Fisheries Enhancement in the Fish Creek Basin

Evaluation of In-Channel and Off-Channel Projects

Annual Report
1984

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FISHERIES ENHANCEMENT IN THE FISH CREEK BASIN--AN EVALUATION OF IN-CHANNEL AND OFF-CHANNEL PROJECTS, 1984

Annual Report 1984

by

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ABSTRACT

This S-year project which began in 1983 is designed to construct and evaluate habitat improvements in the Fish Creek basin by personnel of the Estacada Ranger District, Ht. Hood National Forest, and the Pacific Northwest Forest and Range Experiment Station. The work is jolntly funded by BPA and USDA-Forest Service.

The evaluation has focused on activities designed to improve spawning and rearing habltat for chinook and coho salmon and steelhead trout. Specific habitat improvements being evaluated include: boulder berms, an off-channel pond, a side-channel, addition of large woody debris to stream edge habitats, and hardwood plantings to improve riparian vegetation. The initial phases of habitat work have proceeded cautiously in concert with the evaluation so that knowledge gained could be immediately applied to future proposed habitat work.

The evaluation has been conducted at the basin level, rather than reach or site level, and has focused intensely on identification of factors limiting production of salmonids in Fish Creek, as well as physical and biological changes resultlng from habitat improvement.

Identification of limiting factors has proven to be difficult and requires several years of all-season investigation. Results of this work to date indicate that spawning habitat is not limiting production of steelhead or coho in the basin. Coho habitat is presently underseeded because of inadequate escapement. Key summer habitats for coho, age 0 and age 1+ steelhead are beaver ponds, side channels, and pools, respectively. Key winter habitats appear to be groundwater-fed

side channels and boulder-rubble stream margins with 30+ cm depth and low velocity water. Additional work is needed to determine whether summer habitat or winter habitat is limiting steelhead and coho production. Chinook use of the basin appears to be related to the timing of fall freshets that control mlgratory access into the system.

Instream habitat improvements show varying degrees of promise for meetlng their Intended objectives, but all will require some modification to the original design for future use. Boulder berms designed to increase spawnlng habitat have already Impounded small amounts of gravel and are providing spawning areas for steelhead. Some winter habitat was lost, however, due to construction at each berm site. An off-channel coho rearing pond produced a few exceptionally large coho smolts the first year after construction. A side channel development was used by spawning coho and chinook soon after construction in 1984, but few juvenile salmonids were found there in the winter of 1984-85. It is too soon to evaluate riparian plantings or addition of woody debris to stream edges. Comprehensive benefits or losses are difficult to determine for projects only one or two years old since fish response to improvements often takes several years. The success of each improvement must be measured in terms of increased smolt outputs.

Our work indicates that the risk of failure associated with habitat improvement projects is very high withou: 1) a detailed analysis of limiting factors in a basin, and 2) an evaluation of physical and biological changes in a basin, including smolts produced, resulting from improvements.

INTRODUCTION

Construction and evaluation of salmonid habitat improvements on Fish Creek, a tributary of the upper Clackamas River, was contiued in fiscal year 1984 by the Estacada Ranger District, Mt. Hood National Forest and the Anadromous Fish Habitat Research Unit of the Pacific Northwest Forest and Range Experiment Station (PNW), USDA Forest Service. The study began in 1982 when PNW entered into an agreement with the Ht. Hood National Forest to evaluate fish habitat improvements in the Fish Creek basin on the Estacada Ranger District. The project was initially conceived as a 5-year effort (1982-1986) financed by Knutson-Vandenberg (K-V) funds from the Suspender Timber Sale on Fish Creek. Several factors limiting production of salmonids in the basin were identified during the first year of the study, and the scope of the habltat Improvement effort was subsequently enlarged.

The habitat improvement program and the evaluation of improvements were both expanded in mid-1983 when the Bonnevillew Power Administration entered into an agreement with the Ht. Hood National Forest to provide additional funding for work on Fish Creek.

Habitat improvement work in the basin is designed to increase the annual number of chlnook, coho, and steelhead smolt outmigrants from the basin,

The primary objectives of the evaluation Include the:

1) Evaluation and quantification of changes in salmonld spawning and rearing habitat resulting from a variety of habitat improvements.

2) Evaluation and quantification of changes in fish populatlons and biomass resulting from habltat improvements.

3) Evaluation of the cost-effectiveness of habitat improvements developed with BPA and KV funds on Fish Creek.

Several protoype enhancement projects were constructed during the first three years of the study with the tntent of identifying the most successful techniques which could then be broadly applied within the basin. This stepwise procedure has been largely successful in identifying enhancement techniques that can withstand the high energy conditions of Fish Creek and increase the quantity and quality of selected habitats for anadromous salmonids.

This annual progress report will focus on the projects completed In the basin in 1983 and 1984 and their evaluation, but will also Integrate older Information as needed for comparative purposes.

DESCRIPTION OF STUDY AREA

The Fish Creek basin lies in north central Oregon on the west slope of the Cascade Range and drains into the upper Clackamas River (Fig. 1). The watershed is 21 km long, averages approximately 10 km in width, and covers 120 km^2. The terrain is steep and mountainous with bluffs in the lower canyons typical of the Columbia River Basalt formatlon. The valley bottoms are typically narrow with incised stream channels and narrow floodplains.

Fish Creek heads near the summit of the Cascade Mountains at an elevation of about 1,400 m and flows generally north for about 21 km to its confluence with the Clackamas River about 14 km east of North Fork Reservolr. The channel gradient is steep throughout this distance, generally exceeding 5 percent except for the lower 6 km where gradients average 2 percent. The steep gradient and vocanic geology create a stream with predominately riffle environment and boulder substrate. The mainstem of Fish Creek is 5th order as defined by Strahler (1957) and the annual flow variation near the mouth ranges from 0.5 m^3/sec in late summer to more than 100 m^3/sec during winter freshets.

One major tributary, Wash Creek, a 4th order system, heads in the southwest protion of the Fish Creek basin and enters Fish Creek at km 11. The Wash Creek subbasin covers 36 km^2 and has a mainstem length of 8 km. The stream heads at an elevation of about 1,200 m. The mainstem habitat of Wash Creek is steep bouldery riffle in a narrow incised channel. Average minimum summer flow is approximately 0.3 m^3/sec.

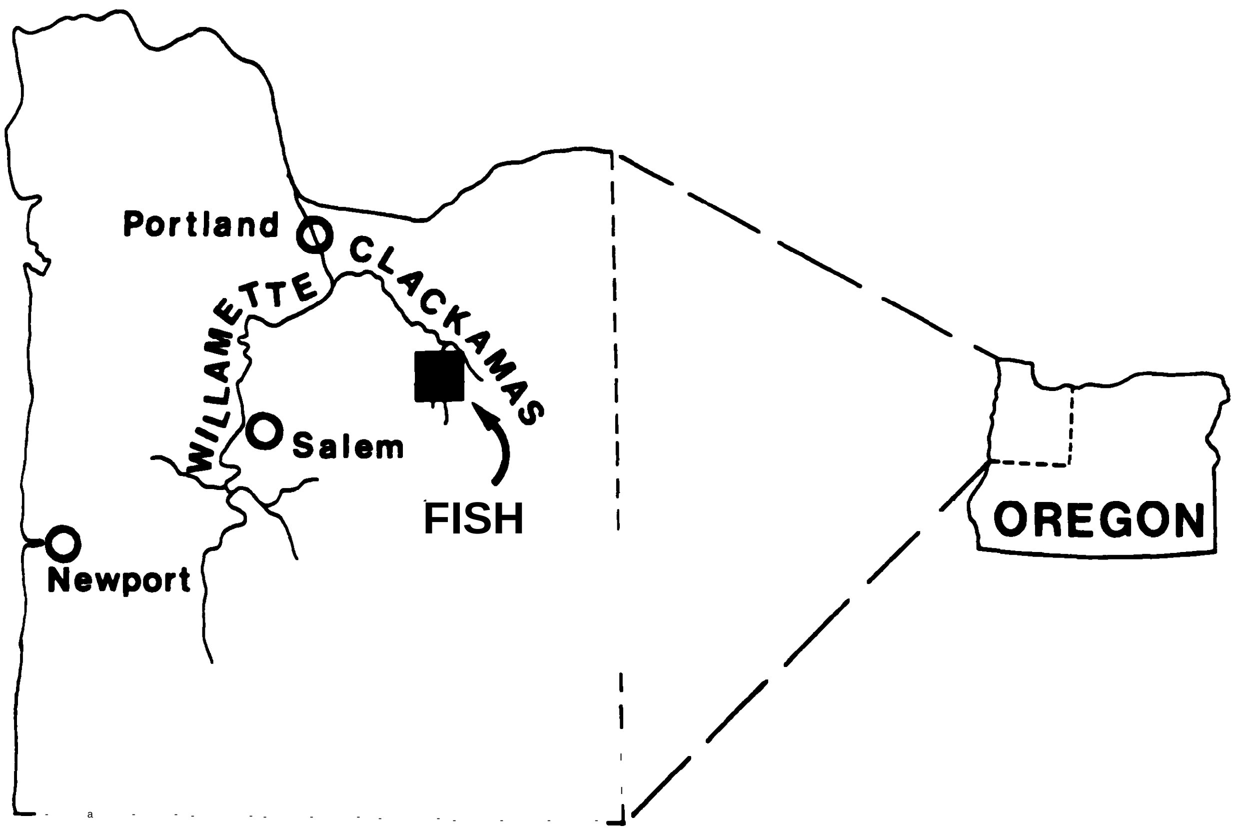


Figure 1. The Fish Creek basin is located in northwest Oregon.

The Fish Creek basin supports a significant population of anadromous salmonids, including summer and winter steelhead trout (Salmo gairdneri). spring chinook salmon (Oncorhynchus tshawytscha), and coho salmon (O. kisutch). Upper areas of the basin contain resident rainbow trout (S. gairdneri). Few resident salmonids are found within the range of anadromous fish and all rainbow sampled there were treated as steelhead. Approximately 16 km of habitat are used by anadromous salmonids, Including the lower 4.7 km of Wash Creek. The upper reaches of both Fish and Wash creeks are blocked to anadromous salmonids by major waterfalls. Water temperatures in habitat used by anadromous fish are generally favorable for fish production, ranging from near 0^{o} C at times in winter to about 20^{o} C in most summers. In years with low summer streamflow and high summer temperatures, however, water temperatures can reach stressful levels for salmonids. FOF example, in early September 1980, temperatures In lower Fish Creek reached 24^{o} C for several consecutive days. Special emphasis on streamside management In the basin is expected to gradually reduce high summer temperatures and eliminate summer thermal stress for juvenile salmonids

DESCRIPTION OF HABITAT IMPROVEMENTS

Three types of habitat improvements were accomplished on Fish Creek in fiscal year 1984. A flood overflow channel at river km 1.0 was developed to enhance spawning habitat for steelhead, coho salmon, and chinook salmon, and to provide perennial rearing opportunities for juvenile steelhead trout and coho salmon. Stream habitat in proximity to the channel is lacking complex, quiet side channels for summer and winter use by juvenile coho salmon, and generally lacks areas of gravel deposition where adult salmonids can spawn. Several alcove habitats along the stream margin near km 8.5 were enhanced by blasting standing tibmer from the riparian zone into the stream margins which, in this area, lacked complex woody structure. A total of 12 trees were blasted into the stream and 6 were included in the evaluation effort. The objective of this work was to increase the complexity of habitat for young coho salmon and steelhead trout by adding stable large organic debris to the stream margins. Improvement of degraded riparian vegetation was also attempted by planting cottonwood (*Populus augustifolia*) in riparian zones in six clear-cuts straddling Fish Creek and Wash Creek. Water temperature control and bank stabilization are the primary objectives of this work.

Evaluation of two types of habitat improvements that were completed on Fish and Wash Creeks in the summer of 1983 were continued in 1984. Twenty-one boulder berms constructed on Fish Creek and Wash Creek to enhance both spawning and rearing opportunities for steelhead trout and spawning for chinook salmon, and a rearing habitat improvement for juvenile coho salmon constructed at km 2.5 on Fish Creek, were intensively monitored in 1984. Each type of improvement (Fig. 2) is described briefly below.

1983 Habitat Improvements

Boulder Berms

Boulder berms were constructed with heavy equipment by removing the boulder armor layer from the streambed at specific locations and stacking the boulders in a V-shaped curve oriented downstream. There was some question as to whether cross-channel berms constructed with boulders could withstand winter flows on Fish Creek. The engineering and construction of berms was successful and none were substantially altered by high flows during the winter of 1983-84. Finished berms ranged from 1 to 1.5 m in height and up to 30 meters long. All but 3 of the berms extended from bank to bank across the stream. All berms that spanned the width of the channel created large dammed pools upstream which serve as rearing habitat for salmonids and settling basins for dedload gravels moving downstream during high flows. Impounded gravels will eventually serve as spawning areas for adult salmonlds.

Off-channel Rearing Pond

The off-channel rearing pond was developed by building a gravity-feed pipeline from Fish Creek to an ancient flood terrace about 200 m below the pipeline intake. The 25 cm diameter pipe is

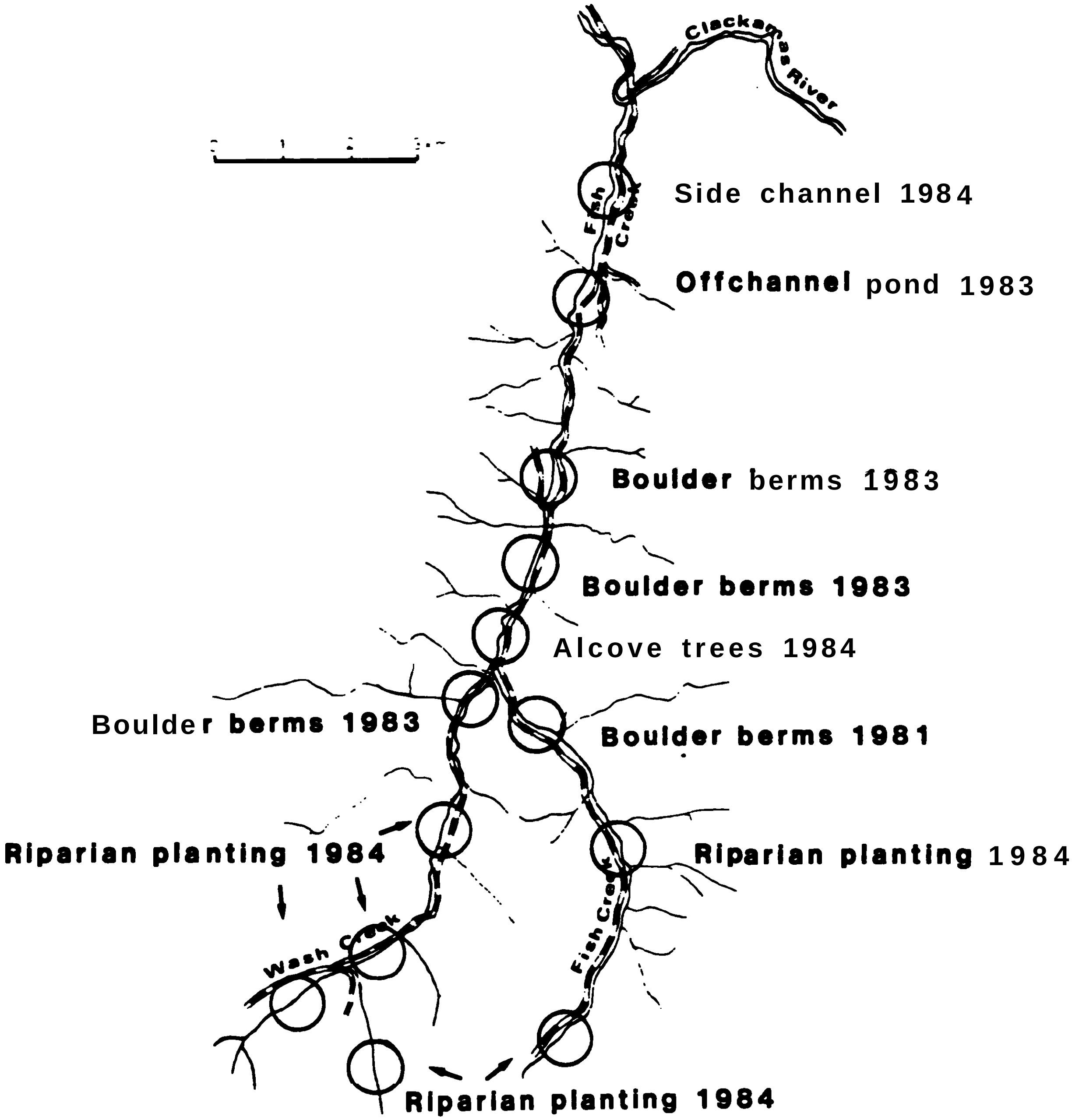


Figure 2. Habitat enhancement projects completed in Fish Creek basin in 1983 and 1984.

about 135 m in length and is capable of delivering about 35 1/sec to the pond. The pond, which formerly was dry in summer, is approximately 90 m in length and 60 m in width. Depth varies from about 0.2 m to 1.25 m, and the surface area is about 0.5 hectares. Volume of the pond is about 3,600 m^3. Water augmentation from the pipeline maintains a near constant water level in the pond throughout the year. A second source of water augmentation for the pond was developed by diverting a small tributary stream at the northeast end of the pond. The stream formerly bypassed the pond but now flows directly into the north end.

1984 Habitat Improvements

Perennial Side Channel

A flood overflow channel about 200 m in length located at km 1.0 on Fish Creek was developed by excavating an Inlet from Fish Creek to provide perennial flow, and by downcutting the outlet to provide easy upstream access for adult and juvenile salmonids. Water velocity and turbulence in the channel were controlled by installation of several rock weir structures. The channel Inlet was armored with logs and cobbles to prevent erosion. The channel was designed to provide off-channel spawning habitat for chinook and coho salmon, and off-channel rearing for juvenile salmonids with special emphasis on Improved winter rearing habitat.

Alcove Enhancement

A project was undertaken by the Estacada Ranger District and Oregon National Guard in late summer of 1984 to Increase the complexity of alcove edge habitats along maInstem Fish Creek in the vicinity of km 8.5. Several Western Red Cedar (Thuja plicata), Douglas-fir (Pseudotsusa menziesii), and Western Hemlock (Tsuga heterophvlla) trees were felled into Fish Creek with explosives. An attempt was made to direct each tree to a preselected point to increase the carrying capacity of edge alcoves for juvenile salmonlds. In September, 12 trees were blasted into the stream and an evaluation of physical and biological changes caused by the trees was Initiated at six sites.

RIparian Revegetation

As a result of logging, stream surface shading has been reduced on numerous perennial tributaries in the upper Fish Creek basin. A portion of the riparian zone in six clearcuts was planted with 2-year old cottonwood in the spring of 1984. The purpose of plantings in the clearcuts was to reduce solar heating of upper Wash Creek and stabilize stream banks in the harvest unit.

METHODS AND MATERIALS

An important part of the habitat enhancement evaluation on Fish Creek was documentation of pre-improvement habitat characteristics and fish populations. Once these characteristics were established, changes in habitat and fish numbers associated with habitat improvement within the basin could be documented. Physical and biological surveys were also made before and after habitat improvements at specific sites.

Habitat Survevs

The composition of physical habitat was measured by compiling the results of habitat surveys in five 0.5 km reaches in the basin (Fig. 3). Three reaches were located on mainstem Fish Creek between Wash Creek and the mouth, and one each was located on Wash Creek and Fish Creek above the confluence of Wash Creek. Each reach was selected because it was representative of overall habitat conditions in Fish Creek and yet covered as much area planned for habitat enhancement projects as possible.

Five distinct habitat types were found in the reaches. These were riffles, pools, side channels, alcoves, and beaver ponds. Riffles and pools need no elaborate description even though many biologists prefer partitioning these two broad habitats into several additional categories. Side channels are found primarily above canyon constrictions and tributary junctions where sediments have accumulated for centuries. The stream often spreads out at high flow and forms

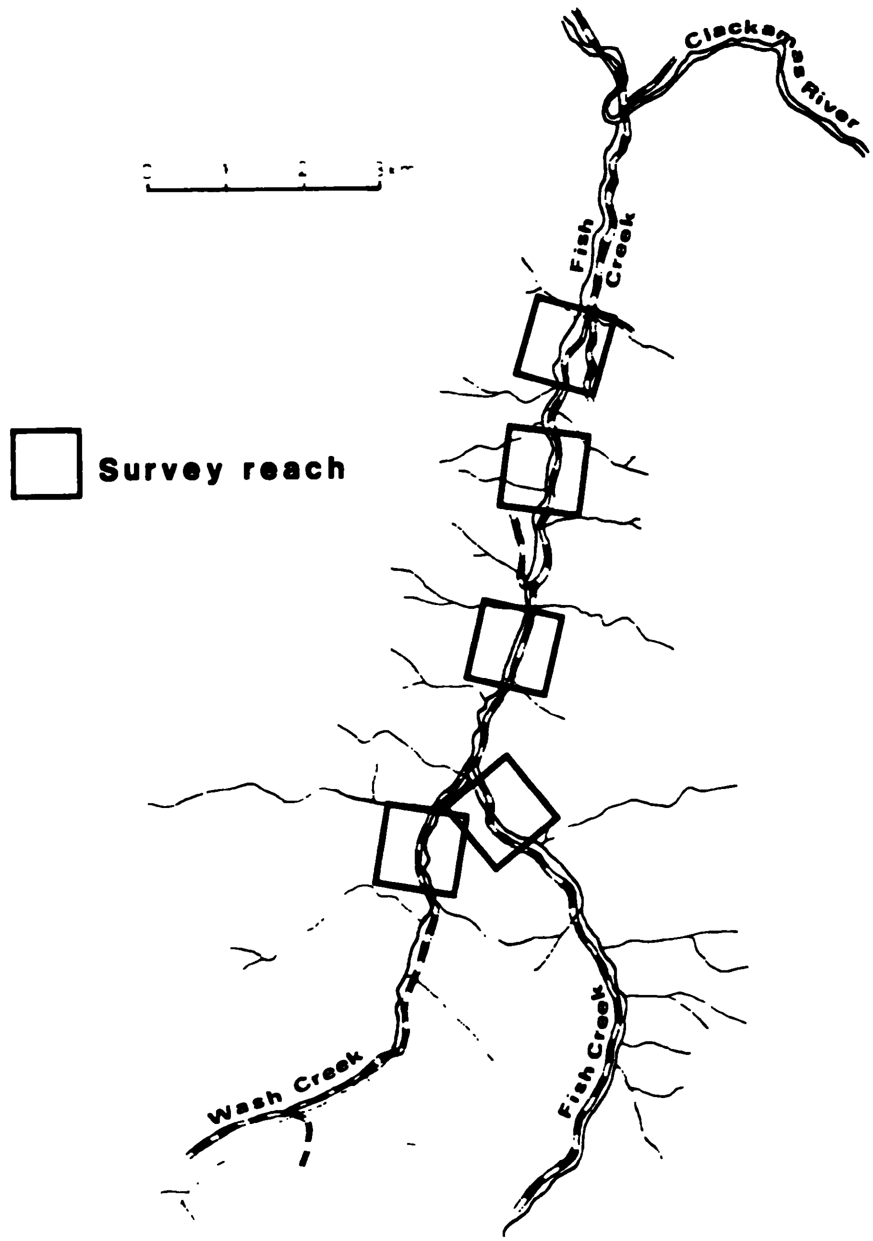


Figure 3. Physical habitat was surveyed at five 0.5 km reaches in Fish Creek basin.

multiple channels in these areas. The side channels are active at high flow in winter and spring, but some are intermittent or dry in Fish Creek during the summer. Those that remain active in summer have characteristically slow water velocity and low stream flow. Alcoves, found along the edges of the main channel, are quiet water habitats formed at high flows by eddy currents below cascades, downed trees, or boulders. Beaver ponds are rare in the system and are found only in areas with side channels that are active in summer. These five habitat types are preferentially occupied by the three anadromous fish species present in Fish Creek.

Physical habitat was measured by compiling results of the five 0.5 km reach surveys in the basin. Surface area and water volume of the five habitat types in each reach were measured. The sampling scheme inventoried about 15 percent of the basin. Results were extrapolated to the rest of the basin accessible to anadromous fish to estimate total habitat in each category available to anadromous fish.

Fish Population Estimates

Fish population estimates for the portion of the basin accessible to anadromous salmonids were made by sampling juvenile salmonids in individual habitat types at 8 locations in the basin (Fig. 4). Fish populations were estimated separately for 36 habitat units (one habitat unit is one riffle, pool, side channel, alcove, or beaver pond) and then extrapolated to the basin based on previous estimates of total available habitat.

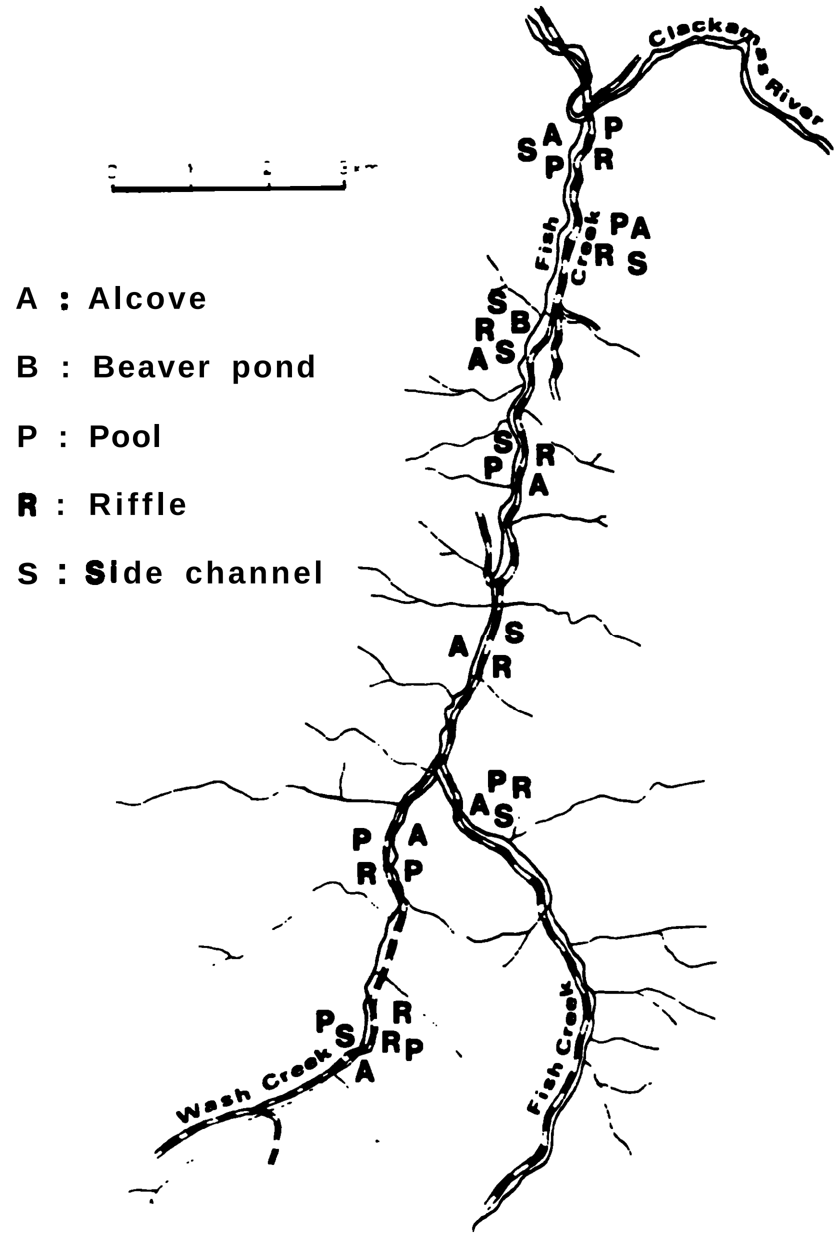


Figure 4. Fish populations were sampled at 8 locations in Fish Creek basin. Thirty-five individual habitat units were sampled.

Populations of juvenile salmonids in each habitat unit were determined by installing 0.47 cm^2 mesh (3/16") block-nets at the upstream and downstream boundries of each site and either electrofishing with either Smith-Root Type VII or XI D.C. Shockers, or by snorkel divers actually counting the number of fish.

Population estimates by electrofishing were calculated by the Moran-Zippen method (Zippen 1958), which is a multiple pass removal method. Each pass included electrofishing from the downstream block-net to the upstream net and return. The sampling concluded when the succeeding catch was less than one-half of the previous catch.

Diver counts of fish were made in some riffles and pools that were either too swift or too deep for effective electrofishing (about 50 percent of the area sampled). The habitat unit to be counted was divided in half longitudinally wherever this technique was used. Two divers, each in a predetermined half of the unit, then moved simultaneously upstream recording the number of fish by species and age-class. After the first count the divers switched halves and each counted the opposite side on a second pass. The diver counts were then averaged to estimate the fish population in the section.

Each salmonid captured by electrofishing was measured to the nearest millimeter (fork length) and the first 25 of each species at each site were weighed to the nearest tenth of a gram on an Ohaus Dial-O-Gram balance. Weights for additional numbers that were measured only were determined by using length/weight frequency calculations involving the first 25 fish weighed and measured. Estimates of biomass in sections counted by divers were made by extrapolation of length-weight data obtained by electrofishing in similar habitat units nearby.

Smolt Production Estimates

An estimate of smolt production for steelhead trout and coho salmon in the basin was calculated from estimated populations and habitat surveys. First, the area and volume of habitats measured in the five 0.5 km reaches was extrapolated to estimate the total area (m^2) and volume (m^3) of the five habitat types available to anadromous fish in the basin. Next, the mean density of juvenile salmonids in each age-class of each species was determined from quantitative data collected from 36 individual habitat units. These data were then applied to the total area and volume in each habitat type to estimate the total number and biomass of juveniles rearing in the basin. Finally, smolt output was estimated for steelhead trout by applying a survival factor to the number of age l+ fish in the system in September to estimate the number that would survive to smolt in Hay of the following year. An identical procedure was used to estimate smolt output for coho. The survival factor applied to l+ steelhead was 0.50 (Personal communication, T. Johnson, WDG). The survival factor applied to 0+ coho was 0.63 (Skeesick, 1970) for the off-channel pond, and 0.40 for fish from other habitats.

Rock Berm Improvements

Physical Surveys--Physical habitat surveys designed to document changes in channel bed topography and substrate size distributions were completed at 21 sites in Fish Creek in the summer of 1983, before and after construction of rock berms. Each pre-construction survey is being used to monitor immediate and long-term changes (5+ years) in habitat resulting from berm construction.

These surveys consisted of longitudinal and transverse profiles, substrate mapping, and photographic records. Pre-work surveys were accomplished within 30 days prior to construction and post work surveys were completed within 14 days after construction. Additional surveys will be scheduled annually at low summer flow.

Each site received a general survey which consisted of a single longitudinal profile traversing the project area at the location of the thalweg. Transverse profiles were located at specified intervals, generally bracketing berm sites.

Additionally, at each site a more intensive survey grid was established consisting of three longitudinal profiles and five transverse profiles. These grids were located over a series of berm sites. Data on bottom elevations, substrate composition, and water depth were taken at 1 m intervals on the grid.

Substrate was mapped at both general and intensive survey areas, bracketing all berm locations. Substrate mapping differentiated the bed into four size classes, boulders (>256 mm), cobbles (256 to 64 mm) gravels (64 to 4 nun), and sands (<2 mm) (Wentworth Scale). Amounts of each size and their locations were recorded.

Photo points were established to provide qualitative photographic evidence of substrate and topographic changes.

Biological Surveys--Fish population structure and biomass were determined at each berm site prior to construction using the techniques described earlier. The initial post construction surveys were completed in the summer of 1984.

Off-Channel Habitat Improvement

A number of features were added to the off-channel coho salmon rearing pond during the evaluation effort in 1983. These included a fish ladder to allow adult and juvenile salmonids access to and from the pond, an upstream-downstream migrant trap, a tributary diversion structure to enhance spawning area in a pond inlet, beaver-resistant access through a beaver dam between the pond and Fish Creek, and a beaver control fence near the pond outlet. The inlet pipe was modified in 1984.

Fish ladder--A fish ladder was constructed in the outlet stream from the pond in the fall of 1983. The structure is built of 10 cm x 15 cm timbers and lined with 13 mm thick plywood. The ladder is 8 m long, 0.8 m in width and contains four jump-pools to assist salmonids migrating to and from the pond. Each jump-pool is 50 cm deep and the maximum elevation between pools is 20 cm.

Migrant Trap--A rotating drum screen 60 cm in diameter by 90 cm long at the head of the ladder diverts upstream and downstream migrants into two screen trap boxes adjacent to the ladder. When the trap boxes are removed migrants are free to move through the trap to and from the pond. When the trap is being fished, the boxes are arranged so that upstream and downstream migrants are captured and held separately.

Tributary Diversion Structure--A small east aspect tributary, with its main channel draining to Fish Creek 50 m north of the pond, was redirected with a small concrete diversion dam into an overflow channel draining into the pond. The diversion dam is approximately 2 m in width and 30 cm in height and has reversed the role of the two channels. The main channel now flows directly into the north end of the pond.

Beaver-Resistant Access--Adult and juvenile salmonids moving from Fish Creek into the rearing pond must traverse a small beaver dam and pond enrout. The stick dam blocks upstream access at moderate to low flow because water percolates evenly through a broad expanse of the dam. To combat this problem, sticks were removed from a 0.5 m width on top of the dam and two parallel howire fences were constructed through the opening. Each fence extends about 4 m down the outlet channel from the dam and 4 m into the beaver pond. The fences deter beavers from closing the breach in the dam and maintain open access for migrating fish.

Beaver Control Fence--Beavers colonized the coho rearing pond soon after it was filled so precautions were taken to prevent beavers from damming the outlet at the mouth of the fish ladder. A hogwire fence 15 m long and 1.2 m high was installed across the outlet end of the pond about 3 m from the opening to the ladder. The fence does not impede movement of rearing fish but stops beavers moving toward the outlet structure.

Pipe Modification--In 1983, a pipe was laid to divert water from Fish Creek into an intermittent pond. The following winter, high flows rearranged the streambed surrounding the pipe inlet, effectively shutting off pipe flow. This past summer, the pipe inlet was cleared of boulders as part of the backhoe equipment rental. Additionally, a low point in the bank of the pond was filled with rock and dirt to prevent water loss and ensure that the pond outlet structure and trap is the water surface elevation control point.

Gravel Ouantity

Separate estimates of gravel quantity for steelhead trout and chinook salmon in Fish Creek and Wash Creek were made in the fall of 1982. A resurvey of chinook gravels was made in 1984. Since the species spawn at different times of year, different flow levels, and utilize slightly different gravel sizes, each of these variations was taken into account when quantifying m^2 of usable gravel. Only gravels of the correct size in the correct position for spawning and with the proper water depth and velocity at the correct time of year were included for each species.

Perennial Side Channel

The objectives of opening a 200 m side channel were to create rearing and over-wintering habitat for coho salmon (Fig. 5). It was

Figure 5a. Section of sidechannel before excavation.

Figure 5b. Same section of sidechannel after excavation.

necessary to excavate both the inlet and outlet of the abandoned channel. The inlet was located on the inside of a bend in the main channel, and was plugged with rock and debris (Fig. 6a). An opening was excavated and a small (3 m) berm extended into the mainstem channel to deflect low flows into the side channel (Fig. 6b). There was a meter drop in elevation from the side channel outlet to the main channel of Fish Creek. The lower side channel was more gently graded into the mainstem by constructing a series of five 30 cm drop structures with local boulders. It was also necessary to remove an old log jam located approximately midway in the side channel. The jam would have deflected flows out of the channel if left in place. Logs from the jam were to be located along the length of the side channel to add complexity. However, most of the wood was rotten and broke up when the jam was removed.

The project was accomplished with an equipment rental of a backhoe and operator. Work was conducted under the direction of a fisheries biologist. The project took 14 hours and cost $5,280 including planning and administration.

The side channel was surveyed and physically mapped in the fall of 1984. Gradients within the channel were determined with a level and stadia rod, and the surface area and volume of each habitat type within the channel was measured. Spawning use by adult salmonids was noted biweekly and the number of juvenile salmonids rearing in the channel will be determined quarterly beginning in the winter of 1984. A photo record of temporal habitat changes in the channel will also be kept.

Figure 6a. Inlet of side channel before excavation.

Figure 6b. Inlet of side channel after excavation.

Alcove Enhancement

Alcove habitat, or quiet water edge habitat, is an important rearing habitat for coho salmon, and functions as over-wintering habitat. It is created by large structure located along stream margins. We attempted to create alcove habitat by falling whole trees, with root wad attached, into the stream channel. Trees were felled with dynamite. A total of 12 trees were felled over a 2.3 km stream reach (Fig. 7, 8). A team of specialists, including fish biologists, hydrologist, blaster, and forester identified trees to be felled. Trees ranged from 45 to 120 cm in diameter. Sites were selected to minimize potential of bank and sideslope disturbance. Two attempts were made at tree falling. One was a weekend Oregon Army National Guard training exercise. The other involved a four person Forest Service crew, led by a certified blaster.

The National Guard felled six trees, five of which entered the stream channel. Their procedure Included digging out around the root system, cutting large roots and two, three, or four "blasts* to fall a tree (Fig. 9). Shape charges and other "slow" explosives were used for blasting.

The Forest Service crew also felled six trees, and again, five fell into the stream channel. The crew's procedure involved fewer steps. A small charge of 10 to 15 pounds of explosive was set to create a cavity between the root mass and earth. A larger charge of 30 to 45 pounds was employed to fall the tree. Trees took from 2 to 3 hours to fall from start to finish. With fewer blasts, the direction

Figure 7a. Reach of Fish Creek to receive tree before blasting.

Figure 7b. Same reach of Fish Creek with fallen tree after blasting.

Figure 8a. Reach of Fish Creek to receive tree before blasting.

Figure 8b. Same reach of Fish Creek with fallen tree after blasting.

Fig. 9a. (upper left) Ideal root wad resulting from blowdown. Root wad is composed of large and small roots forming one large mass.

9b. (above) Typical root wad after falling trees with dynamite. Only large roots remain.

9c. (lower left) Worst case result from blasting. No roots were left attached to the bole.

of fall seemed more controlable. Cost per tree averaged $300 for the Forest Service crew.

Six reaches that were designated to receive blasted riparian trees were surveyed for physical habitat conditions and fish populations prior to blasting. Reaches averaged 50 m in length. The area and volume of each site was determined, and bottom contours and substrate characteristics were mapped. Fish populations were estimated at minimum summer flow by diver counts. Maps of each site were made so temporal changes In physical habitat could be documented. Changes in fish populations will be assessed at low flow during each subsequent year of the study.

Riparian Revegetation

To promote stream shading in the riparian zone, four acres of streamside were planted with cottonwood, a fast growing deciduous tree. Sites planted were primarily revegetated clearcuts, 10 to 25 years old (Fig. 10). While vegetation along the streams was vigorous, and represented an excellent diversity of decidious and conifers species. stream width and orientation required tall trees for shading. Tall trees were lacking In planted sites. Two year old cottonwoods, 1.5 to 2 m tall, were planted in two rows, 1.8 by 1.8 m spacing, along both stream banks. The trees had large root masses, and it was time consuming to plant. Thirty five hundred trees were planted over the four acres by a four person crew. Total cost of the project was $3,050.

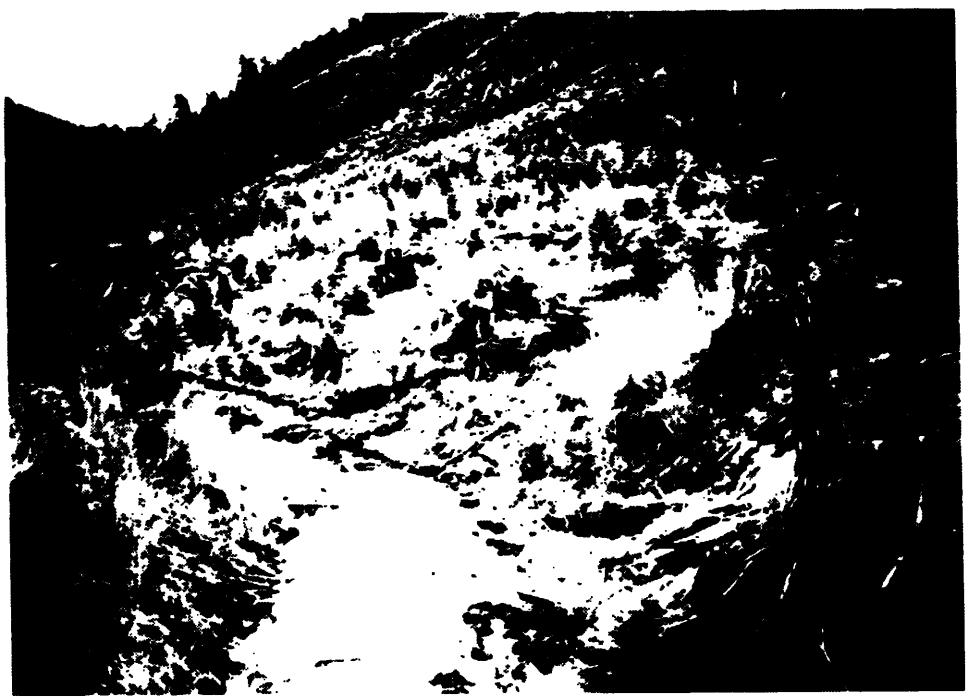


Figure 10. Four acres of riparian habitat were planted with cottonwood seedlings.

A sample of 128 cottonwoods planted In a Wash Creek clearcut was examined In September 1984 for survival, growth, and effect of deer and elk browsing. Growth was measured to the nearest centimeter on the terminal shoot.

Future Habitat Improvement Project Surveys

Three surveys were conducted In the Fish Creek drainage. The purpose of the surveys was to gather information needed in planning and Implementing future habitat improvement projects.

Habitat surveys were conducted on four tributaries of Fish and Wash Creeks. Each of the tributaries is inaccessible to anadromous fish. Three tributaries are blocked by culverts, and one is blocked by a falls. Habitat Information was needed to determine what level of investment could be justified in providing passage over the barriers. Approximately 5.4 km of tributaries were surveyed for $1,240.

Engineering surveys were planned for five potential project sites, either side channel or off channel areas. Sites were prioritized based on project potential and need for engineering data. Only the highest priority slte was surveyed. Due to extensive blowdown on the project site, survey time was extended beyond that planned. Data was collected to produce a one foot contour map using the Forest Service road design system PAL computer programs. A 1.2 ha area was surveyed over three weeks. Total cost for the project was $4,430.

An additional habitat survey was conducted in late fall to identify potential overwintering habitat in lower Fish Creek. During mean hlgh flows, existing and potential refuge areas In the stream channel and outside the channel in the narrow flood plain terrace were identified and mapped. Approximately 7 km were surveyed for a cost of $705.

Trial Construction

Access to the west bank of Fish Creek during high flows is a difficult proposition. A cable car located approximately 4 km upstream from the mouth of Fish Creek was proposed. An analysis of the project by the Estacada Ranger District Identified a number of concerns including public safety, maintenance costs and constructlon costs. An alternatlve was proposed to construct a half mile trail down a steep (70%+) sldeslope from the West Fish Creek road. A District trails specialist was employed to locate and design the trail, and a crew from the Timber Lake Job Corps constructed a minimum specification trail at no cost. Project costs were substantlally reduced from $10,000 to $1,355.

RESULTS

Sumner Distribution of Rearing Juvenile Salmonids In Fish Creek

Chlnook salmon, coho salmon and steelhead trout utilize the Fish Creek basin for rearing. Juvenile chinook and coho salmon rear in the first 5.2 km of the Fish Creek Basin (Fig. 11). Steelhead trout juveniles are distributed throughout the entire 11.8 km of Fish Creek to the falls just above Calico Creek and 6.1 km of Wash Creek to the base of a waterfall. Chinook salmon juveniles begin moving out of Fish Creek by late summer and additional rearing probably occurs In the mainstream Clackamas, three hydropower reservoirs on the Clackamas, and In the Willamette River on their way to the sea. Coho salmon juveniles prefer side channels, alcoves, and quiet pools most of which are located within 5.6 km of the confluence of Fish Creek and the Clackamas River.

Steelhead trout juveniles prefer fast water riffles which constitute the most abundant habltat type in Fish Creek. Young-of-the-year (0+) steelhead trout prefer the low velocity margins of riffles while older steelhead trout (l+) prefer to live and feed in deep swift habitats of boulder riffles.

Fish Creek Physical Habitat--Summer 1982-1984

Riffle habltat made up about 83 percent of the total habitat surface area in Fish Creek In 1982 before the current program of habitat improvement was initiated in the basin. (Fig. 12). Pools made up only 6 percent. The pool to riffle ratio was a low 1:14. Side

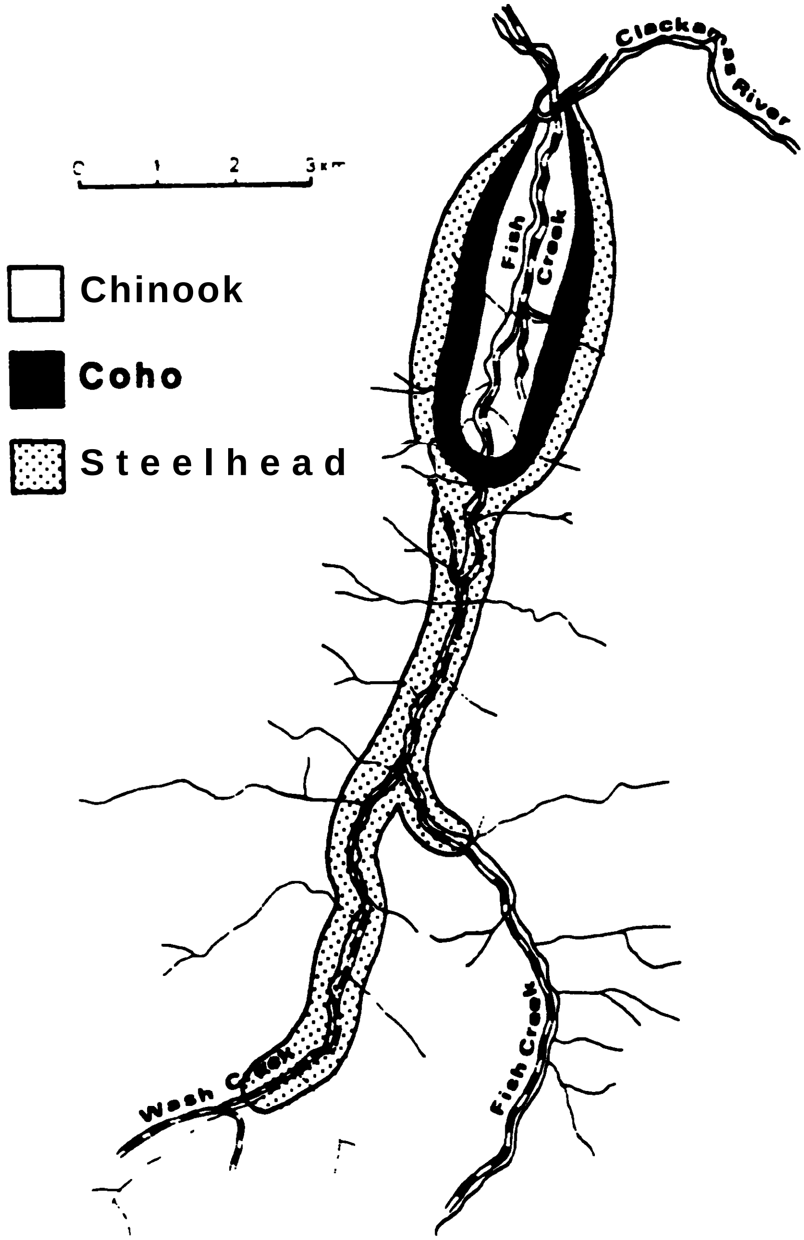


Figure 11. Distribution of juvenile salmonids in Fish Creek.

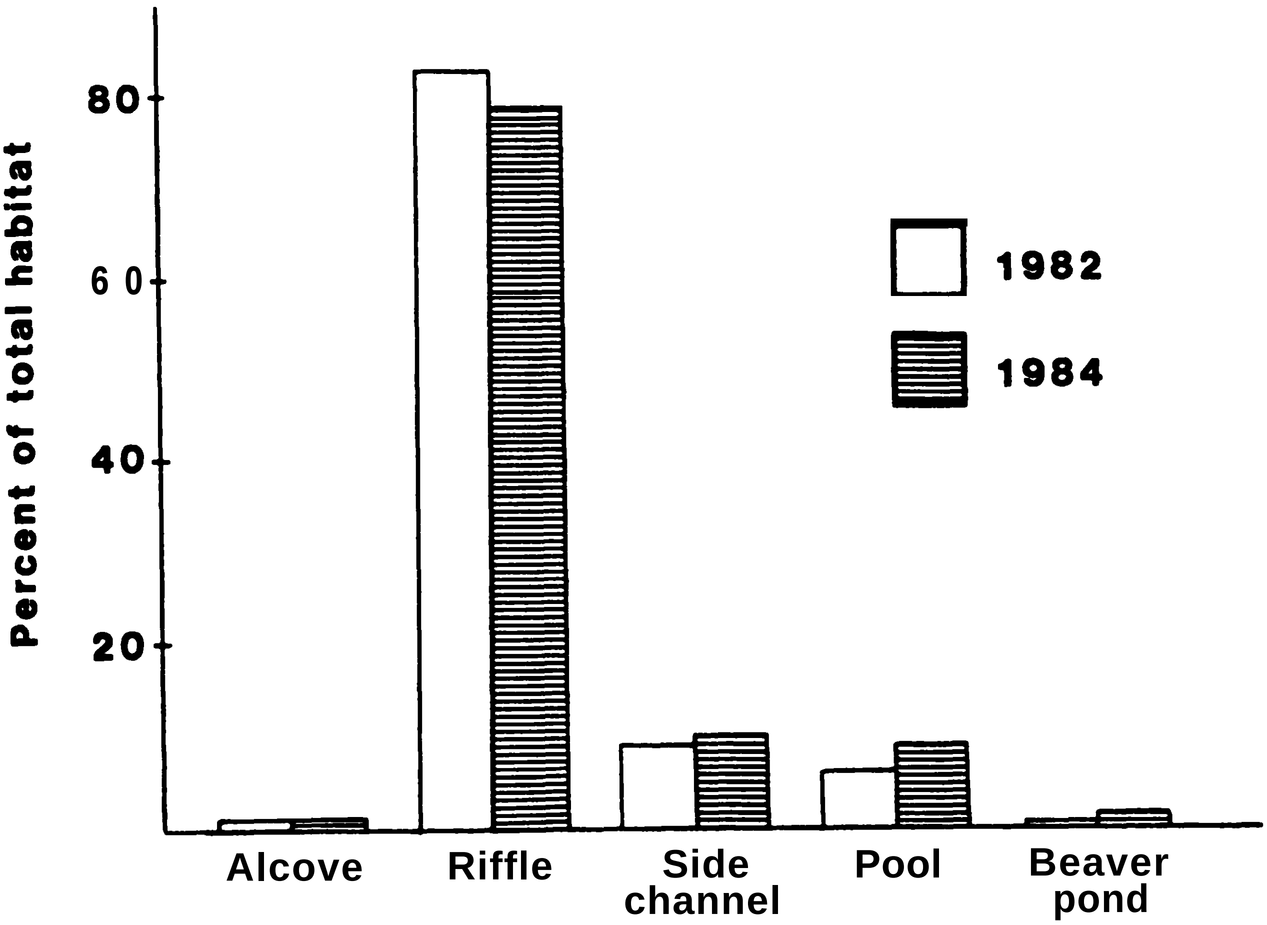


Figure 12. Habitat availability In Fish Creek basin in 1982 before enhancement and in 1984 after two years of enhancement.

channels made up 9 percent, quiet alcoves about 1 percent and a beaver pond on an old channel about 0.3 percent (Fig. 12). Quiet water habitats were scarce in Fish Creek.

Volume of water in the basin reflected the surface area habitat estimates closely (Table 1). Riffles accounted for 82 percent of the volume in the basin, the same as the relative area amount. Pools provided 7 percent of basin volume and side channels about 10 percent. Pools, as expected, accounted for more volume than surface area.

These data accurately described a high gradient stream system with a few deep, fast-moving plunge or scour pools at high water. Side channels were restricted to a few areas in the basin.

The ranking of habitats based on total surface area was unchanged on Fish Creek between 1982 and 1983, however, after construction of boulder berms in late summer of 1983 the area of pools increased substantially. Habltats in decreasing order of abundance were riffle, side channel, pool, alcove, and beaver pond. 1983 was a more abundant water year than 1982 (Table 2) and increased minimum flows in September caused an overall increase in habitat and some changes in the abundance of the 5 habltat types. Total habitat area was increased by 9 percent, from about 338,000 to about 370,000 m^2. The largest increase in wetted surface area, however, occurred in edge habitats and pools (Table 3). Surface area of alcoves, side channels, and beaver ponds at reference sites increased by 34, 27, and 54 percent, respectively. Area of pools at the same reference sites

Table 1. --Area and volume of rearing habitat types in Fish Creek and their associated salmonid densities and biomass.

FISH CREEK. 1982

SPECIES	HABITAT	AREA IN SYSTEH	VOLUME IN SYSTEH	NUMBER FISH ESTIMATE BY HABITAT	BIOMASS (g) FISH ESTIMATE BY HABITAT	$\#/m^2$	g/m^2	$\#/m^3$	g/m^3
COHO	Alcove	949	264	305	1,885	0.30	2.00	1.20	7.10
	Riffle	78,300	21,675	1,951	6,341	0.02	0.10	0.10	0.30
	Sidechannel	11,864	2,643	2,115	14,640	0.20	1.20	0.80	5.50
	Pool	3,796	1,850	131	1,286	0.03	0.30	0.10	0.70
	Beaver pond	192	36	264	1,223	1.40	6.40	1.30	34.0
	Total	95,101	26,468	4,766	20,565				
CHONOOK	Alcove	949	264	9	63	0.01	0.07	0.03	0.24
	Riffle	78,300	21,675	0	0	--		.	--
	Sidechannel	11,864	2,643	0	0	--		--	
	Pool	3,796	1,850	121	557	0.03	0.15	0.07	0.30
	Beaver pond	192	36	0	0	--	--	--	
	Total	95,101	26,468	130	620				
0+STHD	Alcove	3,319	814	1,808	4,119	0.50	1.20	2.20	5.10
	Riffle	282,147	66,716	146,952	432,921	0.50	1.50	2.20	6.50
	Sidechannel	30,411	2,441	32,867	82,934	1.10	2.70	13.50	34.00
	Pool	21,964	11,390	8,082	21,807	0.40	1.00	0.70	1.90
	Beaver pond	192	36	1	8	0.01	0.04	0.03	0.20
	Total	338,093	81,397	189,710	541,795				
1+STHD	Alcove	3,379	814	154	2,815	0.10	0.90	0.20	3.50
	Riffle	282,141	66,716	41,894	769,949	0.20	2.70	0.60	11.50
	Sidechannel	30,411	2,441	4,082	14,556	0.10	2.50	1.70	30.50
	Fool	21,964	11,390	4,028	89,088	0.20	4.10	0.40	7.80
	Beaver pond	192	36	4	40	0.02	0.20	0.10	1.10
	Total	338,093	81,397	50,162	936,508				

Table 2.--Summer rainfall (inches) at North Fork Reservoir, 1982 and 1983. (Doug Cramer, PGE personal conunununication).

