FIFTEENMILE BASIN
HABITAT IMPROVEMENT PROJECT

1990 ANNUAL REPORT

BY

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Prepared for

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ABSTRACT

U.S.D.A. Forest Service activities in the Fifteenmile basin during 1990 involved the placement of 84 log structures in a two mile reach of Fifteenmile Creek (RM 45.4 - 47.4) by a combination of falling trees into the channel, bucking in blowdown trees spanning the creek, and winching in existing blowdown and log segments from newly fallen trees. The primary project objective on Fifteenmile Creek was to increase physical habitat diversity and rearing habitat for age l+ winter steelhead trout. USFS personnel also conducted spring spawning surveys in sections of Ramsey and Eightmile Creeks, physical habitat pre-project monitoring in the above project reach, water temperature monitoring, and macroinvertebrate sampling.

INTRODUCTION

The Fifteenmile basin habitat improvement project is a multi-year fish habitat improvement effort aimed at increasing numbers of wild winter steelhead trout *Oncorhynchus mykiss* in the basin. Cooperators in this enhancement program are the Oregon Department of Fish and Wildlife (ODFW) and U.S.D.A. Forest Service, Mt. Hood National Forest (USFS), in consultation with the Confederated Tribes of the Warm Springs Indian Reservation (Tribes). The majority of the project is funded by the Bonneville Power Administration (BPA) under the Northwest Power Planning Council's Fish and Wildlife program (Measure 783(C), Action Item 4.2). Fifteenmile Creek and its major tributaries, Eightmile Creek, Fivemile Creek, and Ramsey Creek support the easternmost population of wild winter steelhead trout in the Oregon portion of the Columbia River Basin. The winter s'ceelhead run is depressed relative to historic and estimated ptential production levels (Smith et al. 1987) and is an ODFW and USFS stock of concern.

The major limiting factor to steelhead production in the Fifteenmile basin is lack of low flow rearing habitat (Smith et al. 1987). Past enhancement efforts in the basin were designed to correct this problem and consisted of instream structure and passage improvement construction, including an ODFW,project to improve passage over the falls at the Fifteenmile Creek mouth and USFS projects to provide passage at two culverts on Ramsey

Creek (MacDonald and Hutchinson 1986). The USFS has also completed road rehabilitation projects on Fivemile and Ramsey Creeks to improve watershed conditions. Instream structures were placed in Ramsey Creek during 1986, 1987, and 1988 and in Fifteenmile Creek during 1989 on the National Forest utilizing BPA funds. USFS funds were used for habitat enhancement work in Eightmile Creek at Eightmile Crossing Campground in 1987. To date, USFS has treated 4.0, 3.0, and 1.0 miles of stream using instream structures on Ramsey, Fifteenmile, and Eightmile Creeks, respectively. ODFW and Wasco County Soil and Water Conservation District were involved in rehabilitation of private agricultural lands following the 1974 flood. USFS and ODFW are conducting ongoing spawning surveys, stream habitat surveys, fish population surveys, water temperature monitoring, and macroinvertebrate monitoring to better estimate current and potential anadromous fish production.

Tasks addressed in 1990 as outlined in the Clackamas/Hood River Habitat Enhancement Project 1990/91 Statement of Work and Budget included:

Objective 1: Baseline Basin-wide Monitoring in Coordination with the Oregon Department of Fish and Wildlife

Task 1.1: Conduct spawning surveys on National Forest land as a relative indicator of population status and trends.

Task 1.2: Continue macroinvertebrate monitoring with ODFW;

analysis conducted by Dr. Fred Mangum - Aquatic Ecologist, USFS, Region 4.

Task 1.3: Continue water temperature monitoring in cooperation with ODFW.

Objective 2: Ramsey Creek Habitat Improvement

Task 2.1: Structures installed in 1986 - 1988 have not been evaluated to determine maintenance needs. The evaluation will occur in 1991.

Tasks 2.3 and 2.5 : Post-project monitoring was completed in 1989.

Task 2.4: Post treatment peer review has not occurred.

Objective 3: Fifteenmile Creek Habitat Improvement

Task 2.1:

1. Hand placement of instream structures between river miles (RM) 45.4 and 47.4.
2. Pre-project monitoring of the project area to document changes in fish habitat as a result of project work. The biolological portion (snorkeling) of the pre-project monitoring was not completed in 1990. Post-project monitoring of work completed in 1989 was postponed until 1991 or 1992.

Task 2.2: Maintenance survey of 1989 project work was not completed and will be done in 1991.

Objective 4: Fivemile Creek Habitat Improvement

Task 3.1: Project planning and environmental analysis report for habitat improvement work in Fivemile Creek was initiated and will be completed in 1991.

DESCRIPTION OF PROJECT AREA

The Fifteenmile Creek basin, located in north central Oregon, drains a portion of the northeast corner of the Mt. Hood National Forest (Figure 1). Fifteenmile Creek is a fifth order, class I tributary to the Columbia River, entering the Columbia just downstream of The Dalles Dam (RM 192). The basin encompasses approximately 373 mi^2, the upper fifth (71 mi^2) of which lies on the Mt. Hood National Forest. Headwater elevations in the basin range from 6200 ft for Fifteenmile Creek to 4200 ft for Ramsey Creek; drop to near 2500 ft at the forest boundary and approach sea level (72 ft) at the Fifteenmile Creek mouth. The streamflow regime is characterized by high spring runoff from melting snowpack combined with spring rains, followed by low summer flows. Water quality in the basin is generally good, and the water is relatively productive with moderate to high biomass potential (ODFW, unpublished data).

Two surface irrigation diversions are located within the National Forest boundary. One diversion is located on Fivemile Creek 300 ft upstream from the National Forest boundary and

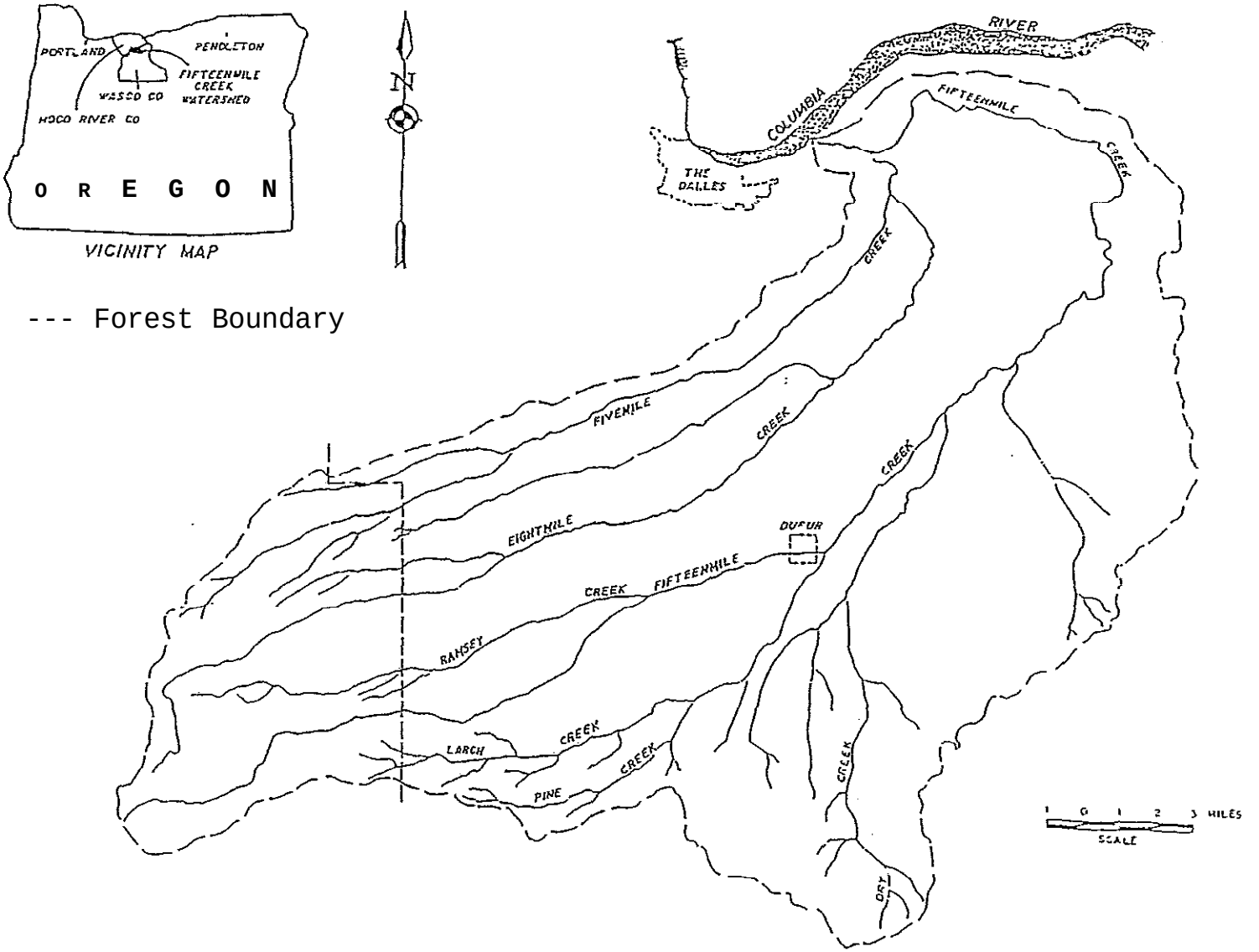


Figure 1. Fifteenmile Creek basin located in north central Oregon.

consists of a small dam with a two inch PVC pipe diverting water. The other diversion is on Eightmile Creek at RM 29.7 (Eightmile Crossing Campground). A rotating screen was placed on this diversion in 1990. Most surface water is withdrawn from the basin by pumping (ODFW and Tribes 1989).

