers which have a differential in head, resulting from water impoundment, were considered as a definite hindrance to upstream migration. Delays in migration no doubt occurred at these points even though most of the fish eventually worked their way through the log jams. Silver salmon have been observed literally "worming their way" upstream among the debris. An estimated 40 percent of the log jams removed fell into this category.

FIGURE 10. Abandoned dam on Olds Creek, 1/4 mile upstream from mouth prior to correction. This was a partial barrier to upstream migration of fishes. Photo by Gerald Holman, January 6, 1960.

FIGURE 11. Olds Creek dam was breached by conservation crews to permit fish passage. Photo by Gerald Holman, December 21, 1960.

FIGURE 12. Crews working on a natural bedrock barrier on Hayworth Creek, approximately 2 miles above mouth. Photo by Gerald Holman, May 31, 1961.

FIGURE 13. Hayworth Creek natural barrier after correction by blasting. Photo by Gerald Holman, August 13, 1962.

3. Removal of potential barriers to upstream migration. This was the major category of log jams cleared.

It was logical to reason that while clearance work was being carried out in these remote areas it would warrant some consideration of the future. It is known that the high water conditions each winter cause additional debris to wash downstream and be added to small log jams started at channel constrictions. If not corrected currently, many of these could conceivably become serious log jam barriers within a few years. Thus, removal of potential log jam debris was believed justified. An estimated 55 percent of the log jams were in this category.

4. Improvement of the spawning and nursery areas.

This is believed one of the most important benefits of the project. Sand, gravel, and silt, the normal products of accelerated stream erosion in these logged-over areas, collect behind the log jams which act as debris catchment basins. In severe instances, channels immediately upstream from large log jams may contain such material to depths of 10 or 12 feet (See Figure 14). Under such conditions the cobbles and gravel of the normal streambed are buried beneath the sediments for a distance of perhaps a hundred yards upstream. The bottom materials in such situations are usually tightly packed and do not offer satisfactory conditions for fish spawning or survival of aquatic insect foods.

Collectively, the destruction of bottom habitat by the presence of many small log jams is believed to be the most important destructive factor resulting from logging debris in streams. Once the log jam has been removed, huge quantities of erosional materials are washed downstream during subsequent winter floods. It was not uncommon for such streambeds to be lowered several feet and return the bed to its more normal gradient.

It was not uncommon for this scouring process to uncover many old logs previously completely buried. Sometimes a second clearing of logs was needed under these conditions. Generally, however, such semiburied logs provided excellent cover and stability to the stream bottom and removal was not necessary or desirable.

By means of scouring, the fine materials were carried away and a stable bottom of larger cobbles and heavy gravels results.

It was amazing how great the changes in bottom appearance could be even after a single winter of heavy runoff. Further specific measurements of these changes would be worthwhile, in an effort to relate them to desirable spawning and nursery area conditions.

5. Law enforcement of future logging.

One of the major problems of preventing or correcting current logging damages has been our inability to distinguish sufficiently for legal action, log jams resulting from new operations and those found five or more years ago. The mere presence of old log jams on a stream is a definite deterrent to our insisting that no additional ones be formed.

Consequently, the removal of all major debris from a stream system gives us a clean slate, so to speak, for controlling future logging damage in that drainage. We hope in the future to be able to clearly define responsibility for debris accumulations, resulting from logging, found in these streams. This has, therefore, been deemed an important benefit of this project.

There are also benefits derived in human rehabilitation through the Conservation Camp program, however, this factor will not be considered in this report.

The experience gained from the initial stream clearance project on the North Coast was most valuable for more effective implementation of future projects. Some of the valuable lessons learned were related to the following:

1. Field survey techniques.

   The importance of exploring fully the best access routes into the drainage systems before detailed surveys were initiated was found to save considerable time.

   Improvements in recording the log jam data during field surveys have resulted from this project. The method of estimating the cubic feet of volume of material in log jams was difficult. Despite attempted training, volume estimates of the same log jam by several people varied widely. A better system of calculating debris volumes and converting these into removal costs is needed.