	1982	1983	1984
May	3.05	9.40	18.03
June	3.05	13.21	17.27
August	4.32	6.35	0.25
September	11.18	2.79	8.89
October	15.24	6.86	18.29

Table 3.--Changes in wetted area and volume of habitat types at reference sites on Fish Creek and Wash Creek, September 1982 and 1983.

	Volume (m^3)			Area (m^2)		
Habitat Type	1982	1983	% change	1982	1983	% change
Alcove	41	51	+24	152	203	+34
Riffle	116	155	+34	409	439	+7
Side channel	60	96	+60	360	458	+27
Pool	431	606	+41	823	1,182	+44
Beaver Pond	36	124	+344	192	296	+54

increased by 44 percent. Changes in fish populations were associated with changes in habitat area. Total area and volume for each habitat type used by each species in 1983 is listed In Table 4.

Habitat surveys in the summer of 1984 after two summers of habitat enhancement in the Fish Creek basin showed substantial changes In some of the five habitat types (Fig. 12). Construction of boulder berms, a side channel, and an off-channel pond caused the greatest changes. The relative proportions of riffles and pools in the system have changed in favor of pool habitat. Riffles comprised 83 percent of total habitat in 1982, but only 79 percent In 1984. During the same period of time pool area Increased from 6 to 9 percent. These changes were due primarily to construction of boulder berms in 1983. Construction of a side channel in 1984 increased this habitat type from 9 to 10 percent and construction of the off-channel pond in late summer of 1983 Increased "beaver pond" habitat from 0.1 to 1.3 percent of the total habitat in the basin. While the percentage change is small, the changes in absolute area of the habitats are significant. The real increase in pool, side channel, and "beaver pond" habitats, ignoring minor variations in summer sream flow, was about 5,900 m^2, 1,000 m^2, and 4,600 m^2, respectively.

The total habitat area available to rearing salmonids in the summer of 1984 (Table 5) was about 2.5 percent less than in 1983. The difference is attributed to slightly lower minimum stream flow in the summer of 1984. The changes in area and volume of available habitat types at reference sites between 1983 and 1984 are presented in

Table 4. Area and volume of rearing habitat types in Fish Creek used by anadranous fish and their associated salmonid densities and biomass, September, 1983.

SPECIES	HABITAT	AREA IN SYSTEM (m^2)	VOLUME IN SYSTEM (m^3)	ESTIMATED NUMBER OF FISH BY HABITAT	ESTIMATED BIOMASS (g) OF FISH BY HABITAT	#/m^2	g/m^2	#/m^3	g/m^3
COHO	Alcove	1,272	327	433	2,120	0.30	1.90	1.30	6.50
	Riffle	03,180	29,044	3,490	19,395	0.04	0.20	0.10	0.70
	Side channel	15,044	4,229	0,867	25,704	0.60	1.70	2.10	6.10
	Pool	5,420	2,609	1,688	7,168	0.31	1.43	0.65	2.98
	Beaver pond	2 %	124	241	675	0.80	2.30	1.90	5.40
	Total	105,820	36,333	14,719					
CHINOOK	Alcove	1,212	327	9	27	0.01	0.02	0.03	0.08
	Riffle	83,780	29,044	388	1,551	0.005	0.02	0.01	0.05
	Side channel	15,044	4,229	0	0	0	0	0	0
	Pool	5,420	2,609	1,688	7,768	0.31	1.43	0.65	2.98
	Beaver pond	2 %	124	0	0	0	0	0	0
	Total	104,606	35,141	1,218	6,048				
0+ STHD	Alcove	4,527	1,009	1,015	2,841	0.20	0.60	1.00	2.00
	Riffle	301,897	89,399	99,115	217,522	0.30	0.90	1.10	3.10
	Side channel	38,622	3,906	22,210	70,152	0.60	1.80	5.70	18.10
	Fool	31,333	16,059	10,755	35,492	0.34	0.13	0.67	2.21
	Beaver pond	2 %	124	4	13	0.01	—	0.03	—
	Total	376,673	110,497	133,099	386,620				
l+ STHD	Alcove	4,521	1,009	165	4,340	0.04	1.00	0.20	4.30
	Riffle	301,897	89,399	43,670	785,077	0.10	2.60	0.50	8.00
	Side channel	38,622	3,906	3,396	57,732	0.10	1.50	0.90	14.00
	Pool	31,333	16,059	6,165	118,807	0.34	0.13	0.67	2.21
	Beaver pond	2 %	124	0	0	0	0	0	0
	Total	376,673	110,497	53,396	965,956				

Table 5.-- Area and volume of rearing habitat types in Fish Creek used by anadramus salmonids and their associated densities and biomass, September, 1984.

FISH CREEK, 1984

SPECIES	HABITAT	AREA IN SYSTEM (m^2)	VOLUHE IN SYSTEH (m^3)	ESTIMATED NUMBER OF FISH BY HABITAT	ESTIMATED BIOMASS (g) OF FISH BY HABITAT	#/m^2	g/m^2	#/m^3	g/m^3
COHO	Alcove	865	183	505	1,894	0.58	2.19	2.76	10.4
	Riffle	82,942	18,589	4,069	15,666	0.05	0.19	0.05	0.84
	Sidechannel	14,141	3,637	13,587	44,158	0.96	3.12	3.14	12.14
	Pool	4,994	2,635	964	5,736	0.25	1.15	0.19	2.18
	Beaver pond[1]	266	101	591	1,736	2.22	6.58	2.22	17.32
	Total	103,208	25,145	19,716	69,203				
CHINOOK	Alcove	865	183	0	0			--	
	Riffle	82,942	18,589	0	0			--	
	Sidechannel	14,141	3,637	0	0	--	--	--	
	Pool	4,994	2,635	195	2,184	0.04	0.44	0.07	0.83
	Beaver pond[1]	266	101	9	116	0.03	0.44	0.09	1.15
	Total	103,208	25,145	204	2,300				
o+ STHD	Alcove	3,078	565	1,093	2,186	0.36	0.71	1.93	3.87
	Riffle	293,115	55,508	149,522	363,339	0.51	1.24	2.69	6.55
	Sidechannel	36,305	3,359	20,001	51,602	0.55	1.42	5.95	15.36
	Fool	34,158	18,542	9,069	24,124	0.26	0.69	0.49	1.30
	Beaver pond[1]	266	101	0	0	0	0	0	0
	Total	361,522	78,075	179,685	441,251				
1+ STHD	Alcove	3,078	565	156	4,158	0.05	1.55	0.28	8.42
	Riffle	293,115	55,508	42,815	941,920	0.15	3.21	0.77	16.97
	Sidechannel	36,305	3,359	4,958	81,410	0.14	2.24	1.48	24.24
	P001	34,758	18,542	8,113	214,183	0.23	6.16	0.44	11.55
	Beaver pond[1]	266	101	8	260	0.03	0.98	0.08	2.57
	Total	367,522	78,015	56,050	1,242,531				

[1]The off-channel pond has added 4600 m^2 of "beaver pond" habitat to the system.

Table 6. White both habitat areas and volumes were lower In 1984 than in 1983, 1984 figures were still much higher than those observed in 1982.

Table 6.--Changes In wetted area and volume of habitat types at unimproved reference sites on Fish Creek and Wash Creek, September 1983 and 1984.

	Volume (m^3)			Area (m^2)		
Habitat type	1983	1984	% change	1983	1984	% change
Alcove	51	28	-44	203	138	-32
Riffle	155	100	-38	439	445	-3
Side channel	96	83	-14	458	432	-6
Pool	606	614	+16	1,182	1,092	+11
Beaver Pond	124	101	-19	296	266	-10

Salmonid Densities and Biomass--Summer 1982-1984

1982--Steelhead trout were the most abundant salmonid in the basin in 1982. Fish Creek, with its abundance of fast water habitats, is an excellent stream for tearing juvenile steelhead trout.

Juvenile steelhead trout accounted for 98 and 99 percent of the numbers and biomass of salmonids in the basin. respectively. Young-of-the-year (0+) steelhead trout were the most abundant fish numerically. Even though yearling steelhead trout made up less than one-third the number of total salmonids, their biomass accounted for more than one-half the total salmonid biomass (Table 1). Coho salmon were a minor component of the rearing salmonids in Fish Creek, representing about 2 percent of the total salmonid numbers and only about 1 percent of the biomass. Chinook salmon represented less than 0.1% of total salmonid numbers and biomass in the basin.

Young-of-the-year steelhead trout utilized riffles and side channels preferentially. Side channels represented 9 percent of available habitat but 17 percent of the numbers and 15 percent of the biomass of 0+ steelhead trout utilized them. FOF this age group side channels were twice as important as the habitat area would suggest (Fig. 13). Densities of 0+ steelhead trout in side channels averaged 1.1 fish/m^3 (Table 1). Side channels appear to be key habitats for newly emergent steelhead trout.

Yearling and older steelhead trout (1+) were found mostly in riffles (84 percent). On a density basis, 1+ steelhead trout occupied pools and riffles (0.2/m^2) about equally, although larger Individuals of this age group were found primarily at the heads of pools. Since size is an indication of dominance, the largest l+ steelhead trout were found preferentially in these areas (Table 1, Fig. 13).

Coho salmon utilized different habitats than did steelhead trout. Even though 41 percent of the total coho salmon juvenlles were found in riffles (Fig. 14). they were utilizing the margins of the stream and were most abundant in pocket pools on the edge and within

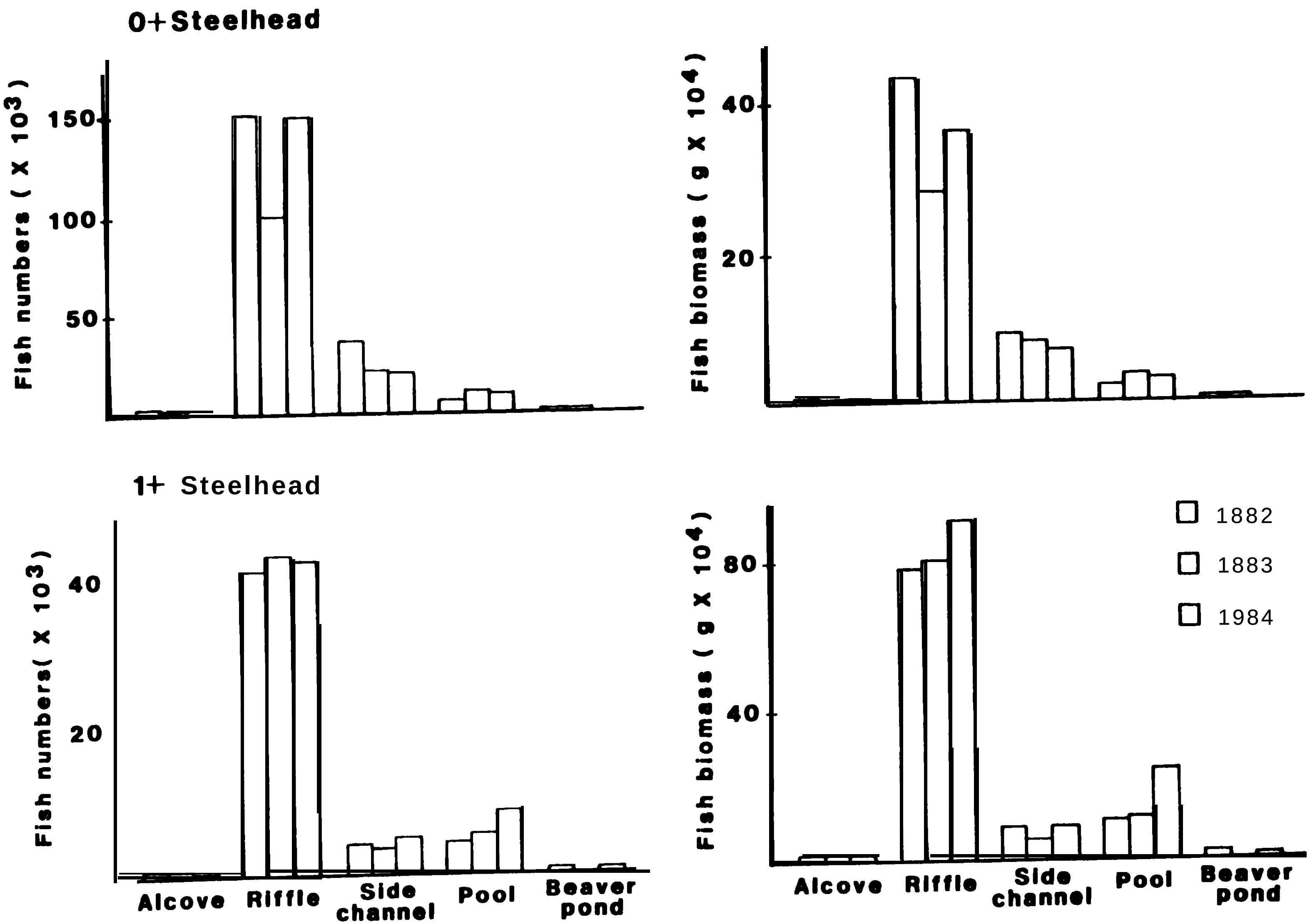


Figure 13. Habitat utilization by juvenile steelhead trout in Fish Creek basin, 1982-1984.

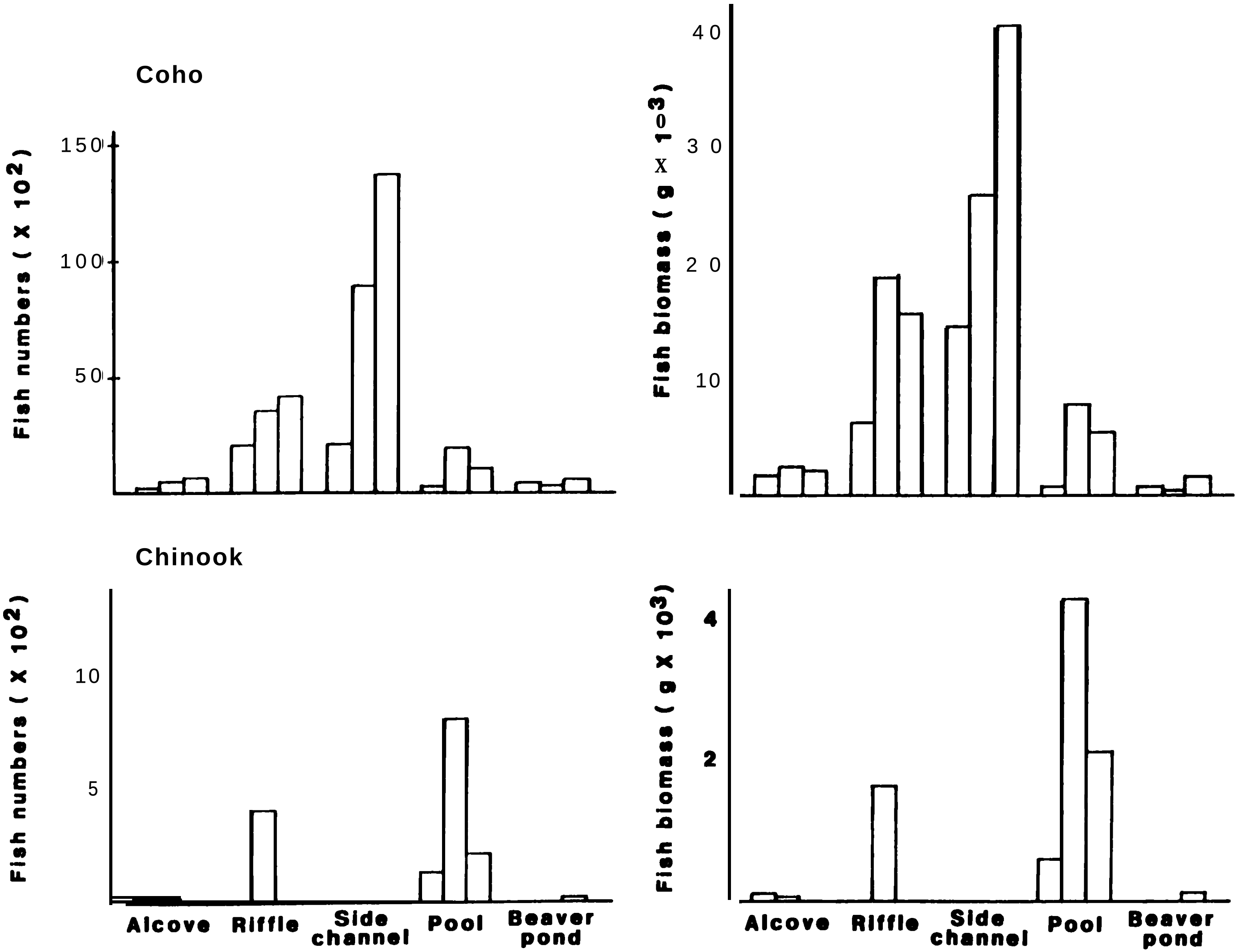


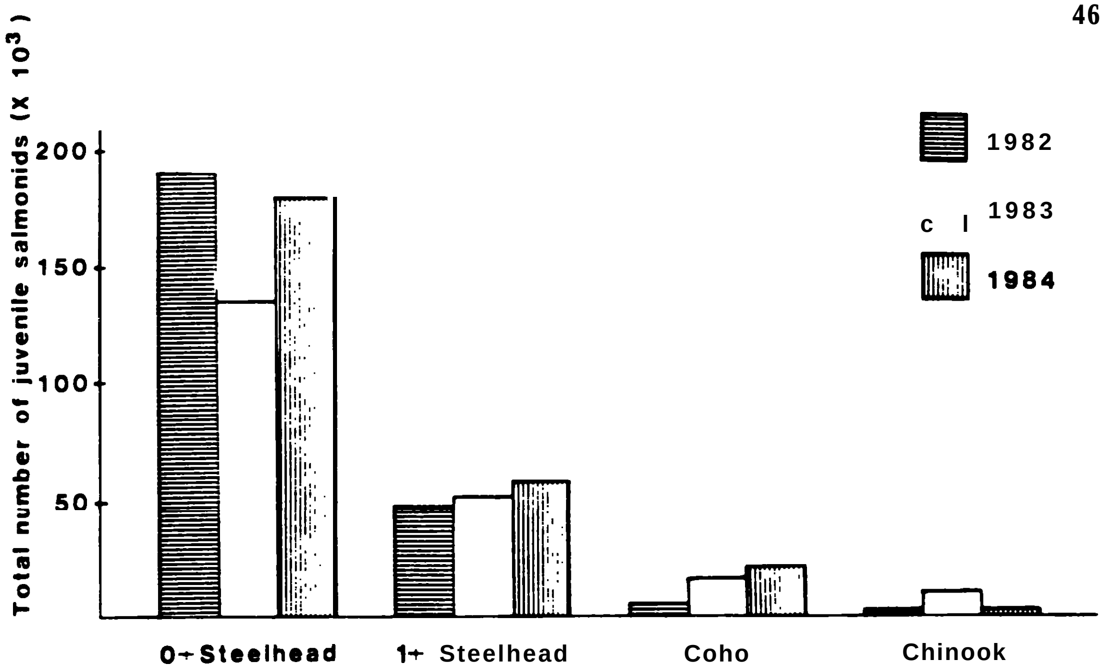
Figure 14. Habitat utilization by juvenile coho and chinook salmon in Fish Creek basin, 1982-1984.

Foot wads OF debris which afforded cover. The biomass of coho in riffles was only 25 percent of the total. This indicates that the smaller individiuals were Occupying less preferred habitat types (Fig. 14). The largest individual coho salmon were found in alcoves and pools (Table 1). The beaver pond which amounted to only 0.3 percent of the total habltat was rearing 6 percent of the total coho salmon and 5 percent of the total coho salmon biomass. The importance of thls habitat type to rearing coho salmon far exceeds Its general availability. Beaver ponds as well as side channels play a disproportionately large role in coho salmon rearing in Fish Creek.

Even in habitats preferred by coho salmon such as alcoves OF side channels, steelhead trout were more numerous than coho salmon by two OF three fold (Table 1). Steelhead trout completely dominated pools and riffles (95 and 97 percent of salmonids, respectively). The beaver pond was almost exclusively the domain of juvenile coho salmon.

The few chlnook salmon observed in the system in 1982 were found almost exclusively In large mainstem pools (Table 1).

<u>1983</u>--Steelhead trout remained the most abundant salmonid in Fish Creek in 1983, but there were significant changes in age-class Strength of steelhead and in total numbers of coho and chinook salmon. The major changes Included a 30 percent reduction (58,000 fish) (Fig. 15, Table 4) in the number of 0+ steelhead trout, a 320 percent increase in the number of coho salmon, and an increase from about one hundred chinook salmon in 1982 to about 1200 in 1983.



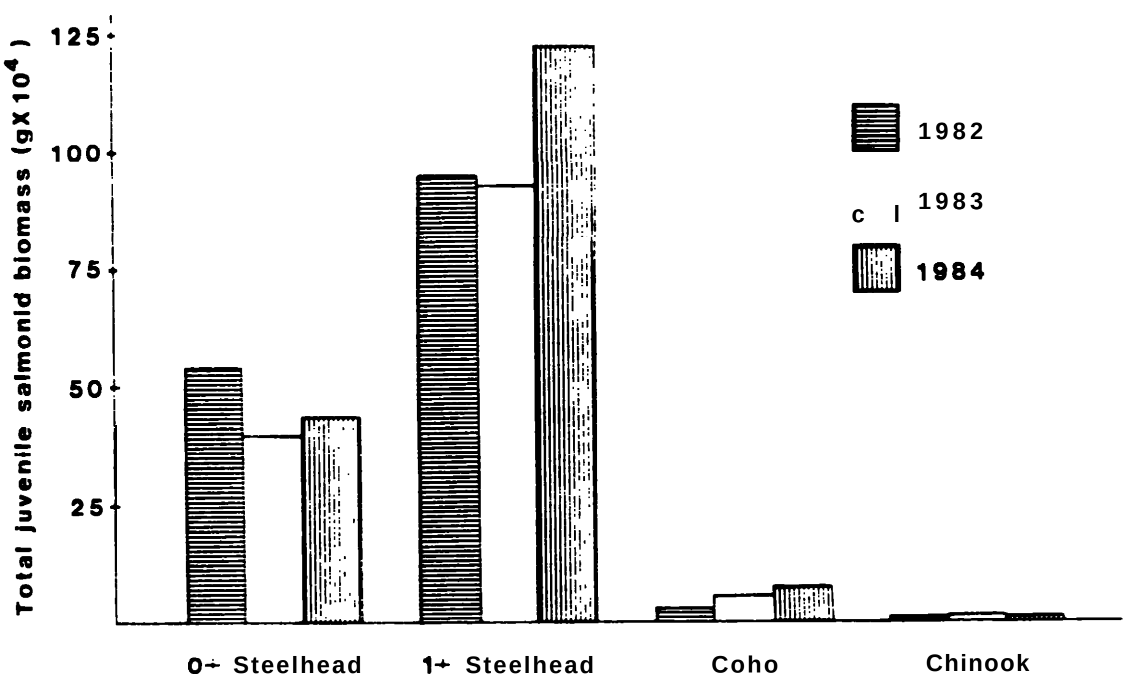


Figure 15. Estimated numbers and biomass of juvenile salmonids in Fish Creek basin, 1982-1984.

The decrease in the population of 0+ steelhead trout in 1983 can be attributed to three possible factors. The adult run of steelhead trout over N. Fork Dam on the Clackamas was 15 percent lower in 1982-83 than in 1981-82. The reduction in parent run size for 1983 0+ progeny could have resulted in a 15 percent reduction in egg deposition and fry production in Fish Creek and account for approximately half of the observed decrease. Second, the largest decrease in numbers of rearing 0+ steelhead trout occurred in riffles (Fig. 13). In 1982 about 147,000 0+ steelhead trout were rearing in the margins of mainstem riffles of Fish Creek and Wash Creek. In 1983 only about 99,000 were estimated to be using these same habitats. It seems probable that increased low flows in 1983 are partially responsible for the decrease. The steep boulder riffles of the mainstem are a strenous environment for 0+ steelhead trout and suitable living space in riffles is directly related to conditions at the margin. Lower stream flows provide more quiet water marginal habltat in riffles suitable for 0+ steelhead trout, while increased flows provide more high velocity habitat for 1+ fish. Third, the favored habitat for 0+ steelhead trout, side channels, increased by about 27 percent in 1983, but use of this habitat by coho salmon Increased by more than 300 percent (Fig. 14). Since juvenile coho salmon are larger and more aggressive than 0+ steelhead trout, competition for space in side channels in 1983 might have reduced 0+ steelhead trout numbers there. Together these factors could easily account for a 30 percent reduction in 0+ numbers in 1983.

The pattern of habitat use by 1+ steelhead trout in 1983 was similar to that observed in 1982. Riffle habitats favored by this age group increased in area by 7 percent in 1983 and fish numbers increased by about 5 percent. In both years about 82-83 percent of the 1+ steelhead trout were rearing in riffles and 10-11 percent at the head of pools (Fig. 13).

Coho salmon juveniles were far more abundant in Fish Creek in 1983 (15,000) than in 1982 (5,000). Much of the difference might be related to escapement. The parent run in 1982 consisted of 1280 coho salmon counted over N. Fork Dam; in 1983 2,949 fish were counted over the dam. Seeding increase alone could account for more than two-thirds of the observed increase in coho salmon, but favored rearing habitats also increased significantly. Side channels increased 27 percent in area, but the number of coho salmon rearing in side channels increased by a factor of four. Significantly larger numbers of coho salmon were also found in mainstem pools and riffle margins in lower Fish Creek in 1983 (Fig. 14). It appears that as favored edge habitats (side channels, alcoves, and beaver enhanced side channels) reached carrying capacity for juvenile coho salmon, excess fish moved into less favored riffle margins and pools where few fish were found in 1982.

Few chinook salmon reared in Fish Creek in 1982 but a large parent run resulted in more than 1,200 rearing there in 1983 (Fig. 14). Higher minimum flows in 1983 might also have induced more chinook salmon to remain in Fish Creek rather than migrate to the Clackamas.

Favored habitats for chinook salmon were large mainstem pools in lower Fish Creek.

1984--There were significant changes In fish populations again In 1984 (Table 5). The number of age Ot steelhead trout Increased by about 48,000 fish while the numbers of age 1+ flsh Increased by about 3,000 fish. Coho salmon numbers increased by 4,400 fish and chinook salmon numbers were down by about 1,000 fish (Table 5).

The Increase In the population of 0+ steelhead trout in 1984 can be attrlbuted to an increased escapement of spawnlng adults, and a decrease in mlnlmum summer stream flow. Counts of adult steelhead trout at N. Fork Dam were about 8,000 fish higher in 1983-84 than in 1982-83 and could account for a large percentage of the change. Also, riffle margins provided more ideal habitat in 1984 because of reduced summer stream flows. Quiet water margins of riffles are preferred habitat of Ot flsh and the numbers using this habltat type were 50,000 flsh hlgher In 1984 than In 1983. Use of all other habitat remained fairly constant (Fig. 13).

Habitat utlllzatlon by age 1+ steelhead trout In 1984 was changed slightly from that observed in 1982 and 1983 (Fig. 13). A larger percentage (17 percent) were rearing in pools in 1984 than 1982 or 1983 (10-11 percent) partly due to increased pool habitat created by construction of boulder berms (Sedell et al. in press). Swlft, deep bouldery rlffles produced the most l+ steelhead trout in all years.

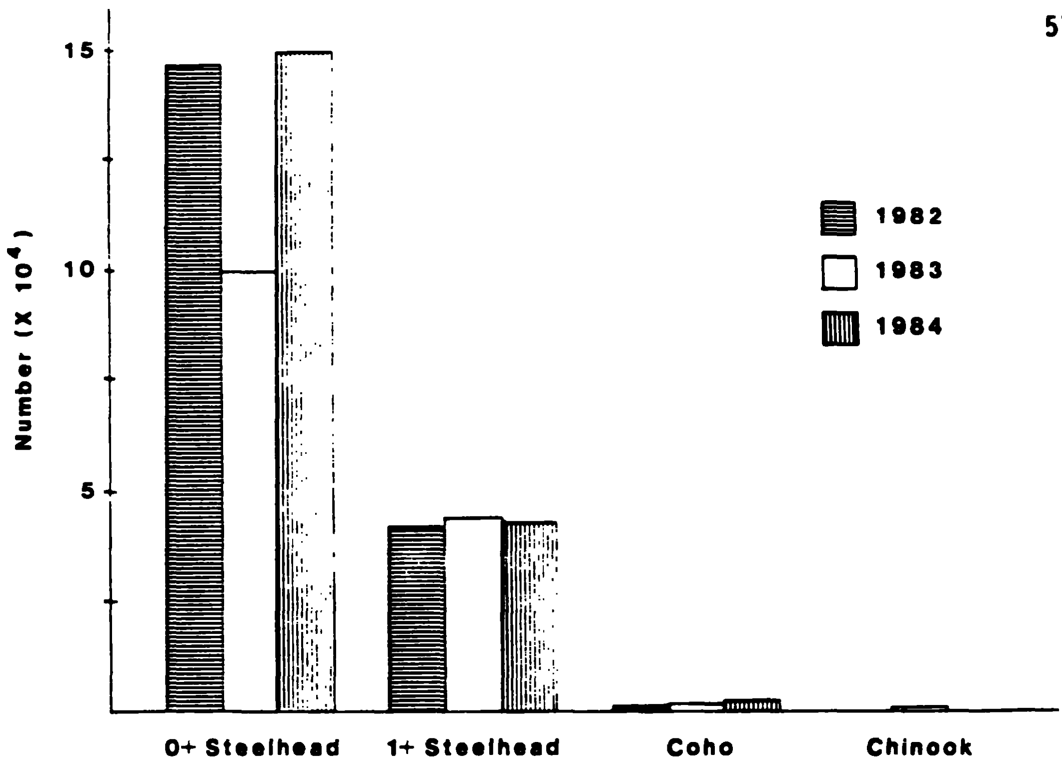
The 29 percent Increase In coho salmon numbers is probably directly related to Increased seediny in the basin. The number of coho salmon adults observed spawning In the Fish Creek basin in 1984 was the highest of the 1982-1984 period. Side channels, beaver ponds, and complex stream margins continued to be the most productive habitats for coho salmon (Fig. 14).

Salmonid Utilization of Different Habitats in Fish Creek summer 1982-84

Riffle Habitats--Salmonid numbers in riffles are dominated by 0+ steelhead trout (77, 68, and 83 percent respectively In 1982, 1983, and 1984) and more than two-thirds of the salmonid biomass consisted of 1+ steelhead trout (Fig. 15). The main differences In salmonid utilization of riffles between 1982, 1983, and 1984 were the high variabillty of numbers of 0+ steelhead trout and chlnook salmon, and a consistent increase In coho salmon numbers.

Pool Habitats--Steelhead trout dominate both biomass and numbers of salmonlds In the pools of Flsh Creek (Fig. 16). In 1982 Ot steelhead trout accounted for two-thlrds of salmonid numbers but decreased to one-half of the total in 1983 and 1984. The main difference was the increased number of coho salmon and chinook salmon juveniles and l+ steelhead trout juveniles in 1983 and in 1984. Nearly 80 percent of the salmonid blomass in pools In 1982 was 1+ steelhead trout (Flg. 16). In 1983, l+ steelhead trout accounted for two-thirds of the salmonid biomass.

Slde Channels--The area of side channels was about 20 percent larger in 1983 and 1984 than in 1982. Coho salmon responded to this habitat expansion in terms of absolute numbers as well as making up a



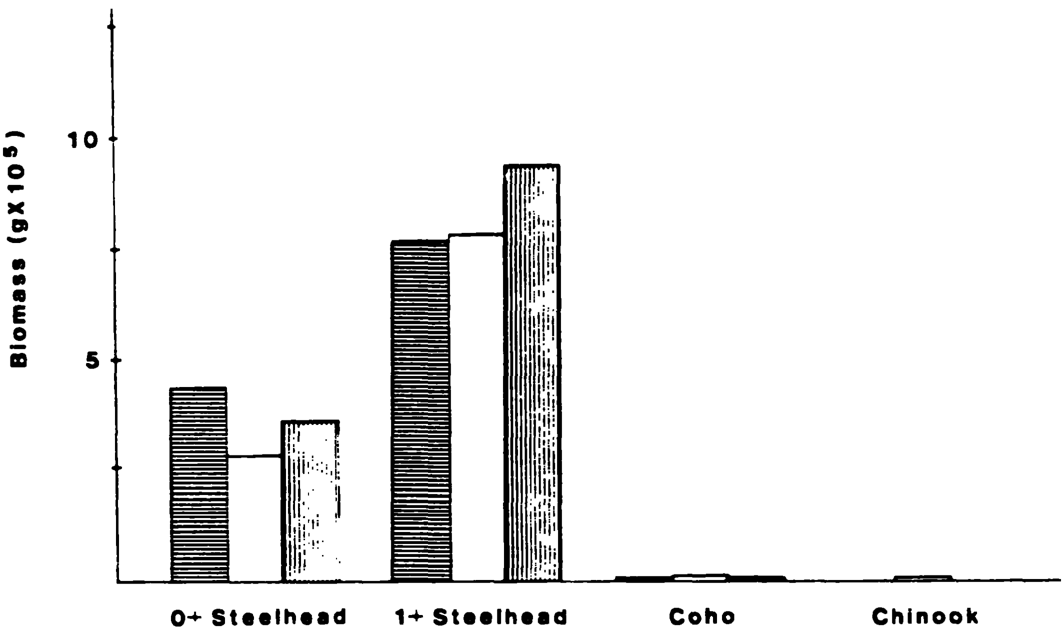


Figure 15. Partitioning of salmonid species, age-class numbers, and biomass in riffle habitats.

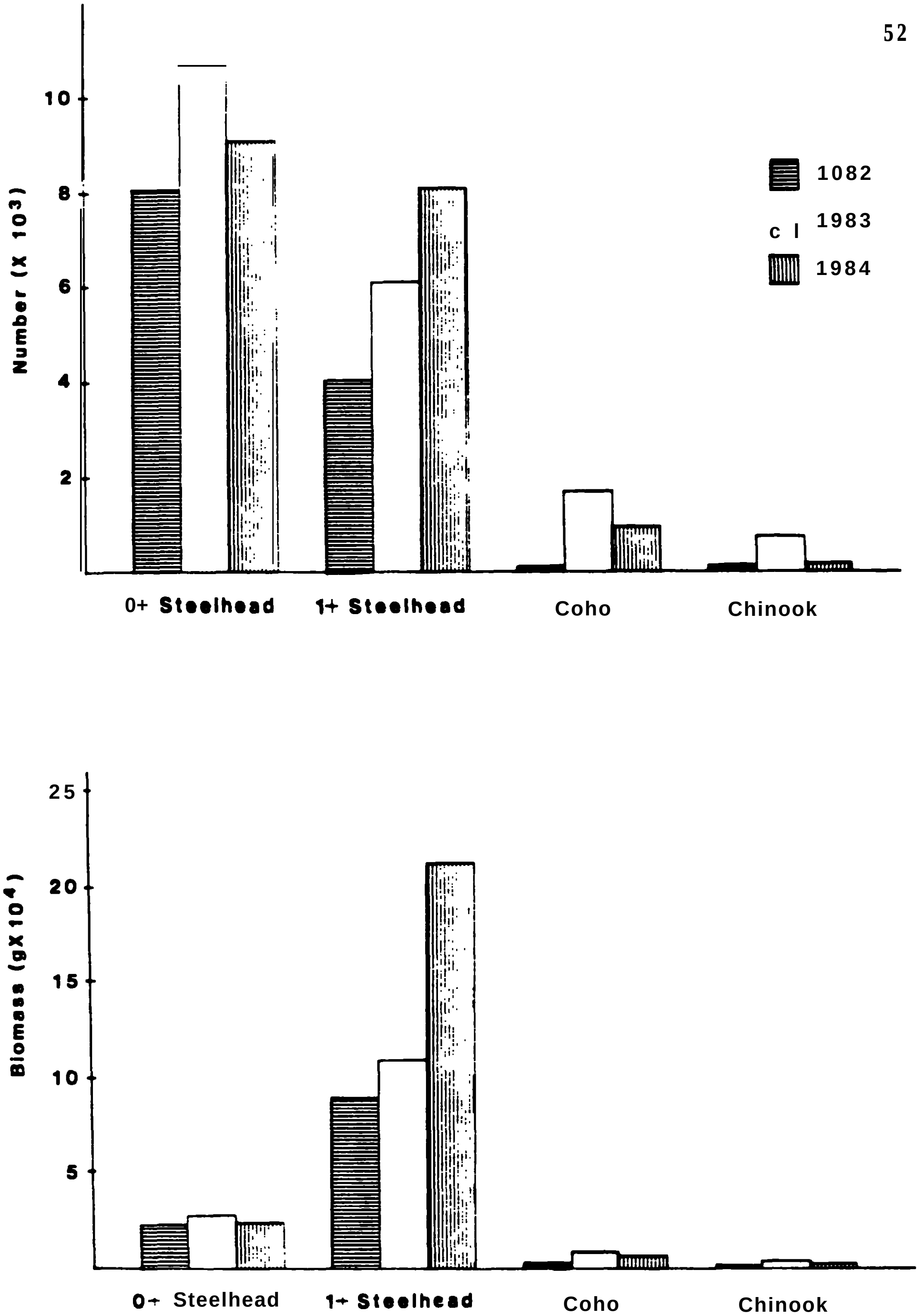


Figure 16. Partitioning of salmonld species, age-class numbers, and biomass In pool habitats.

greater proportion of the salmonid population rearing in side channels (Fig. 17). This habitat type was still dominated by 0+ steelhead trout in 1983 and 1984. On wet summers such as occurred In 1983 and 1984, when the side channels contain water throughout the dry season, rearing coho salmon are selecting this edge habitat. The biomass of salmonids in side channels reflects the increase in coho salmon, but side channels are still dominated by about equal biomasses of l+ and 0+ steelhead trout (Fig. 17).

Alcoves--The edge pools formed around boulders, wood debris and root wads also experienced proportional increases in coho salmon numbers and blomass in 1983 and 1984. Coho represented 27 and 29 percent of the salmonids in alcoves in 1983 and 1984, respectively (Fig. 18) and 0+ steelhead trout fell from 80 percent in 1982 to about 63 percent in 1983 and 1984. Age l+ steelhead trout represented 47 percent of the biomass in alcoves in 1982, 47 percent in 1983, and 54 percent in 1984. The biomass of coho salmon did not proportionately increase (Fig. 18).

Beaver pond--The beaver ponded side channel continued to be the domain of juvenile coho salmon in 1983 and 1984. More than 82 percent of both salmonid numbers and biomass in this habitat was composed of coho salmon juveniles (Fig. 19).

In summary we saw little shift in the utilization of habitat types by different ages and species of salmonids. Proportions of a given species changed within a habitat more on the basis of absolute increases OF decreases in population size rather than a major shift in

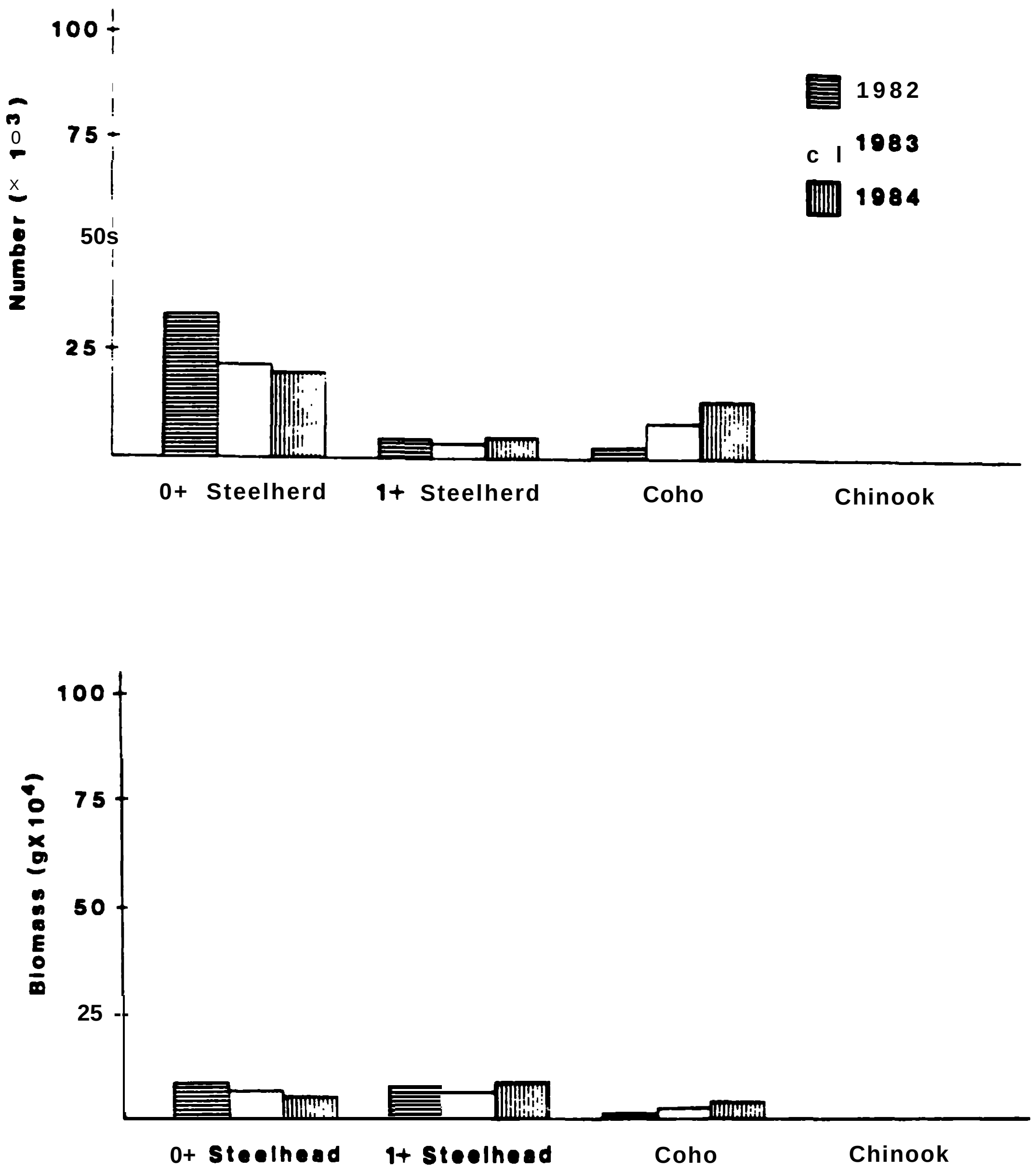
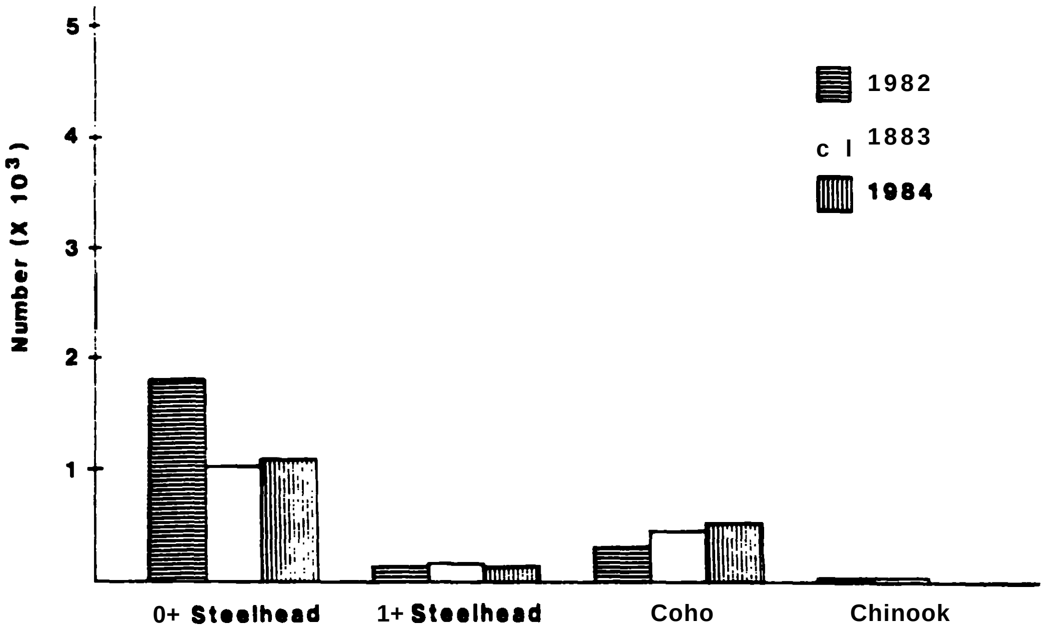


Figure 17. Partitioning of salmonid species, age-class numbers, and biomass in side channel habitats.



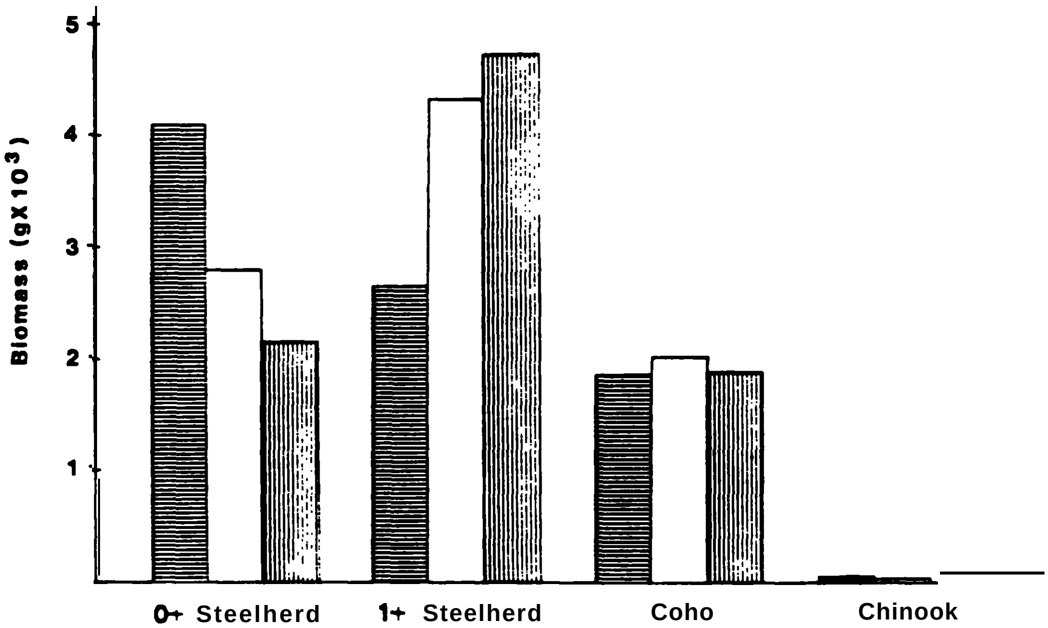


Figure 18. partitioning of salmonid species, age-class numbers, and biomass in alcove habitats

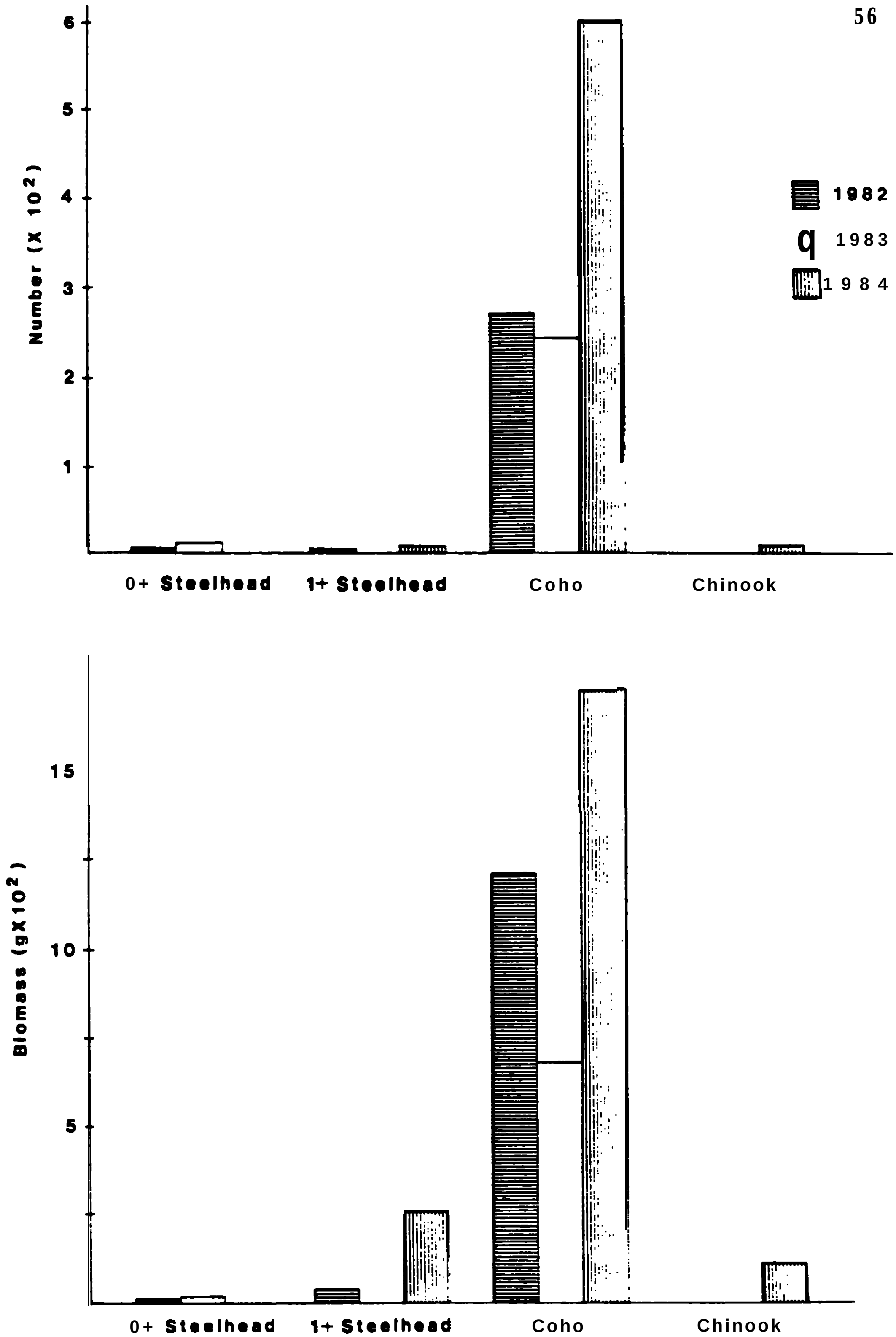


Figure 19. Partitioning of salmonid species, age class-numbers, and biomass in beaver pond habitats.

habitat preference. Coho salmon junveniles increased in numbers and occupied quiet water in edge habitats.

Observations on Winter Habitat Use bv Juvenile Anadromous Salmonids in Fish Creek.

on February 19, 1985, two divers made observations of winter habitat use and behavior of juvenile anadromous salmonids in the mid-basin area of Fish Creek adjacent to the off-channel pond. Careful observations in a 200 m reach of the mainstem revealed no evidence of fish of any species in a variety of riffle, pool, and alcove habitats containing undercut banks and large woody debris. The water temperature was about 3^{o} C. Two age l+ steelhead were subsequently exhumed from the substrate by turning aggregations of loose cobbles at selected locations. About 30 active coho and one 0+ steelhead were found in small side channels leading to and from a natural beaver pond.

Quantitative observatioins on salmonid winter habitat use were made between February 25 and March 1, 1985. Snorkeling observations and electrofishing were conducted at several locations on Fish Creek and Wash Creek. A variety of habitats was sampled, including several in close proximity to the Wash Creek and Fish Creek boulder berms. Habitat types, areas, and densities of fish observed are summarized in Table 7.

Table 7. Habitat type, area, and density of steelhead in winter habitats on Fish Creek and Wash Creek.

		Steelhead			
	Area	Age 0+		Age 1+	
Habitat type	sampled (m^2)	Number	Density/m*	Number	Density/m*
Boulder-cobble alcove	11.2	26	(2.3)	0	(0.0)
Boulder-cobble alcove	5.4	7	(1.3)	1	(0.2)
Boulder-cobble riffle margin	58.5	62	(1.1)	3	(0.1)
Embedded boulder-cobble riffle margin	14.0	1	(0.1)	0	(0.0)
Boulder-cobble riffle margin w/wood	4.0	4	(1 | W	0	(0.0)
Root wad on gravel	2.5	2	(0.8)	1	(0.4)
Undercut banks	10.0	4	(0.4)	0	(0.0)
Spring fed side channel	8.0	6	(0.8)	0	(0.0)
Berm-bank interface	10.0	26	(2.6)	8	(0.8)
Berm borrow area	20.0	2	(0.1)	0	(0.0)
Pool under log jam	8.0	0	(0.0)	0	(0.0)
	151.5	140	(0.9)	13	(0.1)

Several important findings resulted from this work. At no time between February 19 and March 1, 1985, were fish observed in the water column in any habitats in mainstem Fish or Wash Creek. The water temperature ranged from 2.8 to 3.8° C. during this period. Both juvenile steelhead and coho were found hiding in the substrate in a variety of mainstem habitats. The general characteristics of winter habitat consisted of large cobble and boulder substrate with or without woody cover, a minimum water depth of about 25-30 cm, and water velocity near zero. The best habitats had large interstitial spaces within the boulder-cobble complex.