Fish habitat on National Forest land in the basin is generally rated as fair to good (Godbout and Uebel 1982) depending on the stream and reach. Negative factors influencing habitat capability include lack of low flow rearing habitat, locally limited spawning habitat, irrigation diversions or withdrawls, siltation, and passage obstructions. A detailed description of the basin and discussion of limiting factors may be found in the Riparian Resource Assessment (Godbout and Uebel 1982), Fifteenmile Basin Implementation Plan (Smith et al. 1987) and draft Fifteenmile Creek Subbasin Salmon and Steelhead Production Plan (ODFW and Tribes 1989).

Other coldwater fish found in the basin include resident rainbow trout, cutthroat trout *0. clarki,* and sculpin *Cottus sp.* Warmwater tolerant fish exist *in* the lower third of the basin below the National Forest boundary and include suckers *Catastomus sp.,* northern squawfish *Ptychocheilus oregonensis,* and date (family Cyprinidae) (Smith et al. 1987).

The USFS portion of the Fifteenmile Basin Project has been divided into four components:

1) Ramsey Creek
2) Fivemile Creek

3) Rightmile Creek

4) Fifteenmile Creek

For a description of Ramsey, Fivemile, and Eightmile Creeks refer to the 1989 annual report (Cain and Asbridge 1989).

Fifteenmile Creek

Fifteenmile Creek begins as a spring fed creek at 6200 ft then drops 3740 ft over approximately 10 miles before it reaches the National Forest boundary. Anadromous fish habitat condition on the National Forest portion of Fifteenmile Creek was generally rated as good, although habitat capability was suspected to be locally limited by the quality of spawning and rearing habitat (Godbout and Uebel 1982). A falls at RM 49.6 is likely the absolute upper limit of anadromous fish migration, but the best steelhead trout habitat is located between RM 44 and 49.2. The above authors refer to large organic debris (LOD) as playing an important role in the development of fish habitat. Sixty percent of the spawning gravels and 40% of the high quality pools were associated with LOD deposits.

The 1990 project reach (RM 45.4 - 47.4) consisted of sub-reaches where LOD deposit amounts and quantity and quality of pools varied. Overall, pools made up 30% - 40% of the habitat, were of moderate size, depth, and high in effective cover.

However, several reaches lacked LOD deposits and associated high quality pools.

METHODS AND MATERIALS

Spawning Surveys

Spawning surveys in the Fifteenmile Creek basin were conducted during April 1990 on Eightmile and Ramsey Creeks (Figure 2). Fifteenmile Creek was not surveyed on Forest, but USFS personnel assisted ODFW personnel below the Forest boundary. The number of redds and adult steelhead trout were tallied during each survey.

Macroinvertebrate Sampling

In 1986 the USFS and ODFW contracted with Dr. Fred Mangum (Aquatic Ecologist, USFS, Region 4), to establish a macroinvertebrate sampling program in the Fifteenmile Basin. Macroinvertebrates respond to changes in aquatic habitat, and analysis of macroinvertebrate community structure can reveal condition and trends in aquatic ecosystems (Mangum 1987). Monitoring changes of macroinvertebrate populations should be a good indicator of changes in aquatic habitat as a result of habitat improvement work. Three samples were taken at each of five sites three separate times in 1990 (spring, summer, and fall). Sampling procedures and site locations (Figure 2) are

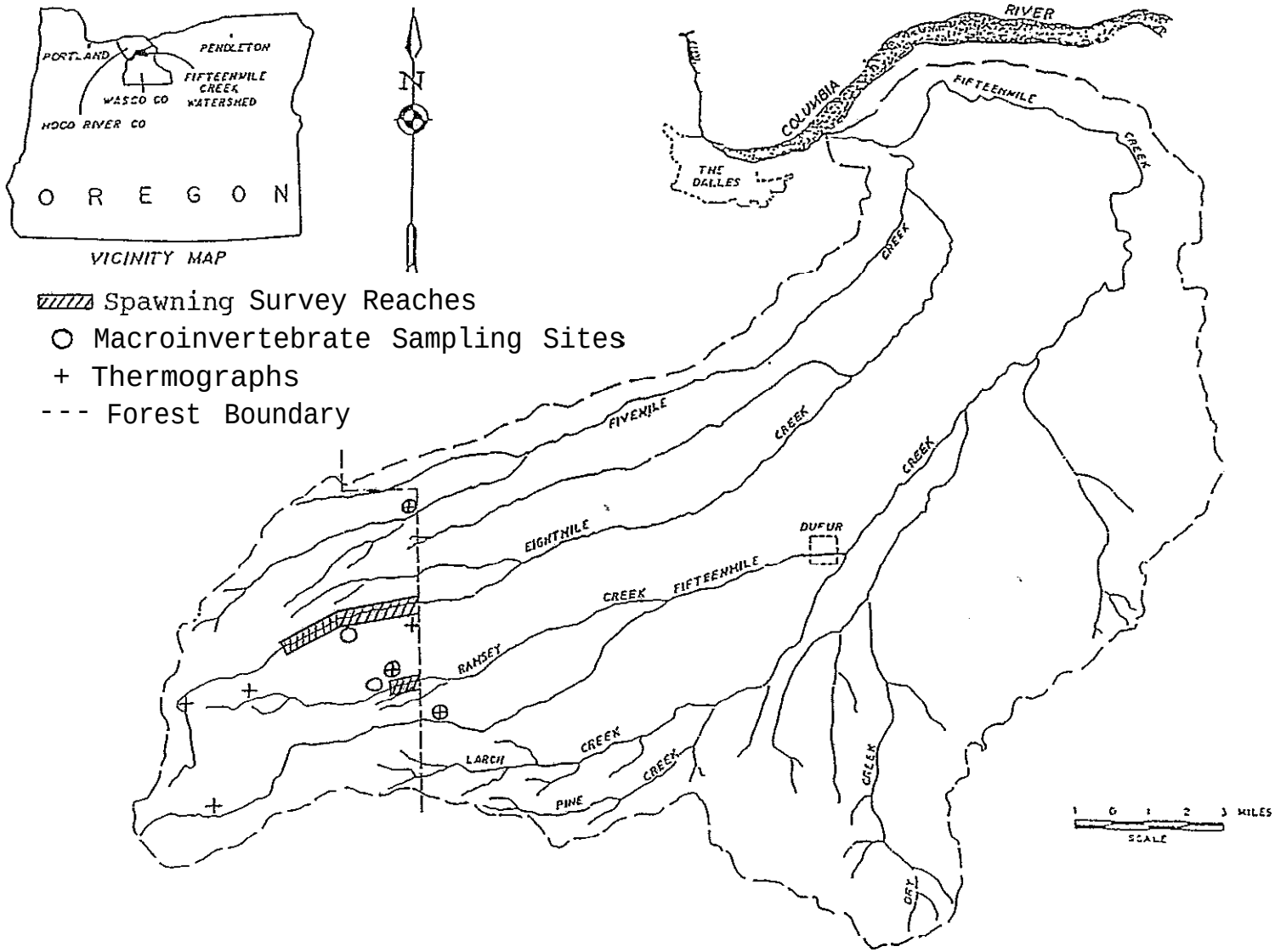


Figure 2. USFS spawning survey stream reaches, macroinvertebrate sampling sites, and thermograph locations in the Fifteenmile Creek basin, 1990.

described in the 1986 annual report (MacDonald and Hutchinson 1987).

Water Temperature Monitoring

Summer water temperatures in the lower portion of the Fifteenmile basin can reach and maintain high levels. Temperatures in the 26.5'C (80'F) range are common, and a temperature of 29'C was recorded near the mouth of Fifteenmile Creek in 1986. An objective of the Fifteenmile project is to improve riparian vegetation shading cover to lower summer water temperatures to a maximum of 21°C at the mouth of Fifteenmile Creek.

Omnidata Datapod[1] electronic temperature recorders (thermographs) were placed throughout the basin to monitor temperature changes. The USFS placed thermographs in the headwaters and at the National Forest boundary on Fifteenmile, Eightmile, and Ramsey Creeks and at the National Forest boundary on Fivemile Creek (Figure 2). Hourly water temperatures were recorded from May through October, except at the headwater location on Fifteenmile Creek where the thermograph was installed in June due to snow accumulation and subsequent lack of access. USFS personnel inspected the thermographs at least once a month for data chip or battery failure and to compare thermograph accuracy with a hand held thermometer. Temperature records were

[1]Use of trade names does not imply endorsement by the U.S.D.A. Forest Service.

downloaded to a computer and daily maximum, minimum and mean temperatures were calculated.