2. Supervision of removal operations.

   The key to effective utilization of Conservation Camp crews in accomplishing the end point desired was found to lie in the orientation and training of the crew foreman. Once he clearly understood the objectives of the project and recommended methods, he was able to proceed with a minimum of day-to-day direct contact. Training courses for crew foremen collectively might be considered in the future. Emphasis in training is needed on such points as:

   a. Degree of debris removal desired (the tendency of new crews is to spend too much time on insignificant small material).

   b. Protection of streamside vegetation and minimizing of additional erosion.

   c. The importance of placing debris above high water mark where it cannot again enter the stream.

3. Evaluation of results.

   No satisfactory means of defining, in specific measurable form, the benefits of this type of work has been developed. Considerable thought has been given to this problem. However, it has the same inherent difficulty of any project evaluation which segregates one factor of a species' environment for change and then attempts to measure the result upon the population. There is some question as to what degree it is practical to pursue evaluation of such a project as this.

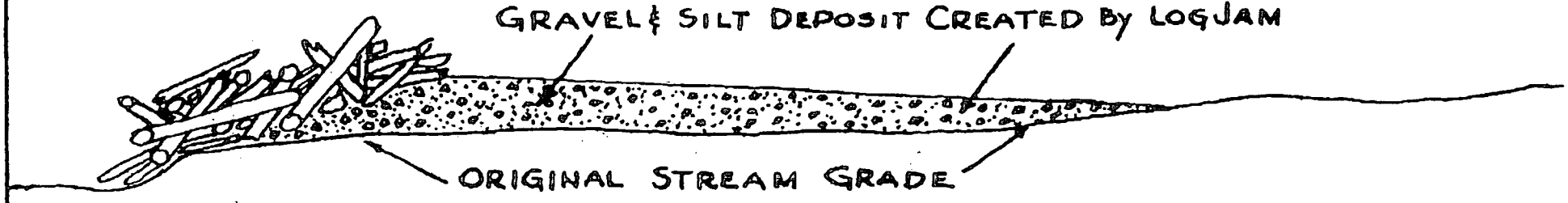

FIGURE 14

CHANGE IN STREAM PROFILE RESULTING FROM LOG JAM

FIGURE 15. DeWarren Creek, two years after stream clearance activities, 1/4 mile above mouth. Photo by Gerald Holman, August 13, 1962.

FIGURE 16. DeWarren Creek, two years after stream clearance activities, 1/4 mile above mouth. Note removed debris. Photo by Gerald Holman, August 13, 1962.

No attempt has been made to evaluate the results on a cost-benefit basis. As indicated, the average cost per mile of stream improved was $880. One difficult question to answer is, how long will the benefits last? It is not uncommon for many of these forested areas to go 15 to 20 years without additional logging activity. In many areas the period is much longer. Therefore, the anticipated period of benefit of stream clearance may be several decades. It is further our hope that second growth logging practices may be sufficiently improved that this serious damage to streams will not be repeated.

The impression should not be given that after clearance work has been undertaken, a stream rapidly returns to an optimum environment for fish life. Additional studies are being conducted to gain further data on rates of stream recovery. It is known that in some areas it may take many years for streams to fully recover.

CONCLUSIONS

Conclusions resulting from this project are as follows:

1. Stream clearance activities can best be accomplished by hand labor with light equipment. Heavy equipment is too damaging to remaining vegetation and induces further erosion from soil disturbance.

2. Under our current value standards for salmon or steelhead spawning and nursery areas, expenditures per mile for stream clearance generally should not exceed $1,000. It is concluded that an expected average cost of not over $500 per mile in the future is not unrealistic.

3. The project is believed beneficial on the basis of visual comparisons of stream appearance and juvenile fish abundance both before clearance and after. No empirical data could be developed which documented either environmental or fish population changes and related them directly to the stream clearance work.

RECOMMENDATIONS

It is recommended that:

1. The stream clearance work be continued throughout the North Coast area, taking in turn each river system until all important drainages have been completed.

2. New techniques for conducting surveys and preparing cost estimates be developed.

3. Methods of evaluating results be given further study.

4. Upon completion of stream clearance work in a drainage, other types of stream rehabilitation projects be developed which will hasten full recovery of these streams.