A total of about 150 m^2 of habitat was intensively investigated. It became immediately apparent that densities of steelhead in favorable winter habitat were much higher than those observed in favorable summer habitats. Maximum densities of age 0+ steelhead exceeded 3 fish/m^2 in some winter habitats while the maximum density observed the previous summer was 0.55 fish/m^2 in side channels. A similar relationship was observed for age l+ steelhead. Densities reached one fish/m^2 in some winter habitats while the maximum observed summer habitat densities reached 0.23/m^2 In pools. These observations indicate that juvenile steelhead actively seek suitable winter habitat and concentrate in the most favorable habitats.

The amount of suitable winter habitat in the system appears to be quite small. Our observations are based on a small sample, but it appears that as little as 10 percent of the total surface area of the

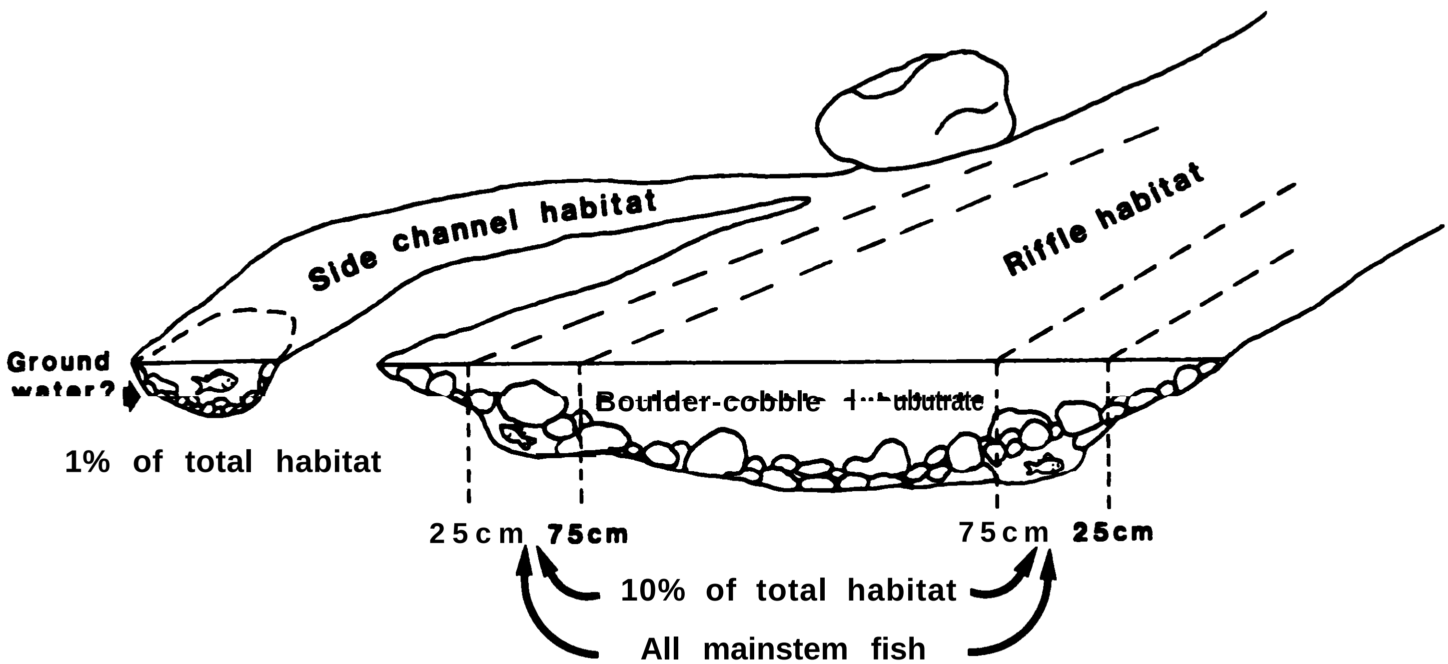


Figure 20. Salmonid winter habitat use in Fish Creek (temperature < 4°C).

mainstem may actually be suitable winter habitat. The best habitat generally occurs in a narrow strip along each margin of the stream (Fig. 20)

Some habitat manipulations designed to improve spawning habitat appear to have had a negative impact on winter habitat. Boulder berms designed to improve spawning habitat for salmonids were built from rubble and boulders removed from the streambed. The density of juvenile steelhead wintering in areas from which rubble was borrowed was less than one-tenth that observed in nearby undisturbed areas (Fig. 21). The berms did create a small amount of exceptional winter habitat where large boulders were piled at the ends of each berm to minimize bank erosion. The net effect, however, appears to be a substantial loss of winter habitat. About 5 m^2 of winter habitat at each berm site was improved by construction while about 50 m^2 was degraded.

The ratio of age 0+ to age l+ steelhead appeared to change significantly between September 1984 and February 1985. In September the ratio of 0+ to l+ steelhead averaged about 6:l in Fish Creek and nearly 1:1 in Wash Creek. By February the ratio had increased to 14:l in Fish Creek and 6:l in Wash Creek. These data are difficult to interpret without more information, but at least three possibilities occured to us: 1) age l+ fish suffer higher winter mortality that age 0+ fish, 2) there is a fall emigaration of age 1+ fish from the system, or 3) our limited surveys in 1985 failed to find the preferred winter habitat of age l+ fish. Additional observations in the winter of 1985-86 will be needed to clarify these possibilities.

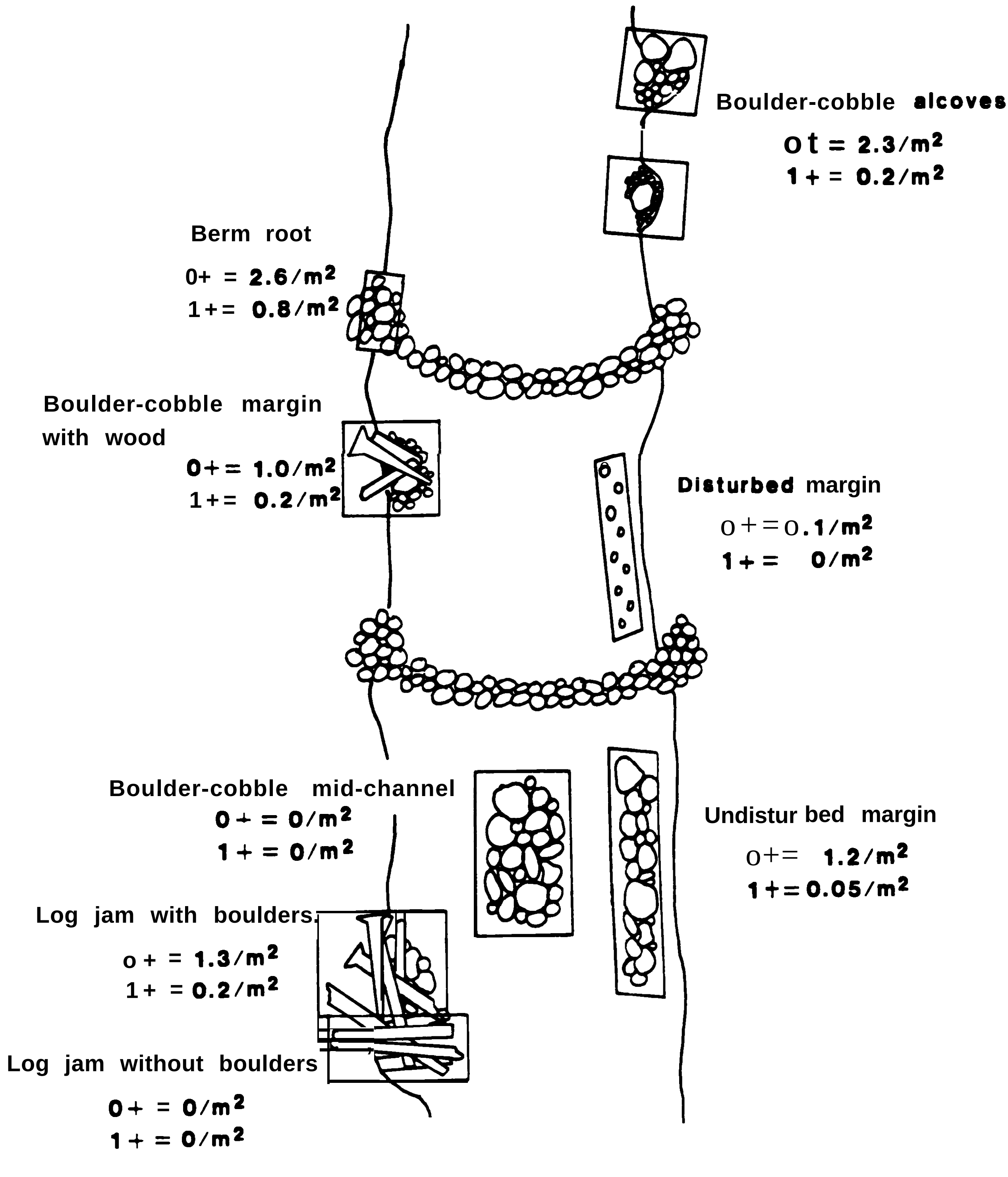


Figure 21. Steelhead winter habitat use in Fish Creek and Wash Creek.

Large Woody Debris In Fish Creek Basin

Wood debris, an important component of fish habitat, has been greatly diminished in Fish Creek from repeated stream salvage sales following the 1964 storm of record. Over 30 percent of the total wood presently occurring in the floodable channel was brought in by the ice and wind storm of Christmas 1983 .

Fish Creek was arbitrarily divided into four sections for an inventory of woody debris in the channel: (1) a lower reach consisting of 26.0 km^2 and 6.6 km of anadromous fish bearing stream; (2) a middle reach of 21.9 km^2 and 2.7 km of anadromous fish bearing stream; (3) Upper Fish Creek 37.5 km^2 and only 1.6 km of anadromous fish bearing stream; and (4) Wash Creek 36.0 km^2 and 4.7 km of anadromous fish bearing streams (Fig. 22). Table 8 summarizes the quantities of wood in each part of the basin.

The lower section of Fish Creek contained 37 percent of the total wood found in the basin accessible to anadromous fish. Thirty percent of the wood found in the channels used by anadromous fish was in the lower part of the basin. The middle reach of stream contained 17 percent of the pieces of wood in the basin. The 247 pieces of wood found in this 2.7 km reach of Fish Creek represented the highest density found in the areas sampled. The volume per piece was low, however, reflecting the small length of the pieces found. No clumps of wood were found in this section. The lack of debris jams on the sides of the channel reflect the canyon-like section of stream found in the middle reach. Upper Fish Creek had the lowest amounts of wood (11 percent) in terms of total volume of

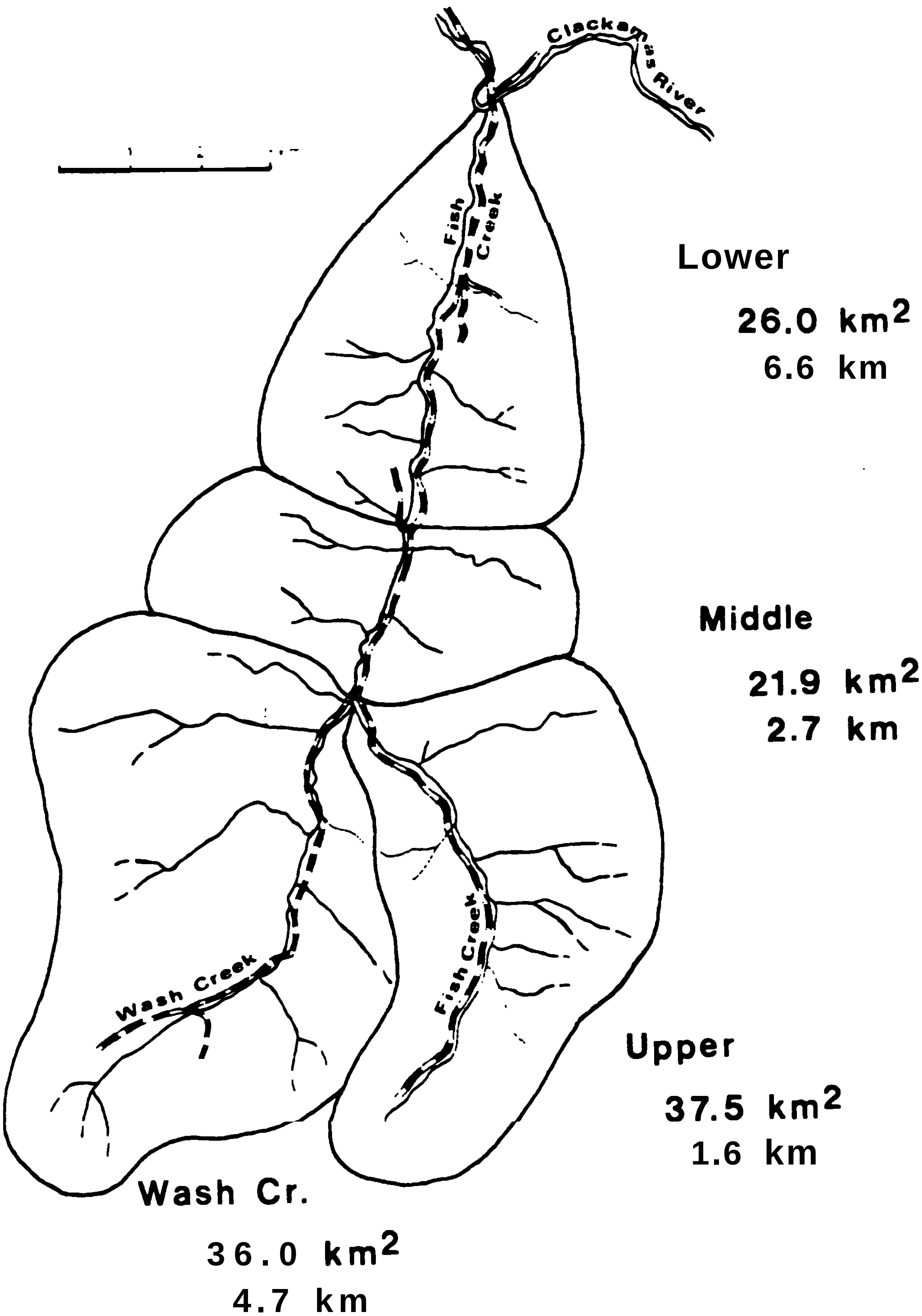


Figure 22. Watershed area and length of stream accessible to anadromous fish, Fish Creek basin.

Table 8.--Fish Creek Wood Debris 1984

	Pieces				Clumps or wing jams			
Section	#	#/100 m	Board feet	% of total board feet in system	#	#/100 m	Board Feet	% of total board feet in system
Lower (6641 m)	206	3.1	225,000	30	18	0.3	52,300	7
Middle (2734 m)	241	9.0	123,000	17	0	0	0	0
Upper (1600 ml	104	6.5	51,500	7	8	0.5	32,300	4
Wash (4296 m)	177	4.1	102,000	13	27	0.6	184,000	24
Basin Total	723	4.8	507,500	65	53	0.4	268,500	35

Total board feet = 776,000

the four sections surveyed. The density of pieces and clumps per 100 m channel, however, was high for this basin. Wash Creek had 37 percent of the total wood surveyed. The 27 debris clumps or jams in this section represented over two-thirds of all of the volume found in clumps within the basin and represented 24 percent of total wood volume in the basin. The wood clumps have created large amounts of spawning gravel and some excellent winter habitat.

The length and diameter frequency of individual pieces of wood was highly variable throughout the Fish Creek basin (Fig. 23 and Fig. 24). There were significant differences between mean lengths and diameters of large woody debris in the four different sections of the basin.

Wash Creek had the largest mean diameter of pieces at 0.59 m (standard deviation (SD) = 0.24) and these pieces had an average length of 8.1 m (SD = 5.23). The average length was the smallest in the Fish Creek basin and probably reflects both the smaller drainage area and steep side slopes which result in severe breakage when a tree falls. Smaller stream discharges In Wash Creek allow smaller pieces to remain in place longer, or take a larger storm to move. There were 27 clumps of wood in the Wash Creek anadromous fish reach. The mean volume of each clump (jam) was 32.1 m^3 (SD = 82.8) the highest average volume of clumps in the basin. There was one clump containing over 440 m^3 of wood and several containing 60-80 m^3, but most clumps contained 9-15 m^3.

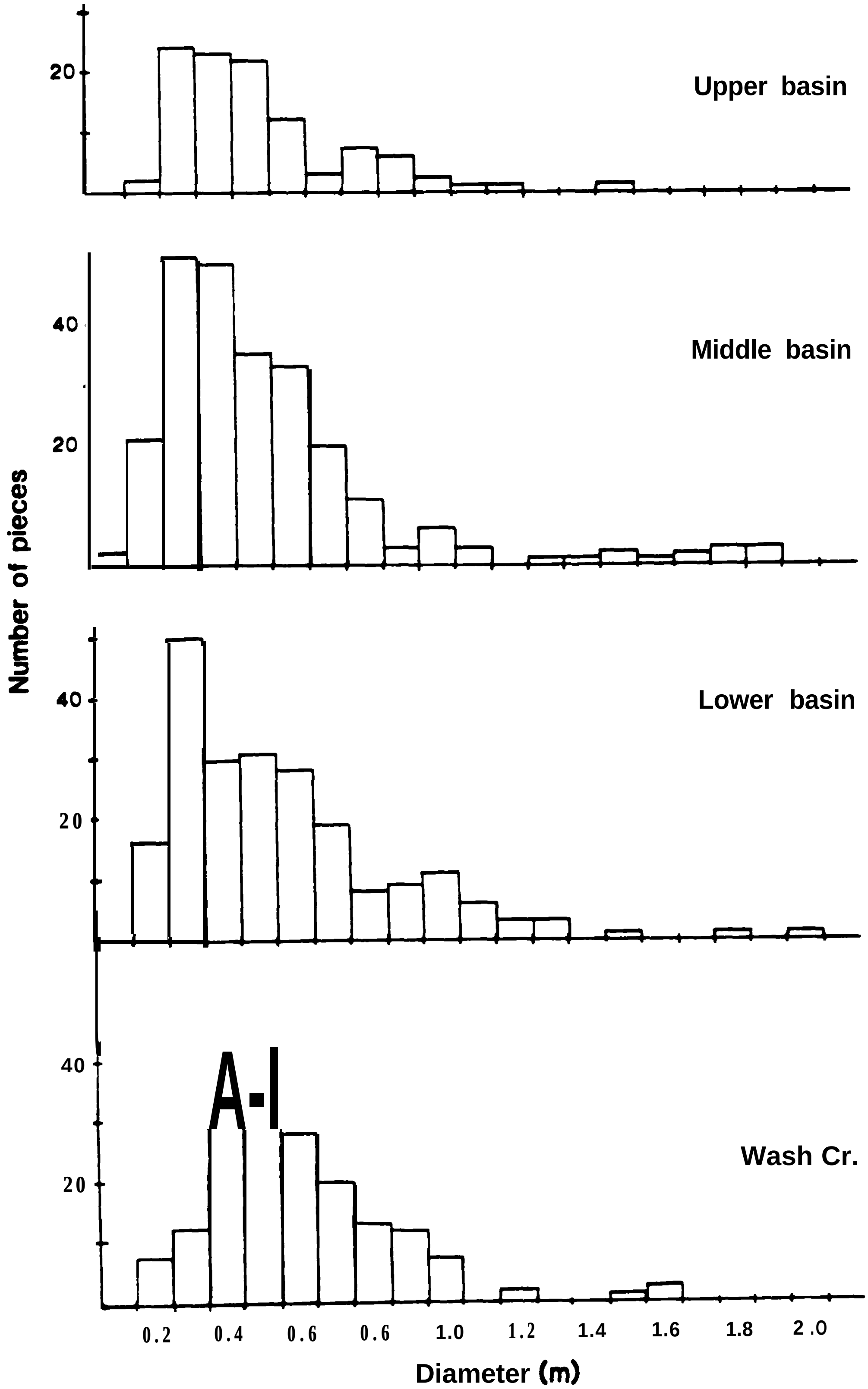


Figure 23. Diameter frequency of individual pieces of wood in Fish Creek basin.

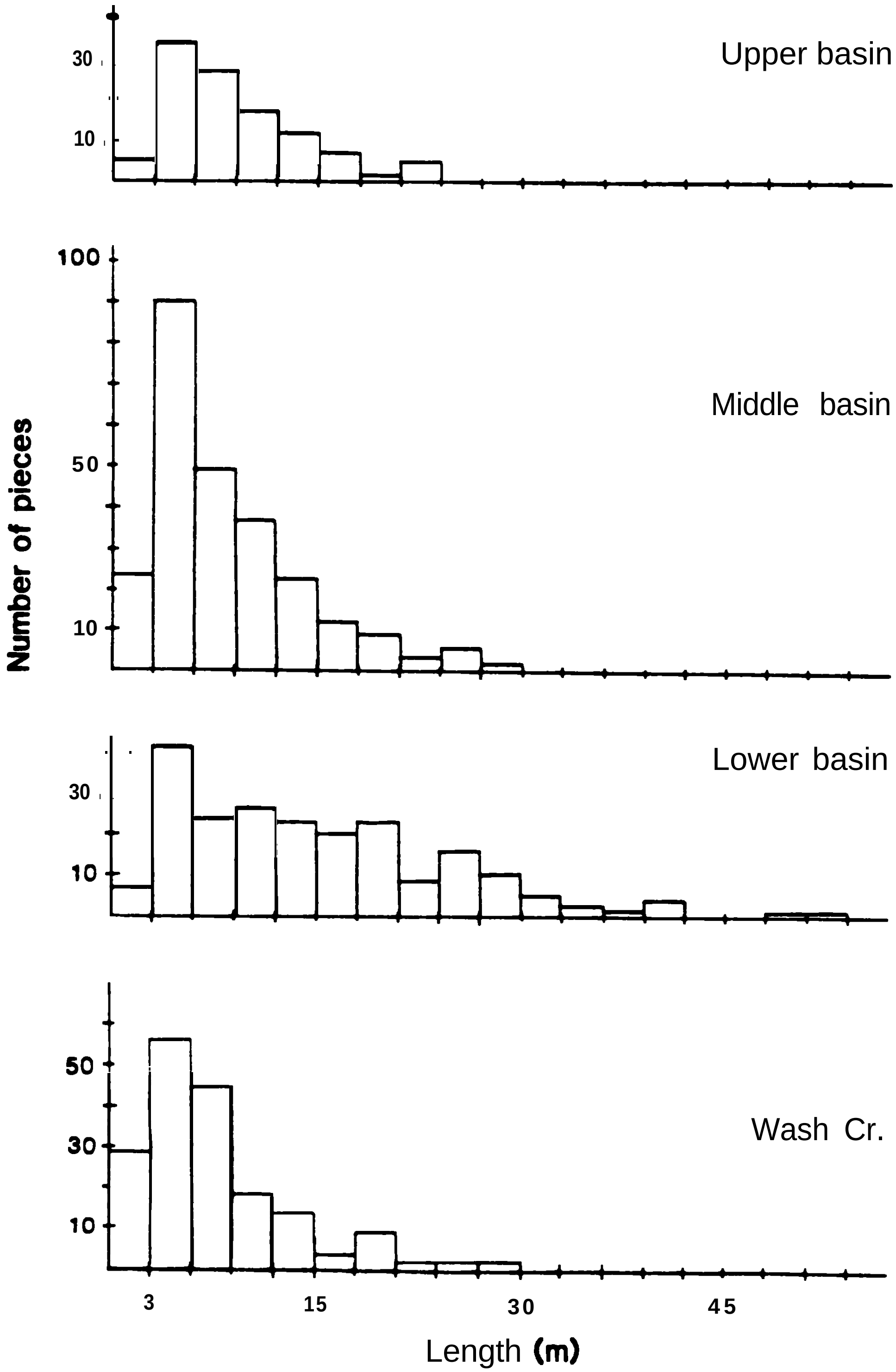


Fig. 24. Length frequency of individual pieces of wood in Fish Creek basin.

Individual wood pieces in upper Fish Creek averaged 0.52 m (SD = .23) in diameter and 8.9 m (SD = 4.6) in length. The average diameter was statistically the smallest in the basin yet in absolute terms is not much different than the middle and lower parts of the basin. The 18 clumps of wood had a mean volume of 19 m^3 (SD = 42.1). The biggest clump was 132 m^3 and most of the jams ranged between 3-4 m^3. The middle Fish Creek basin had no clumps or jams present. The mean length of a piece of wood was 8.7 m (SD = 5.3) and the mean diameter was 0.54 m (SD = 0.34). This was about the same as in the upper basin. The middle reach is canyon-controlled with little opportunity for jams to form.

The wood in lower Fish Creek was greatly increased by the Christmas 1983 Ice and wind storm. The mean length of wood in this reach was 15.1 m (SD = 9.5) and the mean diameter was 0.56 (SD = 0.3). The diameters were In the same range as other reaches surveyed in the basin although the mean was statlstically greater than the upper and middle Fish Creek reaches. The mean length of individual pieces was about double that of any other reach in the basin. This is related to 1) a wider floodplain in the lower basin and trees that toppled without splintering against the opposite side wall as in Wash Creek, and 2) the discharge is highest at the bottom of the basin and tends to float smaller pieces to the edges or downstream to the Clackamas River. The clumps found in the lower reach of Fish Creek had a mean volume of 13.7 m^3 of wood (SD = 13.4) and ranged between 1.5-57 m^3 with most of the clumps in the 5-7 m^3 range. This again reflects the power of the lower reach to rotate downed trees and float pieces to the edge of the stream thus reducing the opportunity to form clumps or wing jams.

This survey and analysis of large woody debris in Fish Creek is more complete than the information reported in the 1983 progress report. The results between the two years have been refined but the conclusions are the same. There is less wood in Fish Creek than one would expect to find if no salvage logging had occurred. The average of 4-5 pieces per 100 m of stream is about one-fifth of what one would find in streams flowing through natural old-growth forests (Sedell, et al., in press). This indicates that a serious reduction In favorable salmonid rearing habitat has occurred as well as loss of spawning gravels that are often deposited around pieces of large organic debris along the stream margins From the few studies available, it appears that coho salmonid smolt output could be substantially enhanced with a significant increase in large woody debris In the lower reach of Fish Creek basin.

New Observations on Limiting Factors

Three years of data on salmonid populatlons and habitat utilization in the Fish Creek basin have provided several insights on factors limiting production in the basin. The observations are summarized below for each species.

Steelhead--An analysis was made in 1982 to determine whether spawning or rearing habitat was limiting steelhead trout populations in the basin. Gravel resources and rearing areas were quantified and compared (Everest and Sedell 1984). The conclusion was that spawning habitat was more than adequate to seed available rearing habitat and that rearing habitat was limiting steelhead trout production.

Analysis of data collected between 1982 and 1984 has helped identify the components of rearing habitat that limit steelhead trout production in the basin, and which age-class of steelhead trout Is most affected. Substantial variations in age-class strength of 0+ steelhead trout are directly related to adult spawners (Fig. 250, but despite variation in numbers of 0+ fish, the number of age 1+ fish has remalned remarkably constant over the same time period (Fig. 26). If numbers of age 1+ steelhead trout were determined by age-class strength of 0+ steelhead trout, one would expect to see a direct relationship between 0+ numbers in one year and 1+ numbers the following year. Our data, however, show no relationship between 0+ numbers and 1+ numbers the following year. These data indicate that either winter habitat for 0+ steelhead trout or summer habitat for age 1+ steelhead trout, rather than seeding, limits the number of age 1+ steelhead trout rearing In the basin.

The question of whether 1+ steelhead trout numbers are limited by the number of 0+ fish surviving the previous winter or by summer habitat conditions available for the 1+ age-group cannot be answered with present data. The consistency in numbers of 1+ fish In the system in September of 1982-1984, however, leads us to speculate

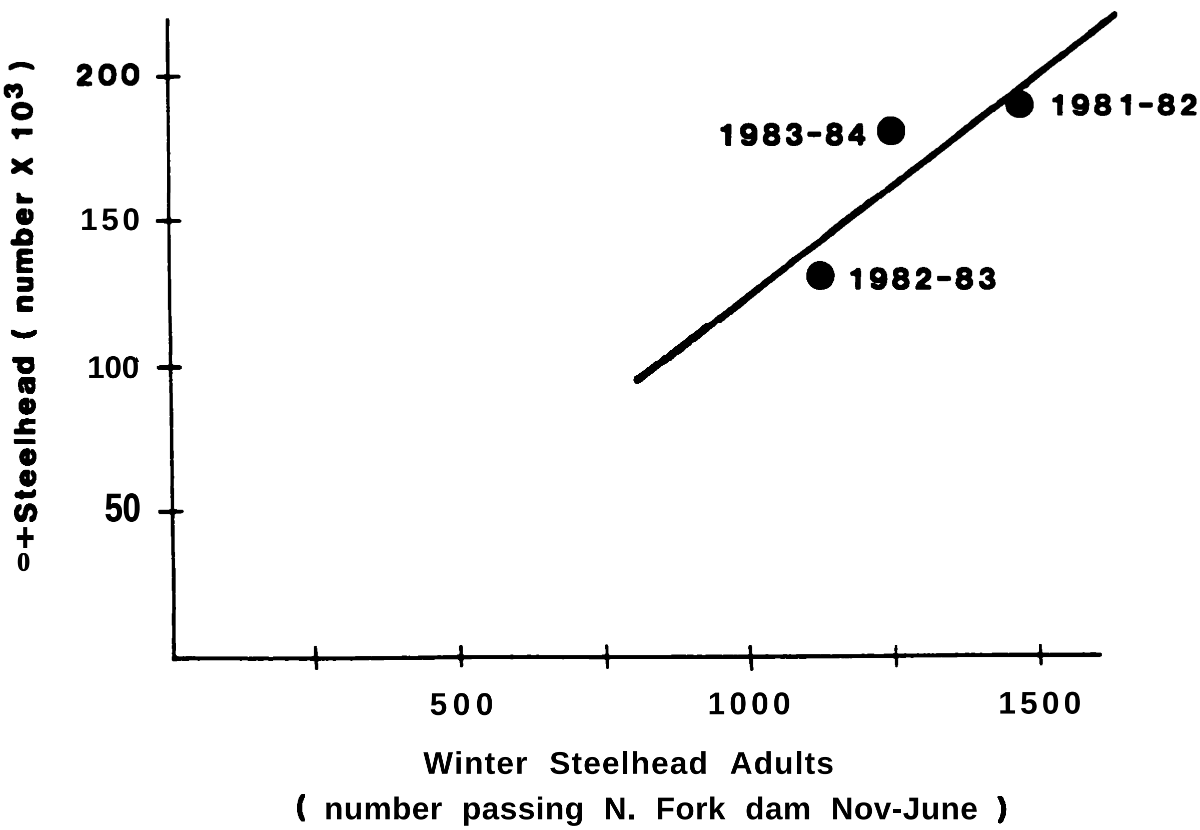


Figure 25. Relationship between numbers of 0+ steelhead in Fish Creek and winter steelhead adults passing North Fork Dam, 1982-1984.

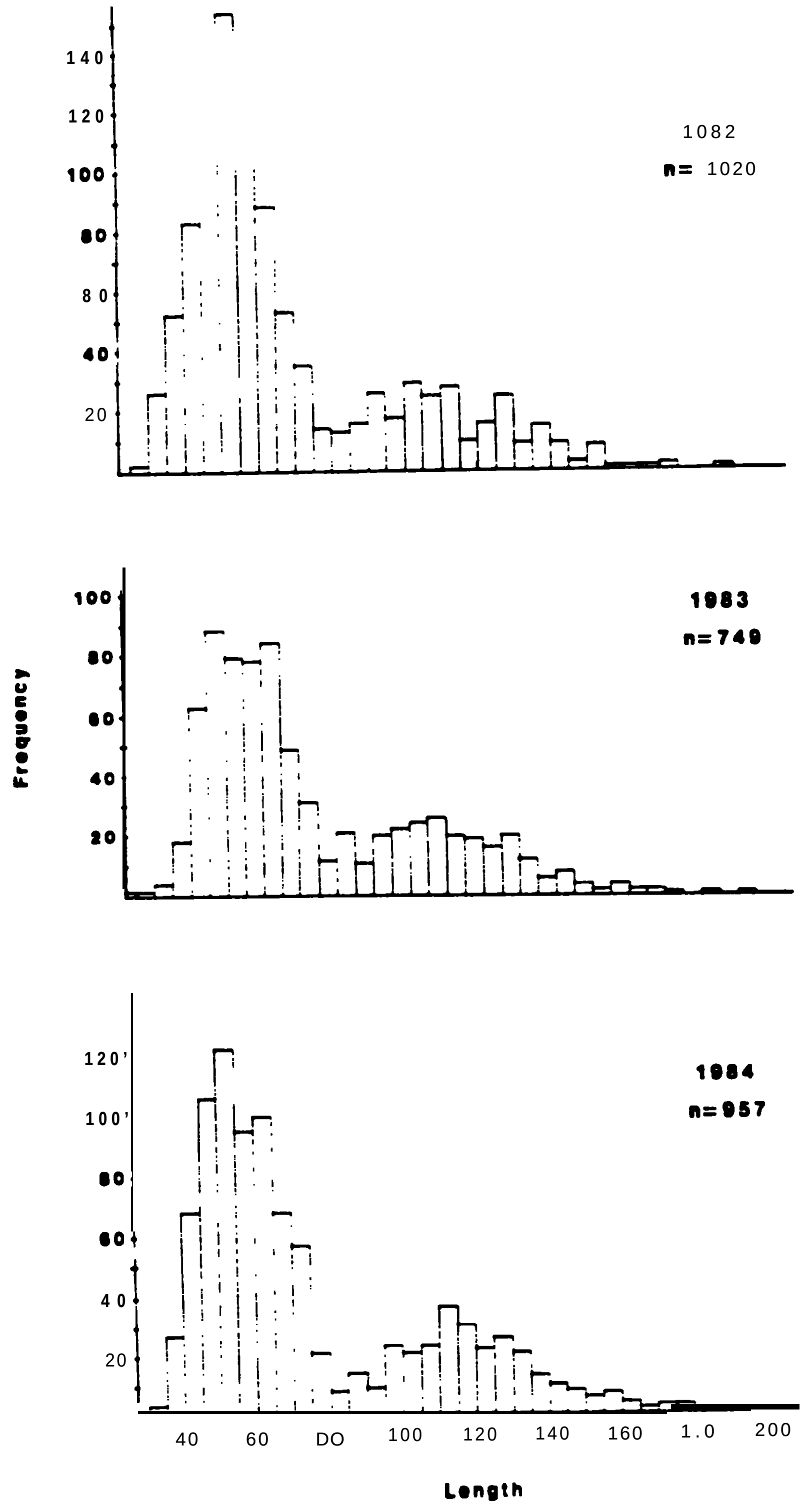


Figure 26. Length frequency of juvenllle steelhead in Fish Creek basin, 1982-1984.

that it is summer rearing habitat that limits the number of this age-group (Fig. 15).

Analysis of habitat area and utilization by 1+ steelhead trout indicates that availability of pool habitat is limiting summer rearing. Pool habitat is the most productive habitat in the system for 1+ steelhead trout, but is in short supply relative to riffle habitat. Further addition of deep bouldery pools would be the factor most llkely to enhance summer rearing capability for age 1+ steelhead trout.

The question remains as to whether summer or winter habitat availability limits steelhead trout smolt production in the basin. The only way to answer this critical question is to estimate the actual smolt output by sampling migrants leaving the basin in the spring.

Competltlve interactions between coho salmon and steelhead trout mlght limit the numbers of 0+ steelhead trout in side channels in summer (Fig. 27). Side channels are favored habitat for both 0+ steelhead trout and 0+ coho salmon, but coho salmon of this age class are larger than steelhead trout and tend to dominate interspecific interactions. In years of high coho salmon abundance In side channels, numbers of 0+ steelhead trout decrease in that habitat. No overall effect on steelhead trout production in the basin appears to result from this interactive competion, however, since summer habitat availability for age 0+ fish is not limiting steelhead trout smolt production.

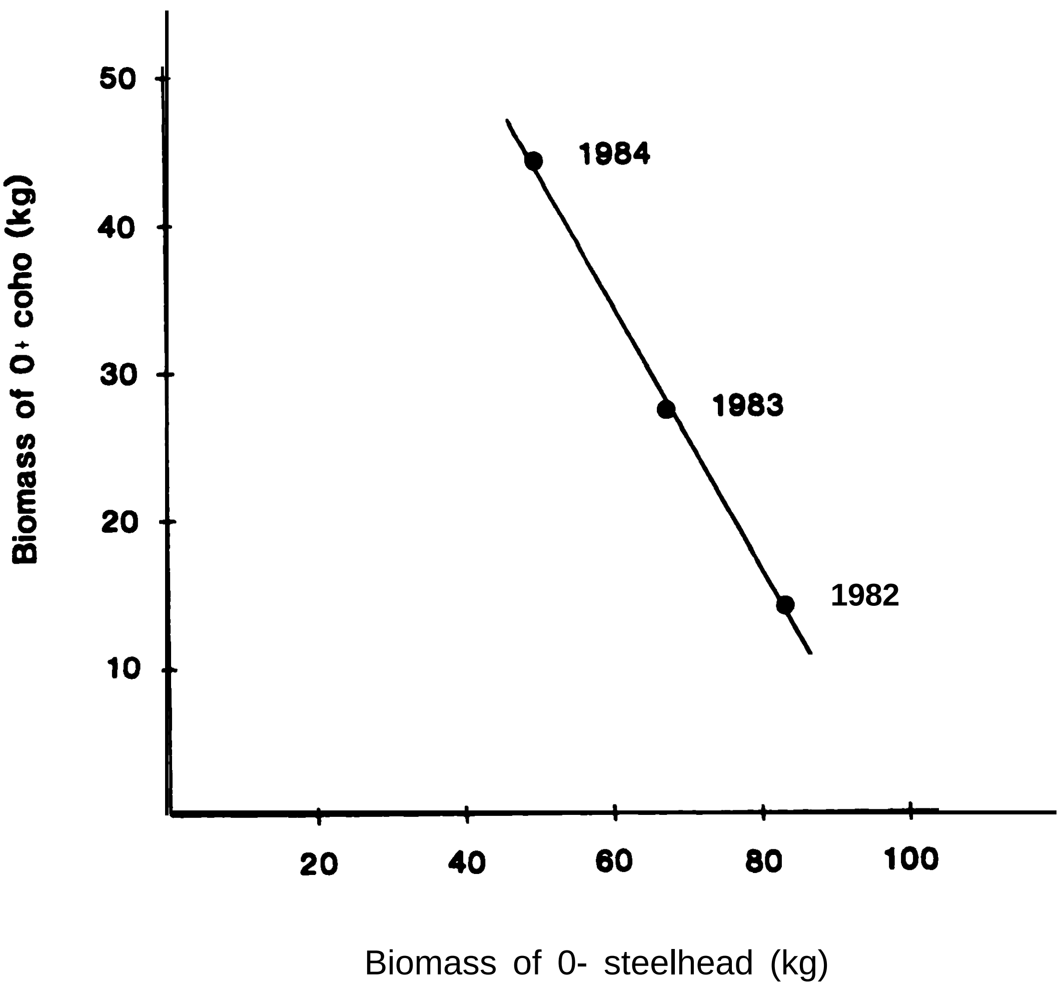
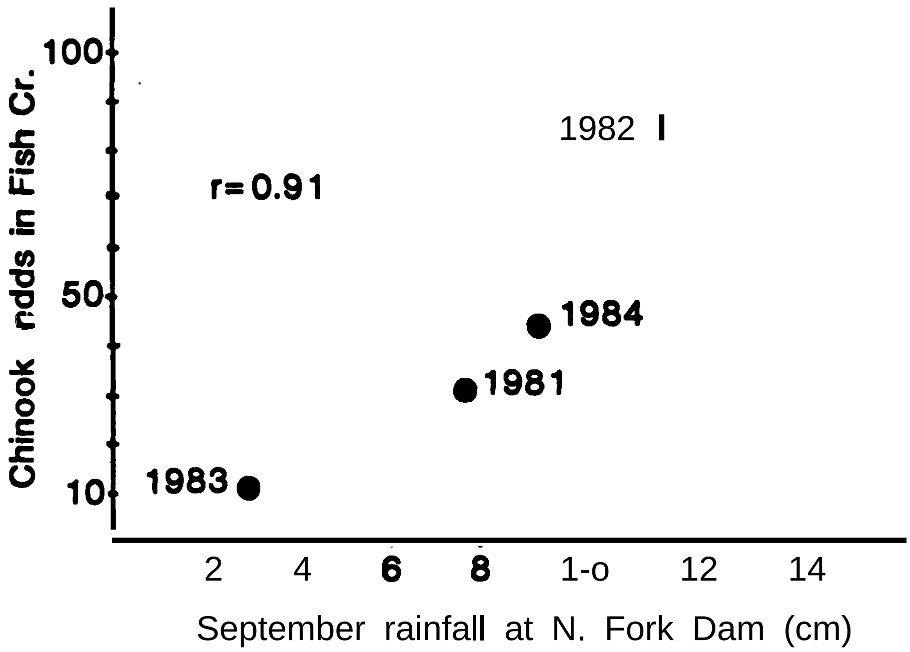


Fig. 27. Relationship between numbers of 0+ steelhead trout and 0+ coho salmon In side channels of Fish Creek, 1982-1984.

Coho salmon--Coho productioin in Fish Creek is apparently limited by inadequate seeding at the present time. The number of juvenile coho salmon in the system in the summer of a given year appears to be directly related to the number of spawners the previous winter. If the number of returning adults increased, production of coho salmon would be limited by rearing habitat rather than spawning habitat. Beaver ponds and side channels are the most productive summer rearing habltats In the system for coho salmon, but combined constitute less than 15 percent of total habitat. To enhance numbers of coho salmon rearing in the basin In summer, escapement of adult coho salmon must first be increased, and then the area and complexity of side channels and off-channel habitats, such as beaver ponds, must continue to be increased. The importance of winter habitat to coho smolt production is presently unknown.

Chinook salmon--The number of chinook salmon produced by Fish Creek appears to be directly related to cllmatological conditions. Spring chinook salmon spawn in October when Fish Creek is often at minimum base flow. If no significant fall storms have raised the flow level before mid-October, adult chinook salmon have a difficult time negotiating the rocky alluvial fan of boulders at the mouth of Fish Creek. The number of spawners in the Fish Creek system is more related to the timing of the first fall freshets than it is to the escapement of chinook salmon to the upper Clackamas basin (Fig. 28). Access at the mouth of Fish Creek might be improved by rearranging boulders on the fan to improve low-flow passage.



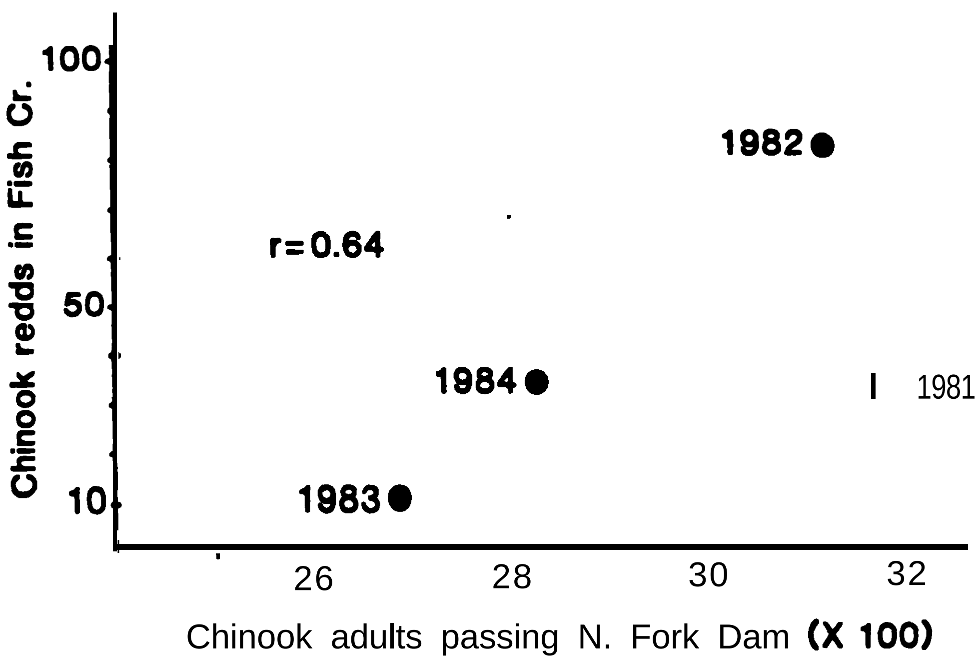


Fig. 28. Chinook salmon redds in Fish Creek as related to fall freshets (rainfall) and adult numbers passing North Fork Dam.

In years such as 1982 when large numbers of adult chinook salmon moved into the system on early fall freshets, spawning habitat is in short supply. Eighty-three females spawned on 190 m^2 of gravel in 1982. Superimposition of redds and use of poor quality habitat was observed. It is impossible to tell, however, whether spawning habitat is limiting production even at these high levels of use without looking more broadly at the upper Clackamas basin. Many juvenile spring chinook salmon that emerge in Fish Creek apparently move out of the system by early summer. Additional rearing occurs in the mainstem Clackamas River and in large hydropower reservoirs downstream. It is presently unknown whether downstream rearing habitats are saturated with young chinook salmon. Also, the total amount of chinook salmon spawning habitat in the upper Clackamas basin is poorly known. Since, significant numbers of juvenile Fish Creek chinook salmon rear off-site, and since the relationship between chinook salmon spawning and rearing habltat in the upper Clackamas is unknown, we can not determine if spawning habitat in Fish Creek is limiting chinook salmon production in years like 1982. It is possible that increasing both spawning area and the amount of large pool habitat would increase chinook salmon production in Fish Creek, especially in years with early fall freshets that allow adults to freely access the system.

Quantity, Dynamics, and Utilization of Spawning Gravels

The reaches of Fish Creek and tributaries accessible to anadromous salmonids have steep-gradients, and consequently spawning gravels in the area are sparse and scattered. The substrate throughout the system is composed predominately of boulders and rubble with isolated patches of gravel suitable for spawning. Gravels suitable for reproduction are often found along the stream margin where physical features such as boulders and large organic debris have caused deposition of gravels. Spawning gravels also occur at the tail of some large pools and in a few side channels and bralded sections of the main channel. There are few large expanses of spawning gravel and those that do occur are in the lower 2.5 km of stream. Most gravel occurs In 5 to 15 m^2 pockets scattered throughout the system.

Adult salmonids spawning in Fish Creek are able to effectively utilize the patchily distributed gravels. Gravel areas as small as one square meter are used by steelhead trout and coho salmon. Chinook salmon have been observed to use areas as small as 2 m^2.

A survey of spawning habitat for anadromous fish in Fish and Wash Creeks was conducted In 1976 by Chuck Whitt, Mt. Hood National Forest. Total usable gravel resources were estimated at 911 m^2 at that time. No attempt was made to estimate gravel availability for each species of anadromous salmonids in the basin.

A resurvey of gravel resources in the basin in 1982 showed a substantial increase In spawning habitat (Table 9). Gravels in the stream reach utilized by chinook salmon were surveyed again in 1984. Another increase, from 190 m^2 to 248 m^2, was noted since the 1982 survey. Gravel resources in the basin seem to be on an Increasing trend over the past 8-year period. During that time span

Table 9.--Amount of spawning gravel (m^2) in Fish Creek basin available to anadromous salmonids, 1976, 1982, and 1984.

Species	1976	1982	1984
Chlnook salmon	}	190	288
Coho salmon	} 911	569	--
Steelhead trout	}	1,348	--

Table 10.--Chinook salmon adults and redds observed on Fish Creek, 1981-1983.

	1981	1982	1983	1984
Chinook salmon redds	31	83	11	44
Adult chinook salmon	32	36	28	35

the basin has experienced few major storm events of sufficient magnitde to produce erosive flushing flows. Also, during that time several debris flows have carried a large volume of inorganic sediment into the channel. It appears that the energy of Fish Creek has been adequate to flush fine sediment from the system, but apparently most gravel and cobbles have remained.

The quantity of gravel available to the different species of anadromous salmonlds in Fish Creek, and the spatial and temporal use of the gravels, varies considerably.

Chinook were found to utilize the 'lower 5 km for spawning (Fig. 29) and have only about 200 m^2 of good gravel available (Table 9). Gravels used range from about 2 to 15 cm In diameter. The number of chinook salmon spawning in Fish Creek varies annually according to run size in the Clackamas River and timing of fall freshets. In some years, 1982 for example, available gravels appear to have been fully utilized (Table 10).

Coho salmon spawn primarily in the lower 5 km of Fish Creek in late fall and early winter when streamflows are fluctuating between storm events. Consequently, not all of the 570 m^2 gravel potentially available to coho salmon can be utilized at all times. High flow events during the spawning season restrict coho salmon spawning to favored habitats along the stream margins, side channels, and lower reaches of small tributary streams (Fig. 30).

Steelhead make the widest use of spawning habitat in the basin. When flow conditions are favorable steelhead trout are able to use

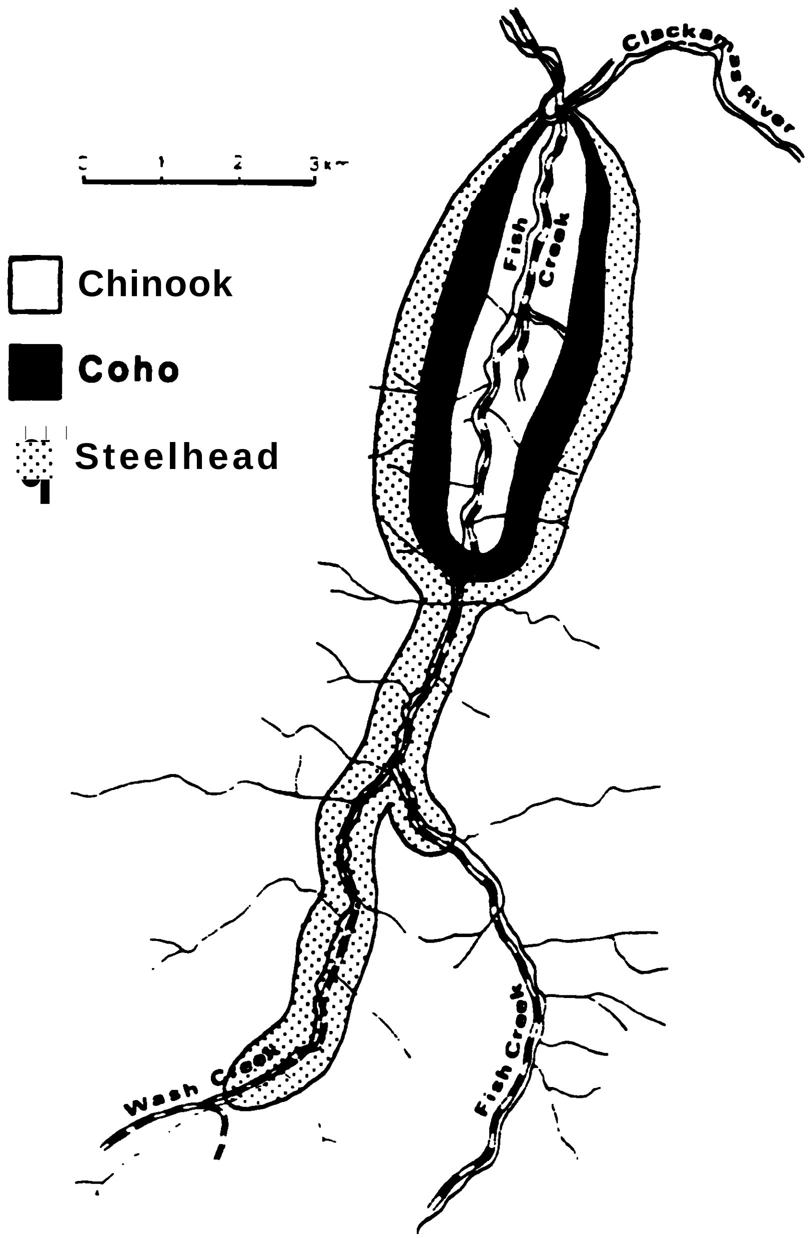


Figure 29. Distribution of spawning salmonids in Fish Creek.

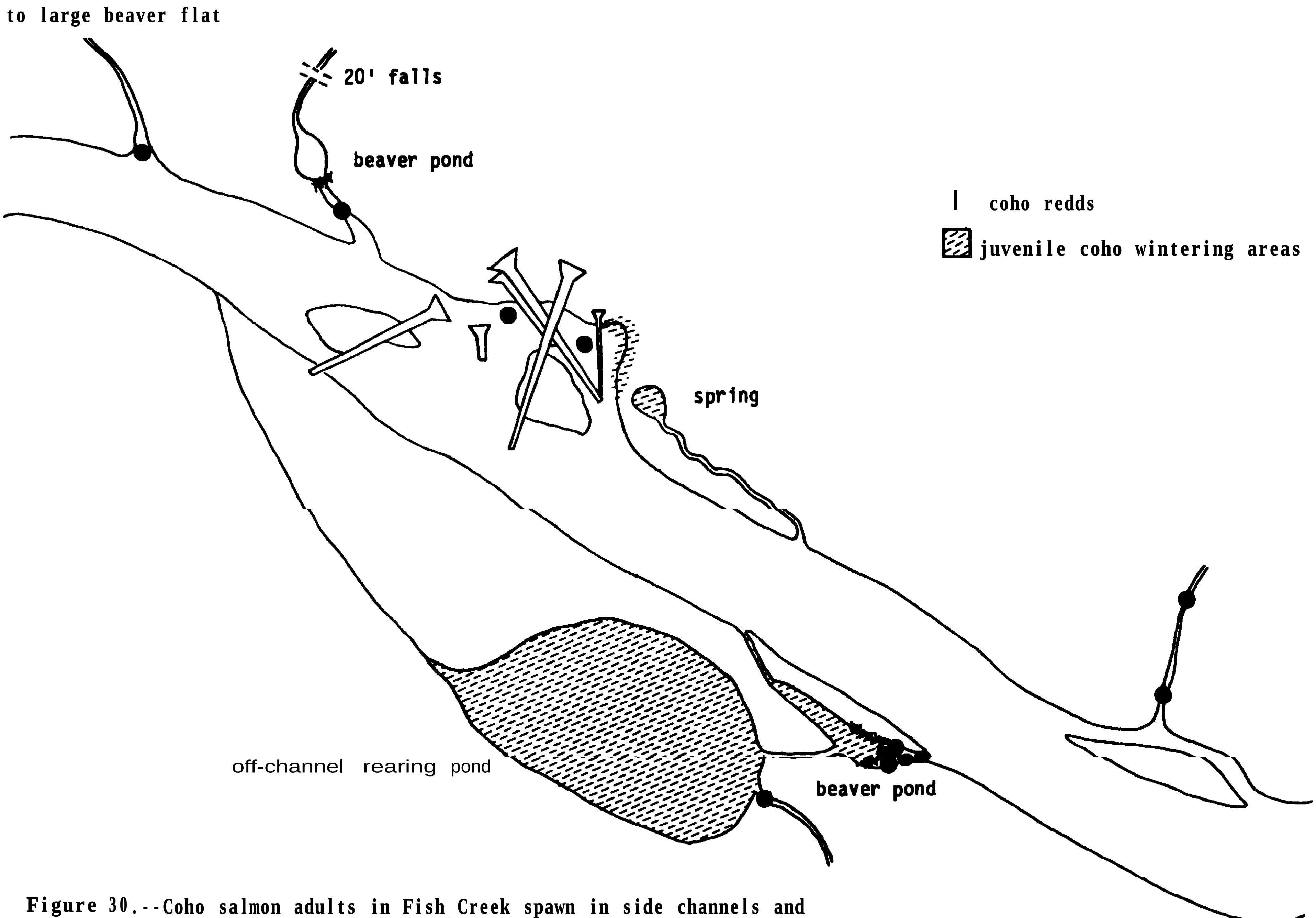


Figure 30.--Coho salmon adults in Fish Creek spawn in side channels and intermittent tributary mouthes. Juvenile coho seek wood protected side channels, spring-fed tributaries and off-channel ponds for winter rearing areas.

gravels from the mouth to the falls on both Fish and Wash Creeks (Fig. 29). Steelhead spawning activity occurs from late winter through spring when flows In the system are generally declining and stabilizing. These conditions favor widespread successful steelhead trout spawning.