Physical and Biological Sampling

Pre-project monitoring was conducted on Fifteenmile Creek from RM 45.4 to 47.4 using a modification of the Hankin and Reeves methodology (Grimes, in press). Monitoring objectives were to gather baseline fish habitat and population information, monitor pre-treatment conditions, and help identify limiting factors.

Fifteenmile Creek Project Implementation

The 1990 Fifteenmile Creek project objective was to increase rearing habitat capability by improving habitat diversity with instream structures within a two mile reach of stream (Figure 3). The focus was to increase low flow pool/glide volume and effective cover for age l+ and older winter steelhead trout. The instream structures were designed to create scour and plunge pools, accumulate spawning gravels, and provide cover.

Structures were placed by one of three ways: falling whole trees into the creek from adjacent riparian areas, bucking existing downed trees into the channel, or winching fallen trees or bucked logs into the creek from the riparian zone. Trees for falling or bucking were pre-selected by USFS

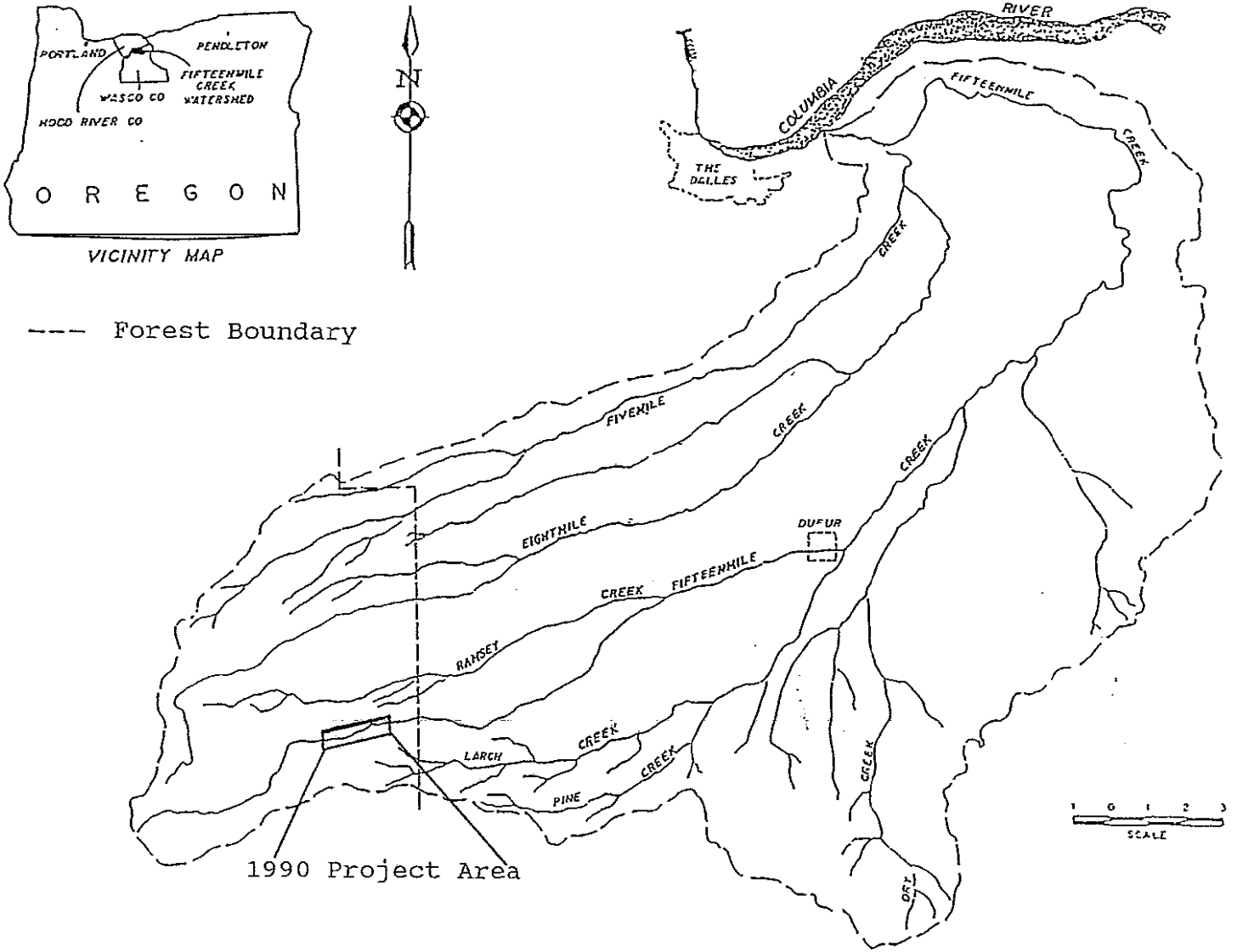


Figure 3. Location of 1990 fish habitat improvement work on Fifteenmile Creek.

personnel in areas where LOD deposits and associated high quality pools were lacking. Care was taken so as not to diminish the potential for long term woody debris input. A professional faller felled and bucked the marked trees under direction from the district fisheries biologist. The felled trees ranged from 50 to 150 ft high and 12 to 48 inches diameter breast height. The felled or existing downed trees were usually bucked at one 'or both ends so more of the trees were in the channel. As much as possible trees were not limbed to retain a natural appearance, provide additional cover, and collect and hold debris.

We used a chainsaw winch and block and tackle to bring downed trees, or top and bottom sections of the felled and bucked trees, into the channel. Using this method we were able to create multi-log structures and,utilise large tree sections which otherwise would have remained out of the channel.

The type of structures described above differ from engineered structures used in other areas of this basin (MacDonald and Hutchinson 1987; Cain et al. 1988; Smith and Marx 1989). We did cable several structures to rocks and/or trees on the bank or in the channel; however, the majority of the trees were large enough to leave uncabled. These trees will move and reposition themselves in the channel, depending on streamflow and hydraulics, creating natural looking and acting structures. These structures, depending on their placement in the channel,

perform like log sills, deflectors, digger logs, and cover logs used in previous USFS enhancement work (Cain et al. 1988).

RESULTS AND DISCUSSION

Spawning Surveys

Spawning surveys were conducted on Ramsey (RM 7.5 - 8.5) and Eightmile (RM 24.5 - 28.5) Creeks on April 26 and May 15 1990, respectively. One redd was observed on Eightmile Creek; no adult steelhead were seen. The lack of sightings may be attributable to the narrow scope of the surveys and/or that run sizes into the basin are, at present, depressed enough so that spawning steelhead are located primarily below the Forest boundary.

The number of redds counted within the Forest boundary since 1986 has varied slightly by stream and year, but, except for Fifteenmile Creek in 1986, the number of redds has been two or less for each stream surveyed (Figure 4). The large number of redds seen in Fifteenmile Creek in 1986 may be attributable to a large returning adult run that year (Tom Macy, USFS, Hood River Ranger District, personal communication). Based on past evidence, it is unlikely large numbers of steelhead trout will utilize spawning habitat on the National Forest until run sizes increase.