Effects of Habitat Improvements on Spawning Habitat

Haibtat improvements on Fish Creek have increased usable spawning habltat by about 6, 5, and 4 percent, respectively for chinook salmon, coho salmon, and steelhead trout (Table 11). Fish of each species have spawned on recently accumulated gravels from habitat improvements. Structures designe to trap bedload gravels for Increased spawning habitat have not yet reached their full potential. Significant movement of bedload occurs only on flood events, and no overbank forbankfull events have occurred since the structures were installed.

Table 11. --Spawning habitat (m^2) created by habitat improvements in Fish Creek Basin, 1981-1984.

	Habitat Improvement			
	Berms			
Species	Fish Creek	Wash Creek	Side channel	Off-channel
Chinook	--	--	15	--
Coho	--	--	15	15
Steelhead	35	15	--	--

Enhancement Projects

Off-channel Pond--When development of the pond was completed in the fall of 1983, 150 juvenile coho salmon were Captured by electrofishing in Fish Creek and released in the pond. The fish averaged 77.4 mm in length and 5.2 g in weight. In March of 1984, coho salmon smolts of extraordinary size began leaving the pond. By April 18, 23 smolts averaging 137 mm and 34 g had emigrated from the pond. The apparent winter growth was exceptional considering that the pond was partially covered by ice and snow during a substantial portion of the winter. Pond temperatures did exceed temperatures in Fish Creek by 2 to 3° during the winter (Fig. 31). The number of migrants captured represented 15 percent of the fingerlings released into the pond, but actual survival is believed to have been higher. During much of the migration period the trap and rotating drum screen were out of service because of beaver activity, or high runoff from spring rains. When such conditions prevailed juvenile coho salmon could escape from the pond undetected.

Between March 30 and July 5, 1984, 1,326 coho salmon fry were electrofished from the margins of Fish Creek and released in the pond. The fry averaged 39.2 mm in length and 0.9 g in weight when released. This group of coho salmon also exhibited rapid growth rates. No sampling was done in the pond to assess growth, but an estimate of apparent growth was made from emigrants leaving the pond in May and July. Fry leaving the pond by the end of Hay averaged about 50 mm and by mid-July emigrants averaged over 60 mm. Between

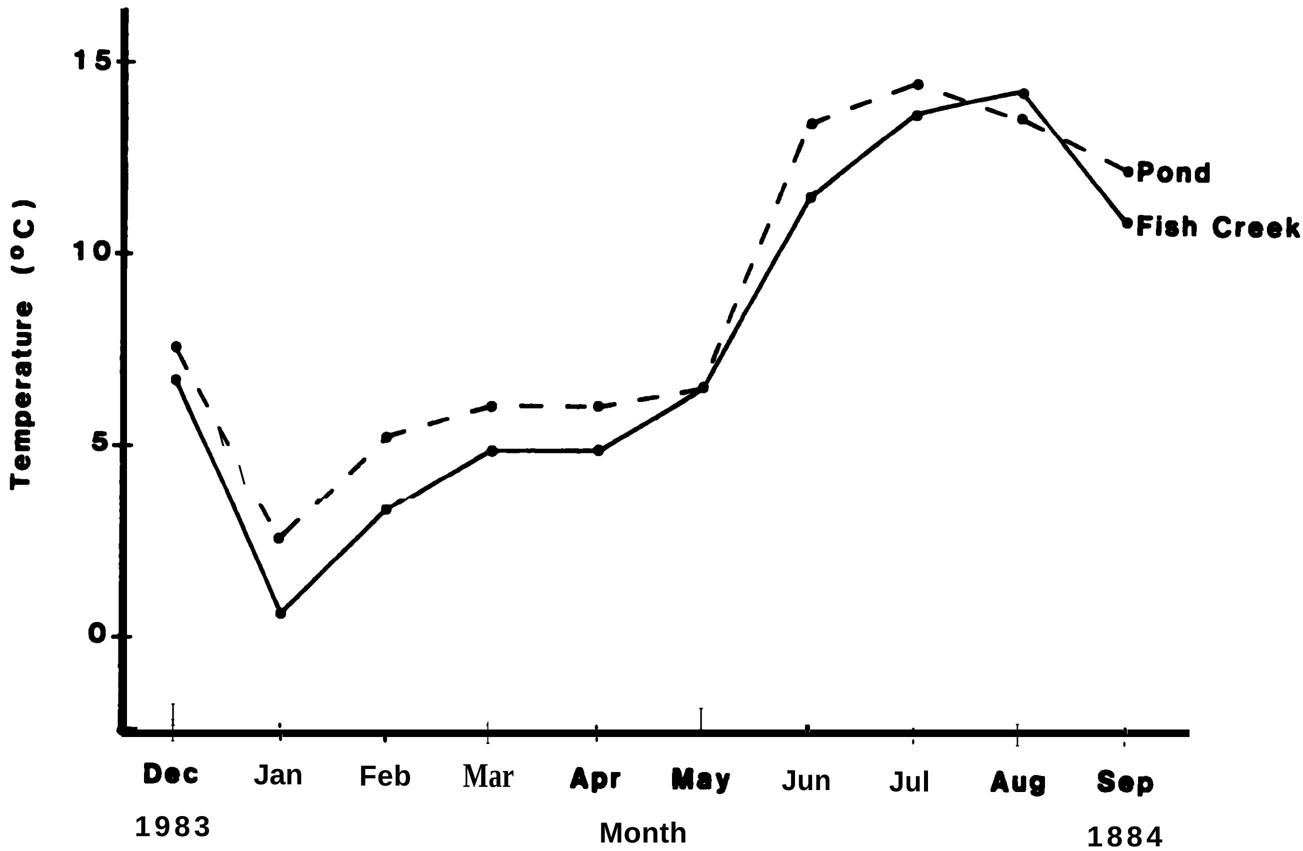


Figure 31. Water temperature in Fish Creek and off-channel pond, December 1983 to September 1984.

July 20 and and August 16, ten age 0+ smolts averaging 86 mm in length (range 73-105 mm) left the pond. The fish had reached smolt size and emigrated in approximately 90 days, a rare occurrence in natural coho salmon populations.

The size of coho salmon smolts leaving the pond is substantially larger than average for the upper Clackamas basin or coastal basins of Oregon (Fig. 32). The size of smolts leaving the pond might decrease, however, when the pond is seeded at a higher initial density. The average size of coho salmon smolts captured at the PGE fish trap at North Fork Dam in April is about 90 mm, and coho salmon smolts from Oregon coastal basins average about 95 mm. The large size of coho salmon srnolting from the pond should enhance their survival and mlght result in a higher than average rate of return to Fish Creek.

Adult coho salmon were observed spawning in the north inlet to the pond in both 1983 and 1984. Adults must move from Fish Creek into a natural beaver pond, then into the outlet of the developed pond, through the trap and screen area into the pond and, finally, into the Inlet stream where spawning takes place. The inlet stream should provide adequate area for full natural seeding when additional adults from smolts reared in the pond return to spawn.

The Oregon Department of Fish and Wildlife and Portland General Electric cooperated in this facet of the evaluation by providing 7 female and 4 male coho adults that were introduced to the pond in February of 1985. Two pairs were observed spawning 3 days after introduction, and eventually all 7 females spawned in the inlet streams.

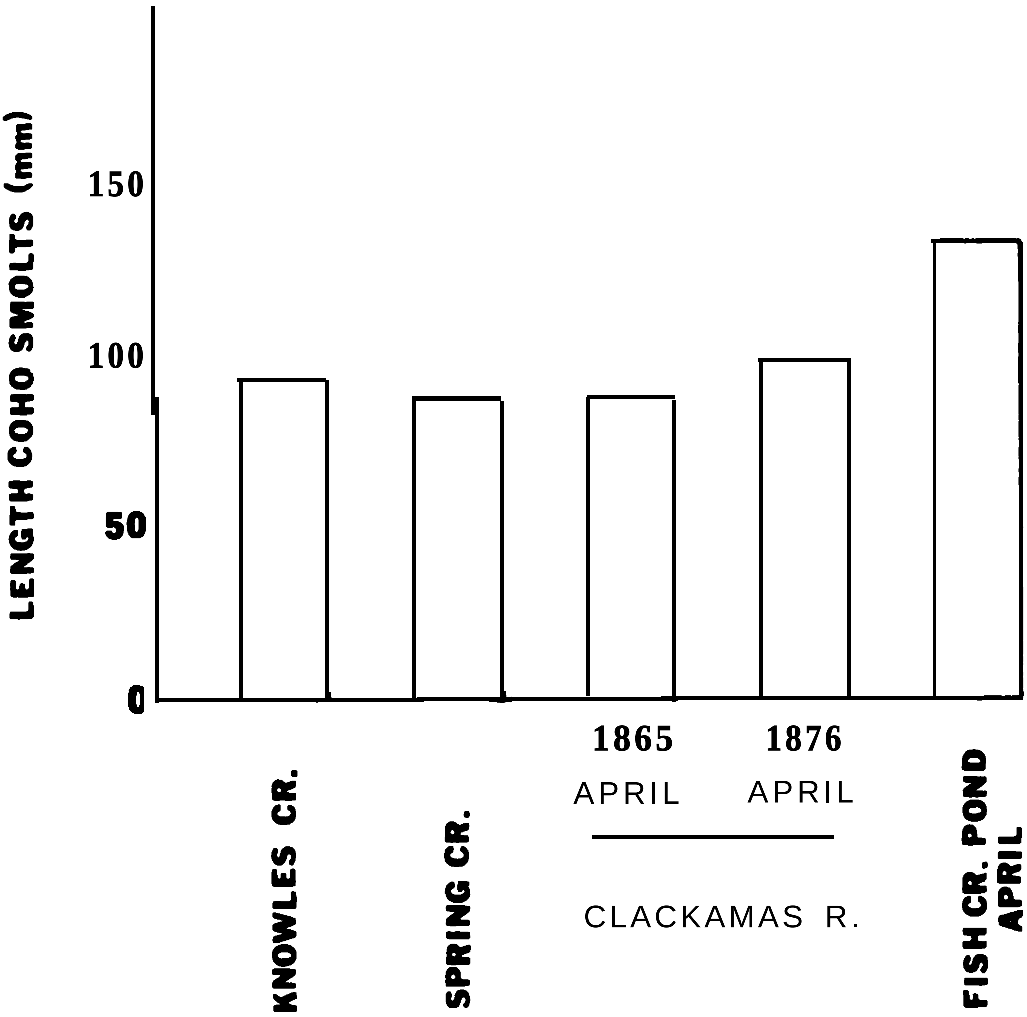


Figure 32. Size of coho smolts from some Oregon waters.

Side Channel Development---A flood overflow channel located at km 1 on Fish Creek was added to the list of Fish Creek improvement projects in 1984. Before development the channel was dry except during large winter freshets. Fish productioin from the area was essentially nil. Occasionally a few juvenile steelhead trout or coho salmon were swept into the channel on flood flows and trapped in a pool near the downstream end when flows declined. The fish were usually lost to dewatering OF predation during the subsequent summer.

Several operations were required to convert the channel into perennial habitat for salmonids. An inlet was excavated with a backhoe to provide perennial flow at all seasons and the outlet was also excavated to improve upstream access for adult and juvenile salomids. The result was a channel 197 m long and 4.4 m wide at minimum summer flow. Total low-flow side channel habitat added to the system was 853 m^2 (Fig. 33). The first 75 m of the channel has a gentle gradient (<1 percent) but gradient increases rapidly downstream and exceeds 3 percent in the lower half of the channel (Fig. 34). A large boulder berm and 5 rock weirs were installed in the lower 140 m of the channel to dissipate stream energy and reduce water velocity. The mouth of the channel was armored with a rock wing deflector on one side and a large log and boulder complex on the other.

Salmonid use of the channel began almost immediately. FOUF pairs of spring chinook salmon spawned in the channel in October; two in the inlet and two in the outlet. In November, after large

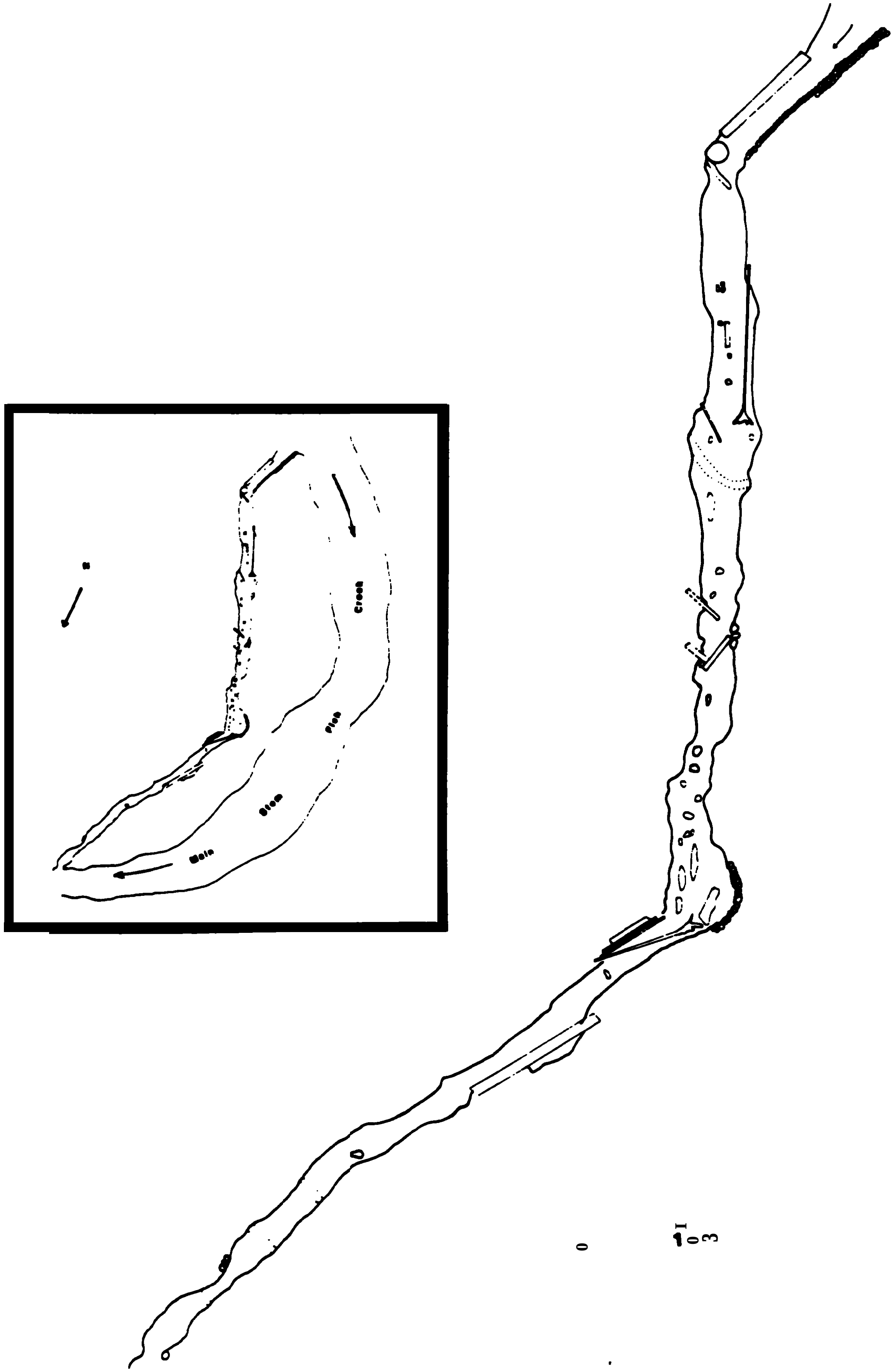


Figure 33 Schematic diagram of side channel development at km 1 on Fish Creek

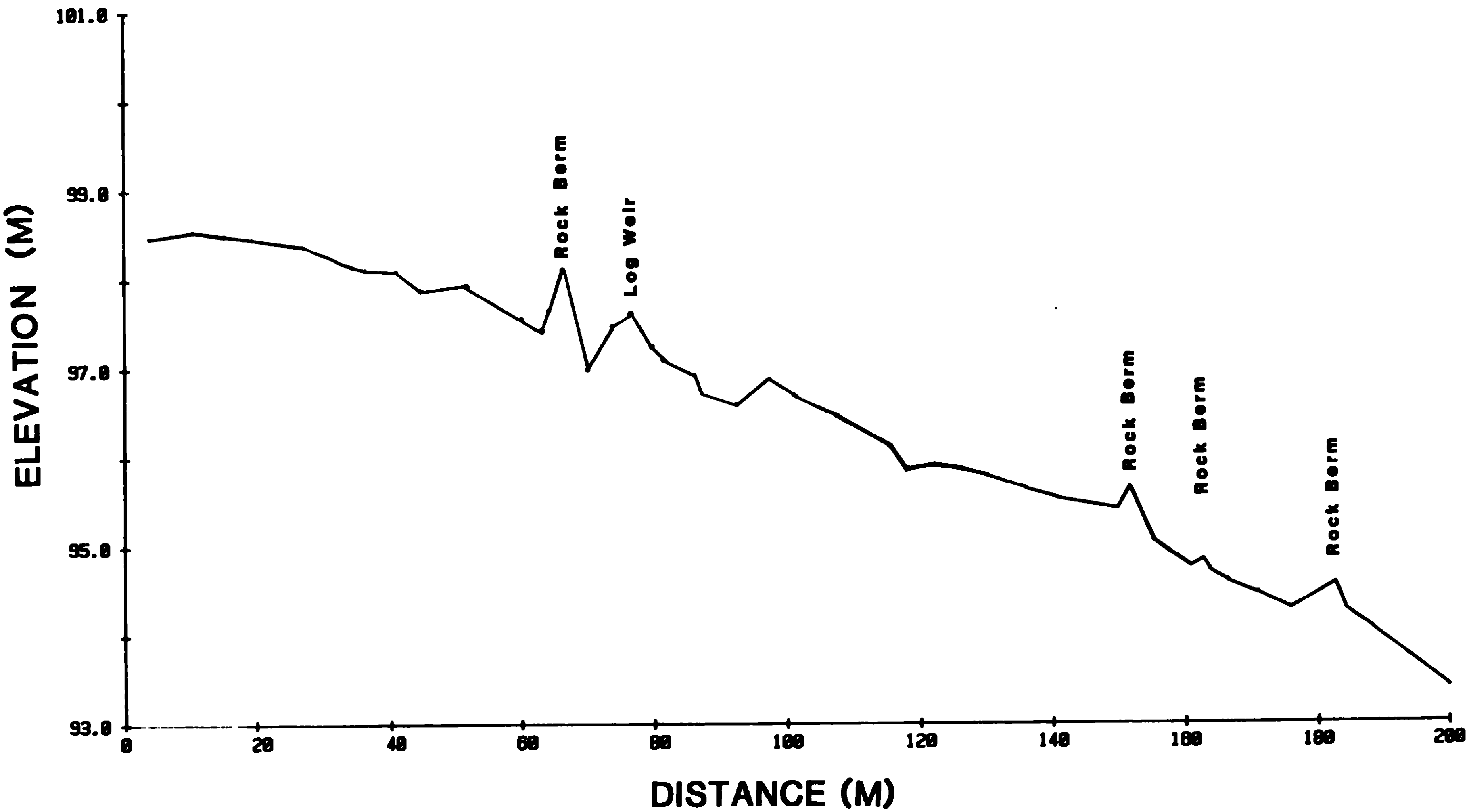


Figure 34. Gradient profile of side channel at km 1 on Fish Creek.

freshets had changed the habitat in the channel, two pairs of coho salmon spawned about 75 m below the inlet. All of the suitable spawning gravel, about 15 m^2 divided evenly between the inlet and outlet, was used.

Extreme flow variations in the channel between mid-October and mid-December negated some of the immediate benefits observed. A severe freshet after chinook salmon spawning was complete raised flows in the channel to more than 200 cfs. The high flows caused severe bank erosion in the channel, breached the large boulder berm, swept away the 5 rock weirs, and Scoured away the chinook salmon redds at the channels inlet and outlet. Also, the large log used to armor the inlet was destabilized and swept 75 m downstream into the channel where it lodged and subsequently impounded about 5 m^2 of spawning gravel. The new gravel was used by spawning coho salmon after flows receded.

Present winter habitat conditions in the channel are marginal for juvenile salmonids. A census of juveniles wintering in the channel in December 1984 indicated that only about 3 coho salmon and 29 steelhead trout were utilizing the three remaining pools and accumulations of woody debris and roots for winter habitat (Table 12). The small steelhead trout population was composed of 20 0+ fish and 9 1+ fish. Habitat conditions seem to favor small fish which are able to find a few suitable niches. Violent flow fluctuations and a general lack of quiet water edge habitats and complex cover limit winter use by juvenile salmonids. These limitations will be remedied in fiscal year 1985 by increasing the roughness elements (boulders and large organic debris) in the channel to reduce winter water velocities and increase cover by modifying the inlet to control winter flows.

Changes in the inlet are critical to the success of the channel. Such changes may be difficult, however, because the channel inlet Is located at a natural depositional area. A large, unconstricted inlet allows adequate low flows, creates good summer rearing habitat, but provides no resistance to high flows, thereby reducing the effectiveness of the channel as overwintering habitat. A small, constricted inlet would reduce high flows, creating a refuge area from the mainstem, but would also promote deposition which would likely close off the channel in low flows. Even without deposition, low flows would be severely limited, reducing summemr rearing habitat. The inlet as built is described by the first option, and while low flow characteristics are optimum, flows are too high in winter for the channel to provide much over-winter habitat.

Table 12. Estimated salmonid numbers and biomass in the developed side channel at km 1 on Fish Creek, December 1984.

Species	Number	Mean length (mm)	Mean weight (g)	fish/ m^2	fish/ m^3	g/m^2	g/m^3
Coho salmon	3	80.7	6.3	0.004	0.01	0.01	0.02
0+ steelhead trout	20	73.8	5.2	.02	.07	.12	.38
1+ steelhead trout	9	116.0	17.9	.01	.03	.20	.59

Boulder Berms--The twenty-one boulder berms constructed on Fish and Wash Creeks in 1983 made immediate changes in the overall habitat structure of the stream (Everest and Sedell 1984; Sedell et al. in press). To summarize the Immediate changes, the berms added 5,763 m^2 and 2,644 m^3 of pool habitat and decreased surface area of riffles by a like amount. The increased gravels behind most berms did not make an immediate Contribution to spawning habitat because of poor positioning.

In the summer of 1984 the berms were resurveyed to assess their effects on physical habitat after weathering through one winter. A special effort was made to compare the height of berms and identify any scour or fill that had occurred in the pools above and below the berms. Comparisons of substrate composition were also made between 1983 post construction data and 1984. Fish populations in the area in 1983 were compared with post-project populations in the summer of 1984.

While all berms were resurveyed in 1984, three groups of berms were selected for detailed reporting here. Survey data on the remaining berms is included in Appendix I. The three sites chosen Included the two upstream berms on Wash Creek and the three upstream and five downstream berms in the 15-berm series in Suspender Timber Sale on Fish Creek.

The Wash Creek site (Site 1) was selected for detailed reporting because it represented the most upstream construction in 1983, and contained the berms that were most likely to impound dedload gravel moving on winter freshets. The longitudinal (thalweg) profile for this two-berm series shows some weathering of berms caused by winter freshets (Fig. 35). Some settling and erosion lowered the height of both berms by about 0.25 m and facial erosion reduced the thickness of both berms. Material eroded from the face of berm 1 moved downstream and added about 10 m^3 of fill behind berm 2. Most of the fill was composed of rubble and was concentrated in the area of the thalweg. Cross-section profiles in this area were essentially unchanged between 1983 and 1984 except in the areas of the thalweg (Fig. 36). Some of the fill material in close proximity to berm 2 was severely eroded, losing more than half of its mass and thickness In the area of the profile. Berm 1 should have been the first to receive bedload in the winter of 1983-84, but no filling occurred. Either Wash Creek produces very little gravel-sized sediment or freshets in the winter of 1983-84 had Insufficient energy to transport bedload gravels.

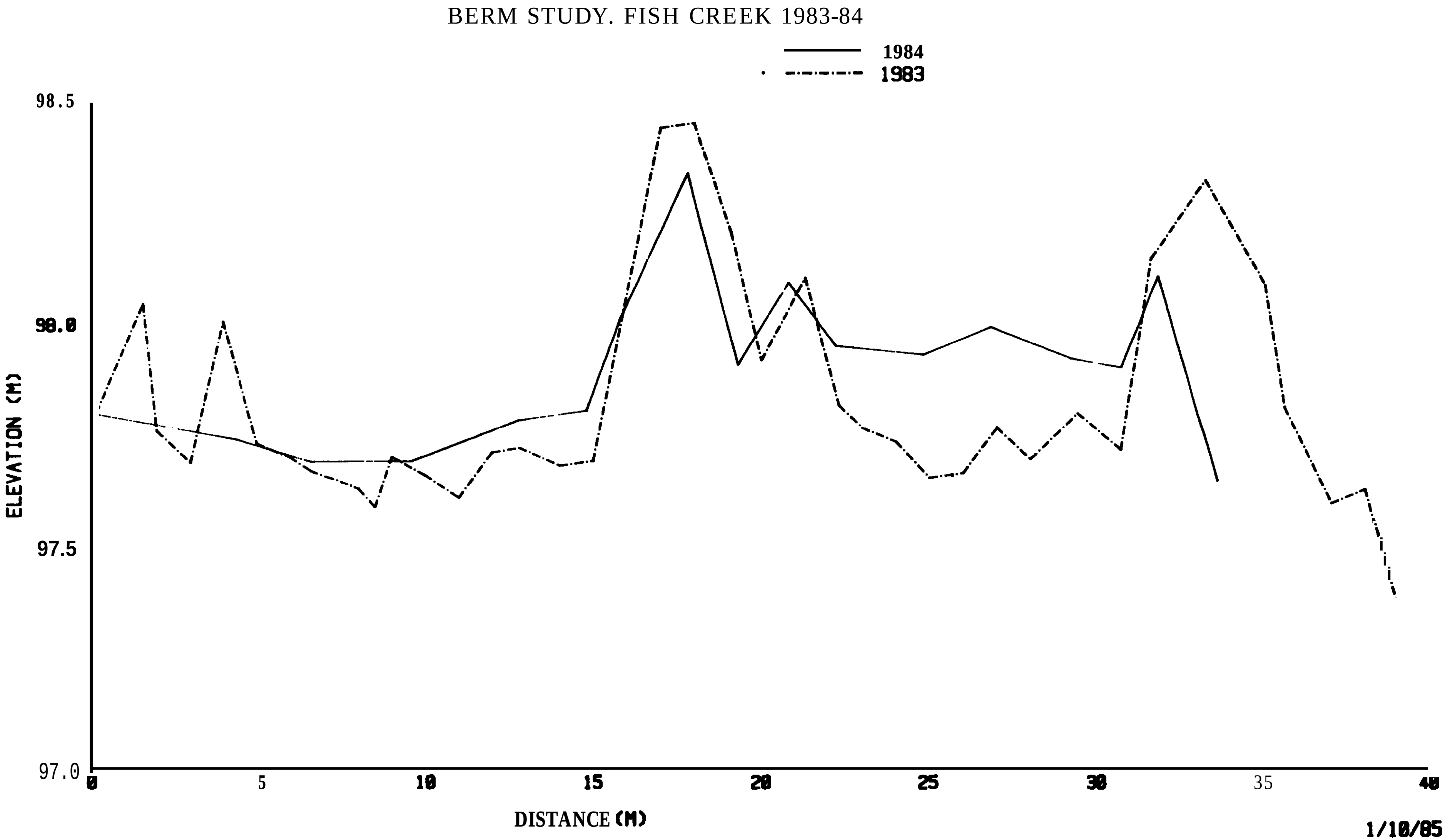


Figure 35. Longitudinal profile through upper Wash Creek berms.

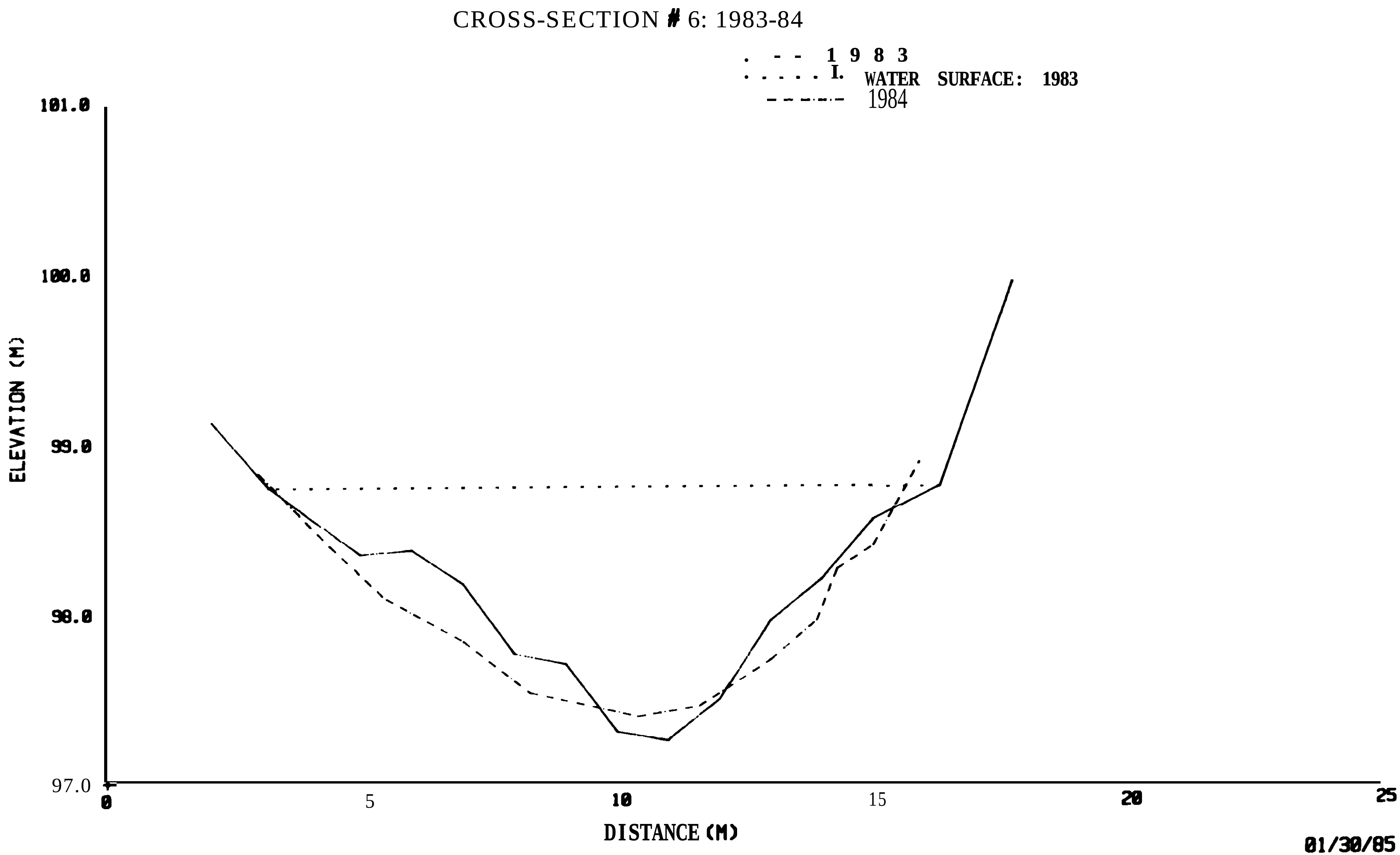


Figure 36. Cross sectional profile through upper Wash Creek berm pool.

Site number 2 included the three upstream berms in the Suspender series (Fig. 37). The heights of berms 1 and 2 remained unchanged after the winter of 1983-84, while the height of berm 3 decreased by about 0.3 m. These berms suffered less erosion than the Wash Creek berms, and there were no significant differences related to scour and fill at either the longitudinal or transverse profiles through the site. Despite small changes in some berms, all are still operating as designed. No significant amount of bedload moved into the berm pools and no additional spawning area was created. These observations hold true for the entire 15-berm series at Suspender.

Site number 3 included the five downstream berms in the Suspender series (Fig. 38). Little erosion of berms occurred at this site although about 0.25 m was lost from the top of three berms. There was no increase in spawning habitat and no significant scour and fill based on analysis of surveyed longitudinal and transverse profiles.

Some changes in the composition of the substrate of these three sites were noted (Table 13). When the berms were constructed in 1983, boulders and large cobbles were removed from the streambed and piled to form the berms. When the heavy armor layer was removed much of the material that remained on the surface of the substrate was gravel in the 5-10 cm diameter range. After the winter of 1983-84, the percentage of cobble and boulder substrates in the berm pools increased and area of gravel decreased. The fate of the gravel is unknown, but apparently winter flows were of sufficient magnitude to re-armor a portioin of the bottom of the berm pools.

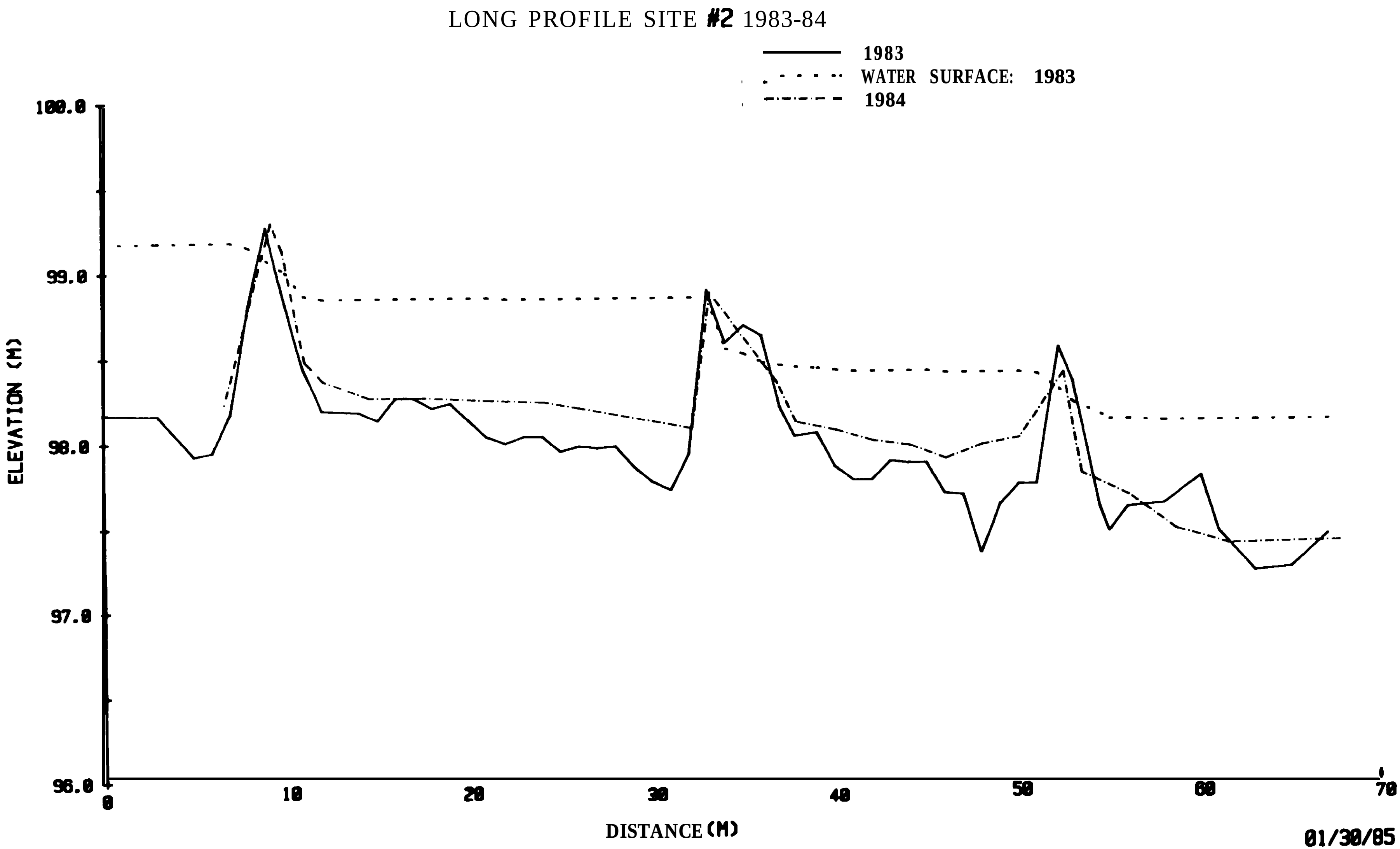


Figure 37. Longitudinal profile through the upper three berms at Suspender site.

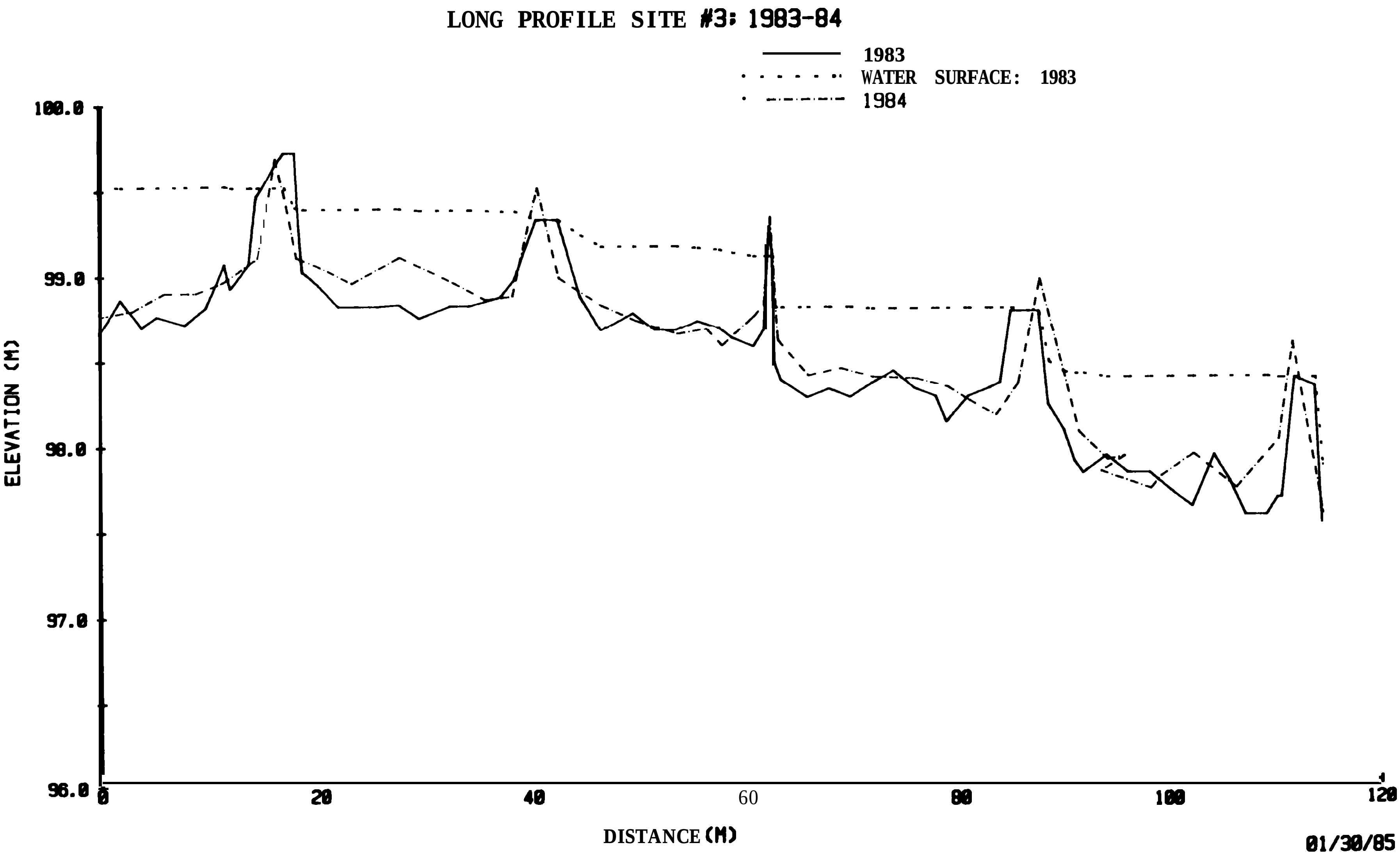


Fig. 38. Longitudinal profile through the lower five berms at Suspender site.

Table 13. Changes in composition (percent) of the substrate in pools behind boulder berms on Wash Creek and Fish Creek, 1983-1984.

Substrate	Wash Creek		Fish Creek			
	Site 1		Site 2		Site 3	
	1983	1984	1983	1984	1983	1984
Boulders	10	10	5	15	10	15
Cobbles	30	55	35	45	40	50
Gravel	60	35	55	30	47	20
Sand	--	--	5	10	3	15

Very little change in fish populations were noted in areas where berms were constructed, but this is not surprising since the berms were designed to enhance spawning habitat rather than rearing habitat. The salmonid population was composed entirely of steelhead trout in the area of the berms. Natural pools in Fish Creek are more productive habitat for age 1+ steelhead trout than riffles. The productivity of berm pools was similar to that observed in natural pools. The loss of riffle habitat and gain in pool habitat from berm construction resulted in an estimated net gain of 383 1+ steelhead trout (Everest and Sedell, in press), or less than 200 potential smolts. Because of the variability in estimates these data do not indicate that any significant increase in steelhead trout production resulted from the berms.

Riparian Reveoetation--Four acres of streamside planting was completed in the spring of 1984. This project was postponed from the 1983 program proposal when it was determined that planting survival would be improved In the spring. Two-year-old cottonwood planted in a clearcut along Wash Creek were evaluated in September of 1984. A minimum sample of 100 young trees was examined for state of health, growth, and browse effects by deer and elk (Table 14). Survival in the clearcut exceeded 70 percent with about 44 percent of the trees in good health. Trees in the clearcut had grown nearly 8 cm since they were planted in the spring, and the effects of deer and elk browsing were negligible.

Table 14.--Survival, growth, and browse use of two-year-old cottonwood planted in a Wash Creek clearcut, September 1984.

	Health %			Growth, cm				
Area	Dead	Weak	Robust	Robust	Weak	x	Browse (%)	(n)
Wash Creek	26	30	44	11.1	2.8	7.8	0	128

Alcove Trees--Physical and biological surveys were conducted at five sites where woody cover was to be added to the channel by explosives. A detailed map of each stream reach including banks, width, substrate, depth, and woody debris was completed for each area

(Fig. 39). Fish populations were determined for each area by diver counts (Table 15).

Blasting took place in September 1984. The blasters exercised reasonably good control over the direction of falling trees. Blasted trees entered four of the five study reaches; the fifth tree fell away from the stream (Fig. 40). The desired orientation was achieved in only one case and the actual orientation was changed in most cases when trees were rotated downstream by fall freshets. It appears that rotation and flotation by freshets has left some of the trees above mean high water. These apparently have lost much of their immediate potential for creating complex edge habitat in spring, summer, and fall, but might still contribute to winter habitat. Subsequent freshets, however, could move these trees back into favorable positions for habitat enhancement at all seasons.

The objective of using dynamite to fall trees was to leave the root wad attached to the tree, but because some buttress roots were sawn and others broken by the blast, root wads on the trees were much smaller than those on trees that fall naturally (Fig. 9). The root wad and lower bole were completely shattered on one large old Western Red Cedar (Fig. 9c). The loss of root mass on the trees will probably diminish their long-term retention In the system.

The initial effect of the trees on fish populations and the quality of edge habitat will not be determined until summer 1985. Fish were abundant in the five reaches before blasting (Table 15).

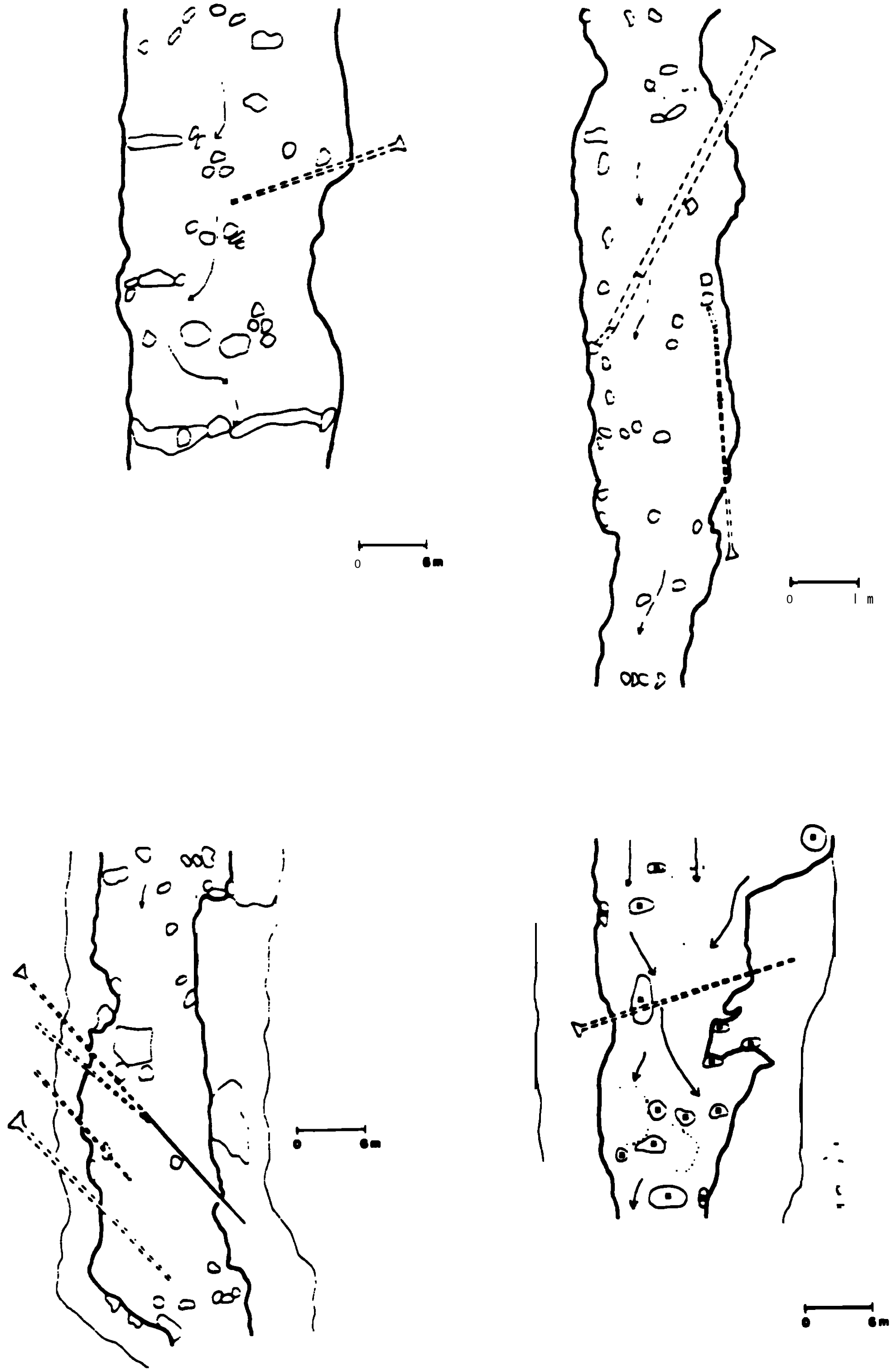


Figure 39. Reaches into which riparian conifers were felled with explosives.

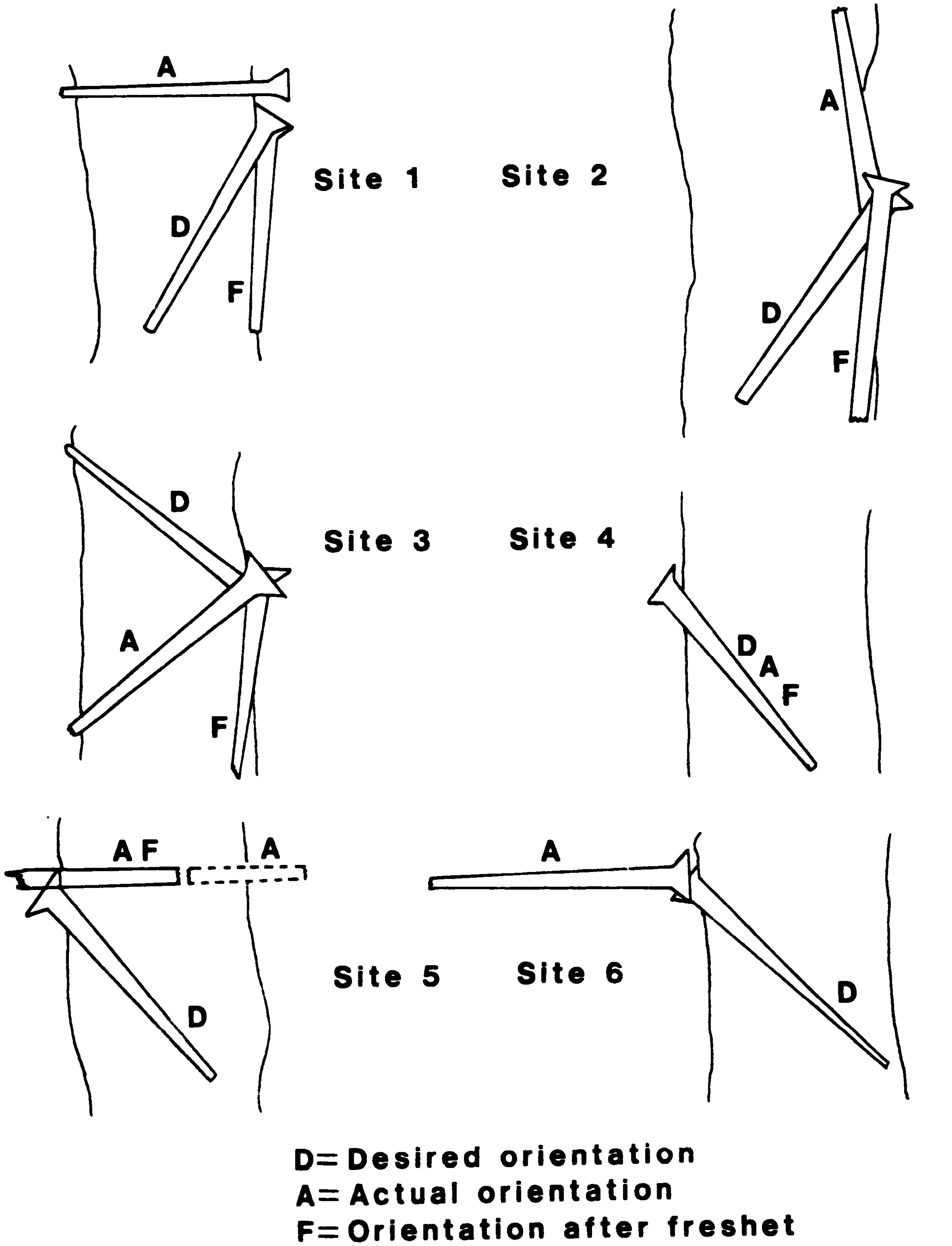


Figure 40. Desired and actual orientation of alcove trees felled with explosives, and orientation after freshets.

Table 15. Estimated salmonid populations in sites designated to receive blasted alcove trees, August 1984.

Site	Steelhead o+	Steelhead 1+	Coho salmon	Chinook salmon	Habitat Type
1	55	68	10	0	Riffle
2	54	79	6	0	Riffle
3	52	85	28	0	Riffle
4a	35	59	66	0	Riffle
4b	8	13	0	0	Riffle
5	54	69	106	2	Pool

Future Habitat Improvement Project Survevs

The Fish Creek/Wash Creek drainage has a number of third-order tributaries with potential for anadromous productlon. Four of these, with fisheries access blocked near their confluence with the mainstem of Fish or Wash Creek, were surveyed in the spring of 1984 (Appendix c). The purpose of the surveys was to identify: the probable extent of blocked anadromous habitat; total available spawning habitat; and all rehabilitation/enhancement opportunities including upstream barriers to fish migration. These surveys are to provide a base level of information from which to make decisions regarding passage improvement work. Initial review of the information indicates Pick Creek to have the highest priority for passage work. Such work would be funded with Forest Service money since passage is blocked by a culvert near the mouth of the tributary. Additional reconnaisscance will be required to prioritize any instream habitat improvement which would be desirable on this stream. Rehabilitation/enhancement opportunities, listed for the stream, will assist in the planning.

To facilitate drainage-wide planning of rehabilitation/ enhancement work, an assessment of existing and potential edge and off-channel winter habitat was conducted during the winter of 1984-1985 (Appendix D). Since it appears that over-winter survival of juvenile coho salmon and/or steelhead trout may be limiting, this assessment was needed to augment existing summer habitat information. The assessment was limited to existing or potential quiet water habitats (alcoves, side channels, and ponds) felt to provide optimum over-wintering characteristics. The assessment team was encouraged to identify all possible areas where future work might be desired. Actual implementatlon of such work will not occur until evaluation results document the need for additional overwintering habitat. Should this occur, potential sites identified in this assessment could serve as the basis for more intense field reconnaisscance and planning.