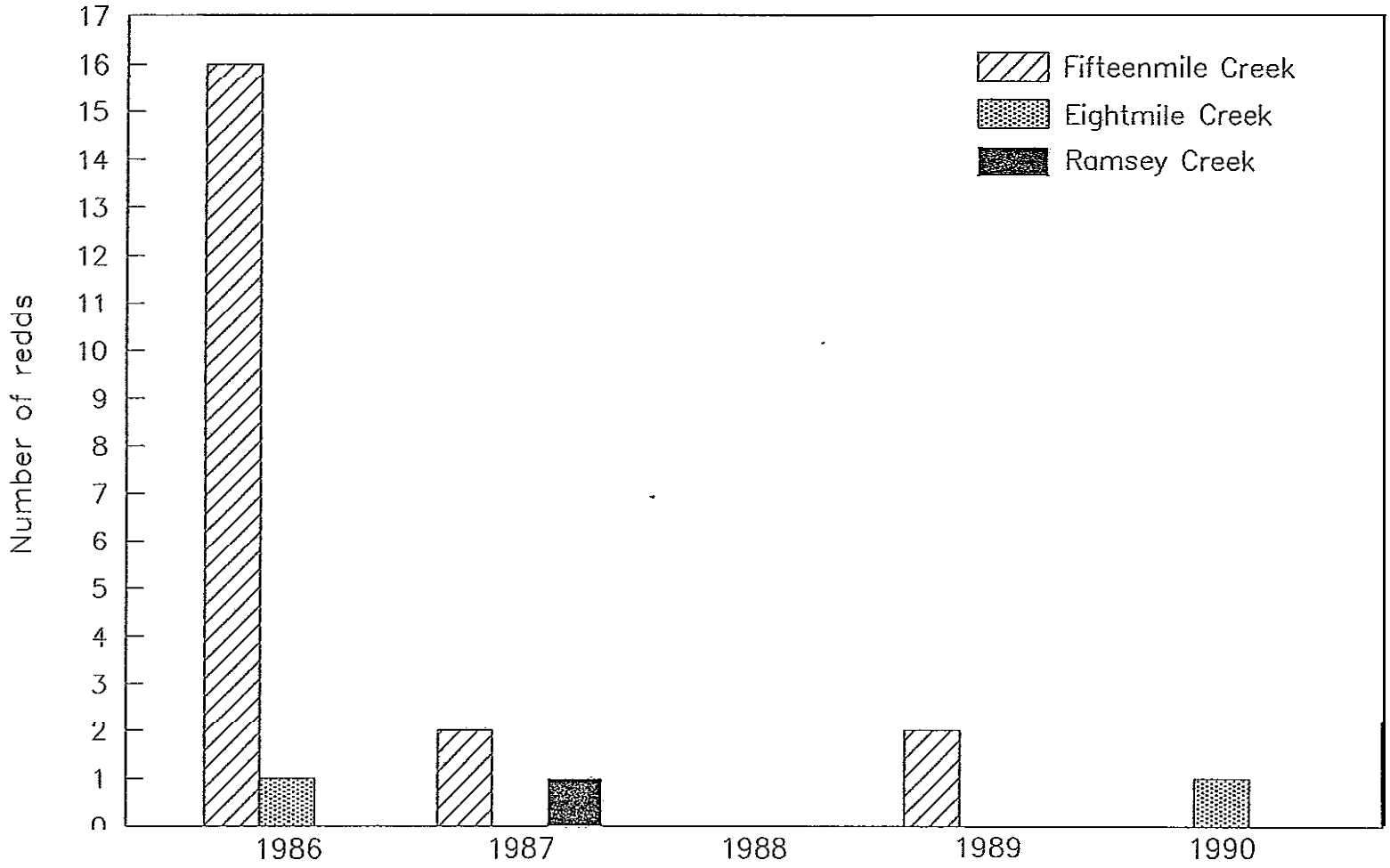


Figure 4. Number of steelhead trout spawning redds counted in Fifteenmile, Eightmile, and Ramsey Creeks during 1986 – 1990 upstream from the National Forest boundary. Fifteenmile Creek was not surveyed in 1990.

Macroinvertebrate Analysis

Forty five macroinvertebrate samples were collected during April, July, and November 1990 in Ramsey, Fivemile, Eightmile, and Fifteenmile Creeks. The 1989 and 1990 annual reports from the USFS Region 4 macroinvertebrate analysis lab are currently in preparation.

Macroinvertebrate diversity indices are a measure of stress in the environment and assume that large numbers of species are present in an unpolluted, or unstressed, environment (Mason 1981). For the DAT diversity index used in this analysis (Mangum 1987), values between 11 and 17 indicate good environmental conditions while values greater than 18 indicate excellent conditions. From 1986 through 1988 none of the Fifteenmile basin macroinvertebrate samples taken within the National Forest exhibited DAT diversity index values below those considered good, and most were in the excellent range (Figure 5). There was year to year and seasonal variation, but given the variable nature of aquatic ecosystems this was not unexpected.

Water Temperature Monitoring

Water temperatures in the Fifteenmile basin on the National Forest are well below upper lethal limits for salmonids. Daily maximum water temperatures of 18.5, 1'8.0, 17.0, and 16.0 'C were recorded during August in Fifteenmile, Fivemile, Eightmile, and Ramsey Creeks, respectively (Figures 6 and 7).

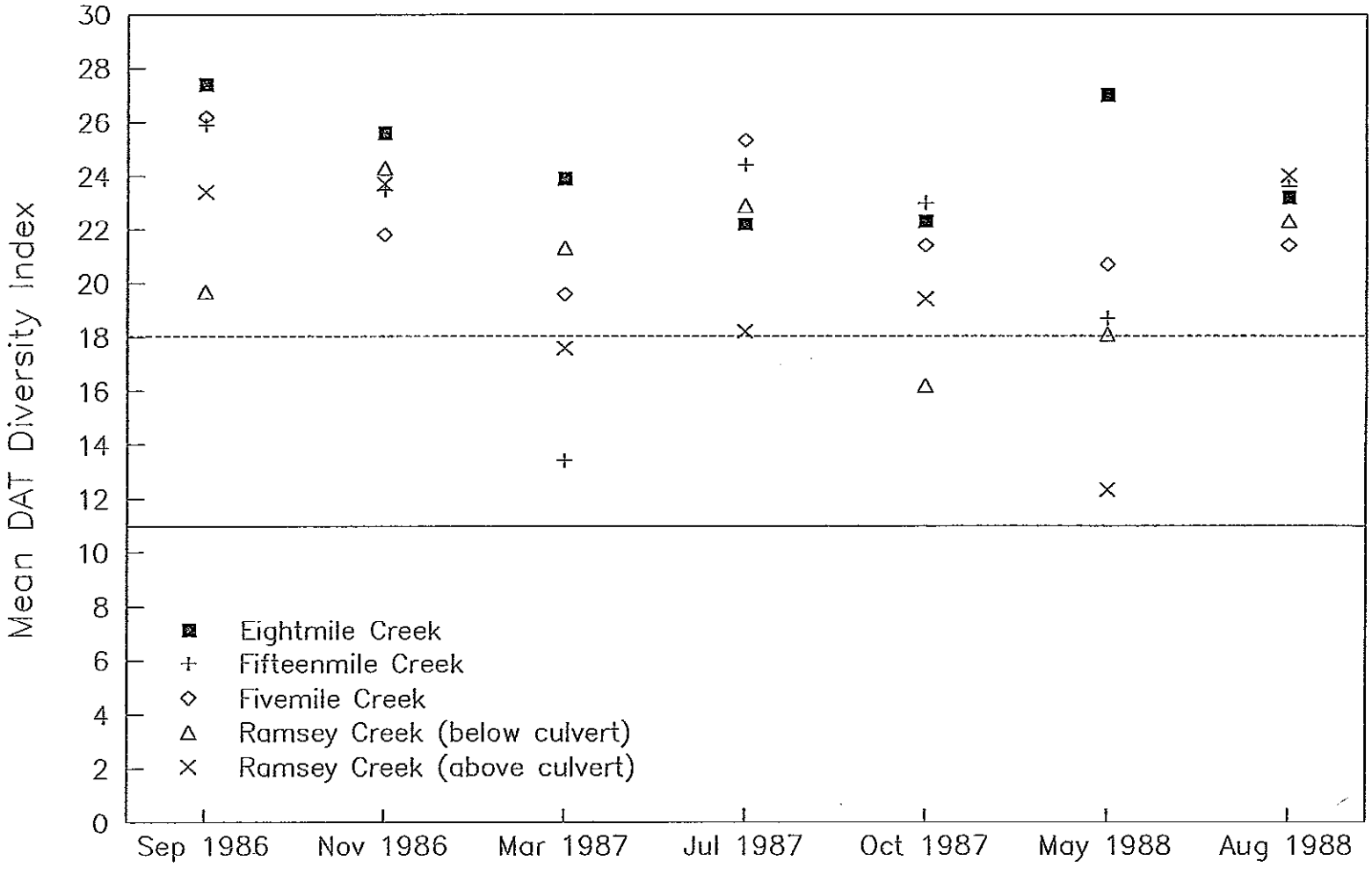


Figure 5. Mean DAT diversity index values for macroinvertebrates collected from five sites within the Fifteenmile Creek basin during 1986 - 1988. Each point represents the mean from three samples taken at each site. Values above the dashed horizontal line are considered excellent, values between the dashed and solid horizontal lines are considered good.