Estlmated Smolt Prduction Capability

The capability of the Fish Creek system to produce salmon and steehead smolts is dynamic and dependent on numerous factors. The capability of any system can be altered temporarily or permanently by climatic trends, watershed disturbances, changes in fish community structure, pollution, or manipulation of physical habitat. In its pristine state, the smolt production capability of Fish Creek probably varied little around an average figure. Harvest of riparian timber and salvage of dead and down timber in the channel of Fish Creek and Wash Creek has probably reduced the historic smolt production capability for some species to the levels presently observed. Present levels for all species could probably be Increased by habitat enhancement. Estimates of smolt production capability for the Fish Creek basin under present conditions, present conditions with full seeding, and potential capability with enhancement are presented in Table 16. Current data are insufficient to derive these figures with certainty. The assumptions used in their derivation are listed below for each species.

Table 16.--Estimates of smolt production from the Fish Creek basin.

Species	Present	Present with full seeding	Potential with full seeding and enhancement
Steelhead trout	28,000	28,000	32,000
Coho salmon	2-6,600	12,000	25,000
Chinook salmon	?	?	?

Steelhead--Current estimates of the number of steelhead trout smolts produced by Fish Creek are based on the number of age 1+ fish In the system the previous September. A survlval factor Is applied to the September population to estimate the number of fish surviving the winter to begin their seaward migration the following spring. Such survival factors are poorly documented, but we have used a factor of 0.5 based on a Washington study. In reality it remains unknown whether winter habitat for 0+ fish, or summer or winter habitat for 1+ fish, is actually limiting steelhead trout smolt productlon in Fish Creek. Additional study of fish habitat utilization in winter is needed.

The estimates In Table 16 are based on an observed population of 56,000 1+ steelhead trout in Fish Creek in September of 1984. We believe this is near the maximum summer carrying capacity for this age group. Present production, and potential production since the habitat appears to be fully seeded, would be expected to be about 28,000 smolts. Potential with enhancement is difficult to assess with current knowledge of limiting factors. Assuming that summer rearing habitat for 1+ steelhead trout is limiting production, smolt numbers could probably be Increased by increasing pool habitat. If the riffle/pool ratio in the system was balanced by creating about 100,000 m^2 of pool habitat and reducing riffle habitat by a like amount, an expected Increase of 8,000 1+ steelhead trout would result. smolt production would be Increased by about 4,000 fish.

Coho--Current estimates of the number of coho salmon smolts are based on the number of 0+ fish in the system the previous summer. Since the system is currently underseeded, the number of 0+ fish has high annual variability. Smolt production, estimated by multiplying 0+ September populatlons by a winter survival factor of 0.4 (for changes In in-channel and side channel habitats), has ranged from 2,000 to 7,600 from 1982-1984. We believe that full seeding of present habitat could boost summer populations to 25-30,000 fish, or a maximum smolt production of 12,000 fish. This estimate is based on habitat utilization by coho salmon observed from 1982-84 as populations in the system varied between about 5,000 and 19,000 fish. We do not know If winter habitat is currently limiting coho salmon populations in Fish Creek.

Enhancement of three habitat components could significantly increase summer rearing habitat for coho salmon, and smolt production if summer habitat is limiting. Balancing of the riffle/pool ratio in the lower 5.6 km of habitat used by coho salmon would provide habitat for an additional 18,000 fish. Adding woody complexity and structure to the edges of riffles in the same 5.6 km reach could add an additional 3,000 fish. Development of a second off-channel rearing area, coupled with the present off-channel pond could add, in total, another 11,000 fish. Expected smolt outputs from these three types of improvements, assuming winter habitat is not limiting, would be 12,800 fish. Another 200 smolts might be obtained by improving selected side channels. Improvement of side channels, off-channel habitat, and edges would probably also improve winter survival. Some of these potential projects appear promising and cost-effectlve based on pilot projects now in progress.

Chlnook--There is Inadequate information on chinook salmon to initiate an analysis of smolt production from the Fish Creek basin.

SUMMARY AND CONCLUSIONS

1) Two years of habltat enhancement have made changes In overall availability of four habitat types in the Fish Creek basin. As a result of enhancement, riffle habitat decreased by 4 percent (5700 m^2), pool habitat increased by 3 percent (5800 m^2), "beaver pond" habitat has increased 15 fold (4600 m^2), and side channel habitat increased 2 percent (850 m^2).

2) Populations of 0+ steelhead trout have varied by more than 58,000 fish between 1982 and 1984, but numbers of age l+ steelhead trout have remained remarkably constant, varying by only 6,000 fish over the same period.

3) Steelhead populations are limited by rearing habitat rather than inadequate seeding, but it is unclear as to whether winter habltat for age 0+ fish, or summer or winter habitat for age l+ fish is limiting the production of steelhead trout smolts In the basin.

4) Numbers of juvenile coho in the basin have varied annually in relation to seeding by adults. When full seeding is achieved, edge habitats, side channels, and off-channel ponds will probably limit production.

5) Chinook spawning in the basin is controlled by fall rainfall and the timing of fall freshets. Few juvenile chinook salmon rear in Fish Creek; most move rapidly downstream into the Clackamas River.

6) Immediate changes in fish production associated with the boulder berms, the side channel at km 1, and the alcove trees, have been minimal.

7) Fish response to improvements is often delayed, requiring extended evaluations.

8) Factors limiting productlon of anadromous salmonids are difficult to identify.

9) At least three years of data are needed to understand Interspecies interactions and habltat utilization.

10) The risk of failure to achieve biological objectives of enhancement is high wlthout a thorough pre- and postproject evaluation.

11) A close working relationship between habitat managers and evaluators results in adaptive management.

ACKNOWLEDGEMENTS

We would like to thank Carl McLemore, Judy Bufford, Frank Leone, Sue Hannaman, Lee Benda, and Charlie Dewberry for field work and data analysis. Judy Bufford drew the figures and Phyllis Taylor-Hill perservered with good humor through the typing and organizing of the tables and text. We would like to thank Dave Heller and Dave Hohler of Mt. Hood N.F. for their many helpful comments and interest in the project.

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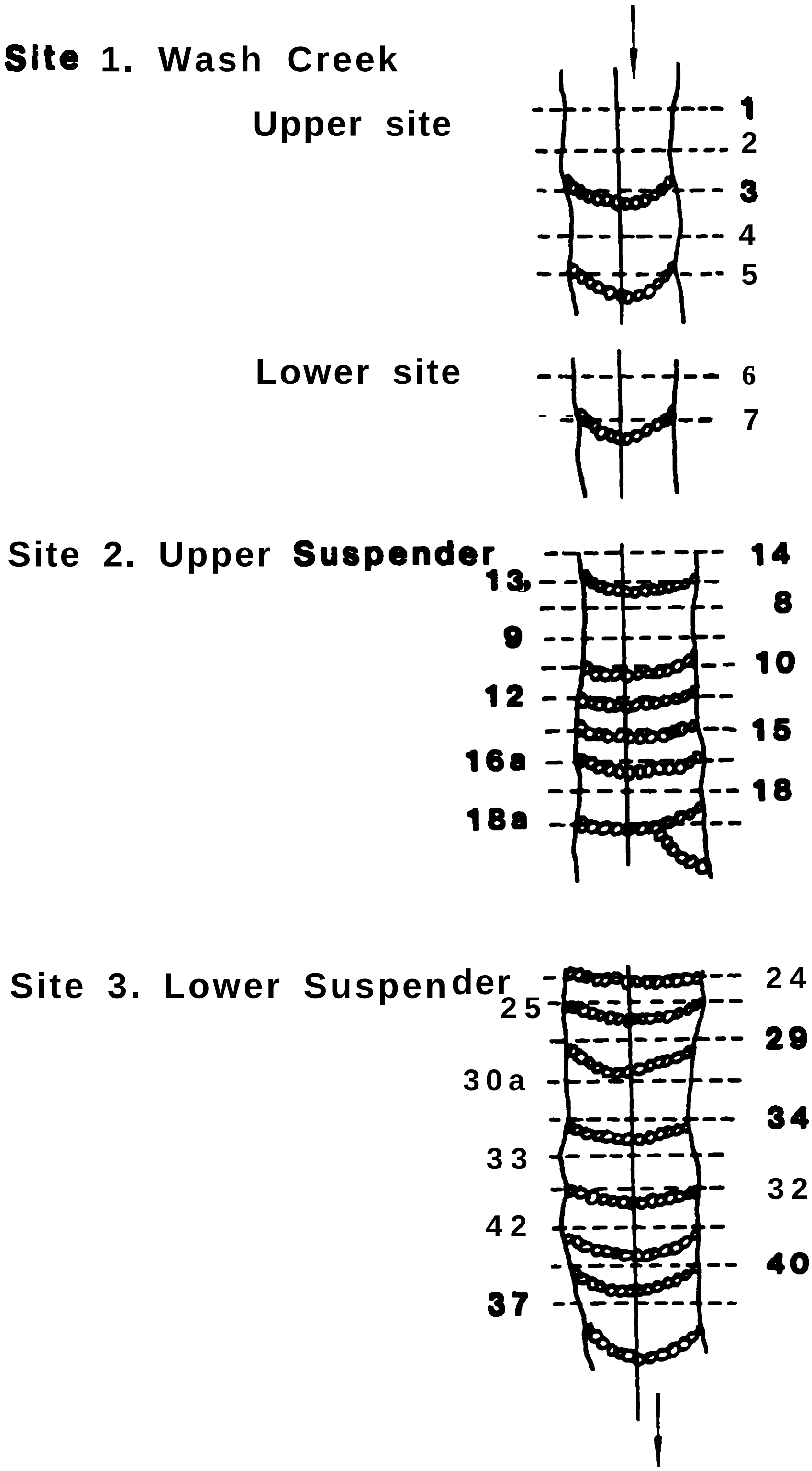
APPENDIX A: BUDGET FOR FISCAL YEAR 1984

BPA BUDGET, FY 1984

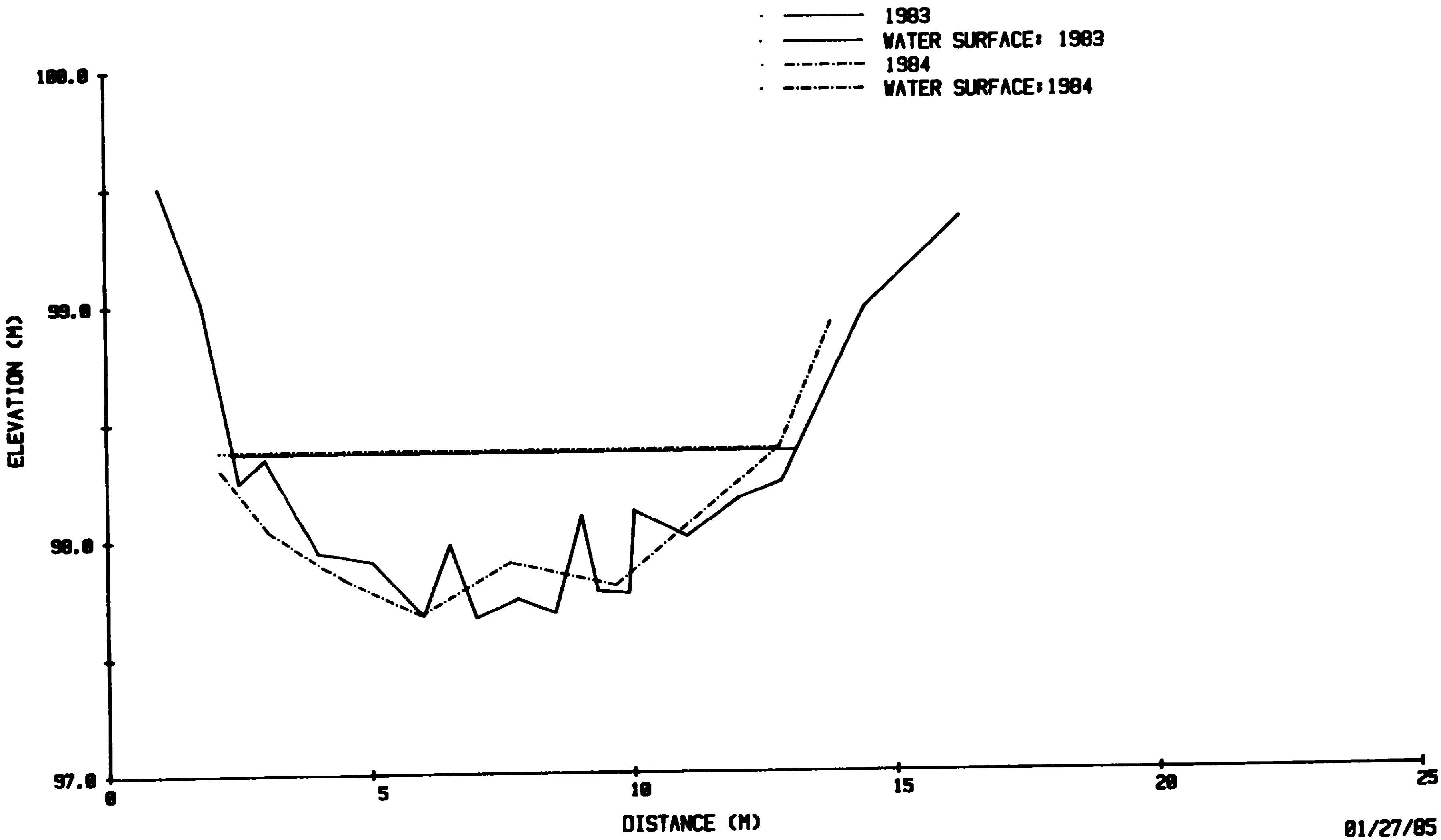
I.	**Habitat Improvement Budget**		
	A. Personnel	22,180.	
	B. Travel/Per Diem	242.	
	c. Equipment/Supplies		
	Expendable	396.	
	Subtotal (A+B+C)		22.818.
	D Administrative Overhead	2,738.	
	E. Contract Costs		
	Equipment Rental	3,760.	
	Subtotal (D+E)		6,498.
	Habitat Improvement Subtotal		29,316.
II.	**Habitat Evaluation Budget**		43,000.
III.	TOTAL		72,316.

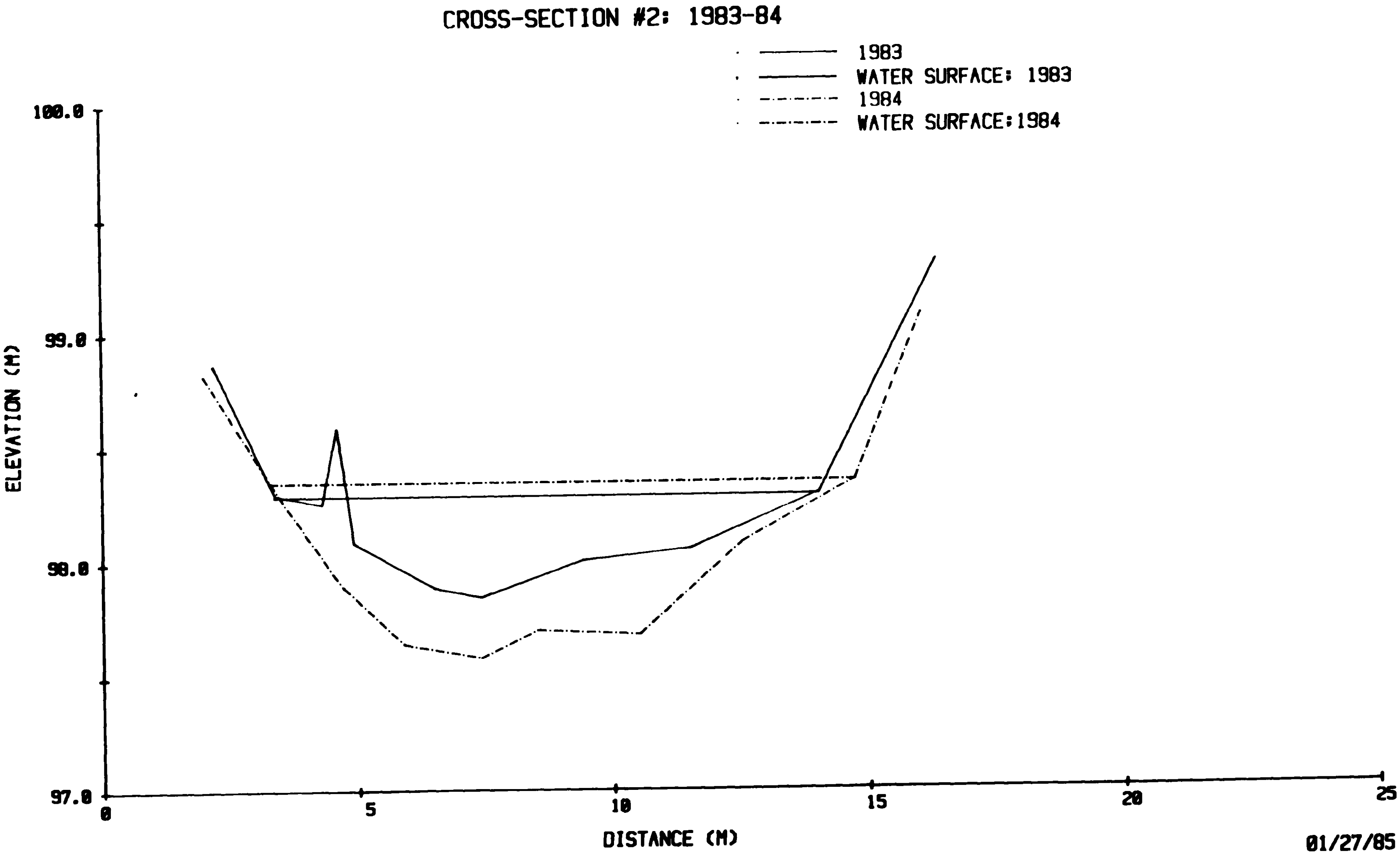
APPENDIX B: SURVEYED PROFILES OF WASH CREEK AND SUSPENDER SITE BERMS ON FISH CREEK



Location of cross sectional profiles.

CROSS-SECTION #1: 1983-84





CROSS-SECTION #2: 1983-84
1983
WATER SURFACE: 1983
1984
WATER SURFACE:1984
100.0
99.0
98.0
97.0
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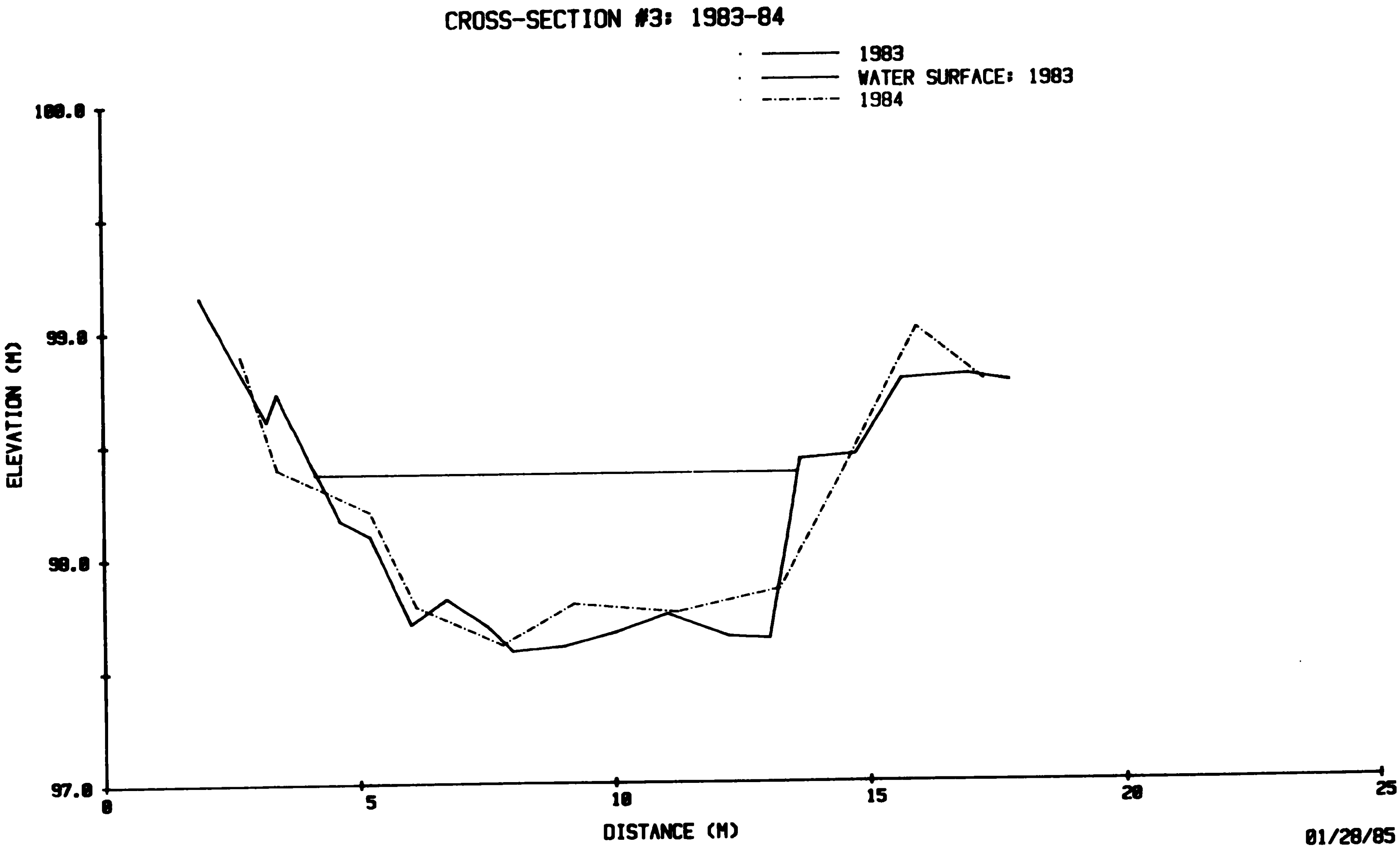
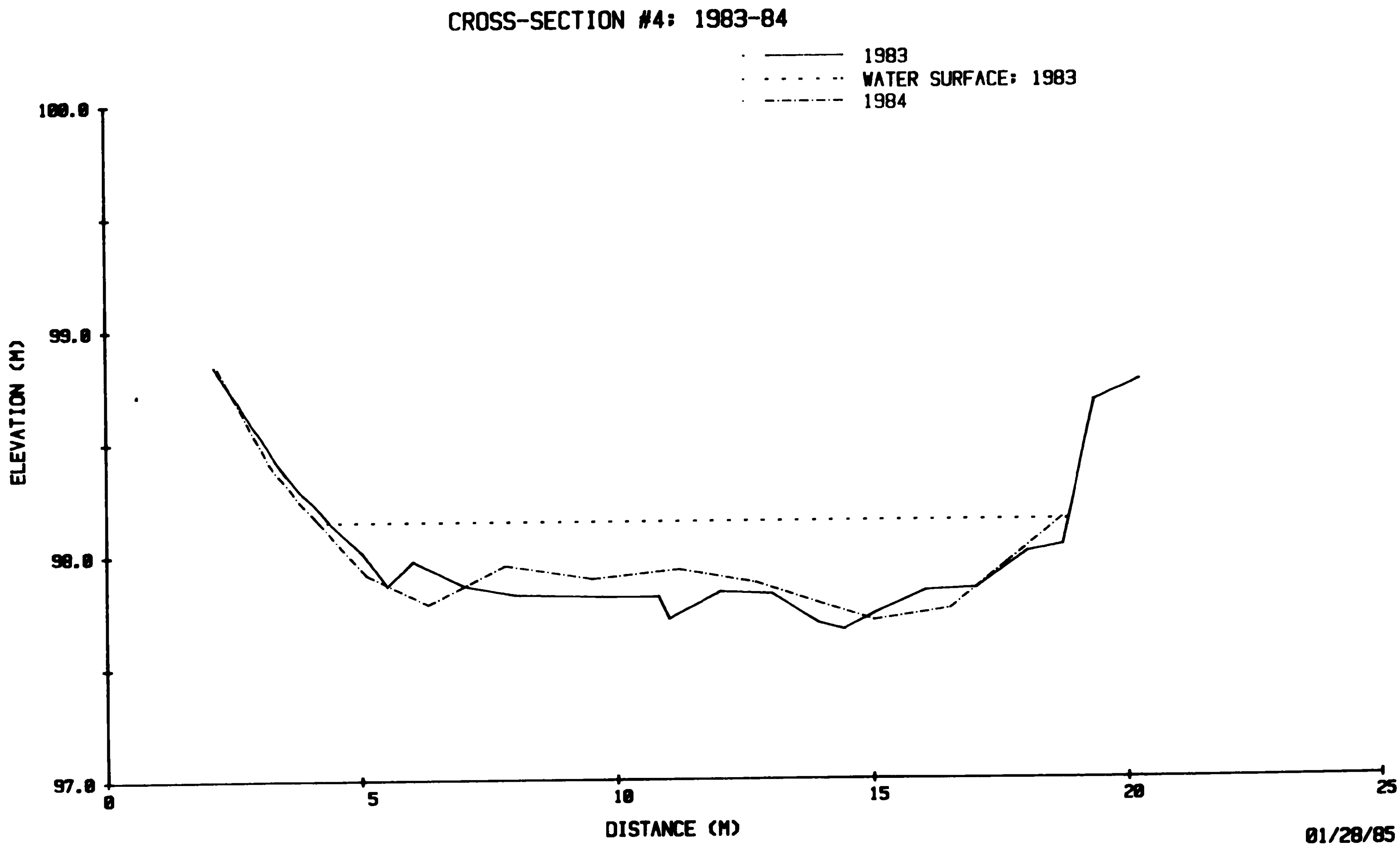
0
5
10
15
20
25
DISTANCE (M)
01/27/85



CROSS-SECTION #3: 1983-84
1983
WATER SURFACE: 1983
1984
100.0
99.0
98.0
97.0
ELEVATION (M)
0
5
10
15
20
25
DISTANCE (M)
01/28/85



CROSS-SECTION #4: 1983-84
1983
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1984
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97.0
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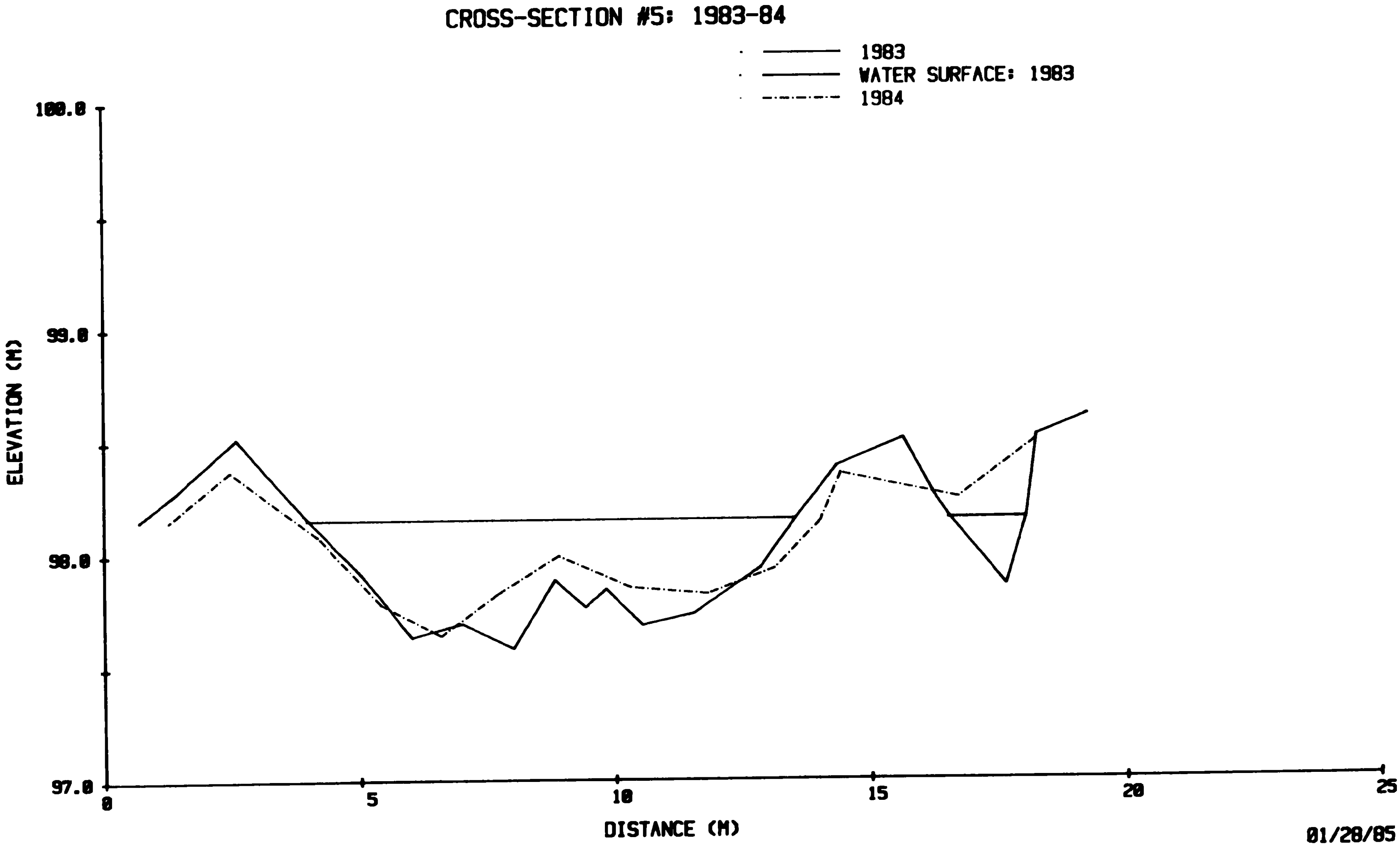
25
DISTANCE (M)
01/28/85



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97.0
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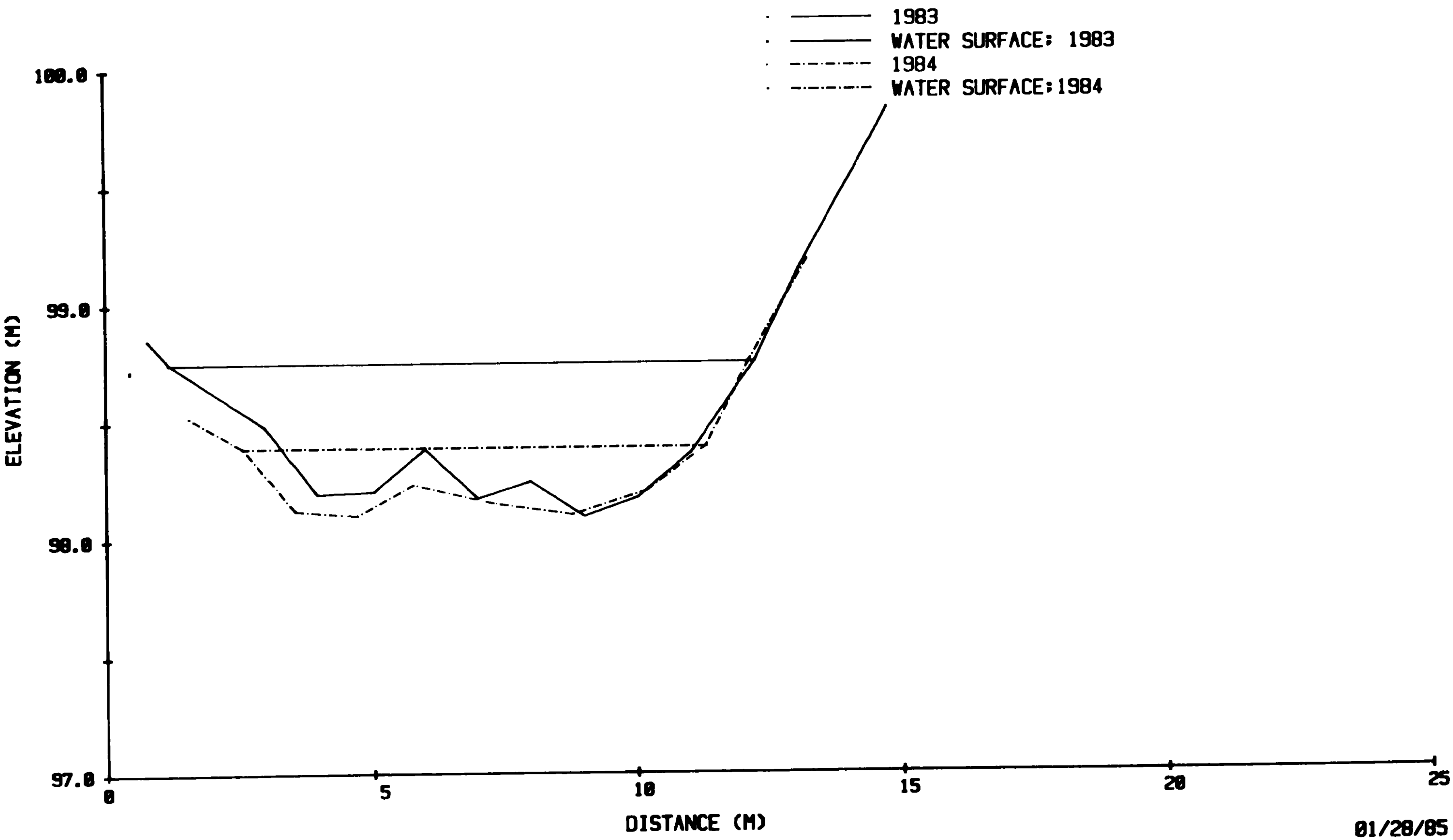
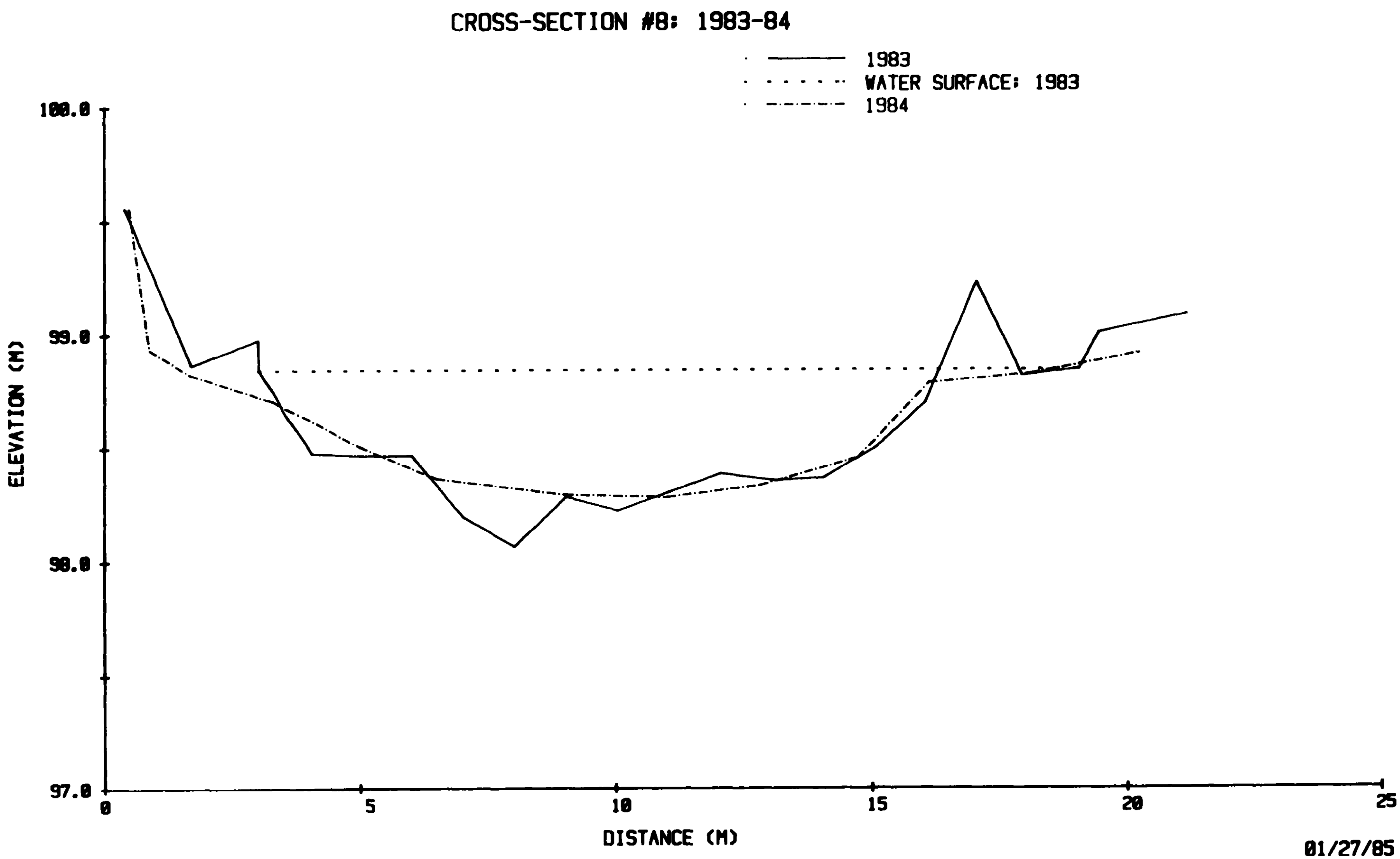
20
25
DISTANCE (M)
01/28/85

CROSS-SECTION #7: 1983-84





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1983
WATER SURFACE: 1983
1984
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99.0
98.0
97.0
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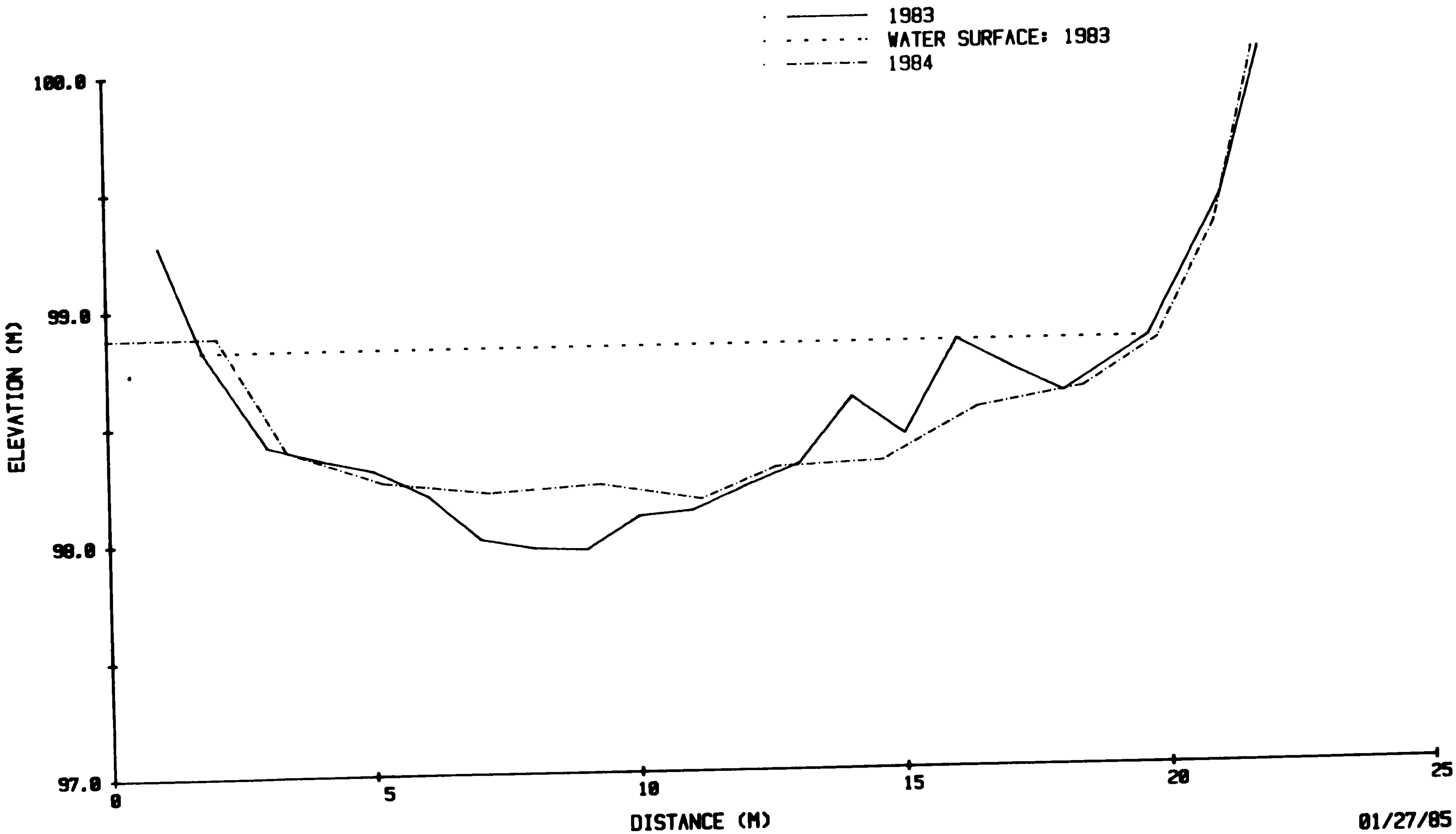
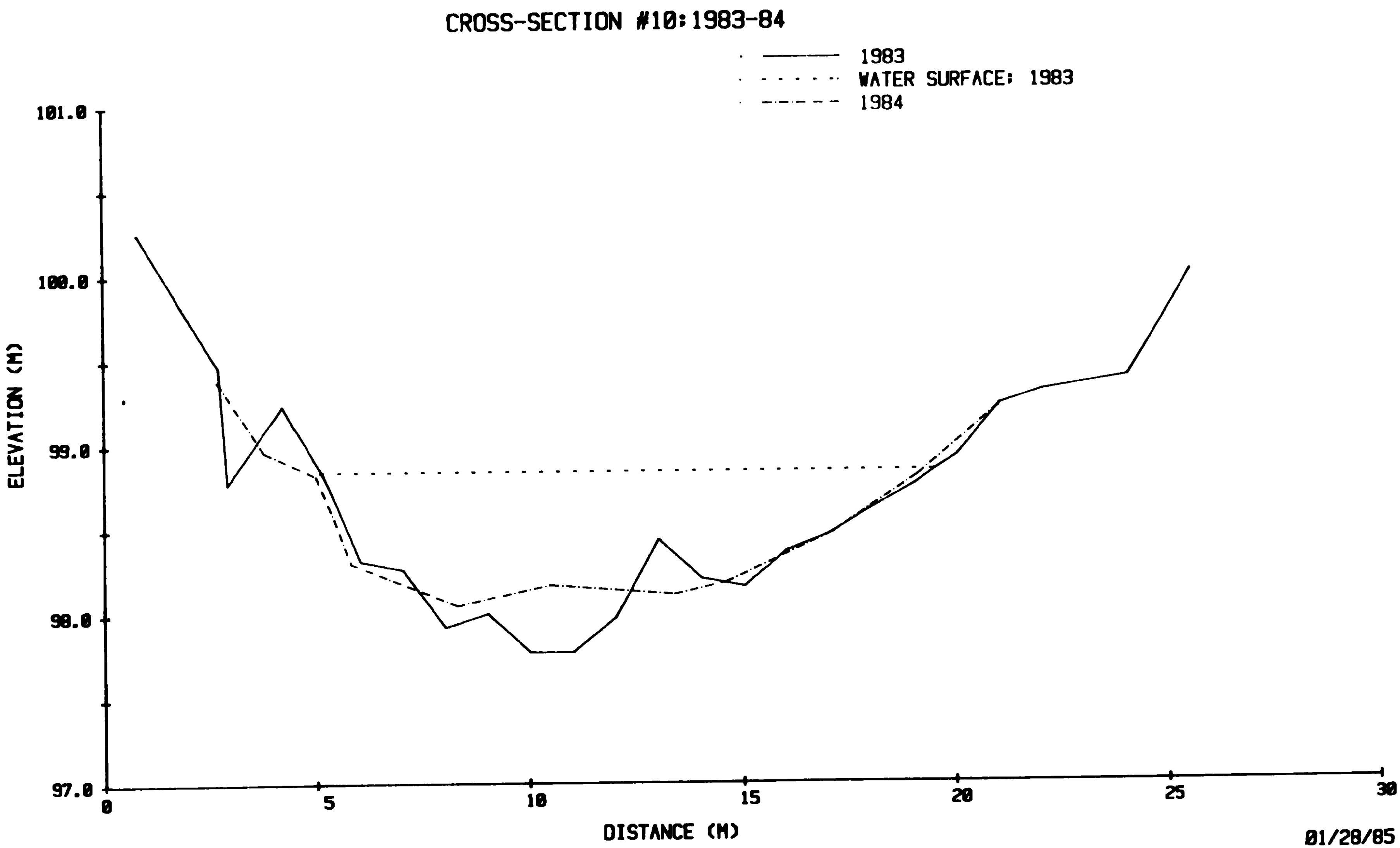
0
5
10
15
20
25
DISTANCE (M)

01/27/85

CROSS-SECTION #9: 1983-84

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98.0
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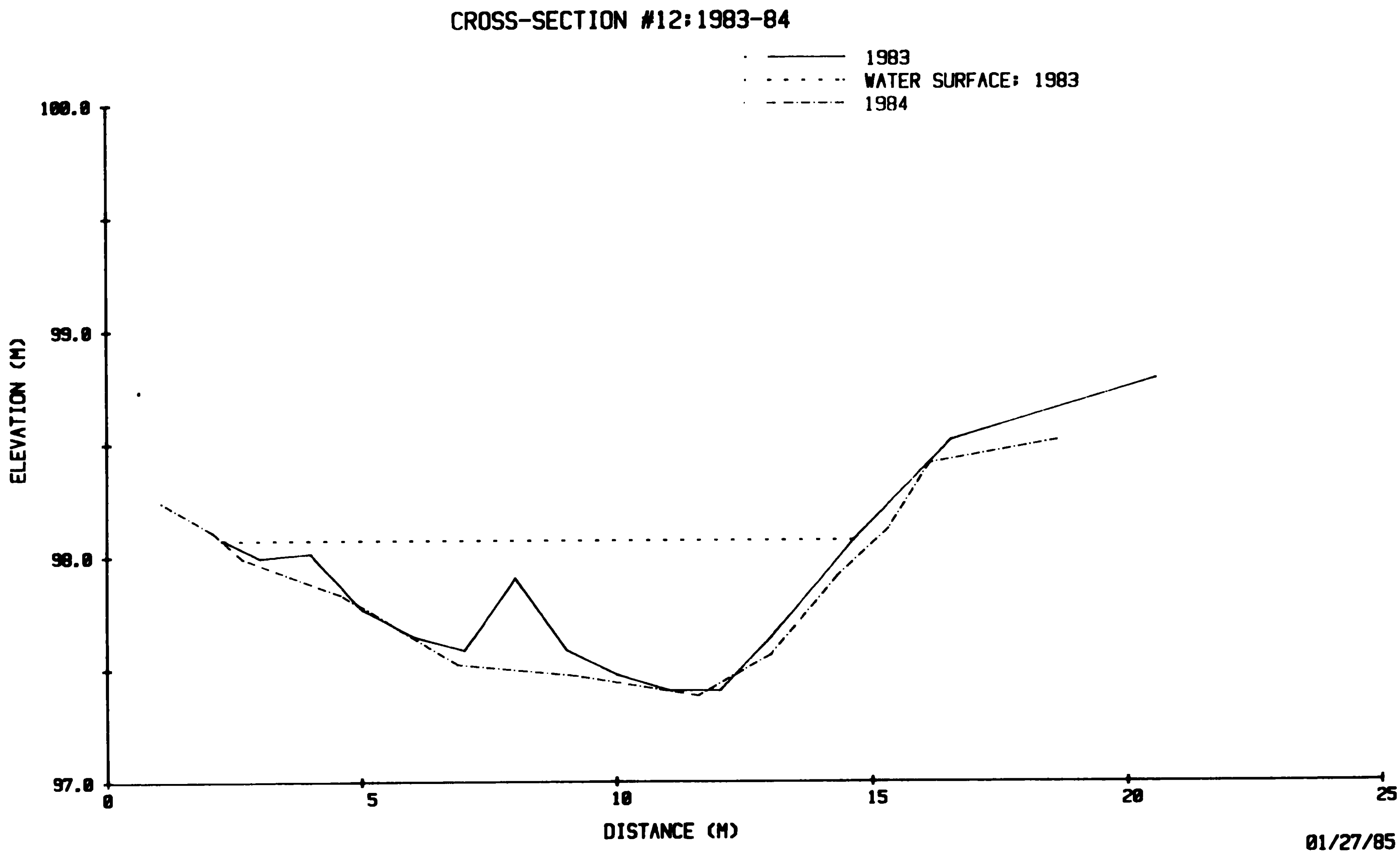
0
5
10
15
20
25
30
DISTANCE (M)
01/28/85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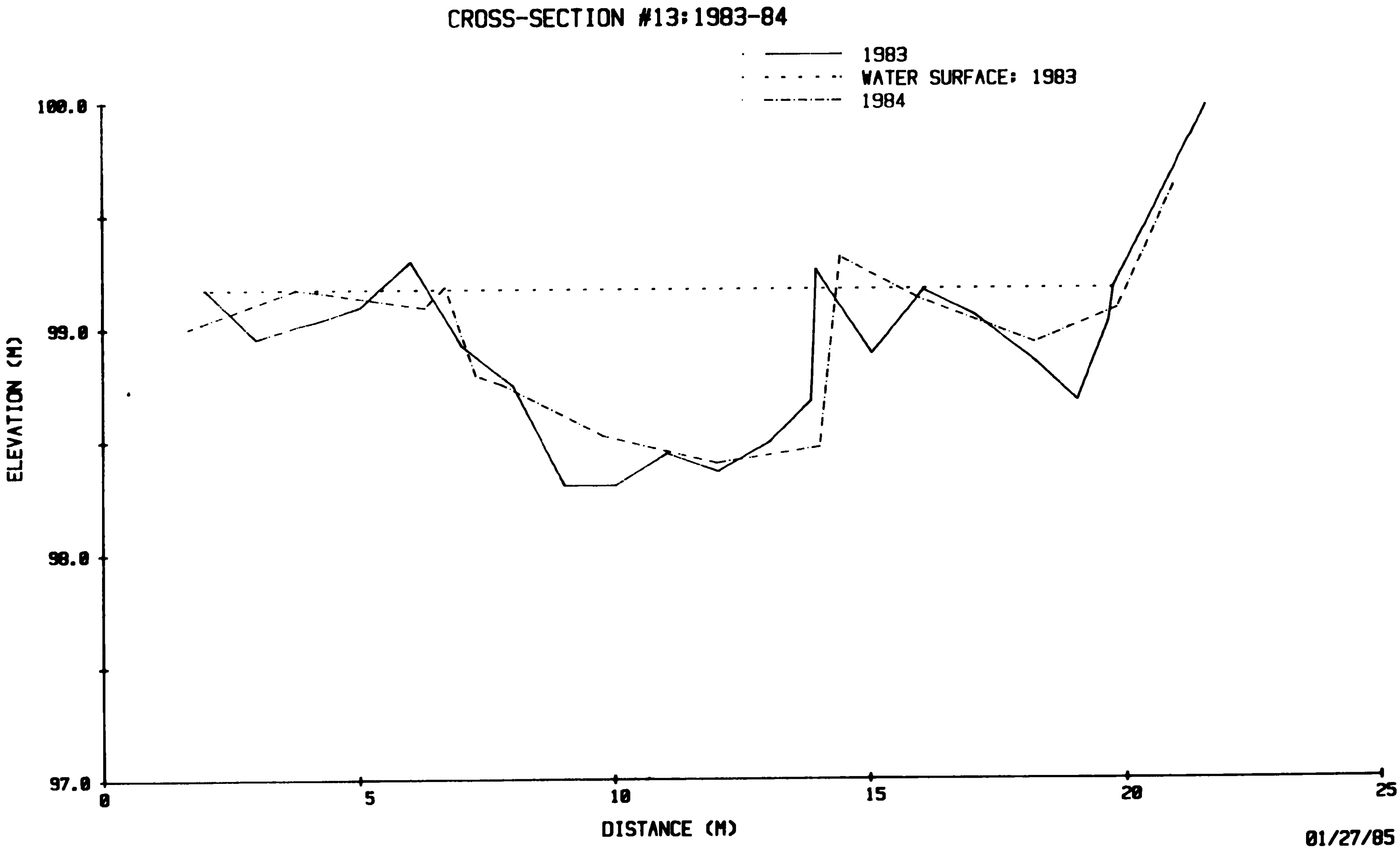
25
DISTANCE (M)
01/27/85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1983
WATER SURFACE: 1983
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98.0
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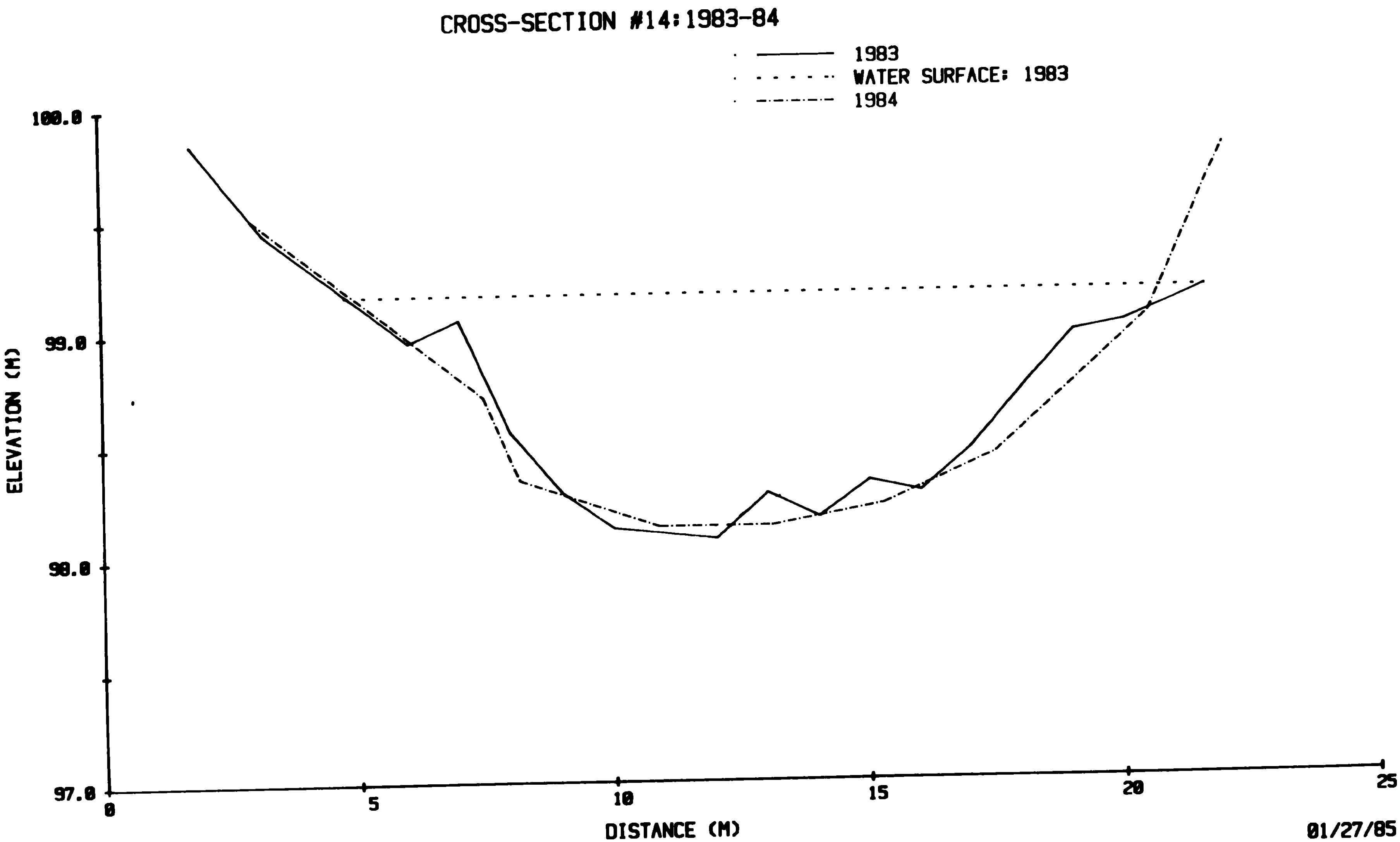
25
DISTANCE (M)
01/27/85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1983
WATER SURFACE: 1983
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99.0
98.0
97.0
ELEVATION (M)
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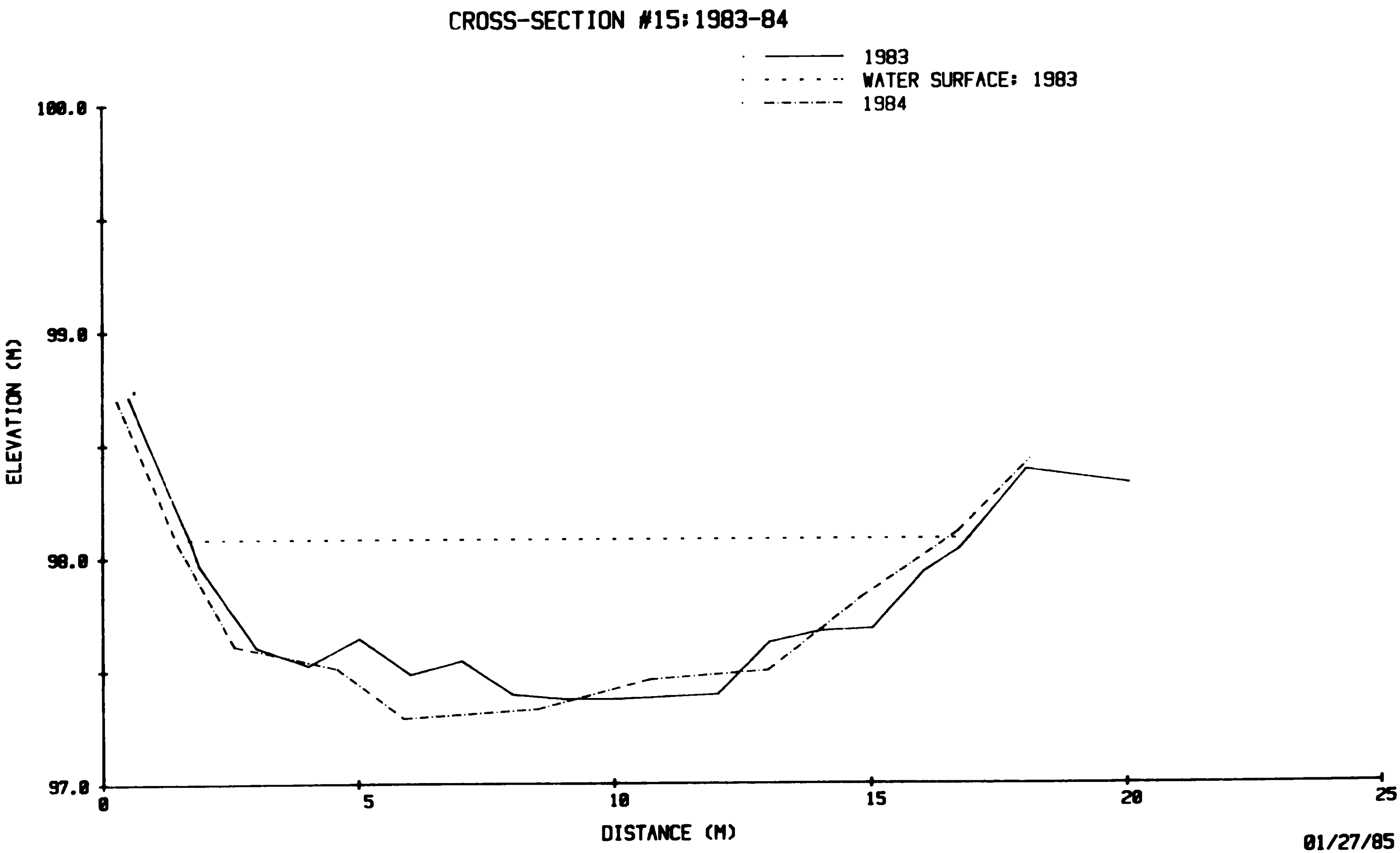
20
25
DISTANCE (M)
01/27/85