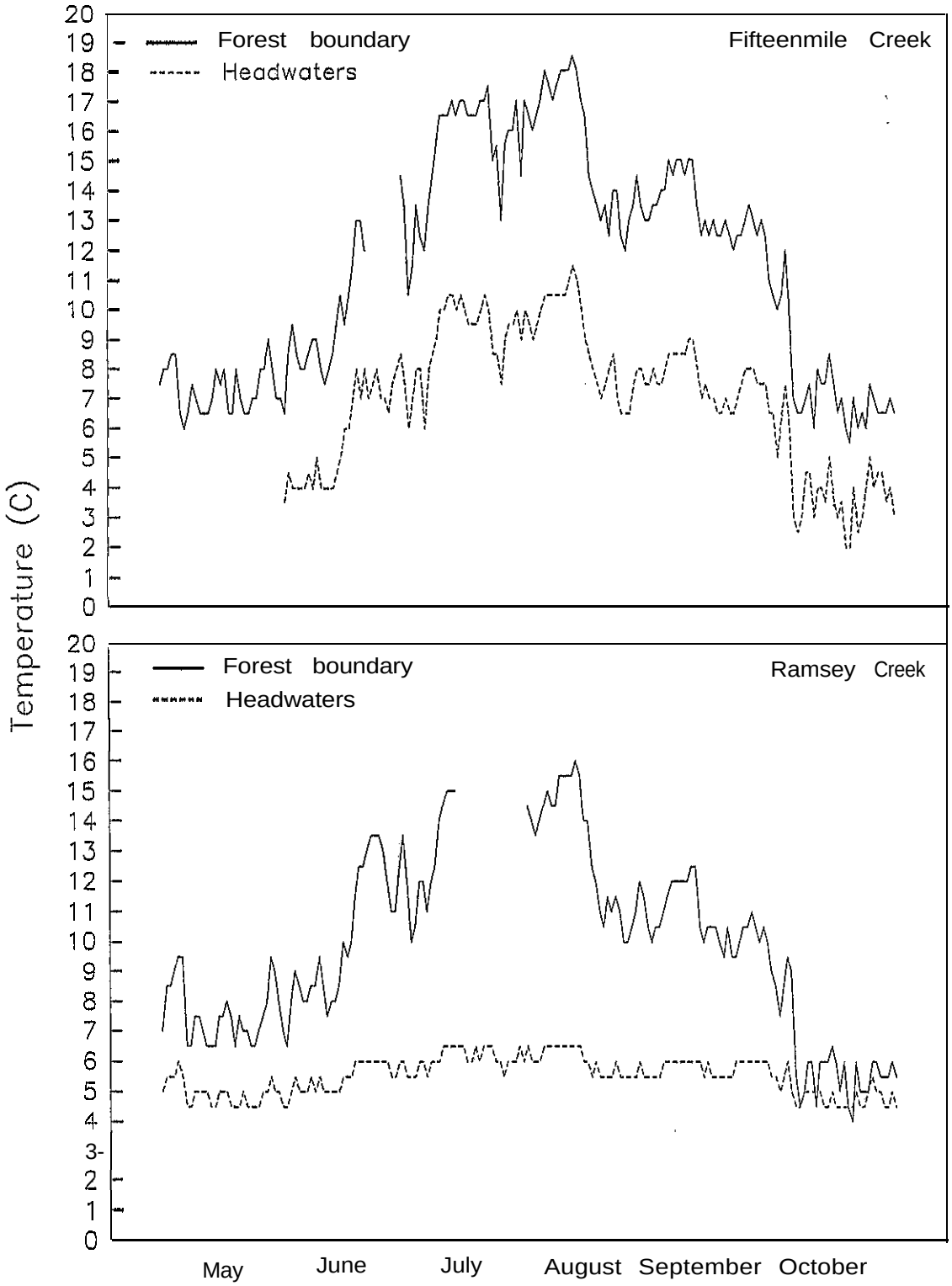


Figure 6. Daily maximum water temperatures ("C) recorded at two sites (Forest boundary and headwaters) in Fifteenmile and Ramsey Creeks from 1 May to 31 October 1990. The head -water thermograph in Fifteenmile Creek was not installed until 1 June 1990.

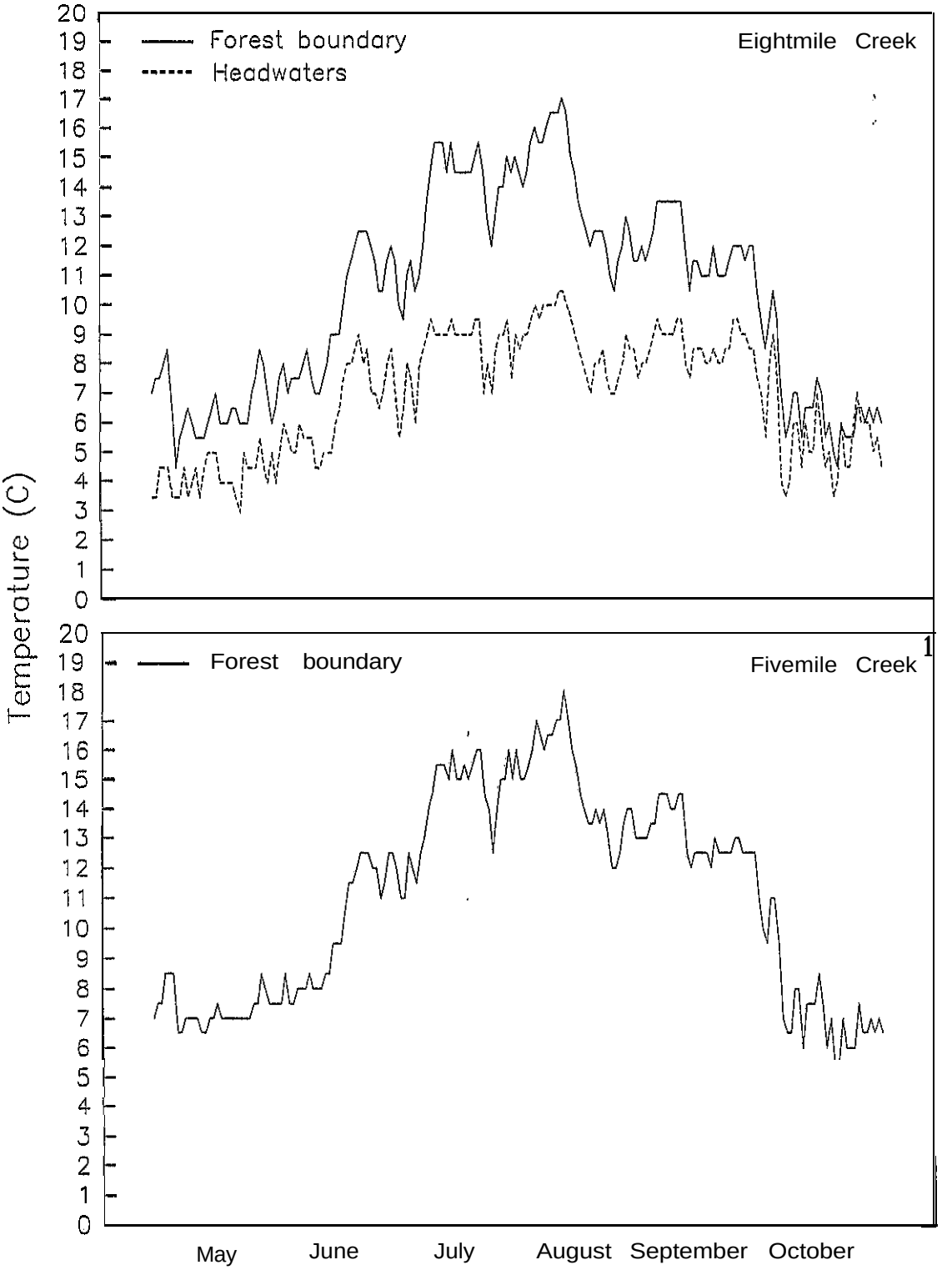


Figure 7. Daily maximum water temperatures ("C) recorded at two sites (Forest boundary and headwaters) in Eightmile Creek and one site (Forest boundary) in Fivemile Creek from 1 May to 31 October 1990.

Generally, Fifteenmile and Fivemile Creeks had the highest daily maximum temperatures, but tbe temperature regimes were similar for the four creeks. One exception was the upper Ramsey Creek site which maintained low temperatures with little diurnal fluctuation during the six month period.

Based on spot checks conducted by USFS personnel none of the thermographs appeared to be recording abnornal water temperatures, with the possible exception of the lower Eight-mile Creek thermograph in late October. On 1 November we recorded a water temperature of 0.0'C! with the hand held thermometer whereas the thermograph read 2.5'C. Missing data during June for the lower Fifteenmile Creek site and July for the lower Ramsey Creek site may have been attributable to weak batteries or moisture in the unit. When the Fifteenmile Creek thermograph was checked on 29 June it was not recording data, the Ramsey Creek thermograph was recording when checked on 30 July but did read one error.

Water temperatures recorded in 1990 generally were slightly higher than those recorded in 1989 (see Appendix A) and were likely due to year to year climatic and/or streamflow variation. Although stream temperatures at the National Forest boundary were not excessively high, they approached the maximum of 21'C targeted for the mouth of Fifteenmile Creek. Fifteen-mile basin streams on the National Forest are generally well shaded, even in timber harvest areas. The chances are low that the USFS, through land management practices, can significantly

lower summer maximum stream temperatures on the National Forest. Even if ODFW is successful in establishing a riparian buffer zone along Fifteenmile basin streams below the Forest boundary, the possibility exists that stream temperatures at the mouth may not reach the 21'C target. Especially considering the usual hot, dry summers in the area and the amount of water diverted or pumped out for irrigation.

Physical and Biological Monitoring

The 1990 Fifteenmile Creek project area was surveyed before habitat enhancement work was initiated. Data are currently being summarized for report preparation. Post-project surveys on 1989 work will not occur until 1991 or 1992 to better evaluate structure success over a longer time period and range of flows.

Fifteenmile Creek Project Implementation

Within the two mile project area the professional faller dropped 39 trees into the channel and bucked 45 existing downed trees spanning the channel. Tree tops, bottoms, or both were winched into the channel at approximately 50% of the fallen and bucked tree sites. The number of structures was increased from 35 (as outlined in the 1990/91 Statement of Work) after pre-project planning surveys indicated a more intensive enhancement effort in this section of the creek was needed. Efforts were concentrated in those sub-reaches which did not have large

amounts of current or potential LOD in the channel. The implementation phase of the project took about three weeks to complete (27 September - 19 October). The majority of this time was spent winching log pieces into the channel; actual falling and most of the bucking took two days.

SUMMARY and CONCLUSIONS

Fifteenmile Creek

Eighty four log structures were placed in a two mile reach of Fifteenmile Creek. Pre-project physical monitoring was completed in the project area. Macroinvertebrate sampling and water temperature monitoring proceeded as scheduled, spawning surveys were not conducted within the National Forest boundary. It is anticipated there will not be any new habitat improvement work in Fifteenmile Creek on the National Forest in the near future.

The type of structures installed in 1990 may be useful in other areas where stream discharge is not overly flashy, and where there are adequate numbers of trees in the riparian zone to fall several in the channel without significantly reducing potential LOD recruitment. The costs in this type of project were significantly lower than if a spyder backhoe or other heavy equipment had been used. In addition, falling trees into the channel and not cabling (when possible) results in more

natural acting and looking structures which may be particularly important in frequently used areas to maintain a natural appearance.

Ramsey, Eightmile, and Fivemile Creeks

Peer review of habitat improvement work on Ramsey Creek to determine if habitat improvement objectives were met was not completed. Macroinvertebrate sampling and water temperature monitoring proceeded according to schedule. Spawning surveys were conducted in sections of Eightmile and Ramsey Creeks, but not in Fivemile Creek. Project planning and environmental analysis for habitat improvement work in Fivemile Creek and Middle Fork Fivemile Creek was begun.

LITERATURE CITED

Cain, T.C. and G.M. Asbridge. 1989. Fifteenmile basin habitat improvement project, 1989 annual report. Bonneville Power Administration, Portland, OR.

Cain, T., C. Hutchinson, and K. MacDonald. 1988. Fifteenmile Basin habitat improvement project. Annual Report to Bonneville Power Administration, Portland, OR.

Godbout, K. and J. Uebel. 1982. Riparian area resource assessment, annual report. Mt. Hood National Forest, Gresham, OR.

Grimes, J. In press. Monitoring and evaluation of Mt. Hood National Forest stream habitat improvement and rehabilitation projects: 1988 annual report. Mt. Hood National Forest, Gresham, OR.

Hankin, D.G. and G.H. Reeves. 1988. Use of visual methods for estimating fish abundance and habitat areas in small streams. Canadian Journal of Fisheries and Aquatic Sciences 45: in press.

Kinzey, D. and C. Hutchinson. 1985. Riparian area assessment (1985) USDA Forest Service, Mt. Hood National Forest, Gresham, OR.

MacDonald, K. and C. Hutchinson. 1987. Fifteenmile Basin habitat improvement project, 1986 Annual Report. In: Natural Propagation and Habitat Improvement. Volume I Department of Energy, Bonneville Power Administration.

Mangum, F. 1985. Aquatic ecosystem inventory, macroinvertebrate analysis. In: Fisheries Habitat Surveys Handbook (R-4 FSH 2609.23) Chapter 5.

Mangum, F. 1987. Aquatic ecosystem inventory, macroinvertebrate analysis. Annual Report to Mt. Hood National Forest, Gresham, OR. 113 pp.

Mason, C.F. 1981. Biology of freshwater pollution. Longman Inc. New York, NY.

Oregon Department of Fish and Wildlife and Confederated Tribes of the Warm Springs Reservation of Oregon. 1989. Draft Fifteenmile Creek subbasin salmon and steelhead production plan. Northwest Power Planning Council, Portland, OR. 59 PP.

Smith, R., D. Heller, J. Newton, H. Forsgren, R. Boyce, and K. MacDonald. 1987. Fifteenmile Basin fish habitat improvement plan. Bonneville Power Administration, Portland, OR.

Smith, R.C. and S.D. Marx. 1989. Fifteenmile basin habitat enhancement project 1988 Annual Report. Bonneville Power Administration, Portland, OR.

SUMMARY OF EXPENDITURES

A. Personnel	Grade	MD	Rate	costs
Project Leader	12	5	$170	$1,190
Project Assistant	11	15	$150	$2,250
Zone Fisheries Biologist	11	10	$150	$1,500
Hydrologist	11	2	$150	$300
District Biologist	9	32	$120	$3,840
Fisheries Biologist	7	40	$90	$3,600
Hydrologist	7	22	$90	$1,980
Laborer	5	10	$75	$750
		Subtotal		$15,410

B. Travel		
6,100 miles @ $0.20/mile		$1,220
GSA Rental 1 vehicle @ $145/month		870
	Subtotal	$2,090

C. Expendable materials		
2,000 ft Galvanized cable @ 0.80/ft		$1,600
Mist (cable clamps, shackles, film, etc.)		350
	Subtotal	$1,950

D. Overhead (12% of A, B, and C)		
	Subtotal	$2,334

E. Contract Costs			
Tree Faller	19 hrs @ $40/hr	Subtotal	$760

F. Macroinvertebrate analysis		
15 sites @ $135/site x 3 samples/site/year		
	Subtotal	$6,075

TOTAL FY 1990-1991 Project Costs	$28,619

Appendix A

1989 and 1990 Monthly Maximum, Minimum, and Mean Water Temperatures on then Mt. Hood National Forest

Fifteenmile Creek [Upper and Lower sites)

	Maximum		Minimum		Mean	
	1989	1990	1989	1990	1989	1990
May	9.0	9.0	3.5	3.5	5.8	6.0
June	7.0	8.5	2.0	2.0	3.5	4.3
	11.5	14.5	5.0	5.0	7.9	8.2
July	10.0	10.5	3.0	3.5	6.4	7.5
	15.0	17.5	7.5	8.0	10.8	13.1
August	10.0	11.5	5.0	4.5	7.1	7.8
	16.0	18.5	8.5	9.0	11.6	13.4
September	9.5	9.0	4.5	5.0	6.7	6.8
	12.0	15.0	6.0	8.0	9.3	11.5
October	9.0	7.5	4.0	1.0	6.8	3.3
	9.5	12.0	2.0	3.5	6.6	6.4

Ramsey Creek (Upper and Lower sites)

	Maximum		Minimum		Mean	
	1989	1990	1989	1990	1989	1990
May	7.0	6.0	2.0	3.5	4.9	4.4
	9.5	9.5	4.0	3.5	6.2	6.2
June	6.0	6.0	4.0	4.0	5.1	5.0
	12.5	13.5	6.0	4.5	9.2	9.0
July	6.0	6.5	4.5	4.5	5.2	5.6
	13.5	15.0	7.0	7.5	10.2	11.4
August	6.0	6.5	4.5	4.5	5.2	5.5
	14.0	16.0	7.5	7.0	10.1	11.6
September	6.0	6.0	4.5	5.0	5.0	5.4
	9.5	12.5	5.0	6.5	7.8	9.6
October	5.5	6.0	3.5	3.5	4.5	4.5
	8.0	9.5	1.5	2.5	5.4	5.2

Appendix A (cont.)

Eightmile Creek (Upper and Lower sites)

	Maximum		Minimum		Mean	
	1989	1990	1989	1990	1989	1990
May	5.5	**5.5**	**1.5**	**1.0**	**2.6**	**3.0**
	8.5	**8.5**	**3.5**	**3.5**	**5.7**	**5.9**
June	**7.5**	**9.0**	**2.5**	**2.5**	**4.7**	**4.8**
	12.0	**12.5**	**6.0**	**5.0**	**8.8**	**8.8**
July	**8.5**	**9.5**	**3.5**	**3.0**	**5.5**	**6.5**
	13.5	**15.5**	**7.5**	**8.0**	**10.7**	**12.6**
August	**9.0**	**10.5**	**4.0**	**4.5**	**6.0**	**7.6**
	15.0	**17.0**	**9.0**	**9.0**	**11.6**	**13.0**
September	**8.0**	**9.5**	**3.0**	**5.0**	**5.4**	**7.6**
	11.0	**13.5**	**6.5**	**8.5**	**9.2**	**11.2**
October	**6.5**	**9.0**	**1.0**	**1.5**	**4.0**	**4.7**
	9.5	**10.5**	**1.5**	**3.5**	**6.2**	**6.0**

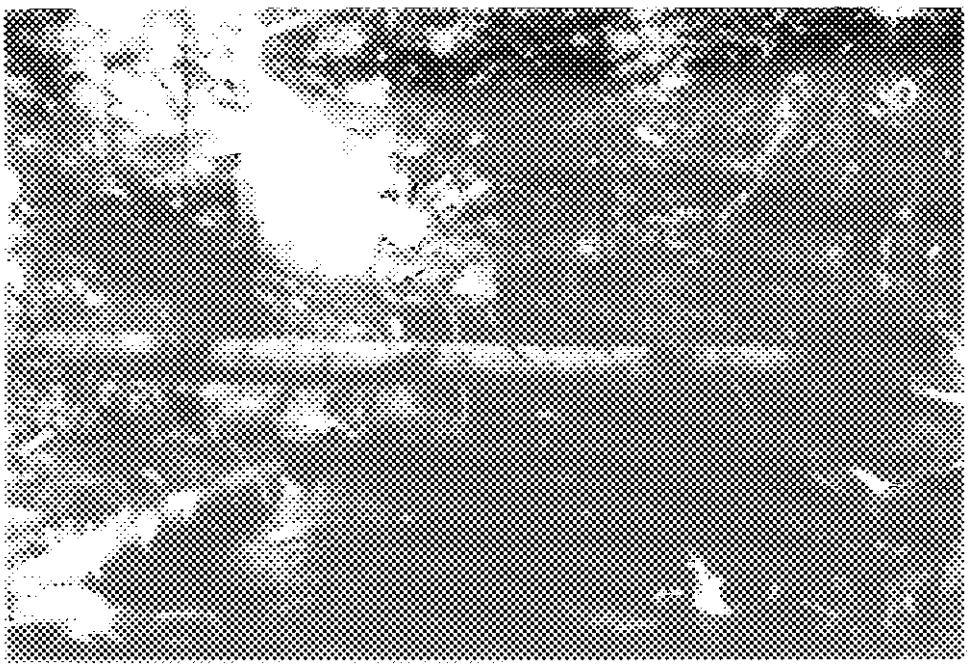
Fivemile Creek (Lower site)