CROSS-SECTION #15: 1983-84
1983
WATER SURFACE: 1983
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98.0
97.0
ELEVATION (M)
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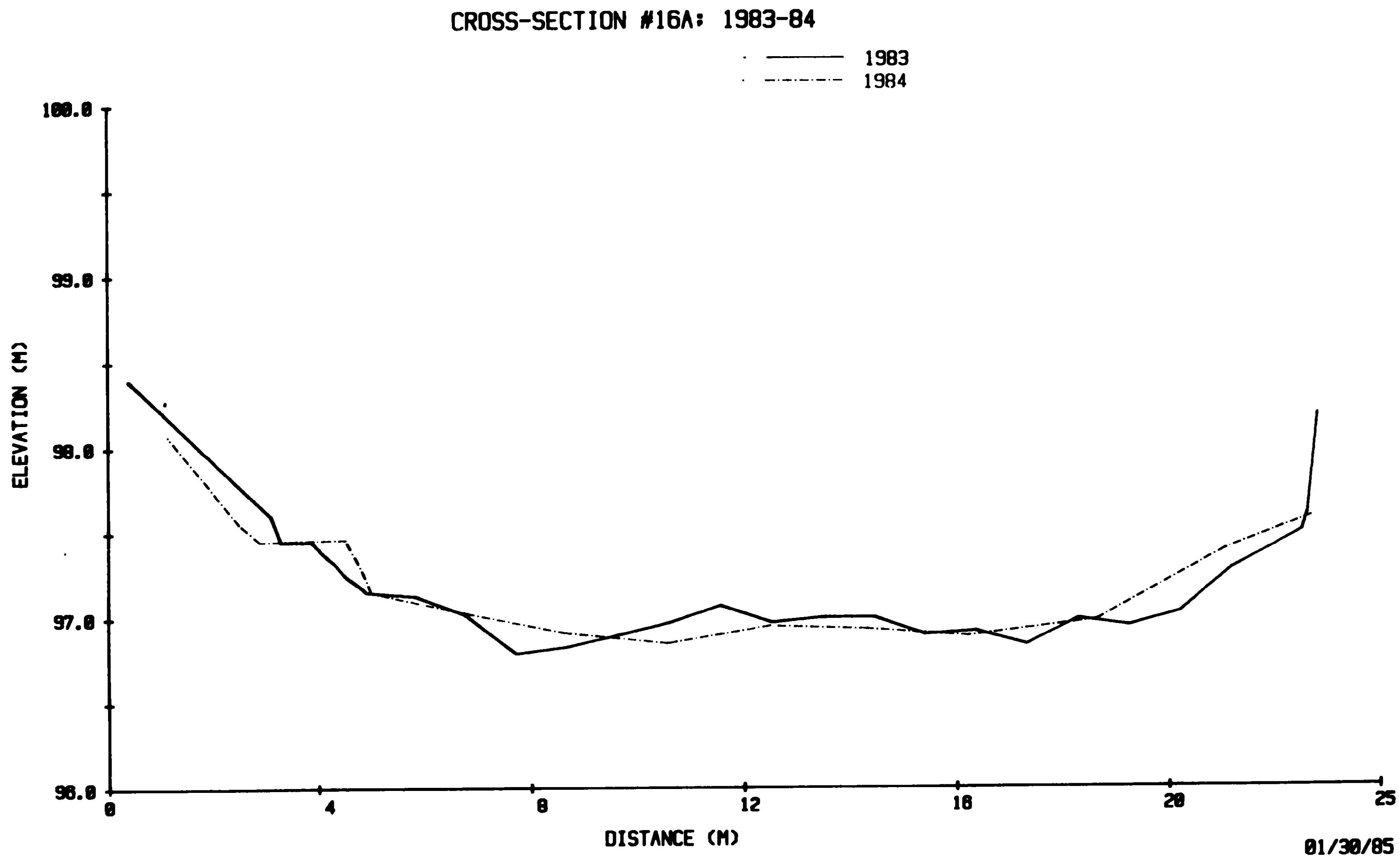
25
DISTANCE (M)
01/27/85



CROSS-SECTION #16A: 1983-84
1983
1984
100.0
99.0
98.0
97.0
96.0
ELEVATION (M)
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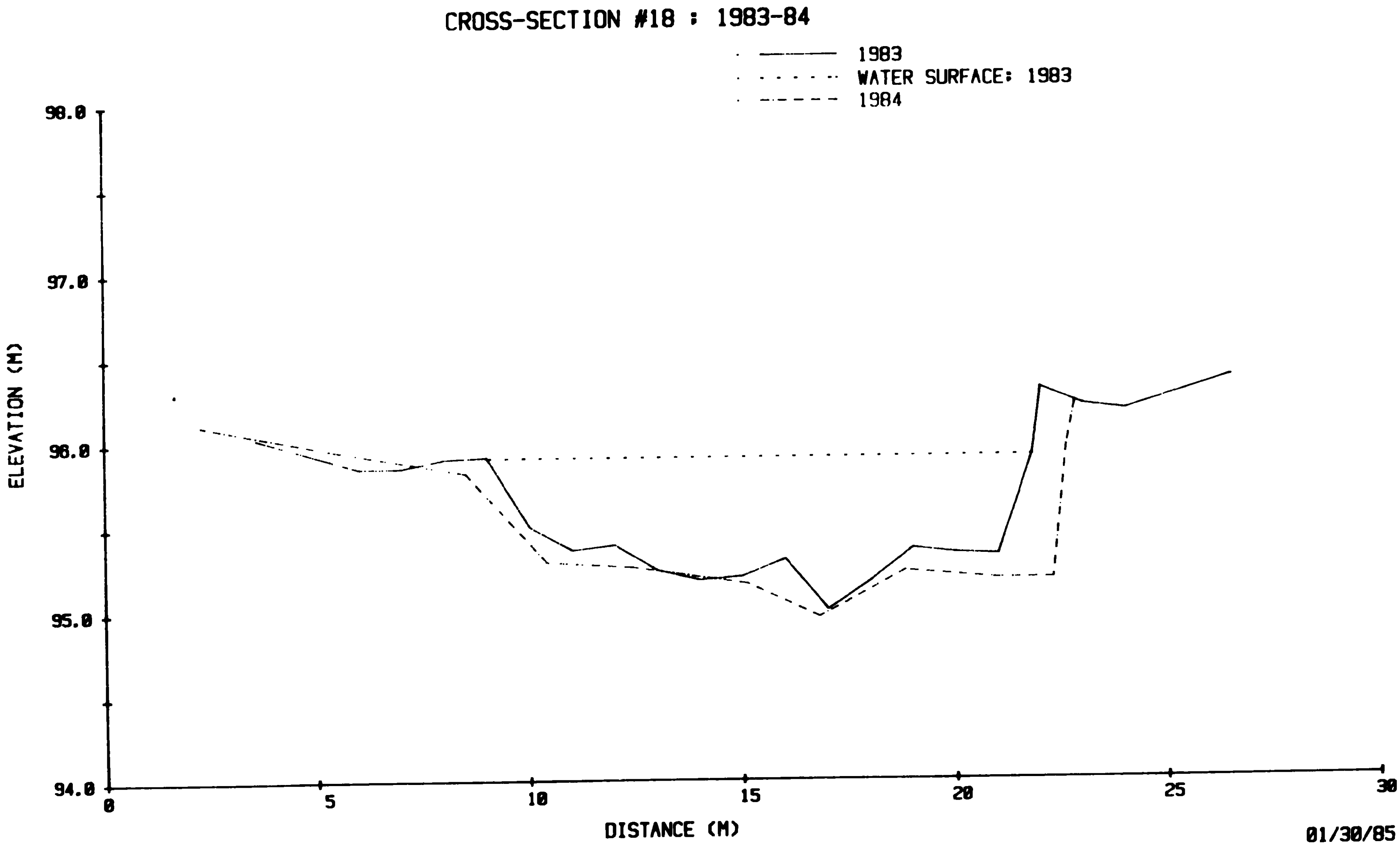
4
8
12
16
20
25
DISTANCE (M)
01/30/85



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1983
WATER SURFACE: 1983
1984
98.0
97.0
96.0
95.0
94.0
ELEVATION (M)
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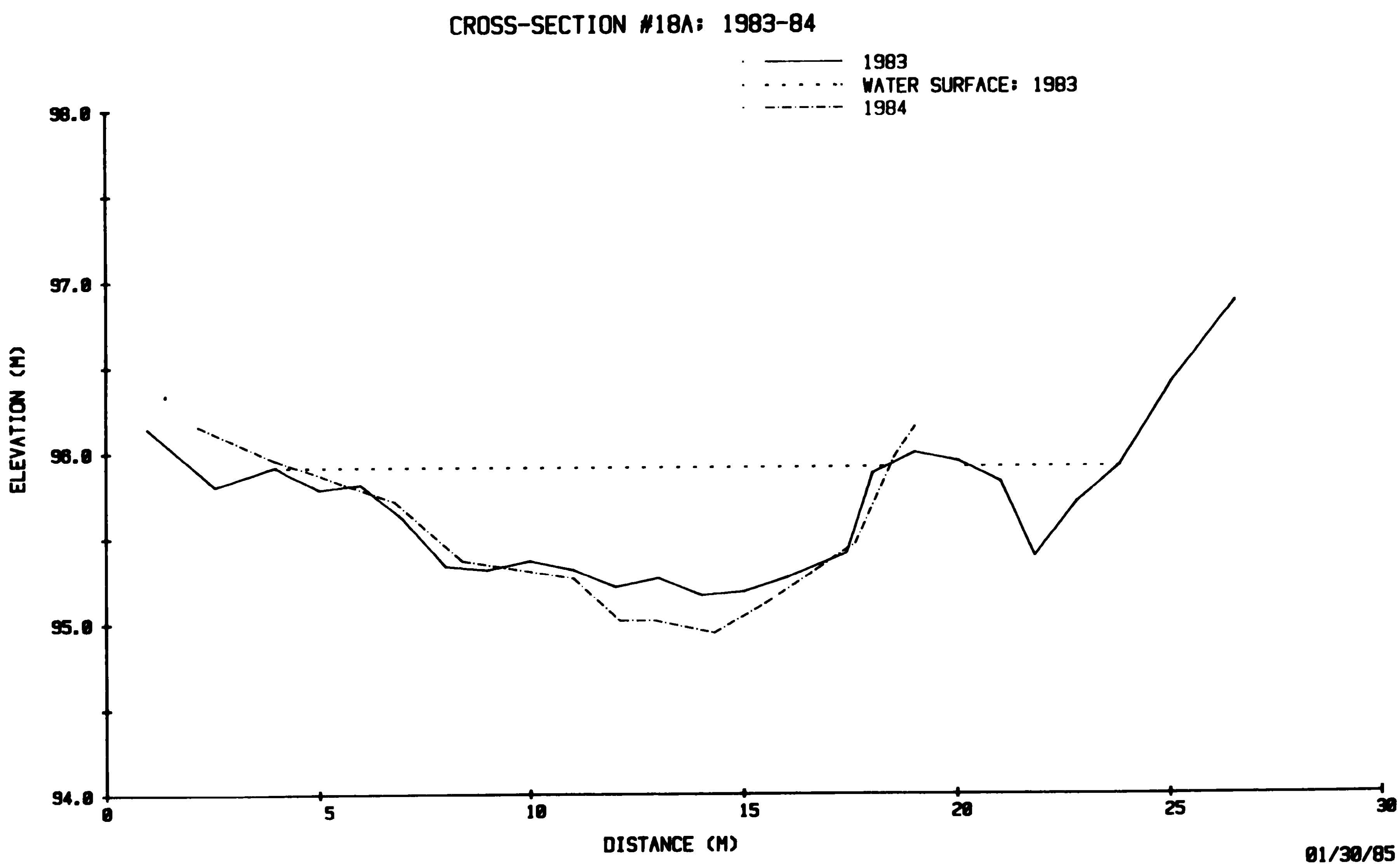
5
10
15
20
25
30
DISTANCE (M)
01/30/85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1983
WATER SURFACE: 1983
1984
98.0
97.0
96.0
95.0
94.0
ELEVATION (M)
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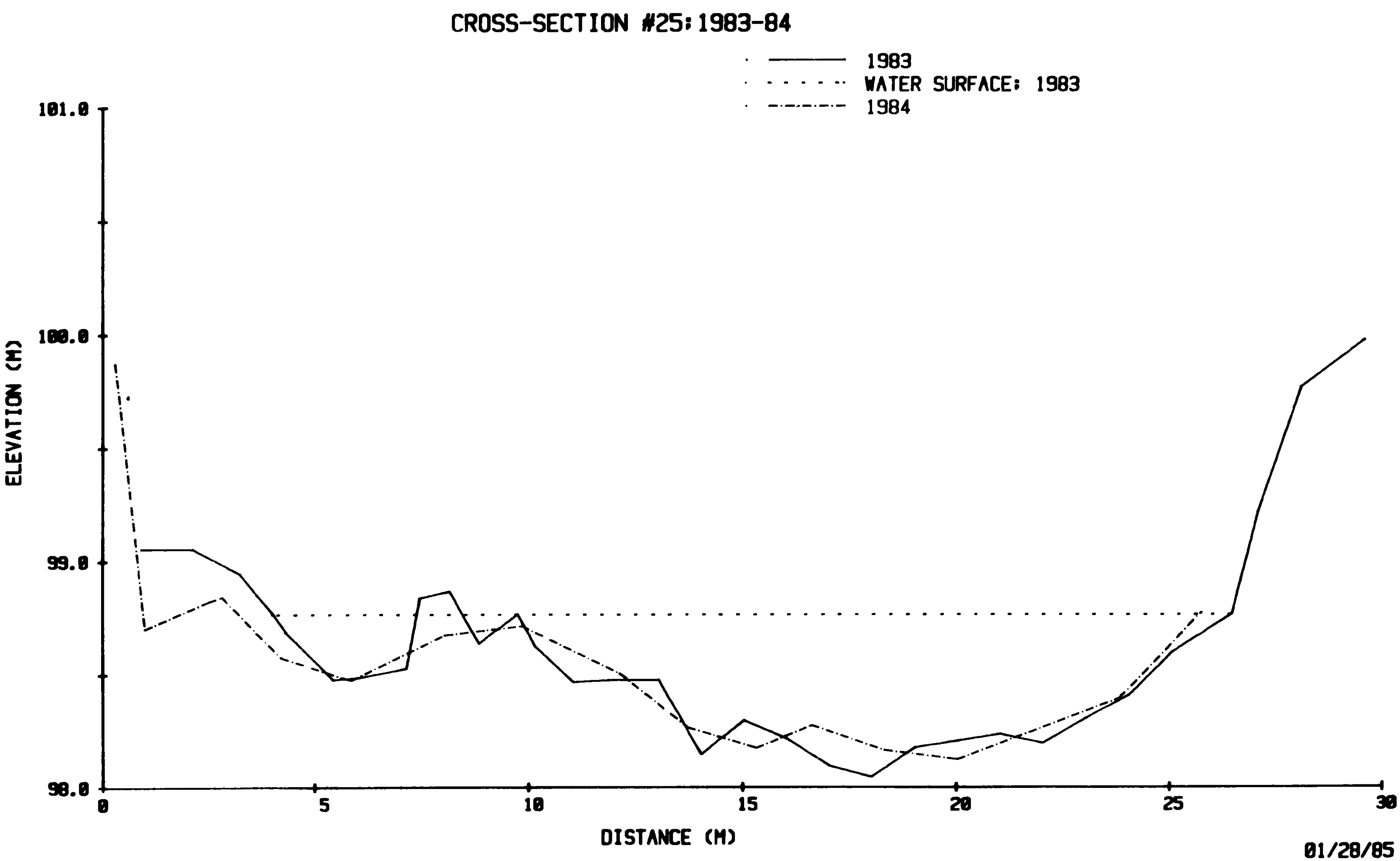
5
10
15
20
25
30
DISTANCE (M)
01/30/85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1983
WATER SURFACE; 1983
1984
ELEVATION (M)
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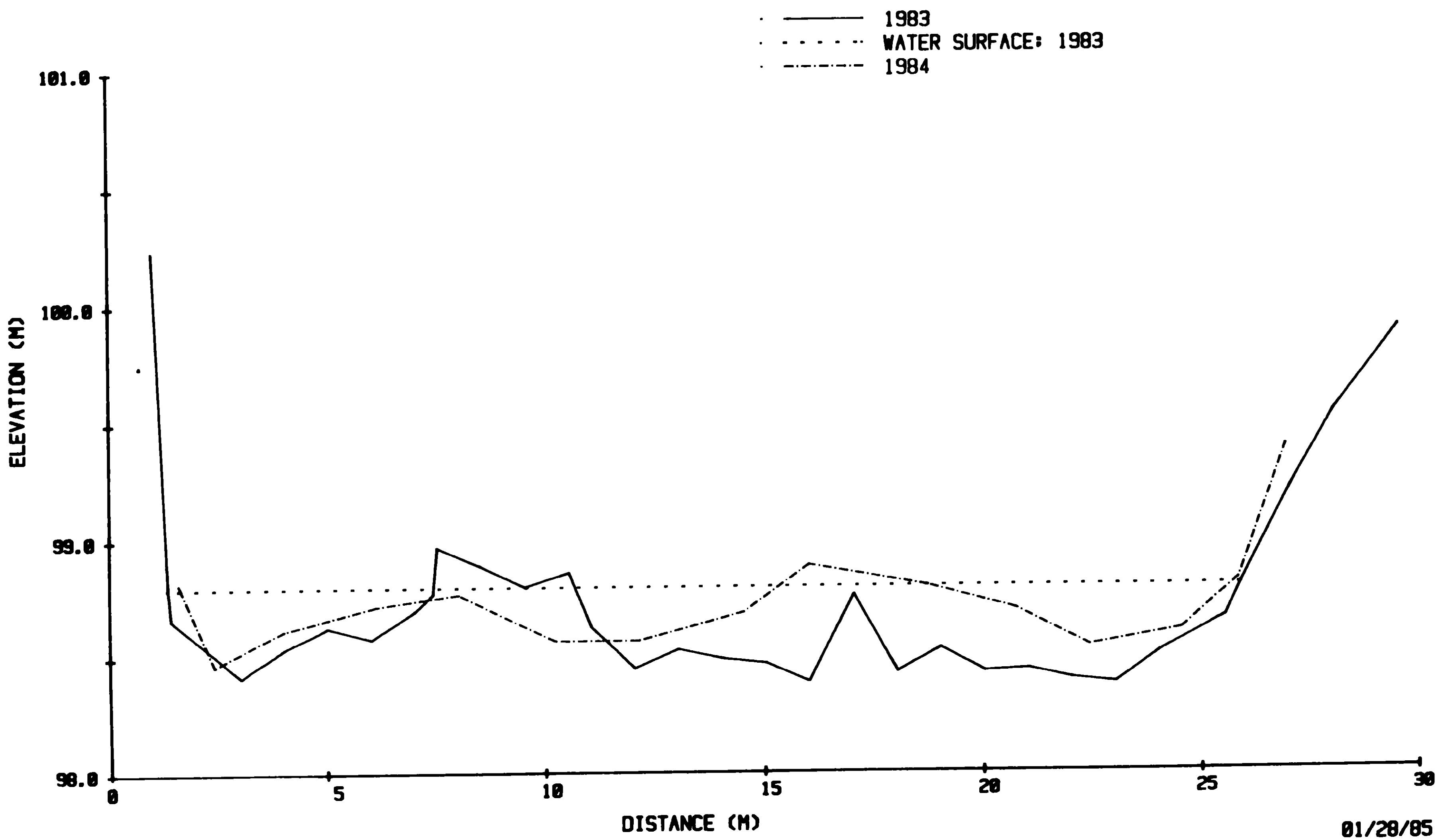
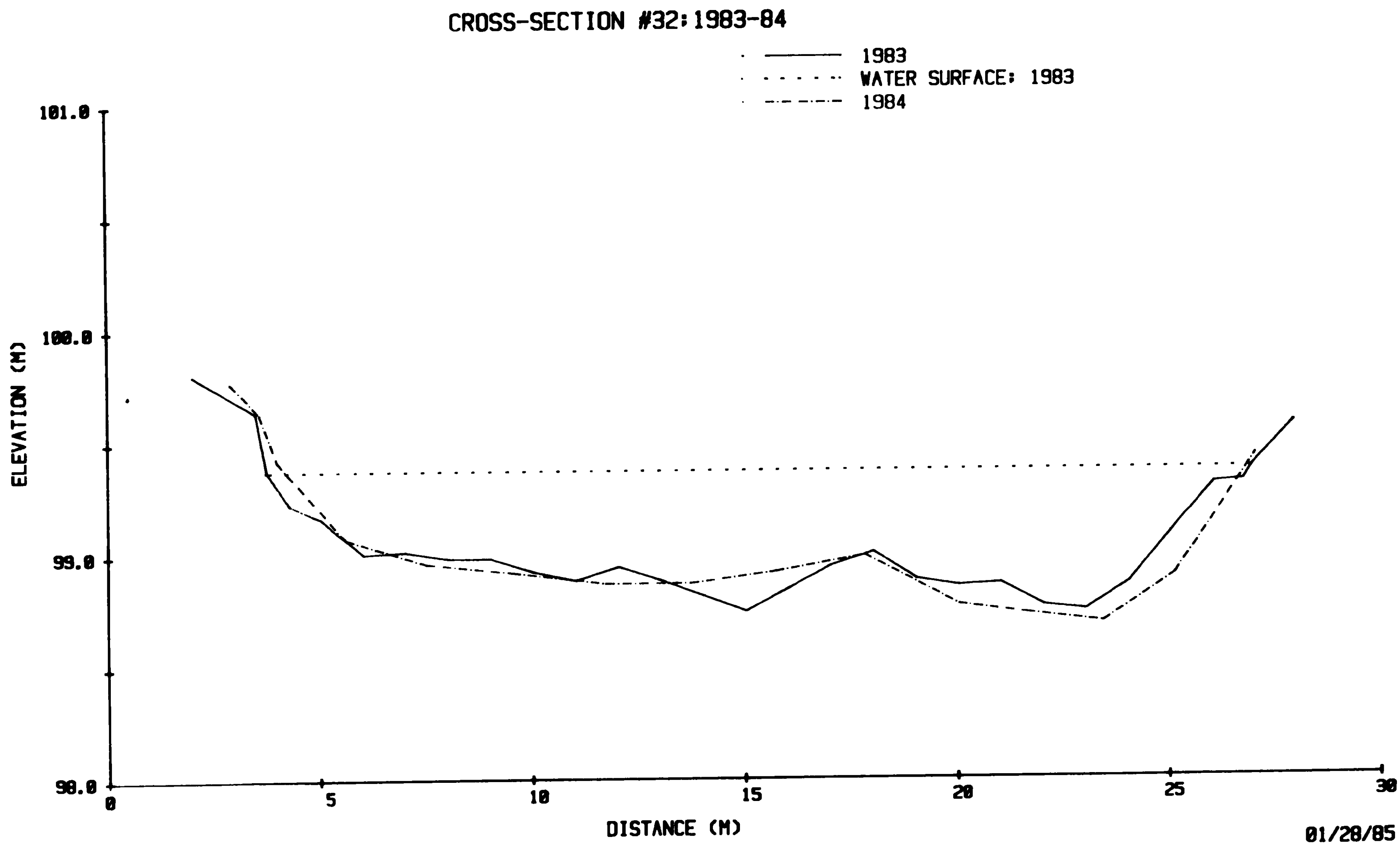
100.0
99.0
98.0
DISTANCE (M)
0
5
10
15
20
25
30
01/28/85

CROSS-SECTION #29: 1983-84

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1983
WATER SURFACE: 1983
1984
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100.0
99.0
98.0
ELEVATION (M)
0
5
10
15
20
25
30
DISTANCE (M)
01/28/85

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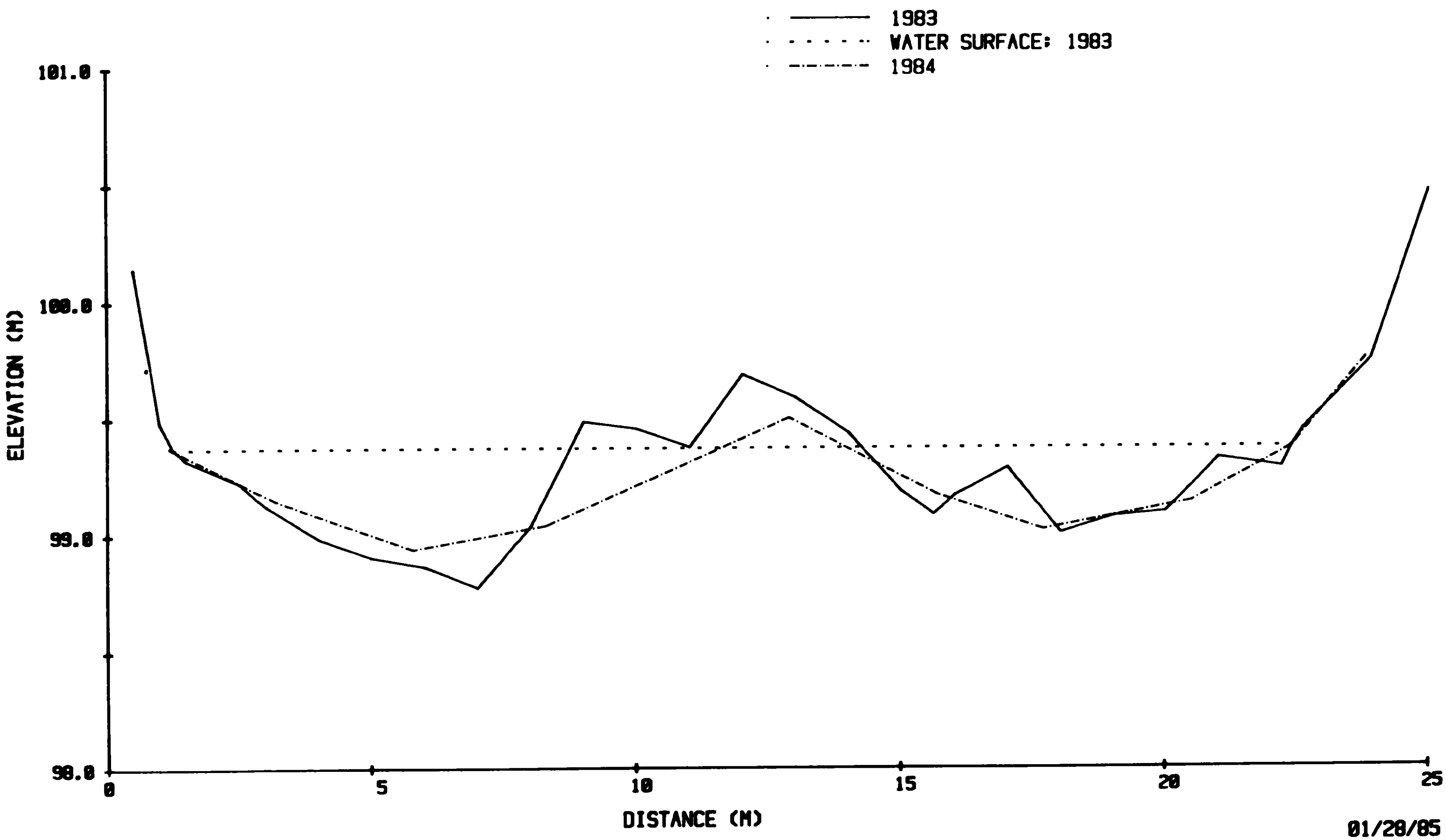

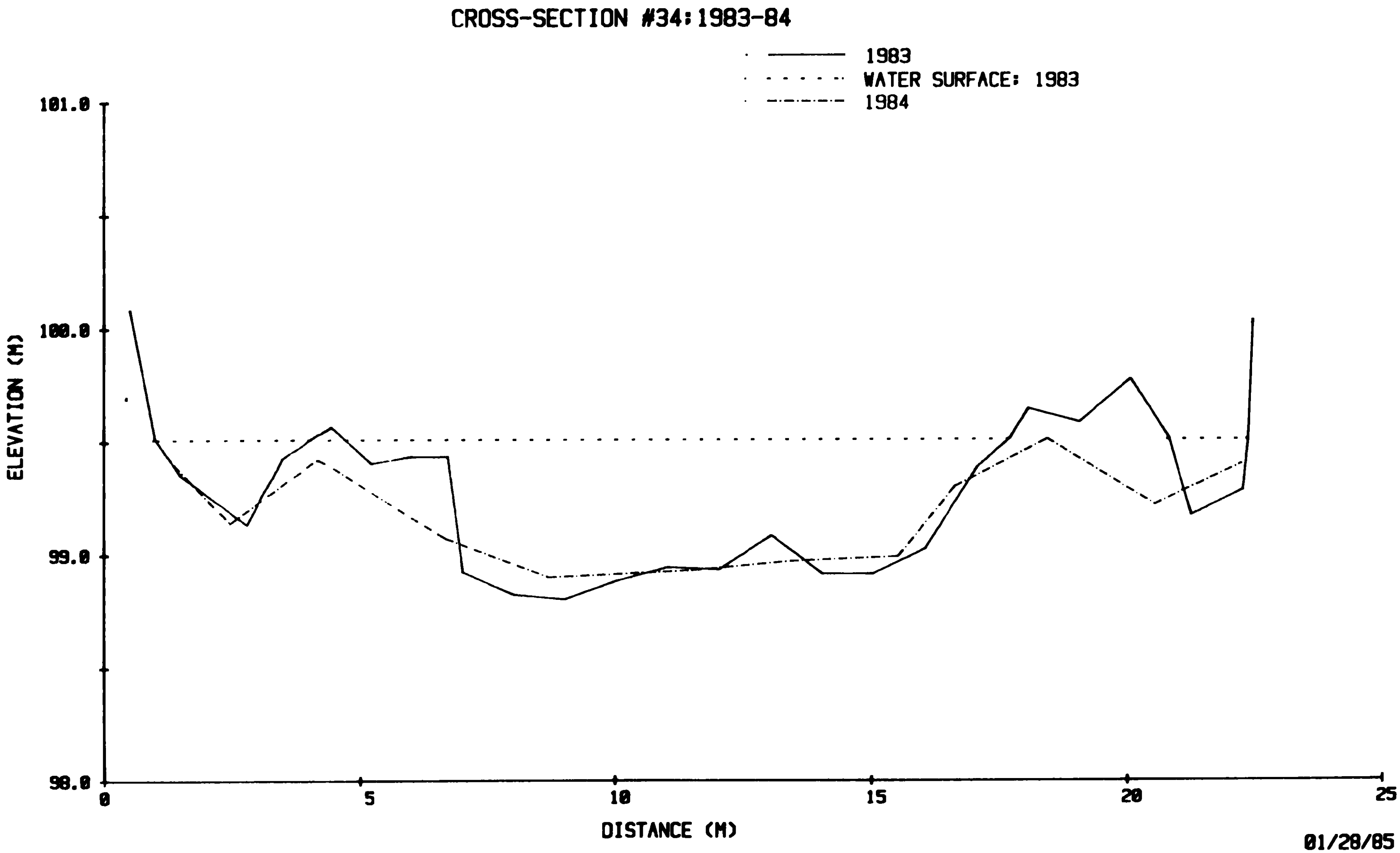

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WATER SURFACE: 1983
1984
ELEVATION (M)
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100.0
99.0
98.0
0
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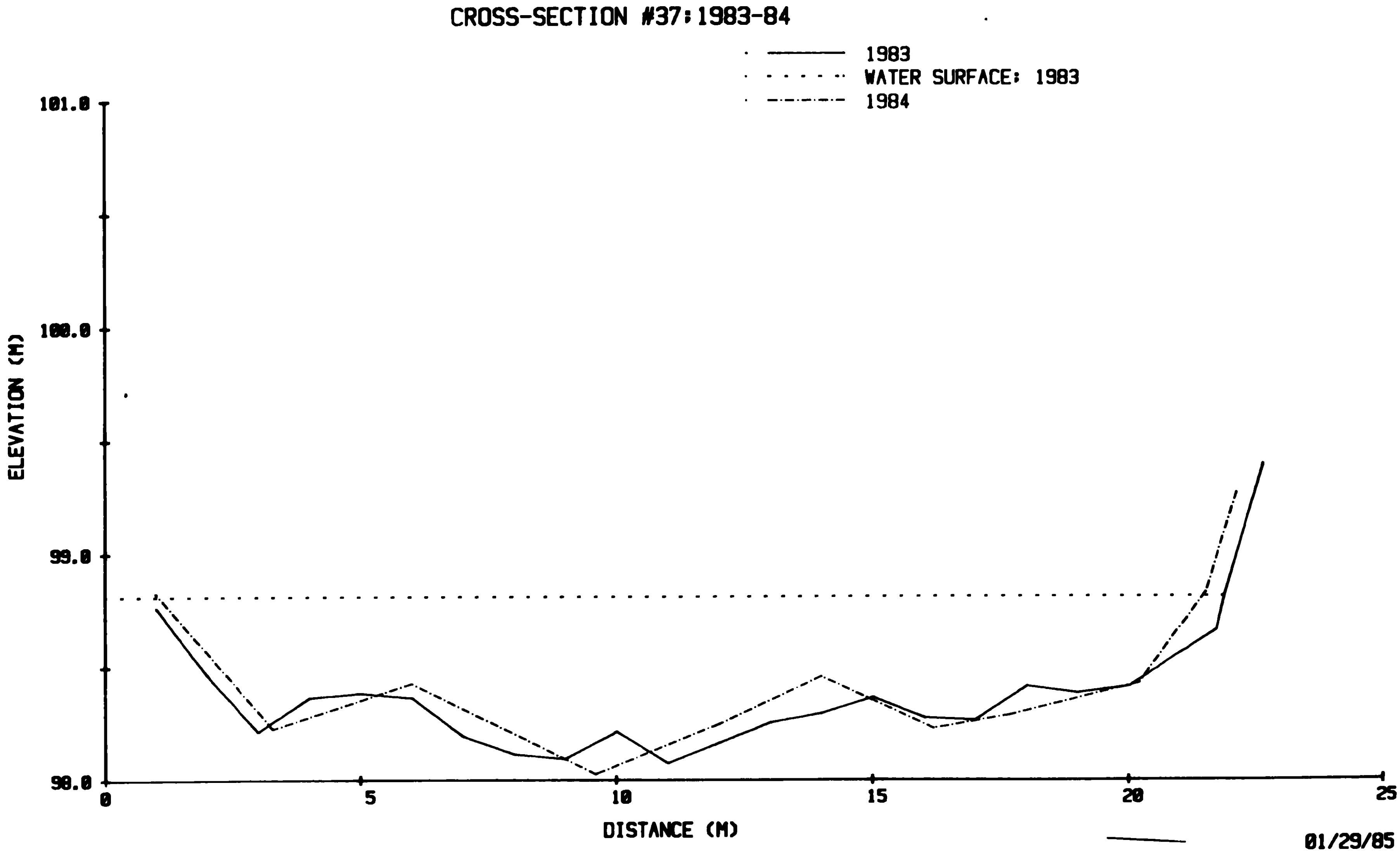
25
DISTANCE (M)
01/28/85


CROSS-SECTION #37; 1983-84
1983
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1984
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100.0
99.0
98.0
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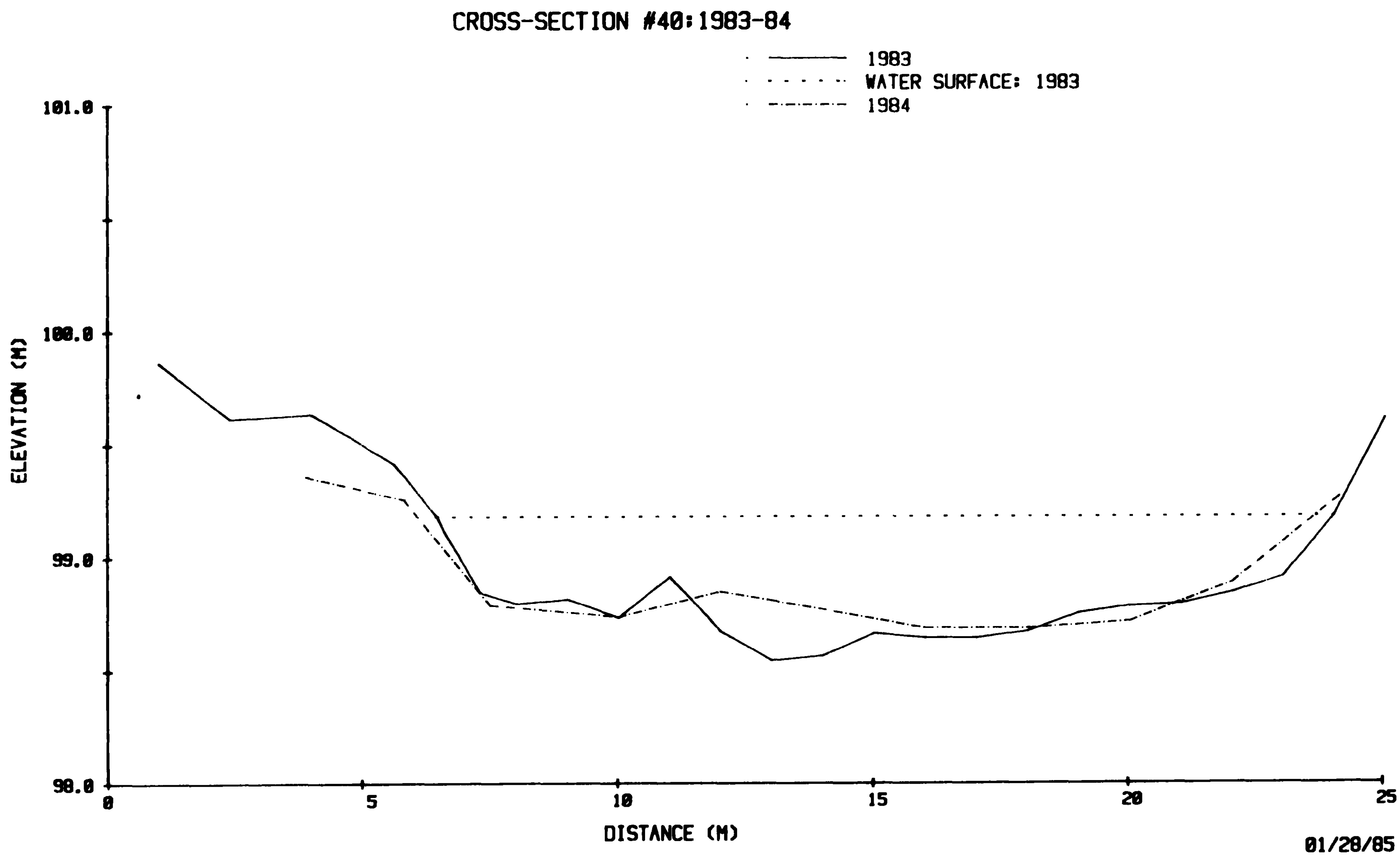
5
10
15
20
25
DISTANCE (M)
01/29/85

142



CROSS-SECTION #40: 1983-84
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WATER SURFACE: 1983
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100.0
99.0
98.0
ELEVATION (M)
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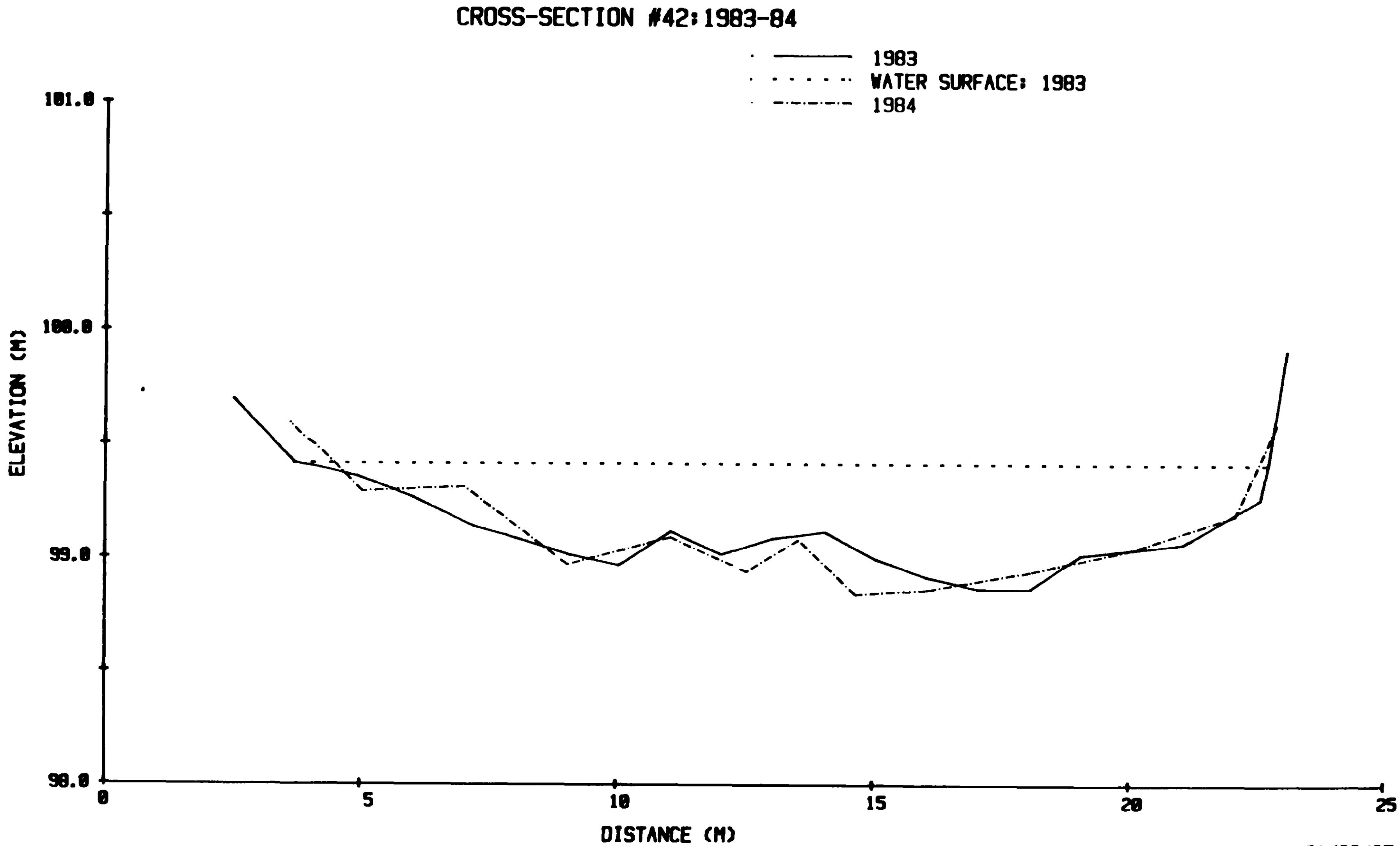
5
10
15
20
25
DISTANCE (M)
01/28/85



CROSS-SECTION #42: 1983-84
1983
WATER SURFACE: 1983
1984
ELEVATION (M)
101.0
100.0
99.0
98.0
DISTANCE (M)
0
5
10
15
20
25

01/28/85

APPENDIX C: FISH CREEK TRIBUTARY SURVEYS

1. THIRD CREEK
2. CALICO CREEK
3. PICK CREEK
4. MUSIC CREEK

THIRD CREEK

Estacada Ranger District

Surveyors: Tom Cain, Doug Kinzey

Date Surveyed: March 7, 12, 1984

Tributary to: Fish Creek

TRI Compartment:
Pup 5402

Gamefish: Trout

Potential Anadromous Species:
Steelhead

Countv: Clackamas

Mouth Location:
T5S., R5E., Sec. 35

Watershed Area:
1,688 acres
2.64 square miles

Stream Length: 2.0 miles

Mean High Water Width: 10 feet

Distance Surveyed:
0.6 miles

Stream Order: IV

Averaqe Fish Habitat Condition Ratinq: 5.3 (fair)

Average Riparian Condition Ratinq: 4.3 (moderate0

THIRD CREEK

Survev Summarv

A. Stream Summary

Third Creek is a fourth order trihutarv to Fish Creek in the Clackamas River drainaqe. On the dates surveved, March 7 and 12, 1984, approximate discharge at the mouth was 6 cfs. The lower 0.6 miles of Third Creek were syrveyed, of which RM 0.0-0.2 appear suitable for anadromous use. Access to this potential habitat is presentlv blocked by the Road 54 culvert crossing at RM 0.05.

B. Watershed Characteristics and Geomorphology

Third Creek flows throuqh a narrow (0-40 feet) flat bottom V-shaped valle throughout the ylength surveyed, RM 0.0-0.6. The flow regime appears moderatelv flashy. Sideslopes are steep (70%). From RM 0.2 - 0.55, the channel is largely bedrock controlled (50% of substrate). It is reported that, from RM 0.6 upstream, landslides and washouts are common. The large slide (100,000 cubicfeet) identified bv the present survey at RM 0.6 appears to be management related (located at bottom of clearcut with a washed-out culvert found in debris).

C. Reach Description

Two reaches are identified. Reach I (RM 0.0 -0.2) appears to be suitable habitat for steelhead, with gradients from 7-10%. Recent (1983-1984) ice-storm blow-down is very heavv on the sideslopes and in the stream channel of this reach. LWD plays a role in 40% of all pool and 90% of high-quality pool habitat formation. Much of the habitat formed by this material appears unstable at present.

In Reach II (RM 0.7 - 0.6) gradient increases (10-14%) as the stream becomes a series of bedrock chutes, slides, and waterfalls. Bedrock/large boulders are responsible for 70% of all pool habitat from RM 0.2 - 0.55. Local source large woody debris is associated with 10% of all pools and 40% of the hiqh quality pools in this reach.

D. Fisheries

The overall habitat condition rating is fair (HCR = 5.3). Spawning gravels are limited, with only 22 years counted over the 0.6 miles surveyed. These were gerenally in small (1 square yead) beds.

The lower 0.2 miles (Reach 1) of this stream appear to posses anadromous potential (HCR = 5.4) if passage is provided at the Road 54 culvert crossing It is presently a complete passage barrier (8% gradeint, 3 ft. jump). From RM 0.2 to 0.55, a nearly continuous series of bedrock chutes and falls likely preclude anadromous use.

E. Riparian Area

The Riparian Condition Rating is moderate (RCR = 4.3). A narrow valley bottom and lack of wetlands or other special habitats are the maior negative factors reducing the score.

F. Rehabilitation and Enhancement

Providing passage at the culvert crossing at RM 0.05 would access 0.2 miles of stream.

Protection of the recent ice-storm blow-down presently in the stream channel, and future source material alonq the steep (70%) sideslopes immediately above the stream, could improve fish habitat through increasing spawning and rearing habitat associated with an increase in stream structure.

Some method of bank stabilization of upstream reaches, such as deciduous plantings alonq clearcut bottoms, could reduce sediment inputs to the Fish Creek drainage.

THIRD CREEK

TABLE I - HABITAT ** DATA SUMMARY

REACH (R.M.)	STREAM				POOLS			RIFFLES (%)						
	HCR	S	P:R	G	d	A	EC	BR	1+	6-12"	1-6"	.1-1"	SD	D
I(0.0-0.2)	5.4	75	3:7	7	M-H	6	M	-	10	40	40	5	5	4
II(0.2-0.6)	5.3	70	4:6	10	M	3	M	50	30	10	*	*	*	6

*These values were ohtained in March during mean high flows. Major variations may be preseent at low flows.

LEGEND:

- HCR: Yabitat Condition Ratinq
- s: Percent of stream shaded
- P:R: Ratio of pool length:riffle length
- G: Average sradient (%)
- d: Average maximum depth (L 12" M = 12 - 29", H _ 30")
- A: Average pool area (sq. yards)
- EC: Effective cover (L 40%, M = 40-60%, H _ 60%)
- BR: Bedrock
- SD: Sand
- D: Average depth (inches)
- *: Present, but less than 5%

THIRD CREEK

TABLE II - FISH SPECIES OBSERVED AND RELATIVE ABUNDANCE/100 FT.

Species	REACH I	REACH II	TRIBUTARIES
Rb	( )	( )	
Ct		( )	
S+W	( )		

LEGEND: L = Low (0-5); M = Moderate (6-50); H = High (50+)
a = adult, j = juvenile

* = habitat suitable, presence reported but not observed.
( )= habitat suitable: may not be present

TABLE III - SPAWNING GRAVEL (SOUARE YARDS)

Reach (R.M.)	Spawninq Gravel (Sq. Yds.) Total	Good	Marqinal
I (0.0-0.2)	9	5	4
II (0.2-0.6)	13	9	4
TOTAL	22	14	a

THIRD CREEK

TABLE IV - FISH MIGRATION OBSTRUCTIONS

STREAM (R.M.)	TYPE	ID #	PASSABLE	RECOMMENDATIONS*
0.05	Culvert	1	N	Provide Passage
(0.1)	Chute	B1	F	Low priority
(0.2)	Falls	F1	N	" "
(0.25)	Falls	F2	N	" "
(0.4)	Falls	F3	N	" "

LEGEND: F = full Passage
P = partial passage
N = no passage

*Refer to special case form for barrier characteristics.