	Maximum		Minimum		Mean	
	1989	1990	1989	1990	1989	1990
May	9.0	**8.5**	**5.0**	**4.5**	**6.6**	**6.4**
June	**13.0**	**12.5**	**7.0**	**6.0**	**9.6**	**8.8**
July	**14.5**	**16.0**	**8.5**	**8.5**	**11.2**	**12.7**
August	**16.0**	**18.0**	**9.5**	**9.5**	**12.3**	**13.5**
September	**12.5**	**14.5**	**6.5**	**8.0**	**9.7**	**11.6**
October	10.0	11.0	**2.0**	**3.5**	**6.7**	**6.5**

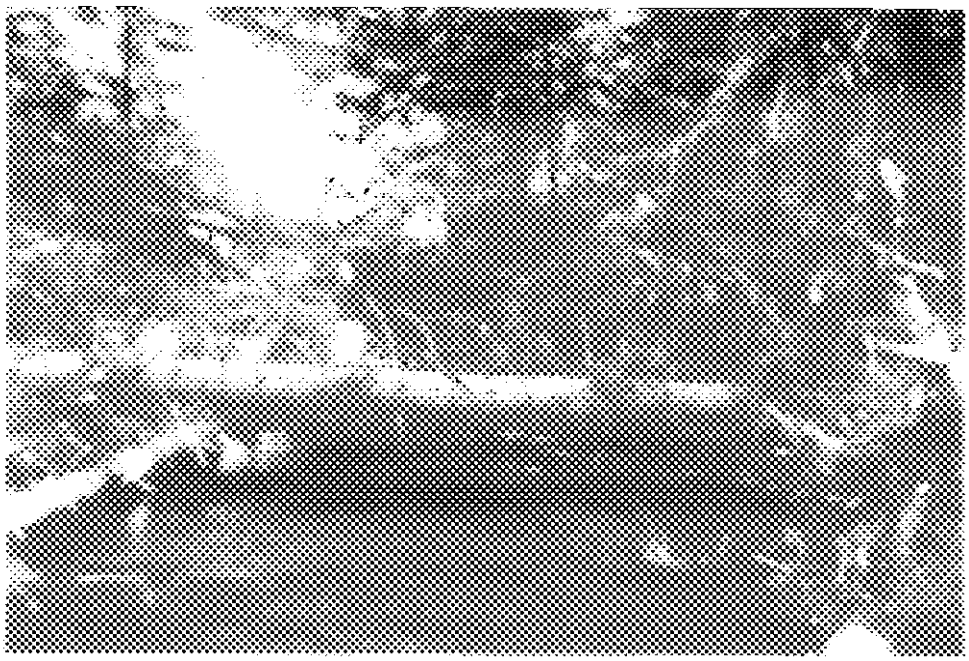
Appendix B.

Selected Photographs of 1990 Project Work an Fifteenmile Creek

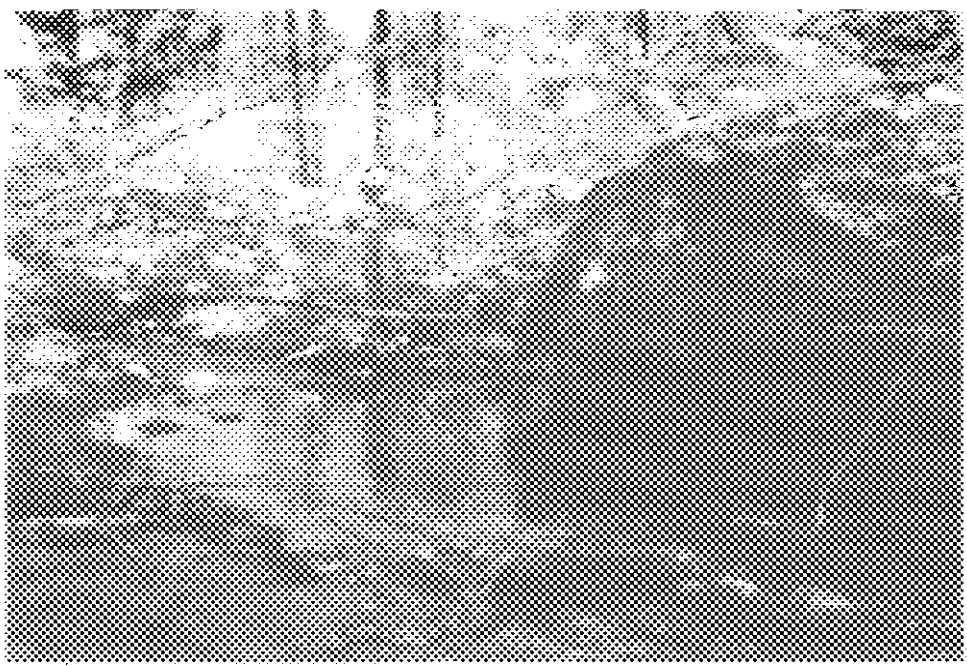
bower project area site, before falling.



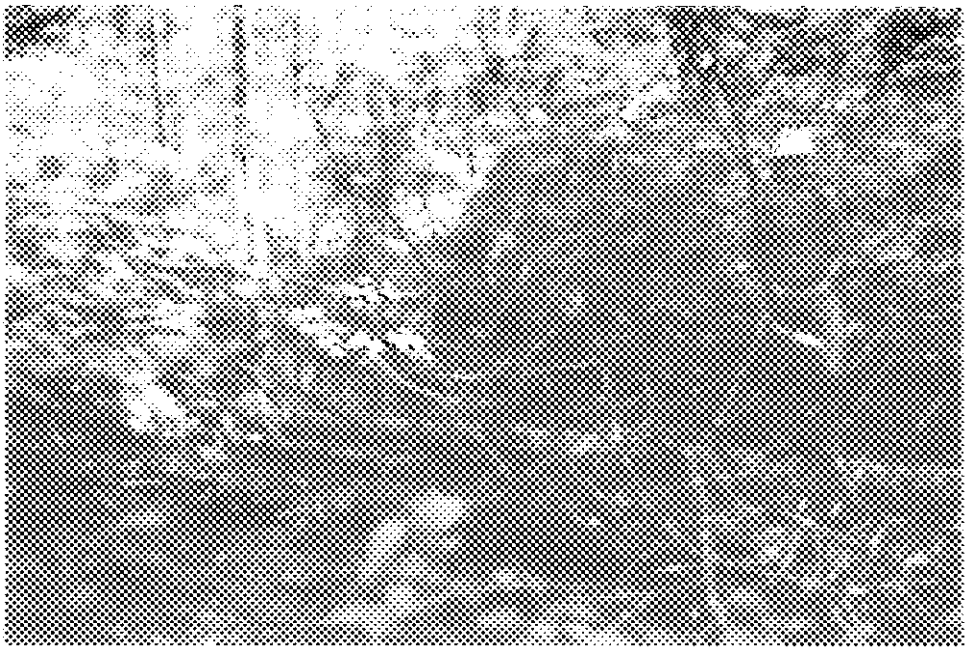
Lower project area site, after fallinq.



lower project area site, after bucking right side.



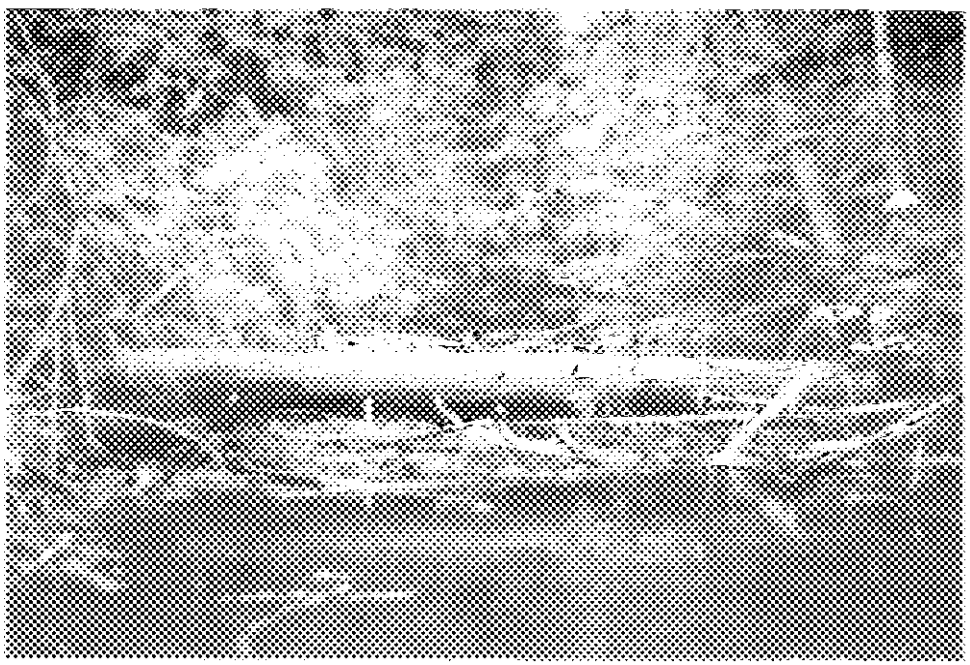
Lover middle project area sire,, before failing.