TABLE V - ANADROMOUS HABITAT SUMMARY

REACH	Miles			Rearing		Spawning		
(RM)	Avail.	Pot.	P:R	Area	Depth	1"-3"	3"-6"	Comments
I(0.0-0.2)		0.?	3:?		[illegible]			
II(0.2-0.2[illegible])	0	0.4	4:1	6	2.5	46		
TOTAL	0	0.6				10	0	

Legend: Avail.: Miles of habitat oresently accessible to anadromous fish if introduced.

Pot.: Additional miles of habitat potentially available with complete passaqe enhancement.

P:R: Ratio of pool length : riffle length.

Area: Average pool area (sq. yds.).

Depth: Average pool depth (feet).

Spawninq: Number of Sa. Yards of gravels observed in the 1"-3" and 3"-6" size classes.

THIRD CREEK

TABLE VI - LWD HABITAT OUALITY INFLUENCE

Reach (R.M.)	SP. GRAVELS Total (%)	SP. GRAVELS HO (%)	POOL Total (%)	POOL HO (%)	LWD CHARACTERISTICS OR	#	L	Dia	Source
II(0.2-0.2)00	100	400	10	90	Perp,Var	SM SM	2 12	1	M
					Perp,Var				L

LEGEND:
- Total: Percent of total habitat area dependant on LWD
- HO: Percent of high quality habitat area dependent on LWD
- OR: Angle of orientation to flow; Perp = perpendicular, Var = variable
- #: Number of logs/structure; S = single log, M = multi-log
- L: Average length of logs, expressed in channel widths
- Dia: Diameter of average logs in feet
- Source: L = local
  - T = transported
  - M = mixture of local and transported

TABLE VII - HABITAT AND HYDROLOGICAL FEATURES FOR SUMMER AND BANKFULL CONDITIONS

Reach (R.M.)	SUMMER* w	SUMMER* d	SUMMER* v	SUMMER* Q	BANKFULL W	BANKFULL D	Floodplain Width (Ft.)
I(0.0-0.2)	8	0.5	1.5	6	12	1	30
II(0.2-0.6)	5	1	1	5	15	1	40

W,W: Stream width (ft)
D,d: Stream depth (ft)
v: Velocity (feet/second)
Q: Average reach flow in cubic feet/second

*Data collected in March

THIRD CREEK

TABLE VIII - TEMPERATURE AND SHADE RELATIONSHIP

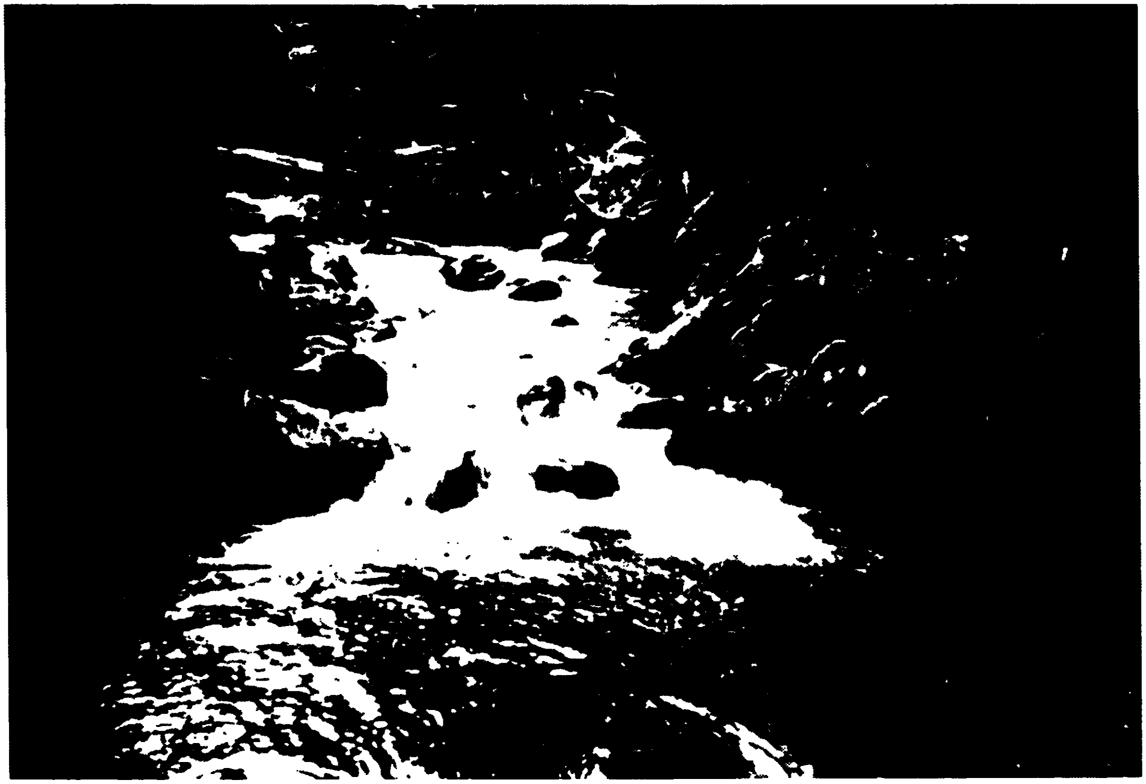
REACH (R.M.)	DATE	FLOW (cfs)	% SHADE	ECT	AIR/WATER A/W		TIME
I(0.0-0.2)	0.23/7/84	6 5	75	ASIW	43/42	47/42	1000
II(0.2-0.6)	3/7/84						
			70				1200

TABLE IX - RIPARIAN HABITAT SUMMARY

VALLEY RM)	RCR	F.P. (ft . . .)	VEGETATION H.U.	Overstory con.	Dec.	AOUATIC Streamclass	Wetland%	Size	Special Habitat
I(0.0-0.2)	4.3	30	4			II	0		0
II(0.2-0.6)	4.3	40	4	3	1	II	0		0

LEGEND:

- RCR: Riparian Condition Rating
- F.P.: Floodplain width in feet
- H.U.: # Habitat units (H _ 4; M = 2-3; L _ 1)
- Con: # Conifer species
- Dec: # Deciduous species
- Wetland: Percent of stream length with adjacent wetlands; (H 50%; M = 25-50%; L 25%)
- Size: Size of wetlands
  - S = small (less than 1 acre)
  - L = large (qreater than 1 acre)

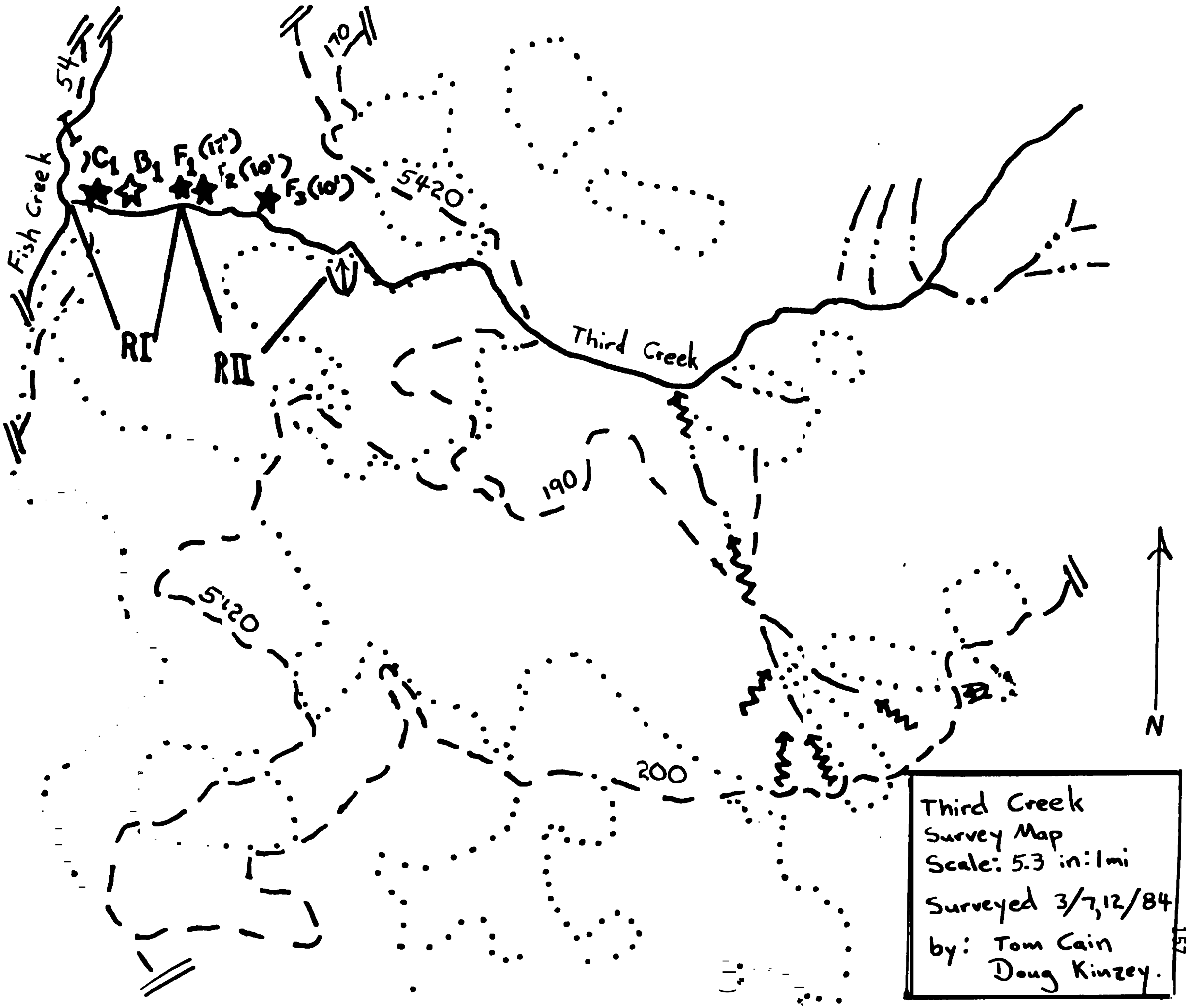


RM 0.1 - Fish habitat in Reach I of Third Creek (RM 0.0 - 0.2) is fair (RCR = 5.4). Anadromous access to the stream is presently prevented bv a harrier culvert for Road 54. Note recent ice-storm blowdown in photo background.

RM 0.25 - Recent (winter, 1984) ice-storm blowdown is forming pools and could retain spawning gravels and increase summer rearing habitat if motected.

RM 0.4 - Bedrock chutes and falls (#F3 pictured) are common throughout Reach II, cumulatively presenting a complete barrier to anadromous migration.

This waterfall at RM 0.2 is an impassable barrier (10 feet high). **In begins** the predominantly bedrock controlled Reach II (RM 0.2-0.6).


54
170
C1
B1
F1 (17')
F2 (10')
F3 (10')
Fish Creek
RI
RII
5420
Third Creek
190
5420
200
N
Third Creek
Survey Map
Scale: 5.3 in: 1 mi
Surveyed 3/7,12/84
by: Tom Cain
Doug Kinzey.

- STREAM SURVEY MAP SYMBOLS -

	CLEAR CUT BOUNDARY
RI,II,III	REACH # rnd SECTION
T1 1.0	TRANSECT # and RIVERMILE
	OBSTRUCT1ON
	BARRIER
J1,2,3,	JAM and #
F( )1,2,3	FALLS, HEIGHT, and #
C1,2,3	CULVERT and #
B1,2,3	CHUTE and #
A	DIVERSION STRUCTURE (I water is used for irrigation purposes)
	MINE or ROCK PIT SITE
	BRIDGE
	LANDSLIDE, SLUMP
	DEBRIS TORRENT TRACK
	SPRING
	UPPER LIMIT OF FISH PRESENT (A limit of potential anadtomous fish habitat)
	BANK EROSION (EXTENSIVE/SEVERE)
	1,2,3, :MISCELLANEOUS
	WETLAND HABITAT
S-47	ROAD AND ID NUMBER
	EARTHFLOW

Culvert # 1 Stream Thi[illegible] Date 3/7/84

Gradient greater than 1½%: Yes 8% No. ______

Type of structure (check)

Round Pipe ✓ | Box | Arch | Open Arch | Open Box | Elliptical

Length of structure 45 ft. Diameter of structure 7 ft.

Are baffles present? Yes ______ No. ✓

Jumping distance into culvert from pool: Height 3'

Pool present below culvert: Length [illegible]', width [illegible]', depth 5'

Stream above culvert: Width 12', gradient 10%'

Stream flowing water: Yes ✓ No ______

Other comments: [illegible]

Culvert # ______ Stream ______ Date ______

Gradient greater than 1½%: Yes ______ No. ______

Type of structure (check)

Round Pipe | Box | Arch | Open Arch | Open Box | Elliptical

Length of structure ______ ft. Diameter of structure ______ ft.

Are baffles present? Yes ______ No. ______

Jumping distance into culvert from pool: Height ______'

Pool present below culvert: Length ______', width ______', depth ______'

Stream above culvert: Width ______', gradient ______'

Stream flowing water: Yes ______ No ______

Other comments: ______

Culvert # ______ Stream ______ Date ______

Gradient greater than 1½%: Yes ______ No. ______

Type of structure (check)

Round Pipe | Box | Arch | Open Arch | Open Box | Elliptical

Length of structure ______ ft. Diameter of structure ______ ft.

Are baffles present? Yes ______ No. ______

Jumping distance into culvert from pool: Height ______'

Pool present below culvert: Length ______', width ______', depth ______'

Stream above culvert: Width ______', gradient ______'

Stream flowing water: Yes ______ No ______

Other comments: ______

Culvert # ______ Stream ______ Date ______

Gradient greater than 1½%: Yes ______ No. ______

Type of structure (check)

Round Pipe | Box | Arch | Open Arch | Open Box | Elliptical

Length of structure ______ ft. Diameter of structure ______ ft.

Are baffles present? Yes ______ No. ______

Jumping distance into culvert from pool: Height ______'

Pool present below culvert: Length ______', width ______', depth ______'

Stream above culvert: Width ______', gradient ______'

Stream flowing water: Yes ______ No ______

Other comments: ______

Falls/Chute # B1 Stream Third Date 1/7

Location: T. ____ R.____ S.____ Stream Survey Mile 0.1

Size: W 5', H 6', L 20' Gradient ____ Barrier: Yes ___ No ✓

Is pool present below the falls? Yes ✓ No ____

Length 8', width 8', depth 4'

Other comments: [illegible] LWD may [illegible]

Falls/Chute # F1 Stream Third Date 1/7

Location: T. ____ R.____ S.____ Stream Survey Mile 0.2

Size: W ___', H ___', L ___' Gradient ____ Barrier: Yes ✓ No ___

Is pool present below the falls? Yes ✓ No ____

Length 20', width 6', depth 5'

Other comments: [illegible]

Falls/Chute # F2 Stream Third Date 1/7

Location: T. ____ R.____ S.____ Stream Survey Mile 0.25

Size: W 12', H 10', L 15' Gradient ____ Barrier: Yes ✓ No ___

Is pool present below the falls? Yes ✓ No ____

Length 15', width 12', depth 5'

Other comments: A1 [illegible] 100 [illegible] B2

Falls/Chute # B3 Stream Third Date 1/7

Location: T. ____ R.____ S.____ Stream Survey Mile 0.4

Size: W 6', H 10', L 2' Gradient ____ Barrier: Yes ✓ No ___

Is pool present below the falls? Yes ____ No ✓

Length ____', width ____', depth ____'

Other comments: [illegible]

Falls/Chute # ____ Stream ____ Date ____

Location: T. ____ R.____ S.____ Stream Survey Mile ____

Size: W ___', H ___', L ___' Gradient ____ Barrier: Yes ___ No ___

Is pool present below the falls? Yes ____ No ____

Length ____', width ____', depth ____'

Other comments: ____

Falls/Chute # ____ Stream ____ Date ____

Location: T. ____ R.____ S.____ Stream Survey Mile ____

Size: W ___', H ___', L ___' Gradient ____ Barrier: Yes ___ No ___

Is pool present below the falls? Yes ____ No ____

Length ____', width ____', depth ____'

Other comments: ____

Landslide # 1 Stream Third Date 3/7

Location: T. ___ R. ___ S. ___ Stream Survey Mile 0.6

Size of Slide: L 200' x W 100' x D 5' = Volume 100,000 cu. ft

Aspect NW Slope 65% Seeps/Spring Present: Yes ✓ No. ___

Estimated Age of Slide: 10 yrs. Torrent Associated: Yes ___ No. ✓

Number of Jams Caused: 0 Original Vegetation: Conifer ...

Still active

Landslide # ___ Stream ___ Date ___

Location: T. ___ R. ___ S. ___ Stream Survey Mile ___

Size of Slide: L ___' x W ___' x D ___' = Volume ___ cu. ft

Aspect ___ Slope ___ Seeps/Spring Present: Yes ___ No. ___

Estimated Age of Slide: ___ Torrent Associated: Yes ___ No. ___

Number of Jams Caused: ___ Original Vegetation: ___

Landslide # ___ Stream ___ Date ___

Location: T. ___ R. ___ S. ___ Stream Survey Mile ___

Size of Slide: L ___' x W ___' x D ___' = Volume ___ cu. ft

Aspect ___ Slope ___ Seeps/Spring Present: Yes ___ No. ___

Estimated Age of Slide: ___ Torrent Associated: Yes ___ No. ___

Number of Jams Caused: ___ Original Vegetation: ___

Landslide # ___ Stream ___ Date ___

Location: T. ___ R. ___ S. ___ Stream Survey Mile ___

Size of Slide: L ___' x W ___' x D ___' = Volume ___ cu. ft

Aspect ___ Slope ___ Seeps/Spring Present: Yes ___ No. ___

Estimated Age of Slide: ___ Torrent Associated: Yes ___ No. ___

Number of Jams Caused: ___ Original Vegetation: ___

Landslide # ___ Stream ___ Date ___

Location: T. ___ R. ___ S. ___ Stream Survey Mile ___

Size of Slide: L ___' x W ___' x D ___' = Volume ___ cu. ft

Aspect ___ Slope ___ Seeps/Spring Present: Yes ___ No. ___

Estimated Age of Slide: ___ Torrent Associated: Yes ___ No. ___

Number of Jams Caused: ___ Original Vegetation: ___

Landslide # ___ Stream ___ Date ___

Location: T. ___ R. ___ S. ___ Stream Survey Mile ___

Size of Slide: L ___' x W ___' x D ___' = Volume ___ cu. ft

Aspect ___ Slope ___ Seeps/Spring Present: Yes ___ No. ___

Estimated Age of Slide: ___ Torrent Associated: Yes ___ No. ___

Number of Jams Caused: ___ Original Vegetation: ___

Landslide # ___ Stream ___ Date ___

Location: T. ___ R. ___ S. ___ Stream Survey Mile ___

Size of Slide: L ___' x W ___' x D ___' = Volume ___ cu. ft

Aspect ___ Slope ___ Seeps/Spring Present: Yes ___ No. ___

Estimated Age of Slide: ___ Torrent Associated: Yes ___ No. ___

Number of Jams Caused: ___ Original Vegetation: ___

Landslide # ___ Stream ___ Date ___

Location: T. ___ R. ___ S. ___ Stream Survey Mile ___

Size of Slide: L ___' x W ___' x D ___' = Volume ___ cu. ft

Aspect ___ Slope ___ Seeps/Spring Present: Yes ___ No. ___

Estimated Age of Slide: ___ Torrent Associated: Yes ___ No. ___

Number of Jams Caused: ___ Original Vegetation: ___

CALICO CREEK
Estacada Ranger District

Survievors: Tom Cain, Douq Kinzey

Date Surveyed: March 7, 1984

Tributarv to: Fish Creek

TRI Compartments: Calico, 5404

Gamefish: Trout, Steelhead

County: Clackamas

Mouth Location: T. 6S., R. SE., Sec. 11

Watershed Area: 1,075 acres, 3.7 sq. mi.

Stream Length: 2.0 miles

Distance Surveyed: 0.4 miles

Averaqe Width (ft.): 8 (MHW)

Stream Order: III

Averaqe Fish Habitat Condition Ratinq: 4.8, (Poor)

Average Riparian Condition Ratinq: 4.1, (Moderate)

CALICO CREEK
Survey Summary

A. Stream Summary

Calico Creek is a perennial, third order tributary to Fish Creek (RM 7.1 of Fish Creek). Flow at the mouth durinq late winter flow conditions is approximatelv 5 cfs. The initial 0.4 miles of stream were surveyed March 7, 1984. No fish were observed durinq the survev,

Access is poor to this section. Forest Service Road S-5440 parallels Fish Creek opposite Calico Creek and S-5420 traverses the headwaters, crossing Calico Creek at RM 1.0. The mouth of Calico Creek is in a steeo (90% sideslopes rocky gorge of Fish Creek.

B. Watershed and Geomorpholoqy

Calico Creek heads on the west side of Fish Creek Mountain and flows in a southwesterly direction to its confluence with Fish Creek. The drainaqe area is approximatelv 1,075 acres (1.7 sq. mi.) and has been extensively loqqed in the headwaters.

The vallev configuration is V-notch with a narrow floodplain width (20 ft.) and steep sideslopes (80%) Tributaries within the survev area are small (less than 1 cfs) and contain no fish habitat. The flow regime appears moderately flashy and the stream appears to carry a large sediment load. Sediment deoosition in pools and interspersed with gravels was evident in the survey area. This could possibly be due to past logging activity in the headwater area. At the time of the survey, road crews were clearing mud flows off s-5420 from numerous headwater tributary landslides.

C. Reach Description

One reach was identified in the survey area. It is hiqh gradient (10-15%) with boulders and bedrock providinq channel structure. Riffles dominate the reach (60%). At RM 0.4, the gradient increases to 25% and the stream cascades over large boulders. This point was determined to be the upper extent of usable anadromous habitat.

D. Fisheries

The fish Habitat Conditian Ratinq is poor (4.8 HCR) within the survey area. This low score reflects the lack of flow (5 cfs) durinq periods approximating mean hiqh water, the high amount of sedimentation present, and the poor quality and quantity of spawning habitat. Althouqh no fish were observed during the survey, the habitat appears suitable for rainbow and cutthroat trout, and winter steelhead.

Pool rearinq habitat is fair. Pools are typically small (2 sq. yes.) with moderate depth (12-24) inches) and moderate cover from boulders and water turbulence.

Spawninq habitat is poor with 80% of the 10 square yards of gravel counted, rated marqinal due to poor channel placement. Gravels are found in small (1-2 sq. yds) patches, and the interstitial spaces are commonly filled with sediments'. Fifty percent of the gravels are of a size class suitable for anadromous utilization.

Passage into Calico Creek may be partiallv blocked by a large debris jam at the mouth. A braid around the south side of the jam apoears to be passable but fish may have a problem locating it. The main attraction flow goes through the jam. Total passage barriers occur-at logjams 31 (RM 0.2) and J2 (RM 0.35) and at a boulder/bedrock chute (B1, RM 0.3). A partial barrier is created by a bedrock chute (B1) at RM 0.25.

E. Riparian Area

The Riparian Condition Ratinq (RCR) is 4.1, (moderate). All five habitat units are present but an absence of deciduous species in the overstory, a narrow floodplain width (20 ft.), and a lack of special habitat units tend to reduce the riparian habitat qualitv.

F. Rehabilitation and Enhancement

Passage enhancement to access the 0.4 miles of anadromous habitat could include partial removal of the logjams (31 and J2), and on the debris jam at the mouth to insure entrance into the stream. This removal appears to be relatively simple and could be accomplished with volunteers using handtools. Passage could also be imoroved at the chutes and cataracts by developing jump and resting pools.

The quantitv of spawning habitat could be increased with the use of qravel catchment structures such as log sills, boulder berms, or gabions. Due to the apparentlv unstable slopes in the headwater area, which could continue to he a source of sediments for many years, the benefits gained by such qravel retaining structures could be lost bv sediments filling the qravel interstitial spaces. Sediments could also reduce the effectiveness of structures to increase and improve pool rearing habitat.

Rehabilitation of the headwater area to prevent further erosion and sediment introduction would benefit both fisheries and road maintenance. Planting fast growning deciduous species along the banks of the headwall tributaries could slow down this erosional process.

CALICO CREEK

TARLE I - HABITAT DATA SUMMARY

REACH (R.M.)	STREAM				POOLS			RIFFLES (5)						
	HCR	S	P:R	G	d	A	EC	BR	1'+	6-12"	1-6"	.1-1"	SD	D
I(0.0-0.4)	4.8	80	4:6	12	M	2	M	30	50	15	*	*	*	6

LEGEND:
- HCR: Habitat Condition Rating
- S: Percent of stream shaded
- P:R: Ratio of pool length:riffle lenqth
- G: Average gradient (%)
- d: Averaqe maximum depth (L ≤ 12", M = 12 - 29", H ≥ 30")
- A: Averaqe pool area (sq. yards)
- EC: Effective cover (L ≤ 40%, M = 40-60%, H ≥ 60%)
- BR: Bedrock
- SD: Sand
- D: Average depth finches)
- *: Present, but less than 5%

CALICO CREEK

TABLE II - FISH SPECIES OBSERVED AND RELATIVE ABUNDANCE/100 FT.

Species	REACH	TRIBUTARIES
	I	
Rb	( )	
ct	( )	
stw	( )	

LEGEND: L = Low (0-5); M = Moderate (6-50); H = High (50+)
a = adult, j = juvenile

* = habitat suitable; presence reported but not observed.
( )= habitat suitable; may not be present

TABLE III - SPAWNING GRAVEL (SQUARE YARDS)

Reach (R.M.)	Spawning Gravel (Sq. Yds.) Total	Good	Marginal
I (0.0-0.4)	10	2	8
TOTAL	10	2	8

CALICO CREEK

TABLE IV - FISH MIGRATION OBSTRUCTIONS

STREAM (R.M.)	TYPE	ID #	PASSABLE	RECOMMENDATIONS*
0.0	Dehris jam	No	P	Partial removal
0.2	Logjam	J1	N	Partial removal
0.25	Chute	B1	P	Develoo resting pool
0.3	Chute	B2	N	Develoo resting pool
-. 0.35	Logjam	J2	N	Partial removal

LEGEND: F = full passage
P = partial passage
N = no passage

*Refer to special case form for barrier characteristics.

TABLE V - ANADROMOUS HABITAT SUMMARY

REACH (RM)	Miles Avail.	Pot.	P:R	Rearing Area	Depth	Spawning 1"-3"	3"-6"	Comments
I (0.0-0.4)	0.7	O.?	4:6	2	1	5	0	
TOTAL	0.3	0.2				5	0	

Leqend: Avail.: Miles of habitat presently accessible to anadromous fish if introduced.
Pot.: Additional miles of habitat potentially available with complete oassage enhancement.
P:R: Ratio of pool length : riffle length.
Area: Averaqe pool area (sq. yds.).
Depth: Average pool depth (feet).
Soawning: Number of Sq. Yards of gravels observed in the 1"-3" and 3'-6" size classes.

CALICO CREEK

TABLE VI - LWD HABITAT OUALITY INFLUENCE

	SP. GRAVELS		POOL		LWD CHARACTERISTICS				
Reach (R.M.)	Total (%)	HO (%)	Total (%)	HO (%)	OR	#	L	Dia	Source
I (0.0-0.4)	20	0	10	10	Perp	S-M	2	2	T

LEGEND: Total: Percent of total habitat area dependant on LWD
HO: Percent of high auality habitat area dependent on LWD
OR: Anqle of orientation to flow; Perp = perpendicular, Var = variable
#: Number of logs/structure: S = single 109, M = multi-log
L: Average length of logs, exoressed in channel widths
Dia: Diameter of average loqs in feet
Source: L = local
T = transoorted
M = mixture of local and transoorted

TABLE VII - HABITAT AND HYDROLOGICAL FEATURES FOR SUMMER AND BANKFUL CONDITIONS

	SUMMER*				BANKFULL		
Reach (R.M.)	w	d	v	0	W	D	Floodolain Width (Ft.)
I (0.0-0.4)	8	0.5	1.7	4.8	10	1	20

W,w: Stream width (ft)
D,d: Stream depth (ft)
v: Velocity (feet/second)
0: Average reach flow in cubic feet/second
* Data collected in March

CALICO CREEK

TABLE VIII - TEMPERATURE AND SHADE RELATIONSHIP

REACH (R.M.)	DATE	FLOW (cfs)	% SHADE	ASPECT	AIR/WATER TEMP.0 F -A/WA/W	TIME
I (0.0-0.4)	3/7/84	4.8	80	SW	5J/44	1530

TABLE IX - RIPARIAN HABITAT SUMMARY

REACH (RM)	RCR	VALLEY F.P. (ft.)	VEGETATION H.U.	VEGETATION Overstory Con.	VEGETATION Overstory Dec.	ADUATIC Streamclass	ADUATIC Wetland%	ADUATIC Size	Special Habitat
I (0.0-0.4)	4.1	20	5	3	0	II	0		0

LEGEND:

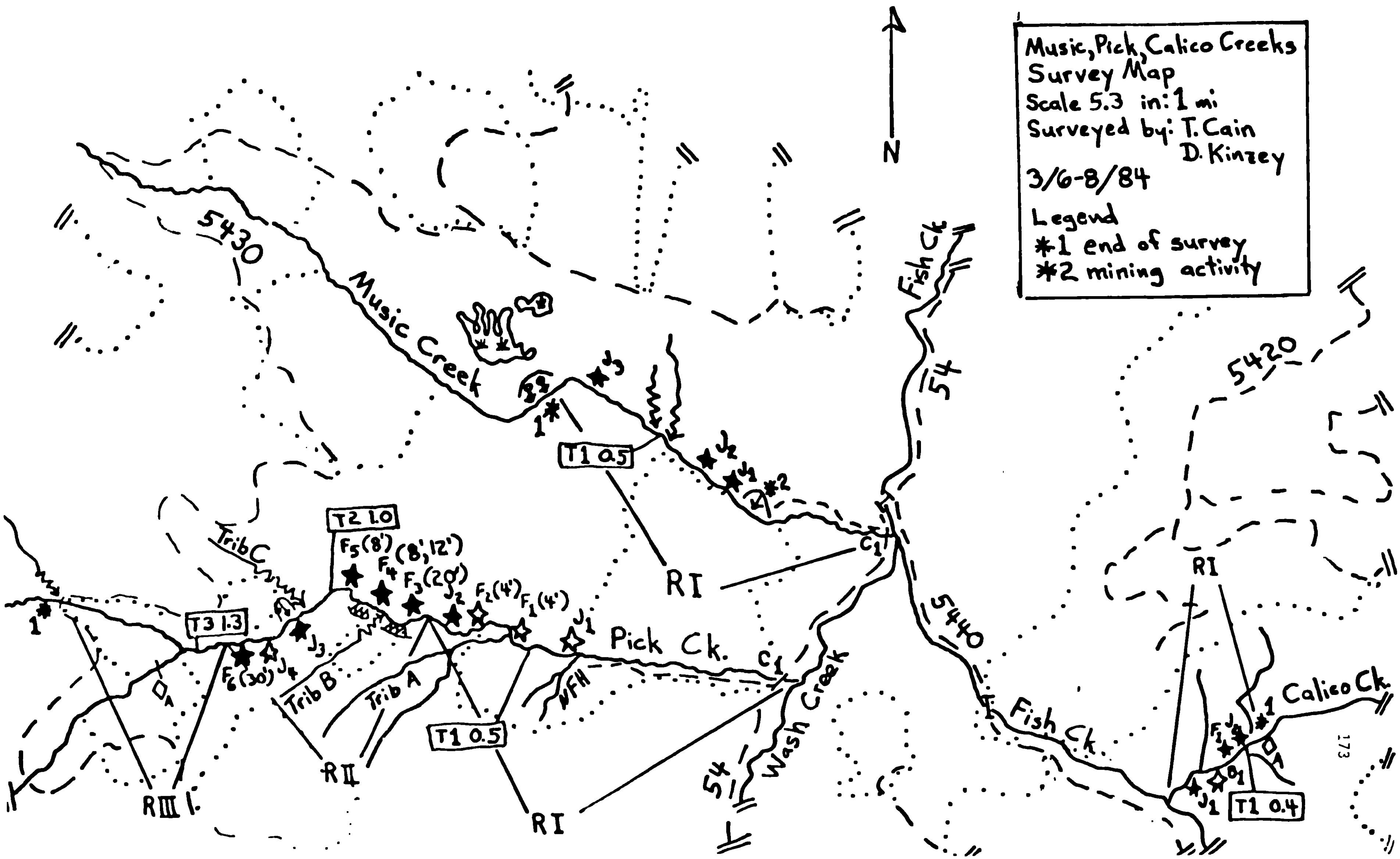
RCR:	Riparian Condition Ratinq
F.P.:	Floodplain width in feet
H.U.:	# Habitat units (H > 4; M = 2-3; L < 1)
Con:	# Conifer species -
Dec:	# Deciduous species
Wetland:	Percent of stream lenqth with adjacent wetlands; (H 50%; M = 25-50%; L 25%)
Size:	Size of wetlands S = small (less than 1 acre) L = larqe fqreater than 1 acre)

A debris jam at the mouth of Calico Creek may be a partial oassage barrier. The main attraction flow (pictured here) oasses through the jam and is impassable A small braid flows along the bedrock wall in the background and is passable. The flow in the braid may be insufficient for fish to detect.

Logiam (J1, RM 0.2) is the first total barrier on Calico Creek. The jam creates an 8-foot waterfall (background) whick is impassable. Partial removal of the jam and deepening the jamp pool could create passage. A 5-foot waterfall (foreground) is also a total barrier which would require modification for passage.

Bedrock is common in Calico Creek and this section (RM 0.3) forms an impassable chute. Blasting or chipping awav the bedrock to develop jump and resting pools could create passaqe.

The upper extent of usable anadromous habitat occurs at RM 0.4. At this point the gradient increases to 25% and the stream cascades over large boulders.



Music, Pick, Calico Creeks
Survey Map
Scale 5.3 in: 1 mi
Surveyed by: T. Cain
D. Kinzey
3/6-8/84
Legend
*1 end of survey
*2 mining activity
N
5430
Music Creek
T1 0.5
RI
Fish Ck
54
5440
5420
Calico Ck.
T1 0.4
T2 1.0
T3 1.3
Trib C
Trib B
Trib A
Pick Ck.
Wash Creek
RII
RIII
F5 (8')
F4 (8', 12')
F3 (20')
F2 (4')
F1 (4')
F6 (30')

- STREAM SURVEY MAP SYMBOLS -

CLEAR CUT BOUNDARY

$R_{I,II,III}$ REACH # and SECTION

T_1 1.0 TRANSECT # and RIVERMILE

OBSTRUCTION BARRIER

J1,2,3, JAM and #
F( )1,2,3 FALLS, HEIGHT, and #
C1,2,3 CULVERT and #
B1,2,3 CHUTE and #

DIVERSION STRUCTURE (I = water is used for irrigation purposes)

MINE or ROCK PIT SITE

BRIDGE

LANDSLIDE, SLUMP

DEBRIS TORRENT TRACK

SPRING

UPPER LIMIT OF FISH PRESENT (A = limit of potential anadromous fish habitat)

BANK EROSION (EXTENSIVE/SEVERE)

1,2,3, :MISCELLANEOUS

WETLAND HABITAT

S-47 ROAD AND ID NUMBER

EARTHFLOW

Log Jam # 1 Stream Calico Date 3/1/84

Location: T.____ R.____ S.____ Stream Survey Mile 0.2

Barrier ✓ Partial Barrier____ No Barrier____

Woody Material: L 20' x W 10' x H 5' = Volume ____ cu. ft.

Sediment Plain: L 50' x W 20' x D 4' = Volume ____ cu. ft.

Washout Potential: Appears Stable ✓ Does Not Appear Stable ____

Comments: Single 5' DBH log sill has captured LWD & sediment, 8' jump. 5' jump 50' downstream. Bedrock

Log Jam # 2 Stream Calico Date 3/1/84

Location: T.____ R.____ S.____ Stream Survey Mile 0.35

Barrier ✓ Partial Barrier____ No Barrier____

Woody Material: L 3' x W 12' x H 4' = Volume ____ cu. ft.

Sediment Plain: L 20' x W 10' x D 5' = Volume ____ cu. ft.

Washout Potential: Appears Stable ✓ Does Not Appear Stable ____

Comments: 5' jump through branches & logs [illegible]. LWD caught among boulders. Possible volunteer job.

Log Jam #____ Stream ____ Date ____

Location: T.____ R.____ S.____ Stream Survey Mile ____

Barrier ____ Partial Barrier____ No Barrier ____

Woody Material: L ' x W ' x H ' = Volume cu. ft.

Sediment Plain: L ' x W ' x D ' = Volume cu. ft.

Washout Potential: Appears Stable____ Does Not Appear Stable ____

Comments: ____

Log Jam #____ Stream ____ Date ____

Location: T.____ R.____ S.____ Stream Survey Mile ____

Barrier ____ Partial Barrier____ No Barrier ____

Woody Material: L ' x W ' x H ' = Volume cu. ft.

Sediment Plain: L ' x W ' x D ' = Volume cu. ft.

Washout Potential: Appears Stable____ Does Not Appear Stable ____

Comments: ____

Log Jam #____ Stream ____ Date ____

Location: T. R. S. Stream Survey Mile ____

Barrier ____ Partial Barrier____ No Barrier ____

Woody Material: L ' x W ' x H ' = Volume cu. ft.

Sediment Plain: L ' x W ' x D ' = Volume cu. ft.

Washout Potential: Appears Stable____ Does Not Appear Stable ____

Comments: ____

Log Jam #____ Stream ____ Date ____

Location: T.____ R.____ S.____ Stream Survey Mile ____

Barrier ____ Partial Barrier____ No Barrier ____

Woody Material: L ' x W ' x H ' = Volume cu. ft.

Sediment Plain: L ' x W ' x D ' = Volume cu. ft.

Washout Potential: Appears Stable____ Does Not Appear Stable ____

Comments: ____

Falls/**Chute** # 1 Stream Calico Date 3/7/84

Location: T. ____ R.____ S.____ Stream Survey Mile .25

Size: W 8', H 6', L 30 Gradient 13% Barrier: Yes Partial No ___

Is pool present below the falls? Yes ✓ No ______

Length 10', width 8', depth 3'

Other comments: Bedrock could easily be blasted to develop resting pool

Falls/Chute # B2 Stream Calico Date 3/7/84

Location: T. ____ R.____ S.____ Stream Survey Mile 0.3

Size: W 5', H 10', L 20' Gradient ______ Barrier: Yes ✓ No ___

Is pool present below the falls? Yes ✓ No ______

Length 12', width 10', depth 3'

Other comments: Bedrock cataracts. Blasting could develop rest pools.

Falls/Chute #____ Stream ____________________ Date __________

Location: T. ____ R.____ S.____ Stream Survey Mile ____________

Size: W ___', H ___', L ___' Gradient ______ Barrier: Yes___ No ___

Is pool present below the falls? Yes ______ No ______

Length __________', width ________', depth ________'

Other comments: ______________________________

Falls/Chute #____ Stream ____________________ Date __________

Location: T. ____ R.____ S.____ Stream Survey Mile ____________

Size: W ___', H ___', L ___' Gradient ______ Barrier: Yes___ No ___

Is pool present below the falls? Yes ______ No ______

Length __________', width ________', depth ________'

Other comments: ______________________________

Falls/Chute #____ Stream ____________________ Date __________

Location: T. ____ R.____ S.____ Stream Survey Mile ____________

Size: W ___', H ___', L ___' Gradient ______ Barrier: Yes___ No ___

Is pool present below the falls? Yes ______ No ______

Length __________', width ________', depth ________'

Other comments: ______________________________

Falls/Chute #____ Stream ____________________ Date __________

Location: T. ____ R.____ S.____ Stream Survey Mile ____________

Size: W ___', H ___', L ___' Gradient ______ Barrier: Yes___ No ___

Is pool present below the falls? Yes ______ No ______

Length __________', width ________', depth ________'

Other comments: ______________________________

PICK CREEK
Estacada Ranger District

Surveyors: Tom Cain
Doug Kinzey

County: Clackamas

Date Surveyed: March 8, 1984

Mouth Location:
T6S, R5E, Sec. 3

Tributary to: Wash Creek

Watershed Area:
2,166 Acres
3.4 Square Miles

TRI Compartments:
Deadhorse 5403
Wash 5405

Stream Length: 2.5 Miles

Distance Surveyed: 1.6 Miles

Gamefish: Rainbow Trout

Low Flow Width (Avg.): 10 ft.*

Potential Anadromous Species:
Steelhead

Stream Order: III

*From 1975 Survey

PICK CREEK

Survey Summary

A. Stream Summary

Pick Creek is a third order tributary to Wash Creek in the Clackamas River drainage. At the time surveyed, March 8, 1984, discharge at the mouth was approximately 15 cfs. The survey was conducted from the mouth to RM 1.6, which is the probable extent of usable anadromous habitat. However, a short 10% gradient section from approximately RM 1.9 to 2.2 may also be suitable for steelhead spawning and rearing (information provided by Jeff Uebel, Mt. Hood Fisheries Biologist). This 0.3 miles of potential anadromous habitat was not included in the present survey due to time constraints and because high stream gradients (10-16%) from RM 1.4 - 1.9 and numerous total passage barriers identified within the surveyed section (see below) likely preclude anadromous use of this potential habitat.

B. Watershed and Geomorpholgy

A large seasonal fluctuation in stream discharge is indicated by a comparison of the present late-winter discharge of 15 cfs with a September, 1975 discharge of 1 cfs recorded by the 1975 stream survey (data on file at Mt. Hood SO).

The valley configuration is a narrow, flat bottomed "V" with a valley floor 40 feet wide and sideslope gradients ranging from 30 to 40% in the lower half-mile to 70-80% by RM 1.0. The drainage has been extensively logged and it appears stream clean-up operations below RM 0.4 may have resulted in channel down-cutting to expose the present boulder substrate. Above this old (15-20 years) clearcut boundary, wood plays a greater role in stream structure. Ten percent of the pool habitat in Reach I (RM 0.0 - 0.8) is wood-dependent, while 50% of pool habitat in Reach III (RM 1.2 - 1.5) is dependent on wood structure.

In Reach II (RM 0.8-1.2), there are numerous indications of recent (6-10 yrs.) accelerated landsliding. Some of these include: sluiced tributary channels; a recent debris avalanche track, several relatively large log jams, and numerous bedrock channel sections. This activity appears to be associated with a 10-15 year old clearcut from RM 1.1 to 1.35.

C. Reach Description

Three reaches were identified. Reach I (RM 0.0 - 0.8) is a steep (10% gradient), boulder-controlled section suitable for steelhead spawning and rearing. Reach II (RM 0.8 - 1.2) appears to be subject to active erosion and debris torrent routing. It is largely bedrock controlled, although logjams (transported source) are common. Six total passage barriers, including one 30' falls, are located in this reach. Reach III (RM 1.2 - 1.6) is wood controlled and lacks the bedrock evident throughout Reach II. Gradient from RM 1.2 to the mouth of Shovel Creek at RM 1.35 is 7-9%. Above Shovel Creek, the stream gradient increases abruptly to 16% by RM 1.5.

D. Fisheries

The overall fish habitat condition rating for Pick Creek is fair (HCR=6.2). Approximately 1.3 miles of habitat suitable for steelhead were observed. The entire survey area (1.6 miles) supports resident trout. Electroshocking in summer, 1982 (Cain and Smith, 1982, Resident Trout Population Assessment - Mt. Hood National Forest) at RM 0.3 indicated a species composition of 98% rainbow trout and 2% cutthroat-rainbow hybrids. Legal-sized fish made up 31% of the estimated 1198 fish/acre.

At present, a total barrier culvert at the mouth of Pick Creek prevents anadromous use of this stream. Providing passage at this culvert alone would access 0.75 miles of fair to good habitat (Reach I HCR=6.6). Conditions at the time of the survey suggest spawning habitat may be limiting in this lower section of stream, with only 20 yards of good gravels, suitable for spawning, counted from RM 0.0 to 0.8. Gravel beds are small (1 square yard) and at the tailouts of pools or downstream of large boulders. The largest concentrations of gravels, in the section surveyed, occur in a 20 square yard accumulation above logjam 3 (RM 1.05), and a 10-15 square yard area between RM 1.2 and 1.3.

Previously reported low summer discharges likely cause substantial reductions in rearing habitat. This factor did not appear limiting at the time of the survey. Pools are numerous (P:R=4:6) with moderate depths and cover. 30% of the pools are at least 30 inches deep. Pool area averages 5 square yards in Reach I and 4 square yards in the upper reaches.

E. Riparian Area

The overall Riparian Condition Rating is moderate (RCR=4.9). A lack of wetlands or other special habitats and a narrow valley bottom are the major negative factors reducing the score.

The riparian overstory from RM 0.0 to 0.4 consists of 15-20 year old alder. A thin (1 chain) clearcut buffer on the southwest streambank from RM 0.85 - 0.95 and a shelterwood above the mouth of Shovel Creek (RM 1.35 - 1.5) have reduced the coniferous overstory in these areas.

F. Rehabilitation and Enhancement

Providing passage at the Rd. 54 culvert (RM 0.0) is a priority if anadromous use of this stream is desired. About 0.8 miles of stream would be made accessible. Further minor passage enhancement projects include two partial barrier boulder cascades at RM 0.6 and 0.7. These latter projects could be performed by volunteers using hand tools such as rock bars. This would improve access through the upper 0.2 miles of Reach I.

Major passage enhancement would be required to access 0.7 miles of potential spawning and rearing habitat in Reaches II and III. Four waterfalls 8 to 30 feet high (RM 0.85, 0.9, 0.95, 1.2) and two major logjams (RM 0.75, 1.05) in Reach II would all likely require extensive work to permit passage.

Construction of log sills/boulder berms to provide spawning and summer rearing habitat in Reach I could benefit this system. The lower 0.4 miles are easily accessible by a Rd. 54 spur paralleling the south side of the stream. An additional opportunity for spawning habitat enhancement exists in the lower 0.1 mile of Tributary A (RM 0.6) Rubble/gravel substrates and 10% gradient for this length create a potential off-channel spawning area which could be enhanced by gravel retention structures.

Bank cutting and erosional problems are evident throughout Reach II. In a recent (<5 years) clearcut, the buffer strip on the southwest stream bank (RM 0.85 - 0.95) is being undercut by the stream and by Tributary B running through the clearcut. Bank stabilization work to protect the buffer strip and decrease sedimentation could possibly be done with KV funding.

G. Special Interest

A series of bedrock waterfalls and pools from RM 0.85 to 1.2 create a scenic corridor along this section of stream.

Pick Creek

TABLE I - HABITAT**DATA SUMMARY

REACH (R.M.)	STREAM			POOLS				RIFFLES (%)						
	HCR	S	P:R	G	d	A	EC	BR	1'+	6-12"	l-6"	1-1"	SD	D
I (0.0-0.8)	6.6	80	4:6	10	M	5	H	--	50	20	20	5	5	6
II (0.8-1.2)	5.2	70	3:7	8	M	4	H	*	90	10	-	-	-	4
III (1.2-1.6)	6.4	90	5:5	9	M	4	H		60	30	5	5	*	4

Note: Reach II transect data does not reflect the substantial amount of bedrock observed within this reach.

**These values were obtained in March during near high flows. Major variations may be present at low flows.

LEGEND:
- HCR: Habitat Condition Rating
- s: Percent of stream shaded
- P:R: Ratio of pool length:riffle length
- G: Average gradient (%)
- d: Average maximum depth (L < 12", M = 12 - 29", H > 30")
- A: Average pool area (sq. yards)
- EC: Effective cover (L < 40%, M = 40-60%, H >60%)
- BR: Bedrock
- SD: Sand
- D: Average depth (inches!
- *: Present, but less than 5%

Pick Creek

TABLE II - FISH SPECIES OBSERVED AND RELATIVE ABUNDANCE/100 FT.

Species	REACH I	REACH II	REACH III	TRIBUTARIES A
Rainbow Trout	M	*	*	( )

LEGEND: L = Low (0-5); M = Moderate (6-50); H = High (50+)
a = adult, j = juvenile

* = habitat suitable: presence reported but not observed.
( )= habitat suitable; may not be present

TABLE III - SPAWNING GRAVEL (SQUARE YARDS)

Reach (R.M.)	Spawning Gravel (Sq. Yds.) Total	Good	Marginal
I (0.0-0.8)	37	20	17
II (0.8-1.2)	52	31	21
III (1.2-1.6)	20	14	6
TOTAL	109	65	44

Pick Creek
TABLE IV - FISH MIGRATION OBSTRUCTIONS

STREAM (R.M.)	TYPE	ID #	PASSABLE	RECOMMENDATIONS*
0.0	Culvert	C1	N	Replace or baffle.
0.4	Logjam	J1	P	Partial removal.
0.6	Falls	F1	P	Raise jump pool.
0.7	Falls	F2	P	Develop jump pool.
0.75	Logjam	32	N	Partial removal
0.85	Falls	F3	N	Major project.
0.9	Falls	F4	N	Major project.
0.95	Falls	F5	N	Major project.
1.05	Logjam	33	N	Major project.
1.2	Falls	F6	N	Major project.
1.3	Logjam	34	P	Low priority.
1.4	Logjam	35	P	Low priority.
1.55	Culvert	c2	N	Low priority.

LEGEND: F = full passage
P = partial passage
N = no passage

*Refer to special case form for barrier characteristics.

TABLE V - ANADROMOUS HABITAT SUMMARY

REACH	Miles			Rearing		Spawning		
(RM)	Avail.	Pot.	P:R	Area	Depth	1"-3"	3"-6"	Comments
I (0.0-0.8)	0	0.8	4:6	5	M	19	-	
II (0.8-1.2)	0	0.4	3:7	4	M	26	-	
III (1.2-1.6)	0	0.4	5:5	4	M	10	4	
TOTAL	0	1.6				55	4	

Legend: Avail.: Miles of habitat presently accessible to anadromous fish if introduced.
Pot.: Additional miles of habitat potentially available with complete passage enhancement.
P:R: Ratio of pool length : riffle length.
Area: Average pool area (sq. yds.).
Depth: Average pool depth (feet).
Spawning: Number of Sq. Yards of gravels observed in the 1"-3" and 3"-6" size classes.

Pick Creek

TABLE VI - LWD HABITAT QUALITY INFLUENCE

Reach (R.M.)	SP. GRAVELS Total (%)	HO (%)	POOL Total (%)	HQ (%)	LWD CHARACTERISTICS OR	#	L	Dia	Source
I (0.0-0.8)	0	0	10	10	Var.	5	l-2	l-2	M
II (0.8-1.2)	90	90	15	10	Perp.	S-M	l-2	2	T
III (1.2-1.6)	70	100	50	80	Perp.	S-M	l-2	2	T

LEGEND: Total: Percent of total habitat area dependant on LWD
HQ: Percent of high quality habitat area dependent on LWD
OR: Angle of orientation to flow; Perp = perpendicular, Var = variable
#: Number of logs/structure; S = single log, M = multi-log
L: Average length of logs, expressed in channel widths
Dia: Diameter of average logs in feet
Source: L = local
T = transported
M = mixture of local and transported

TABLE VII - HABITAT AND HYDROLOGICAL FEATURES FOR SUMMER AND BANKFULL CONDITIONS

Reach (R.M.)	SUMMER* w	d	v	0	BANKFULL W	D	Floodplain Width (Ft.)
I (0.0-0.8)	10	5	3	15	15	1	40
II (0.8 - 1.2)	9	1	1	9	10	15	40
III (M-1.6)	5	1	2	10	15	2	50

*Data obtained in March

W,w: Stream width (ft)
D,d: Stream depth (ft)
V: Velocity (feet/second)
O: Average reach flow in cubic feet/second

Pick Creek

TABLE VIII - TEMPERATURE AND SHADE RELATIONSHIP

REACH (R.M.)	DATE	FLOW (cfs)	% SHADE	ASPECT	AIR/WATER TEMP.0 F A/W	TIME
I (0.0-0.8)	3/8/84	15	80	E	53/42	1100
II (0.8-1.2)	3/8/84	9	70	E	50/42	1345
III (1.2-1.6)	3/8/84	10	90	NE	53/42	1500

TABLE IX - RIPARIAN HABITAT SUMMARY

REACH (RM)	RCR	VALLEY	VEGETATION			AQUATIC			
		F.P. (ft.)	H.U.	Overstory Con.	Overstory Dec.	Streamclass	Wetland%	Size	Special Habitat
I (0.0-0.8)	5.1	40	4	3	2	II	0	-	0
II (0.8-1.2)	4.4	40	3	3	1	II	0	-	0
III (1.2-1.6)	4.8	50	4	3	1	II	0	-	0

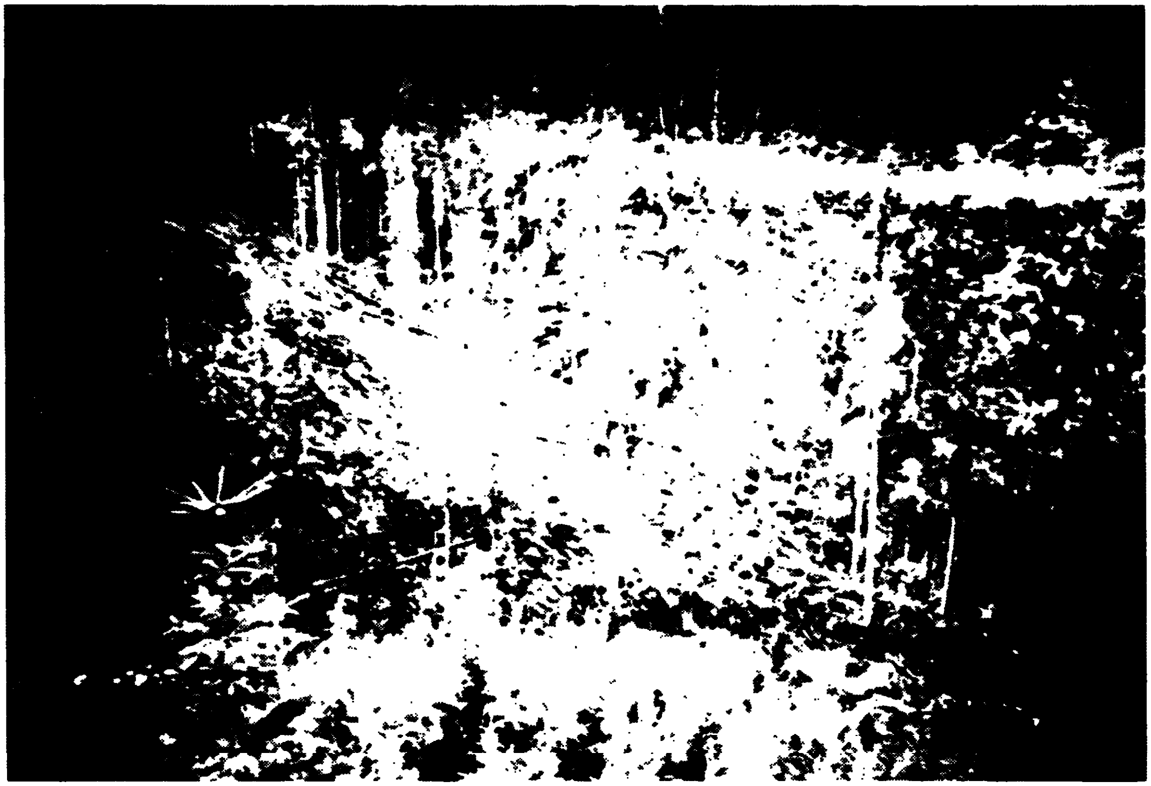
LEGEND: RCR: Riparian Condition Rating
F.P.: Floodplain width in feet
H.U.: # Habitat units (H > 4; M = 2-3; L < 1)
Con: # Conifer species -
Dec: # Deciduous species
Wetland: Percent of stream length with adjacent wetlands; (H 50%; M = 25.50%; L<25%)
Size: Size of wetlands
S = small (less than 1 acre)
L = large (greater than 1 acre)

Providing passage at the total barrier (4 foot jump, 7% gradient) culvert near the mouth (RM 0.05) of Pick Creek would access 0.8 miles of potential steelhead habitat without further work. A total of 1.5 miles of habitat suitable for steelhead could he accessed with additional projects.