Lower middle project area site, after falling. This log was primarily for cover.

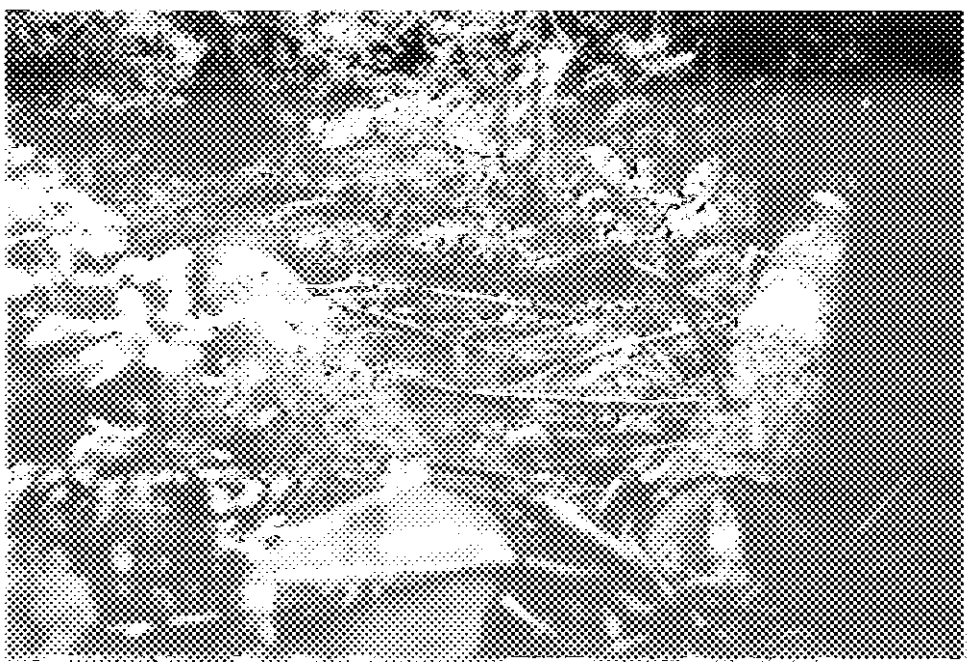
Middle project area site, before falling.

Middle project area. s i t e , after falling

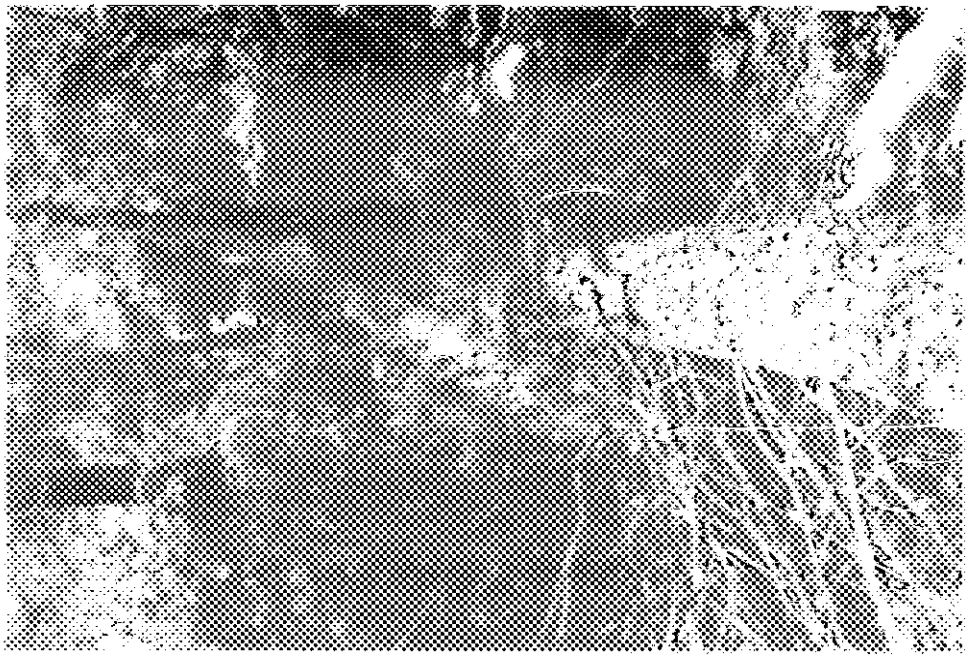


Middle project area site, after bucking right side.

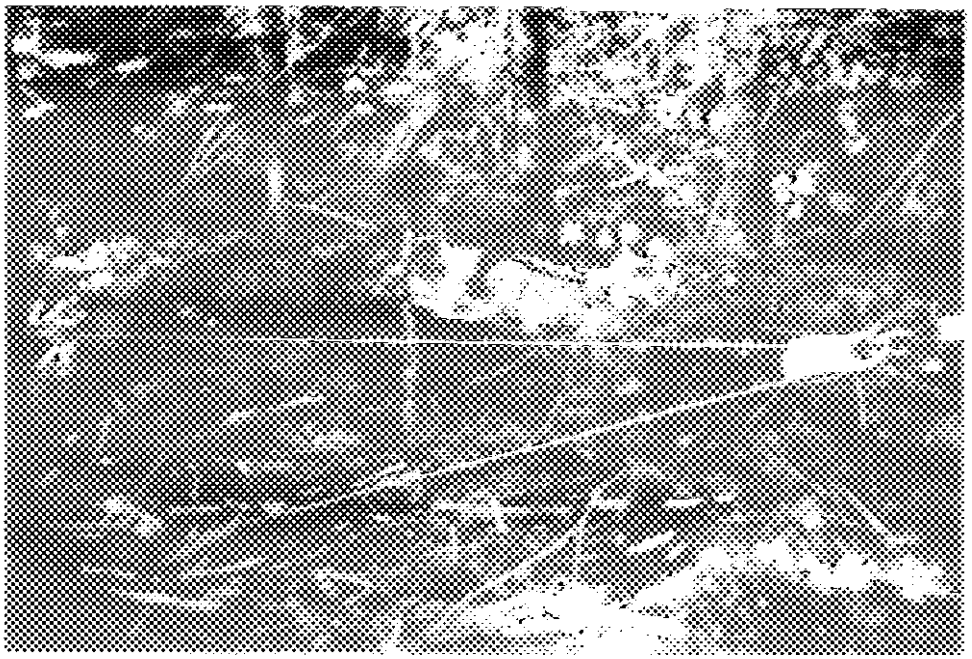
Middle project area site, after winching in log segment.



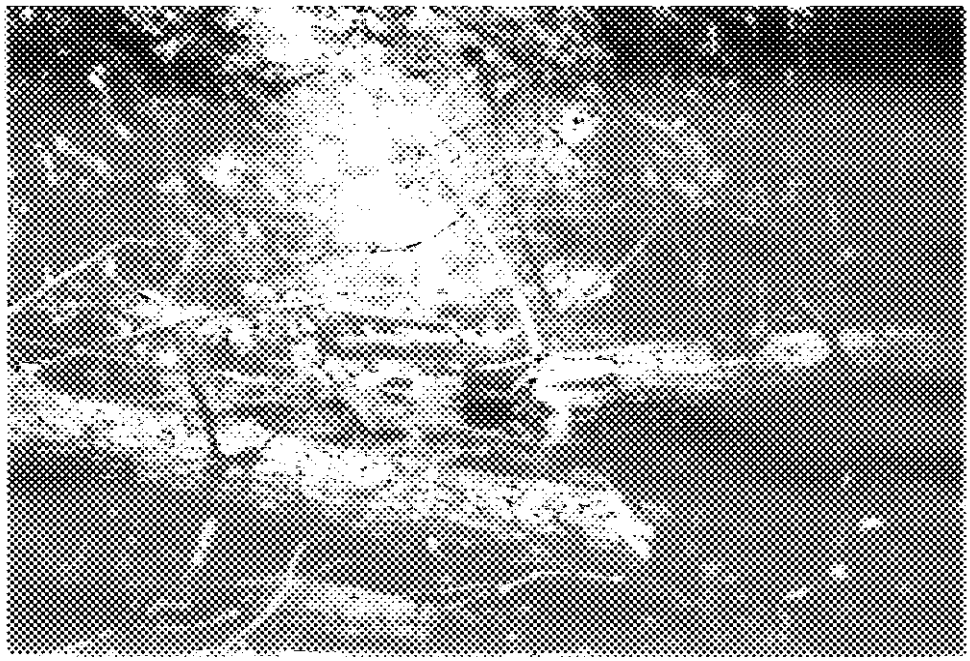
Middle project area site, view from north bank.



Finished structure. Note limb retention,.



Chainsaw winch (left) and one of three pulleys used to winch in log segments.



Upper project area site; winching in log segment.

Upper project area site after two logs had been winched in.