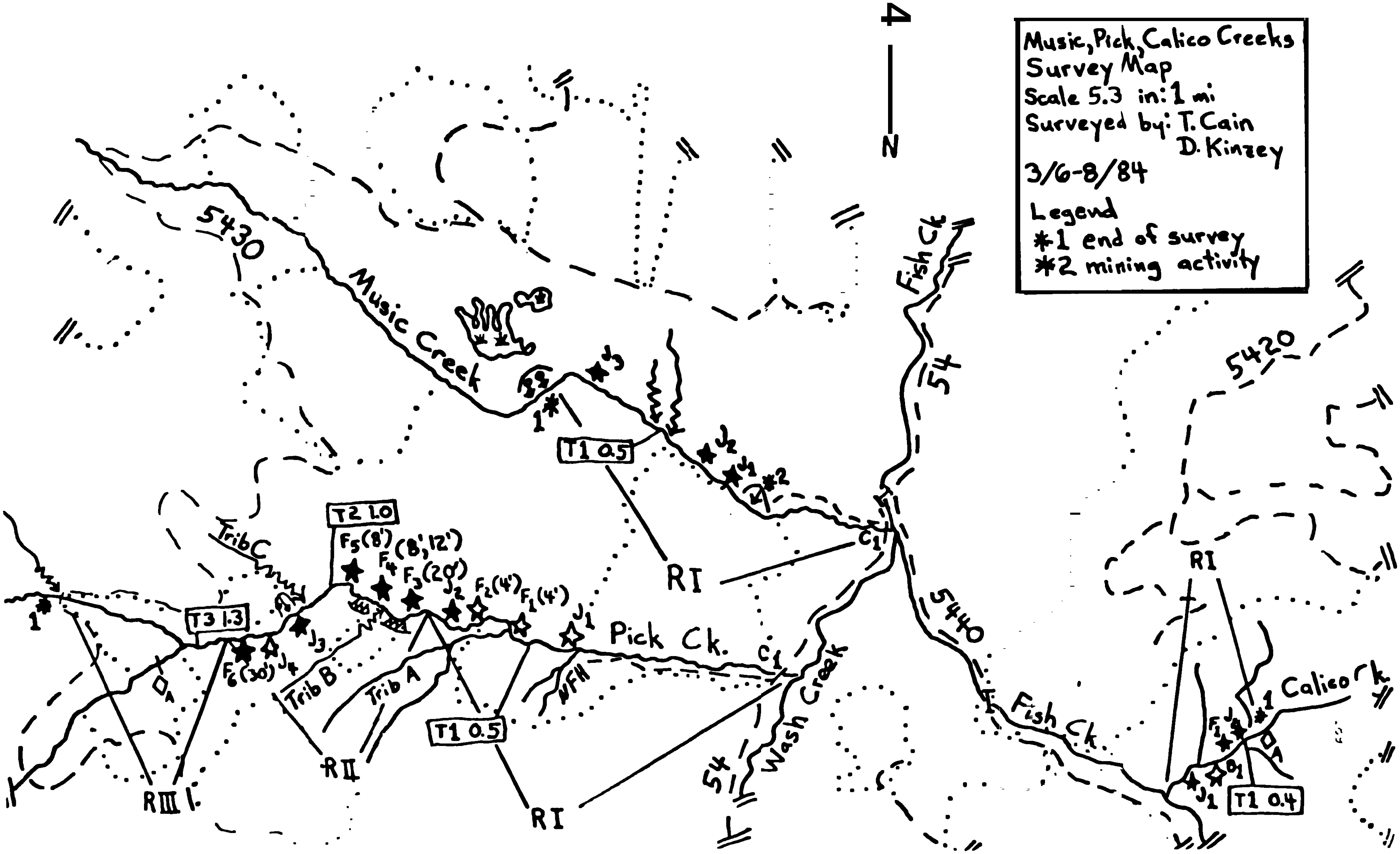
Reach I (RM 0.0-0.8, photo at 0.15) is boulder-dominated with a 10% stream gradient. A lack of wood structure throughout this reach appears to be due to excessive stream clean-out associated with logging activity (compare to photo at RM 1.3). Log sill or boulder berm construction to increase spawning bed size (presently averaqinq 1-2 sauare yards) and improve summer pool rearing habitat could enhance fisheries production in Pick Creek.

RM 0.9 - A series of bedrock chutes and waterfalls throughout Reach II (RM 0.8-1.2, #F4 pictured) would likely require extensive work to access the upper 0.6 miles of potential anadromous habitat on Pick Creek.

RM 1.3 - The role of large woody debris in providing stream structure increases upstream. Approximately 0.1 mile of qood steelhead habitat (pictured) and 0.2 miles of marqinal habitat exist above the chutes and falls of Reach II.



Shovel Creek (foreground) enters Pick Creek at RM 1.35. Reach III gradient increases at this point from 7-W to 16%. A recent shelterwood (<5 years\ has reduced stream shading and increased the probability of bank erosion. Streamside plantings of fast-growing deciduous species could reduce both of these impacts.



Music, Pick, Calico Creeks
Survey Map
Scale 5.3 in: 1 mi
Surveyed by: T. Cain
D. Kinzey
3/6-8/84
Legend
*1 end of survey
*2 mining activity
N
5430
Music Creek
T1 0.5
RI
Fish Ck
54
5440
Fish Ck
5420
Calico Ck
T1 0.4
Trib C
T3 1.3
T2 1.0
F5 (8')
F4 (8', 12')
F3 (20')
F2 (4')
F1 (4')
F6 (30')
Pick Ck.
Trib B
Trib A
NFH
Wash Creek
RII
RIII
RI
T1 0.5

- STREAM SURVEY MAP SYMBOLS -

CLEAR CUT BOUNDARY

R I, II, III — REACH # and SECTION

T1 1.0 — TRANSECT # and RIVERMILE

OBSTRUCTION — BARRIER

J1,2,3, — JAM and #
F(   )1,2,3 — FALLS, HEIGHT, and #
C1,2,3 — CULVERT and #
B1,2,3 — CHUTE and #

DIVERSION STRUCTURE (I - water is used for irrigation purposes)

MINE or ROCK PIT SITE

BRIDGE

LANDSLIDE, SLUMP

DEBRIS TORRENT TRACK

SPRING

UPPER LIMIT OF FISH PRESENT (A = limit of potential anadromous fish habitat)

BANK EROSION (EXTENSIVE/SEVERE)

1.2.3, MISCELLANEOUS

WETLAND HABITAT

S-47 — ROAD AND ID NUMBER

EARTHFLOW

RM 0.05

Culvert # 1 Stream Pud[illegible] Date 3/8/84

Gradient greater than 1½%: Yes 7% No. ____

Type of structure (check)

Round Pipe ✓ | Box | Arch | Open Arch | Open Box | Eliptical

Length of structure 40 ft. Diameter of structure 10 ft.

Are baffles present? Yes ____ No. ✓

Jumping distance into culvert from pool: Height 4'

Pool present below culvert: Length 20', width 15', depth 4'

Stream above culvert: Width 8', gradient 12%

Stream flowing water: Yes ✓ No ____

Other comments: 9s, 8' fill, Concrete bottom No [illegible] Water [illegible]

RM 1.55

Culvert # 2 Stream ____ Date ____

Gradient greater than 1½%: Yes ____ No. ____

Type of structure (check)

Round Pipe | Box | Arch | Open Arch | Open Box | Eliptical

Length of structure ____ ft. Diameter of structure ____ ft.

Are baffles present? Yes ____ No. ____

Jumping distance into culvert from pool: Height ____'

Pool present below culvert: Length ____', width ____', depth ____'

Stream above culvert: Width ____', gradient ____'

Stream flowing water: Yes ____ No ____

Other comments: Barrier. Above anadromous

SEE Culvert Inventory

Culvert # ____ Stream ____ Date ____

Gradient greater than 1½%: Yes ____ No. ____

Type of structure (check)

Round Pipe | Box | Arch | Open Arch | Open Box | Eliptical

Length of structure ____ ft. Diameter of structure ____ ft.

Are baffles present? Yes ____ No. ____

Jumping distance into culvert from pool: Height ____'

Pool present below culvert: Length ____', width ____', depth ____'

Stream above culvert: Width ____', gradient ____'

Stream flowing water: Yes ____ No ____

Other comments: ____

Culvert # ____ Stream ____ Date ____

Gradient greater than 1½%: Yes ____ No. ____

Type of structure (check)

Round Pipe | Box | Arch | Open Arch | Open Box | Eliptical

Length of structure ____ ft. Diameter of structure ____ ft.

Are baffles present? Yes ____ No. ____

Jumping distance into culvert from pool: Height ____'

Pool present below culvert: Length ____', width ____', depth ____'

Stream above culvert: Width ____', gradient ____'

Stream flowing water: Yes ____ No ____

Other comments: ____

TRIB I.D. A Stream Pick Date 3/8/84
Per ✓ Int ___ Gradient 10%-40 %
WIDTH 4 ft. $\bar{X}$ Depth 0.2 ft. $\bar{X}$ Vel 2 ft/s
Q 1.6 c.f.s. M.H.W. WIDTH 5 ft
Marginal fish habitat. 0.1 mile.
Barrier Falls (20-30' high) above
6 yds. spawning gravel.

TRIB I.D. ___ Stream ___ Date ___
Per ___ Int ___ Gradient ___ %
WIDTH ___ ft. $\bar{X}$ Depth ___ ft. $\bar{X}$ Vel ___ ft/s
Q ___ c.f.s. M.H.W. WIDTH ___ ft

TRIB I.D. B Stream Pick Date 3/8
Per ✓ Int ___ Gradient 13 %
WIDTH 2 ft. $\bar{X}$ Depth 0.2 ft. $\bar{X}$ Vel 0.25 ft/s
Q 0.1 c.f.s. M.H.W. WIDTH 5 ft
NFH. Runs through clearcut

TRIB I.D. ___ Stream ___ Date ___
Per ___ Int ___ Gradient ___ %
WIDTH ___ ft. $\bar{X}$ Depth ___ ft. $\bar{X}$ Vel ___ ft/s
Q ___ c.f.s. M.H.W. WIDTH ___ ft

TRIB I.D. C Stream Pick Date 3/8
Per ✓ Int ___ Gradient 16 %
WIDTH 4 ft. $\bar{X}$ Depth 0.2 ft. $\bar{X}$ Vel 0.5 ft/s
Q 0.4 c.f.s. M.H.W. WIDTH 5 ft
NFH. Sluiced-out.

TRIB I.D. ___ Stream ___ Date ___
Per ___ Int ___ Gradient ___ %
WIDTH ___ ft. $\bar{X}$ Depth ___ ft. $\bar{X}$ Vel ___ ft/s
Q ___ c.f.s. M.H.W. WIDTH ___ ft

TRIB I.D. ___ Stream ___ Date ___
Per ___ Int ___ Gradient ___ %
WIDTH ___ ft. $\bar{X}$ Depth ___ ft. $\bar{X}$ Vel ___ ft/s
Q ___ c.f.s. M.H.W. WIDTH ___ ft

TRIB I.D. ___ Stream ___ Date ___
Per ___ Int ___ Gradient ___ %
WIDTH ___ ft. $\bar{X}$ Depth ___ ft. $\bar{X}$ Vel ___ ft/s
Q ___ c.f.s. M.H.W. WIDTH ___ ft

Boulder cascade

Falls/Chute # 1 Stream 'Pick Date 3/8/84

Location: T. ___ R. ___ S. ___ Stream Survey Mile 0.6

Size: W 5', H 4', L 1' Gradient ___ Barrier: Yes Partial No ___

Is pool present below the falls? Yes ✓ No ___

Length 10', width 10', depth 4'

Other comments: Partial barrier. Volunteer project- Raise jump pool w/ boulders on site & remove some from throught w/ rock bar.

Boulder cascade

Falls/Chute # 2 Stream Pick' Date 3/8

Location: T. ___ R. ___ S. ___ Stream Survey Mile 0.7

Size: W 10', H 4', L 3' Gradient ___ Barrier: Yes Partial No ___

Is pool present below the falls? Yes ___ No ✓

Length ___', width ___', depth ___'

Other comments: Develop jump pool. Volunteer project, or blasting.

Boulder/bedrock/logjam cataracts

Falls/Chute # 3 Stream Pick Date 3/8

Location: T. ___ R. ___ S. ___ Stream Survey Mile 0.85

Size: W 20', H 20', L 20' Gradient 18% overall Barrier: Yes ✓ No ___

Is pool present below the falls? Yes ___ No ✓

Length ___', width ___', depth ___'

Other comments: Log sill total barrier waterfall (4-5') 30 yds. downstream of major barrier. Below recent clearcut. Extensive passage enhancement would be required.

Falls/Chute # 4 Stream 'Pick Date 3/8

Location: T. ___ R. ___ S. ___ Stream Survey Mile 0.9

Size: W 30', H 20', L 50' Gradient ___ Barrier: Yes ✓ No ___

Is pool present below the falls? Yes ✓ No ___

Length 15', width 15', depth 4'

Other comments: Two waterfalls 8 & 12' high, in bedrock. Could blast pools to allow passage.

Boulder cascade

Falls/Chute # 5 Stream Pick Date 3/8

Location: T. ___ R. ___ S. ___ Stream Survey Mile 0.95

Size: W 12', H 8', L 10' Gradient ___ Barrier: Yes ✓ No ___

Is pool present below the falls? Yes ✓ No ___

Length 10', width 10', depth 4'

Other comments: Total barrier. Major project

Falls/Chute # 6 Stream Pick Date 3/8

Location: T. ___ R. ___ S. ___ Stream Survey Mile 1.2

Size: W 10', H 30', L 20' Gradient ___ Barrier: Yes ✓ No ___

Is pool present below the falls? Yes ✓ No ___

Length 15', width 20', depth 7'

Other comments: 30' waterfall/bedrock gorge. Major project

Landslide # 1 Stream Pick Date 3/8/84

Location: T. ____ R. ____ S. ____ Stream Survey Mile 1.1

Size of Slide: L 200' x W 40' x D 20' = Volume ________ cu. ft

Aspect SE Slope 80 Seeps/Spring Present: Yes ____ No. ✓

Estimated Age of Slide: 5-10 yrs Torrent Associated: Yes ____ No. ✓

Number of Jams Caused: 1 Original Vegetation: conifer slope

Landslide # ____ Stream ________ Date ____

Location: T. ____ R. ____ S. ____ Stream Survey Mile ____

Size of Slide: L ____' x W ____' x D ____' = Volume ________ cu. ft

Aspect ____ Slope ____ Seeps/Spring Present: Yes ____ No. ____

Estimated Age of Slide: ____ Torrent Associated: Yes ____ No. ____

Number of Jams Caused: ____ Original Vegetation: ____

Landslide # ____ Stream ________ Date ____

Location: T. ____ R. ____ S. ____ Stream Survey Mile ____

Size of Slide: L ____' x W ____' x D ____' = Volume ________ cu. ft

Aspect ____ Slope ____ Seeps/Spring Present: Yes ____ No. ____

Estimated Age of Slide: ____ Torrent Associated: Yes ____ No. ____

Number of Jams Caused: ____ Original Vegetation: ____

Landslide # ____ Stream ________ Date ____

Location: T. ____ R. ____ S. ____ Stream Survey Mile ____

Size of Slide: L ____' x W ____' x D ____' = Volume ________ cu. ft

Aspect ____ Slope ____ Seeps/Spring Present: Yes ____ No. ____

Estimated Age of Slide: ____ Torrent Associated: Yes ____ No. ____

Number of Jams Caused: ____ Original Vegetation: ____

Landslide # ____ Stream ________ Date ____

Location: T. ____ R. ____ S. ____ Stream Survey Mile ____

Size of Slide: L ____' x W ____' x D ____' = Volume ________ cu. ft

Aspect ____ Slope ____ Seeps/Spring Present: Yes ____ No. ____

Estimated Age of Slide: ____ Torrent Associated: Yes ____ No. ____

Number of Jams Caused: ____ Original Vegetation: ____

Landslide # ____ Stream ________ Date ____

Location: T. ____ R. ____ S. ____ Stream Survey Mile ____

Size of Slide: L ____' x W ____' x D ____' = Volume ________ cu. ft

Aspect ____ Slope ____ Seeps/Spring Present: Yes ____ No. ____

Estimated Age of Slide: ____ Torrent Associated: Yes ____ No. ____

Number of Jams Caused: ____ Original Vegetation: ____

Landslide # ____ Stream ________ Date ____

Location: T. ____ R. ____ S. ____ Stream Survey Mile ____

Size of Slide: L ____' x W ____' x D ____' = Volume ________ cu. ft

Aspect ____ Slope ____ Seeps/Spring Present: Yes ____ No. ____

Estimated Age of Slide: ____ Torrent Associated: Yes ____ No. ____

Number of Jams Caused: ____ Original Vegetation: ____

Landslide # ____ Stream ________ Date ____

Location: T. ____ R. ____ S. ____ Stream Survey Mile ____

Size of Slide: L ____' x W ____' x D ____' = Volume ________ cu. ft

Aspect ____ Slope ____ Seeps/Spring Present: Yes ____ No. ____

Estimated Age of Slide: ____ Torrent Associated: Yes ____ No. ____

Number of Jams Caused: ____ Original Vegetation: ____

MUSIC CREEK

Estacada Ranqer District

Survevors: Tom Cain, Doug Kinzey

Tributary to: Fish Creek

Drainage: Clackamas

TRI Comoartment:
Deadhorse 5403

Gamefish: Rainbow trout

Potential Anadromous Species:
Steelhead

County: Clackamas

Mouth Location:
T6S., R5E., Sec. 3

Watershed Area;
1,690 acres
2.6 sq. mi.

Stream Length: 3.7 miles

Distance Surveved:
0.8 miles

Average Width (ft.): 10 (MHW)

Stream Order: III

Average Fish Habitat Condition Rating: 5.2, (Fair)

Average Rioarian Condition Ratinq: 3.7, (Poor)

MUSIC CREEK

sURVEY Summary

A. Stream Summary

Music Creek is a perennial, third order tributary to Fish Creek (RM 6.2 of Fish Creek). At the time of the survev, Music Creek was discharging approximately 6 cfs at its mouth. A total of 0.8 miles (RM 0.0.0.8) were surveyed March 6, 1984. This was determined to be the extent of potential anadromous habitat. At this point the stream gradient increases to 15+%. Some anadromous habitat may exist above this point but due to time constraints an inspection of this area was not made. Music Creek is currently inaccessible to anadromous fish due to an impassable culvert located at its mouth (C2 RM 0.0)

Access to Music Creek is by Forest Service roads S-54 and S-5430 which cross the stream at RM 0.0 and Rm 1.9 respectively. A short spur road parallels the north side of the stream from the mouth to Music Creek Mine (RM 0.3). This is an inactive mine which apparently caused a landslide on the north slope.

B. Watershed Characteristics and Geomorphology

Music Creek heads between South Fork Mtn. and Dead Horse Butte. It flows in an easterly direction to Fish Creek. The drainge area is 1,690 acres (2.6 sq.mi.). It has been extensively loqqed. The drainaqe appears relatively unstable with a landslide at RM 0.3, two sluiced out tributaries around RM 0.6, and a small earthflow from RM 0.75 to 0.8

The valley configuration is a narrow, flatbottom V with an averaqe floodplain width of 30 feet. The flow reqime appears moderately flashv. Flows at the mouth differ from approximately 6 cfs during periods of mean high water to 1 cfs durinq low flow periods (Smith and Caruso survey - September 10, 1975).

Two logjams are present (J1, RM 0.3 and J?, RM 0.4). There are numerous additional old jams and sediment plains which the stream has routed around or through.

C. Reach Description

One reach was identified from the mouth to RM 0.8. The stream is riffle dominated (70%) with a gradient ranging between 8-14%. Channel structure is provided by boulders which compose aoproximatelv 80% of the riffle substrate.

D. Fisheries

The Fish Habitat Condition Rating (HCR) for the survev section is 5.2 (fair). Rainbow trout were observed throuqhout the survey area and the habitat appears suitable for winter steelhead. A barrier culvert at the mouth precludes usage for anadromous species. The culvert is 50 feet feet long with a 10% gradient.

Pool rearing habitat appears fair. Pools are typically small pocket pools (1-2sq. yds.) located behind boulders. Pool depths are moderate (12-30") with moderate effective cover provided by boulders and water turbulence.

Spawninq habitat is poor in terms of both quantity and quality of spawning gravels. A total of 22 sq. yds. of gravel were counted and 60% of these are marginal quality due to poor channel placement. The gravel beds are small (1-2 sq.yd.) patches deposited predominently behind boulders. Thirty-five percent of the qravels are suitable for anadromous utilization.

Three passage barriers occur within the survey-area. A culvert (Cl) at the moutb is a velocity and jump barrier. Two logjams (J1, RM 0.3 and 32, RM 0.4) act as jump barriers. These are large jams (20,000 + cu.ft.) which could be partially removed to create passaqe. Access is poor to this area and the work could be completed with hand tools.

Numerous small, boulder cascades occur in this stream which individually are not Passage problems. A cumulative affect mav occur though, due to these cascades and the high gradient 8-14% that occurs throuqhout.

E. Riparian Area

The Riparian Condition Rating (RCR) is 3.7 (poor). Neqative factors influencing this score include the narrow floodplain width (30 ft.), a lack of deciduous species in the overstory, and the absence of special habitat units.

F. Rehabilitation and Enhancement

Rehab/enhancement opportunities include creating passage at the two logjams and the culvert at the mouth. This would access 0.8 miles of winter steelhead habitat.

Increasing pool depth and area could improve pool rearinq and holding habitat. This could be accomplished using local materials such as boulders greater than three feet in diameter. These structures could also be designed to catch gravels for increased spawning habitat.

Riparian area diversity could be increased by establishing deciduous species in the overstory. A possible site for cottonwood planting is in the area of the landslide (RM 0.3).

MUSIC CREEK

TABLE I - HABITAT DATA SUMMARY

REACH (R.M.)	STREAM				POOLS			RIFFLES (%)						
	HCR	S	P:R	G	d	A	EC	BR	1+	6-12"	1-6"	.1-1"	SD	D
I(0.0-0.8)	5.3	80	3:7	To	M	I	M	*	80	15	*	-	-	6

LEGEND:
- HCR: Habitat Condition Rating
- S: Percent of stream shaded
- P:R: Ratio of pool length:riffle length
- G: Average gradient (%)
- d: Average maximum depth (L < 12", M = 12 - 29", H >30")
- A: Average pool area (sq. yards)
- EC: Effective cover (L < 40%, M = 40-60%, H >60%)
- BR: Bedrock
- SD: Sand
- D: Average depth (inches)
- *: Present, but less than 5%

MUSIC CREEK

TABLE II - FISH SPECIES OBSERVED AND RELATIVE ABUNDANCE/100 FT.

Species	REACH	TRIBUTARIES
Rainbow - a	L	

•

LEGEND: L = Low (0-5); M = Moderate (6-50); H = High (50+)
a = adult, i = .iuveniie

* = habitat suitable; presence reported but not observed.
( )= habitat suitable; may not be present

MUSIC CREEK

TABLE III - SPAWNING GRAVEL (SQUARE YARDS)

Reach (R.M.)	Spawning Gravel (Sq. Yds.) Total	Good	Marginal
I (0.0-0.8)	22	8	14
TOTAL	22	8	14

TABLE IV - FISH MIGRATION OBSTRUCTIONS

STREAM (R.M.)	TYPE	ID #	PASSABLE	RECOMMENDATIONS*
0.0	Culvert	C1	N	Provide Passage
0.25	Cataracts	None	P	Modify to improve passaqe
0.3	Logiam	J2	N	Partial removal
0.4	Logjam	32	N	Partial removal

LEGEND: F = full passage
P = partial passaqe
N = no passage

*Refer to special case form for barrier characteristics.

MUSIC CREEK

TABLE V - ANADROMOUS HABITAT SUMMARY

REACH (RM)	Miles Avail.	Miles Pot.	P:R	Rearing Area	Rearing Depth	Spawning 1"-3"	Spawning 3"-6"	Comments
I(0.0-0.8)	0	0.8	3:7	1	M	5	3	None
TOTAL	0	0.8				S	3	

Legend: Avail.: Miles of habitat presently accessible to anadromous fish if introduced.
Pot.: Additional miles of habitat potentially available with complete passage enhancement.
P:R: Ratio of pool length : riffle length.
Area: Averaqe pool area fsa. yds.).
Depth: Average pool depth (feet).
Spawning: Number of Sq. Yards of qravels observed in the 1"-3" and 3"-6" size classes.

MUSIC CREEK

TABLE VI - LWD HABITAT OUALITY INFLUENCE

	SP. GRAVELS				POOL				LWD CHARACTERISTICS				
Reach (R.M.)	Total	(%)	HO	(%)	Total	(%)	HO	(%)	OR	#	L	Dia	Source
I (0.0-0.8)	50		90		15		10		Perp.	S/M	2	l-2	T

LEGEND: Total: Percent of total habitat area dependant on LWD
HO: Percent of high quality habitat area dependent on LWD
OR: Angle of orientation to flow; Perp = perpendicular, Var = variable
#: Number of logs/structure; S = single log, M = multi-log
L: Average length of logs, expressed in channel widths
Dia: Diameter of average logs in feet
Source: L = local
T = transported
M = mixture of local and transported

TABLE VII - HABITAT AND HYDROLOGICAL FEATURES FOR SUMMER AND BANKFULL CONDITIONS

	SUMMER*				BANKFULL		
Reach (R.M.)	w	d	v	0	W	D	Floodplain Width (Ft.)
I(0.0-0.8)	6	1	1	6	12	1	30

W,w: Stream width (ft)
D,d: Stream depth (ft)
v: Velocity (feet/second)
0: Average reach flow in cubic feet/second
*Data collected in March

MUSIC CREEK

TABLE VIII - TEMPERATURE AND SHADE RELATIONSHIP

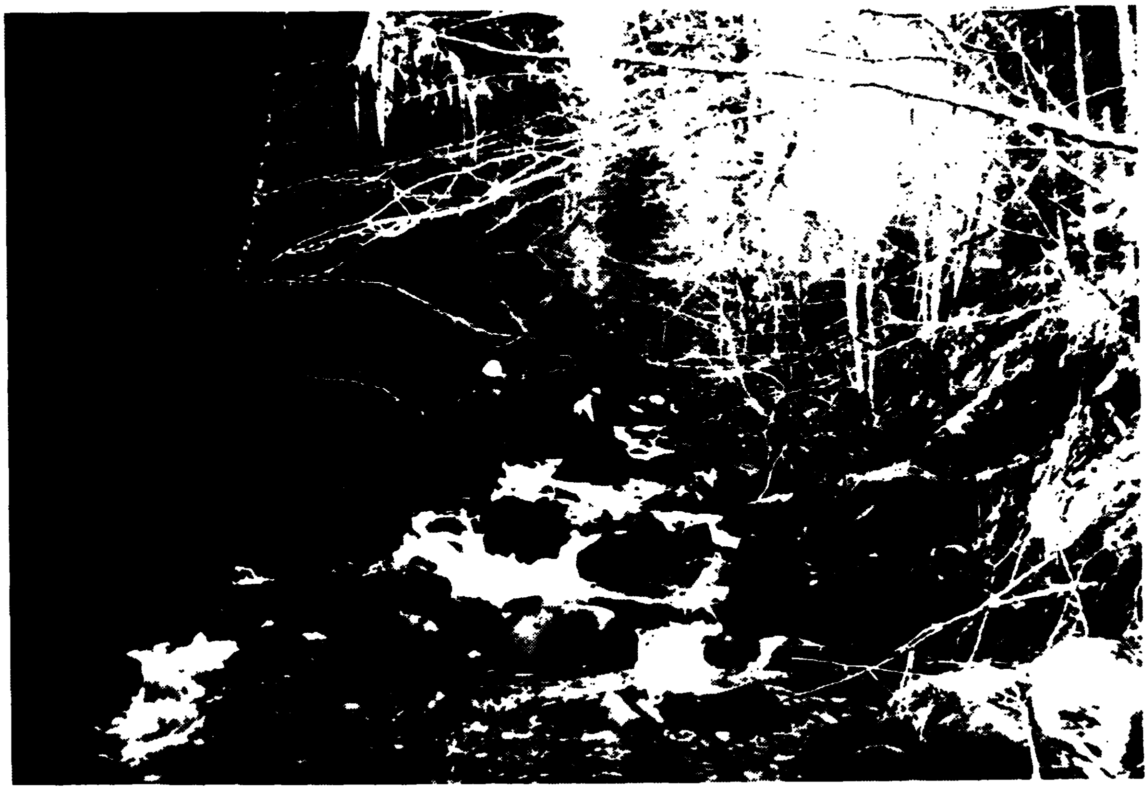
REACH (R.M.)	DATE	FLOW (cfs)	% SHADE	ASPECT	AIR/WATER TEMP.° F A/W	A/W	TIME
I(0.0-0.8)	3-6-84	6	80	SE	51/41		1215

TARLE IX - RIPARIAN HABITAT SUMMARY

REACH (RM)	RCR	VALLEY F.P.	t.	VEGETATION H.U.	Overstory Con.	Dec.	AQUATIC Streamclass	Wetland%	Size	Special Habitat
I(0.0-0.8)	3.7	30		3	3	0	II	0		0

LEGEND: RCR: Riparian Condition Ratinq
F.P.: Floodplain width in feet
H.U.: # Habitat units (H > 4; M = 2-3; L <1)
Con: # Conifer species
Dec: # Deciduous species
Wetland: Percent of stream length with adjacent wetlands; (H 50%; M = 25.50%; L 25%)
Size: Size of wetlands
S = small (less than 1 acre)
L = large (greater than 1 acre)

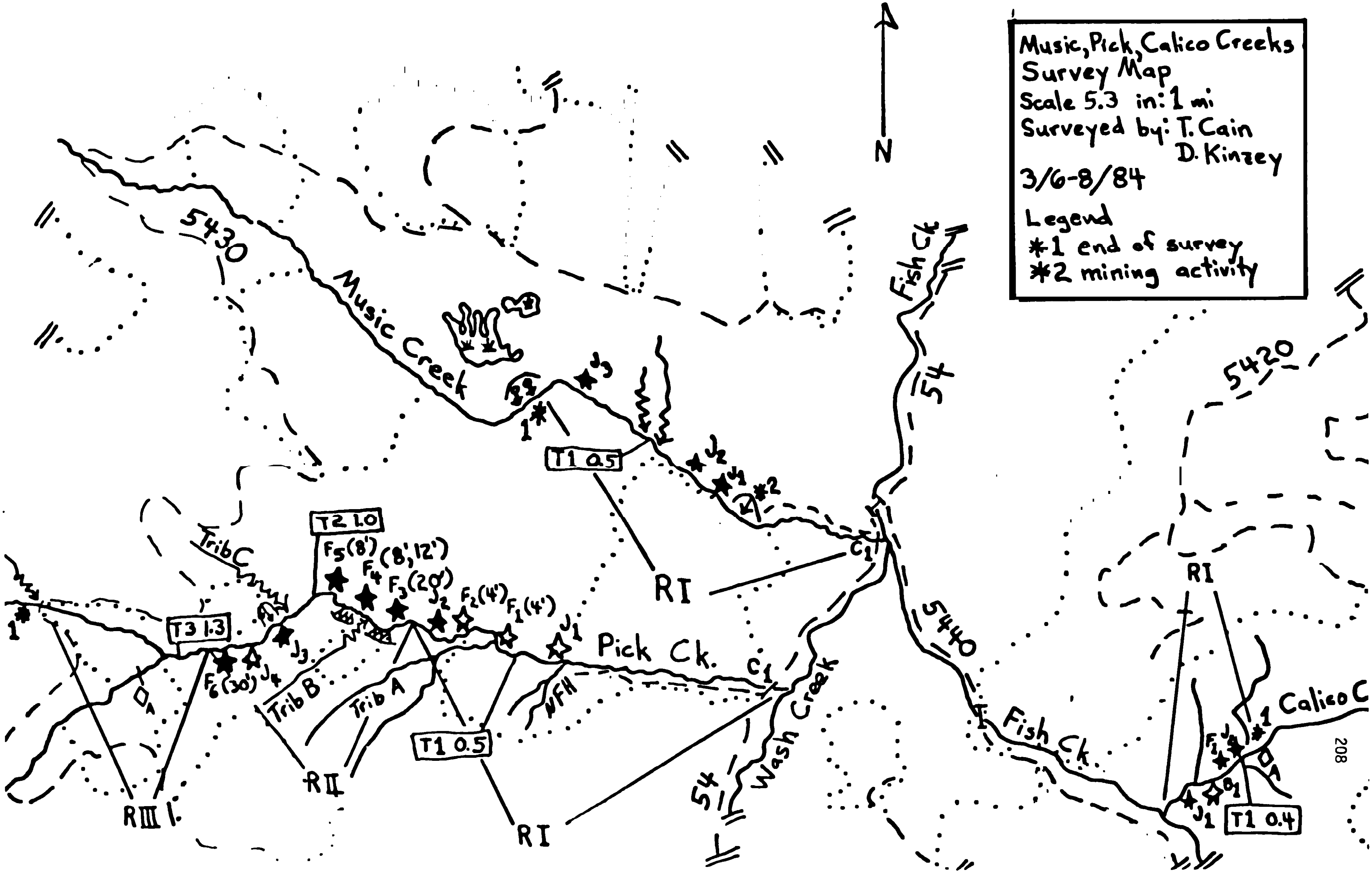
Three total massage barriers and one partial barrier occur on Music Creek from RM 0.0 to RM 0.8; including this culvert at the mouth which is a velocity and jump barrier. At least 0.8 miles of anadromous fish habitat is available if all passage work is completed. Creatiing passage at the culvert would access 0.3 miles of potential steelhead habitat.



Music Creek is a hiqh gradient (8-14%), boulder cascade stream. Riifles dominate the stream area (70%) and pools are typically small (l-2 sq. yd.) with moderate depth and cover. Structures to increase pool area and depth appear important for improving pool rearina habitat. Local materials, such as houlder and/or LWD from logjams could be utilized.

A land slump is located at RM 0.3 and is possibly a result of mining activity. The slump crossed Music Creek but has since been reqraded through. The soil appears to be stabilized bv dense alder growth, except the head of the slide which is exposed soils. A corner post for the-Music-Creek Wine is in the slide area.

Two large logjams (J1, RM 0.3 in photo and J2, RM 0.4) act as total migration barriers. Partial removal of the jams is necessary to consolidate flows and create passage through the jams. Ban4 sloughing (800 sa. ft.) is associated with J2 where the stream is laterally cutting around the jam.


Music, Pick, Calico Creeks
Survey Map
Scale 5.3 in: 1 mi
Surveyed by: T. Cain
D. Kinzey
3/6-8/84
Legend
*1 end of survey
*2 mining activity
N
5430
5420
5440
54
Music Creek
Pick Ck.
Fish Ck
Wash Creek
Calico C
Trib C
Trib B
Trib A
NFH
T1 0.5
T2 1.0
T3 1.3
T1 0.4
RI
RII
RIII
F5 (8')
F4 (8', 12')
F3 (20')
F2 (4')
F1 (4')
F6 (30')
J1
J2
J3
J4
C1

208

- STREAM SURVEY MAP SYMBOLS -

CLEAR CUT BOUNDARY

$R_{I,II,III}$ REACH # and SECTION

T_1 1.0 TRANSECT # and RIVERMILE

OBSTRUCTION BARRIER

J1,2,3, JAM and #

F( )1,2,3 FALLS, HEIGHT, and #

C1,2,3 CULVERT and #

B1,2,3 CHUTE and #

DIVERSION STRUCTURE (I = water is used for irrigation purposes)

MINE or ROCK PIT SITE

BRIDGE

LANDSLIDE, SLUMP

DEBRIS TORRENT TRACK

SPRING

UPPER LIMIT OF FISH PRESENT (A = limit of potential anadromous fish habitat)

BANK EROSION (EXTENSIVE/SEVERE)

1,2,3, :MISCELLANEOUS

WETLAND HABITAT

S-47 ROAD AND ID NUMBER

EARTHFLOW

Culvert # 1 Stream ______ Date ______

Gradient greater than 1½%: Yes ______ No. ______

Type of structure (check)

Round Pipe ✓ | Box | Arch | Open Arch | Open Box | Eliptical

Length of structure ______ ft. Diameter of structure 9 ft.

Are baffles present? Yes ______ No. ______

Jumping distance into culvert from pool: Height ______'

Pool present below culvert: Length ______', width ______', depth ______'

Stream above culvert: Width ______', gradient ______'.

Stream flowing water: Yes ______ No ______

Other comments: 6" ______ 5' wide

Culvert # ______ Stream ______ Date ______

Gradient greater than 1½%: Yes ______ No. ______

Type of structure (check)

Round Pipe | Box | Arch | Open Arch | Open Box | Elliptical

Length of structure ______ ft. Diameter of structure ______ ft.

Are baffles present? Yes ______ No. ______

Jumping distance into culvert from pool: Height ______'

Pool present below culvert: Length ______', width ______', depth

Stream above culvert: Width ______', gradient ______

Stream flowing water: Yes ______ No ______

Other comments: ______

Culvert # ______ Stream ______ Date ______

Gradient greater than 1½%: Yes ______ No. ______

Type of structure (check)

Round Pipe | Box | Arch | Open Arch | Open Box | Eliptical

Length of structure ______ ft. Diameter of structure ______ ft.

Are baffles present? Yes ______ No. ______

Jumping distance into culvert from pool: Height ______'

Pool present below culvert: Length ______', width ______', depth ______'

Stream above culvert: Width ______', gradient ______'.

Stream flowing water: Yes ______ No ______

Other comments: ______

Culvert # ______ Stream ______ Date ______

Gradient greater than 1½%: Yes ______ No. ______

Type of structure (check)

Round Pipe | Box | Arch | Open Arch | Open Box | Elliptical

Length of structure ______ ft. Diameter of structure ______ ft.

Are baffles present? Yes ______ No. ______

Jumping distance into culvert from pool: Height ______'

Pool present below culvert: Length ______', width ______', depth

Stream above culvert: Width ______', gradient ______'

Stream flowing water: Yes ______ No ______

Other comments: ______

Log Jam # 1 Stream M[illegible] Date 3/6/84

Location: T.____ R.____ S.____ Stream Survey Mile 0.5

Barrier ✓ Partial Barrier____ No Barrier ____

Woody Material: L 50' x W 50' x H 10' = Volume [illegible] cu. ft.

Sediment Plain: L 60' x W 30' x D 6' = Volume ____ cu. ft.

Washout Potential: Appears Stable ✓ Does Not Appear Stable ____

Comments: [illegible]

[illegible]

Log Jam # 2 Stream M[illegible] Date 3/6

Location: T.____ R.____ S.____ Stream Survey Mile 0.6

Barrier ✓ Partial Barrier____ No Barrier ____

Woody Material: L 50' x W 40' x H 10' = Volume ____ cu. ft.

Sediment Plain: L 50' x W 30' x D 5' = Volume ____ cu. ft.

Washout Potential: Appears Stable ✓ Does Not Appear Stable ____

Comments: Stream cutting around [illegible] side into bank. 5' jump, no pool.

Log Jam # 3 Stream Music Date 3/6

Location: T.____ R.____ S.____ Stream Survey Mile 0.8

Barrier ✓ Partial Barrier____ No Barrier ____

Woody Material: L 5' x W 15' x H 5' = Volume ____ cu. ft.

Sediment Plain: L____' x W____' x D____' = Volume ____ cu. ft.

Washout Potential: Appears Stable____ Does Not Appear Stable ____

Comments: 6' jump. Logs jammed against boulders. Gradient takes off to 12-14% cascades above.

Log Jam #____ Stream ____ Date ____

Location: T.____ R.____ S.____ Stream Survey Mile ____

Barrier ____ Partial Barrier____ No Barrier ____

Woody Material: L____' x W____' x H____' = Volume ____ cu. ft.

Sediment Plain: L____' x W____' x D____' = Volume ____ cu. ft.

Washout Potential: Appears Stable____ Does Not Appear Stable ____

Comments: ____

Log Jam #____ Stream ____ Date ____

Location: T.____ R.____ S.____ Stream Survey Mile ____

Barrier ____ Partial Barrier____ No Barrier ____

Woody Material: L____' x W____' x H____' = Volume ____ cu. ft.

Sediment Plain: L____' x W____' x D____' = Volume ____ cu. ft.

Washout Potential: Appears Stable____ Does Not Appear Stable ____

Comments: ____

Log Jam #____ Stream ____ Date ____

Location: T.____ R.____ S.____ Stream Survey Mile ____

Barrier ____ Partial Barrier____ No Barrier ____

Woody Material: L____' x W____' x H____' = Volume ____ cu. ft.

Sediment Plain: L____' x W____' x D____' = Volume ____ cu. ft.

Washout Potential: Appears Stable____ Does Not Appear Stable ____

Comments: ____

APPENDIX D: FISH CREEK WINTER HABITAT SURVEY

FISH CREEK

WINTER HABITAT SURVEY

Surveyed by: Tom Cain
Doug Kinzey

November **19, 20, 27,** 1984
Mt. Hood National Forest

FISH CREEK
WINTER HABITAT SURVEY

INTRODUCTION

Rehabilitation and enhancement efforts, funded by the Bonneville Power Administration and USDA Forest Service, have been Initiated on Fish Creek to Improve the habitat quality and anadromous fish runs of this system. Fish Creek Is a major, fifth order tributary to the Clackamas River, and supports populations of steelhead trout, chinook, and coho salmon. In conjunction with rehabilitation efforts the Pacific Northwest Forest and Range Experiment Station is conducting evalutions of project effectiveness, and analysis of habitat types found in Fish Creek. From these studies Everest and Sedell (1984)* showed a disproportionately high value for sidechannels and alcoves as preferred rearing habitats by juvenile salmonids, particularly coho. Although sidechannels and alcoves composed only 10% of the low flow stream area on Fish Creek in 1982, 50% of the total number of coho juveniles and 80% of their biomass were observed in these two habitats. Sidechannels were also heavily utilized by steelhead in 1982, with young of the year (0+) densities over six times as great as in any other habitat type.

Historical proportions of sidechannel and alcove habitat types have likely been reduced by a variety cf management activities. Narrowing and straightening of the stream channel by road construction, and removal of large wood debris (LWD) cover and structure in salvage logging operations appear to be major factors.

In addition to their importance during low flow conditions, It is likely that sidechannels and alcoves also play an important role in providing edge or still water over-winter rearing habitat for juveniles. During periods of high flows the amount of still water area in the main channel is reduced and the need for quiet water refuge areas increases, especially for juvenile coho and 0+ steelhead. Increasing the amount of quiet water refuge areas, as provided by sidechannels and alcoves, should increase the survival of juvenile salmonids.

A stream survey of the lower 4.3 miles of Fish Creek was conducted November 19, 20, and 27, 1984, during flows approximating mean high water. The objective of the survey was to examine existing rearing habitat during winter conditions and to locate and describe opportunities to increase over-winter rearing habitat, particularly for coho juveniles. This survey is intended tc be a basin-level reconnaissance Identifying the range of project opportunities available. Further project-specific planning will be necessary in Implementing the opportunities identified In this report.

* Everest, F.H. and Sedell, J.R. 1984. Habitat enhancement evaluation of Fish and Wash Creeks. In, Natural Propagation and Habitat Improvement, Volume I- Oregon, Supplement A, Dept. of Energy, Bonneville Power Administration.

RESULTS

Forty-four sites with existing or potential overwinter fish habitat are identified. Thirty-five of these appear to have project potential. All sites are described, located on the survey map, and photo-documented.

Twenty-two mainstem sidechannels were located during the survey, of which thirteen were flowing (66,700 square feet estimated surface area) and eight were dry (196,100 square feet estimated channel and bar area) during survey flows. Rehabilitation/enhancement opportunities include: excavating dry highwater sidechannels to capture mean high flaws or groundwater, protecting inlets of ail sidechannels against higher than average winter storm runoff events, and increasing pool area by boulder berm/log sill construction to optimize overwinter quiet water habitat.

Nine, relatively large (average size 42 square yards), existing alcoves are identified. Additionally, seven "edge" locations, which could be modified to provide numerous alcoves, are identified. These edges are shallow water benches with numerous small pocket pools and backwater eddies. They are often overgrown with alder thickets. A total stream length of 650 lineal feet is characterized as edge. Creating alcove habitats at these locations, by dropping trees and/or constructing boulder berm deflectors, could create numerous small to medium sized stilling areas.

Five flood plain terraces are also identified. These presently contain little or no fish habitat but may be suitable for creating off-channel ponds. This would likely be through excavation and interception of ground water and/or flow diversion of mainstem or side tributaries.

A high density of potential projects, and good equipment access, make the area from RM 1.1 to 2.1, around the 1983 beaver pond enhancement site, a high priority for project implementation. Eleven project sites (Site "'s 9-20) including five sidechannel enhancement sites and one floodplain terrace excavation site, could be combined in a single project. Heavy equipment will be just upstream of this area in summer, 1985, to construct the beaver pond #2 enhancement site.

TERMS

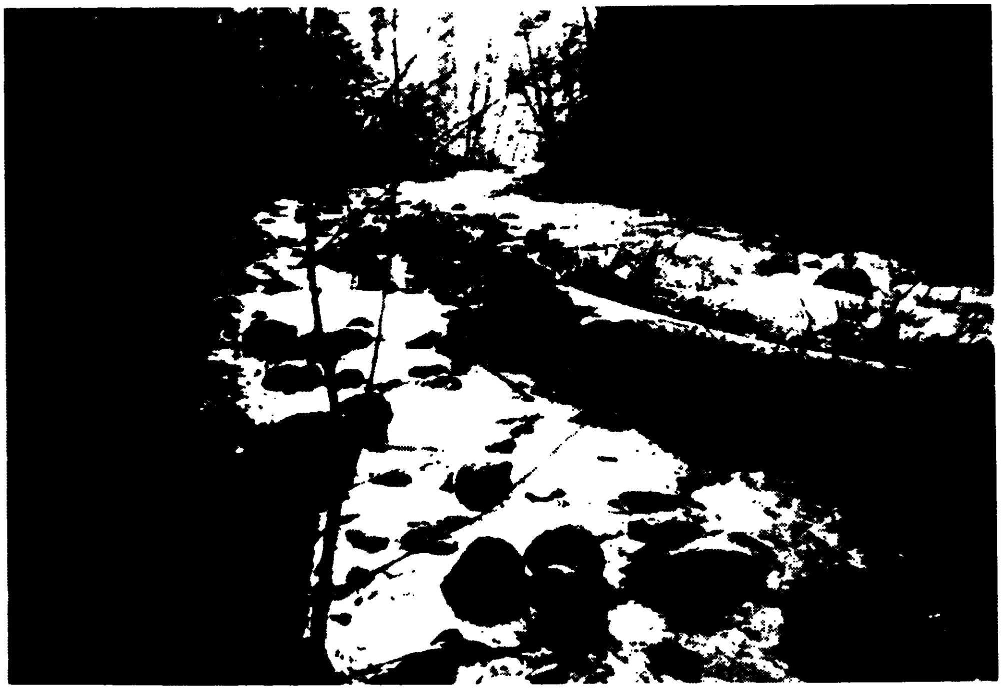
Alcove- Protected pool habitat along mainstem margin formed by large woody debris, boulders, or bedrock.

Edge - Shallow, boulder bench along mainstem edge with numerous small pocket pool s and backwater edd ies.

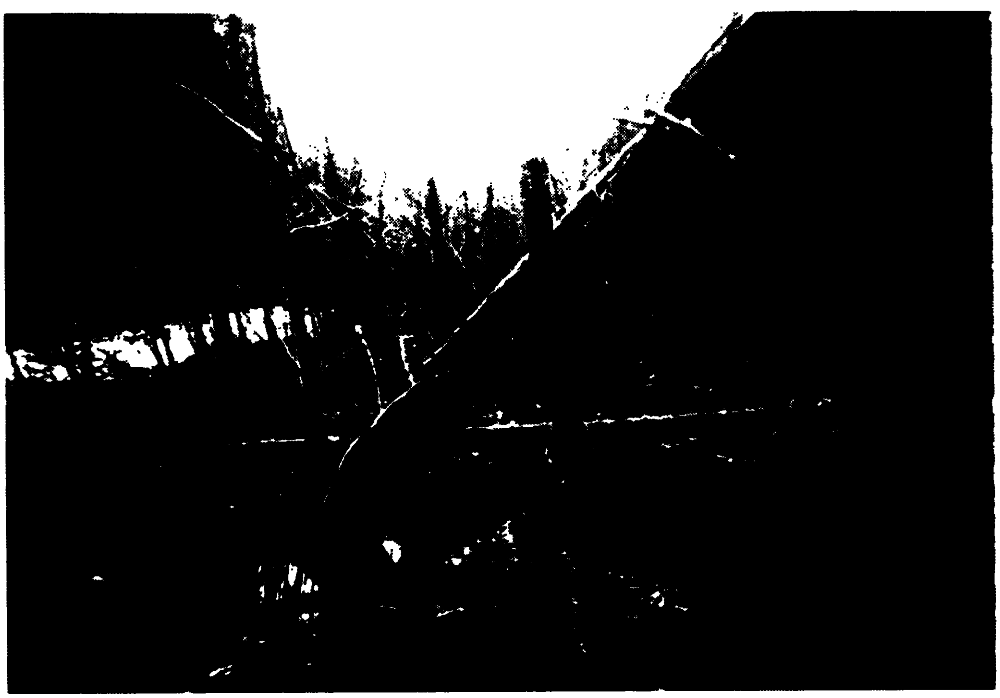
Floodplan terrace - Wide region of floodplain, usually with old channel braids/peak flow channels. Typically 6-12 feet above mainstem.

Sidechannel - Channel braid separated from mainstem by aider covered boulder bar. May be flowing or dry during mean high flows, but appears to receive flows at I east during peak events. Often has a higher proportion of pools/quiet water than mainstem.

Terrace tributary - Tributary which crosses floodplain terrace before entering ma I nstem.

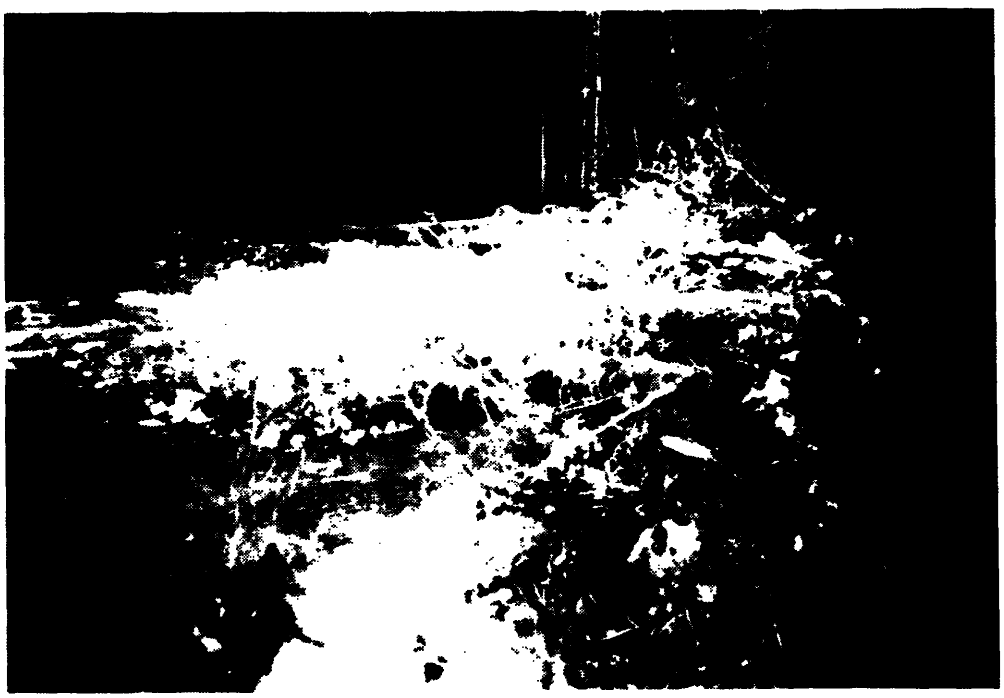


Naturally occurring sldechannels on Fish Creek, such as this at RM 4.05 (Site #40), often have a higher percentage of pools and still water habitat than the riffle-dominated mainstem. They appear disproportionately important as rearing habitat for juvenile salmonids. Successful use of these hab itats by overwintering juveniles can be improved by constructing boulder berms or introducing large woody debris to deflect high peak flows back into the maln channel.



Sidechannels can be created along dry highflow channels, such as Site #9 at RM 1.2, through excavation. As with existing sldechannels, protecting the created channel against peak flows with boulders or large woody debris will help insure overwinter survival of juvenilesa using the sidechannel.

Seven "edge" l ocat ions, such **as Site #21 at RM 2.3, were identified. Shallow** depth with numerous pocket pools and backwater eddies make these **areas** good candidates for whole-tree introduction from the upper bank to create **alcoves and divert** peak flows back into the **main** channel.



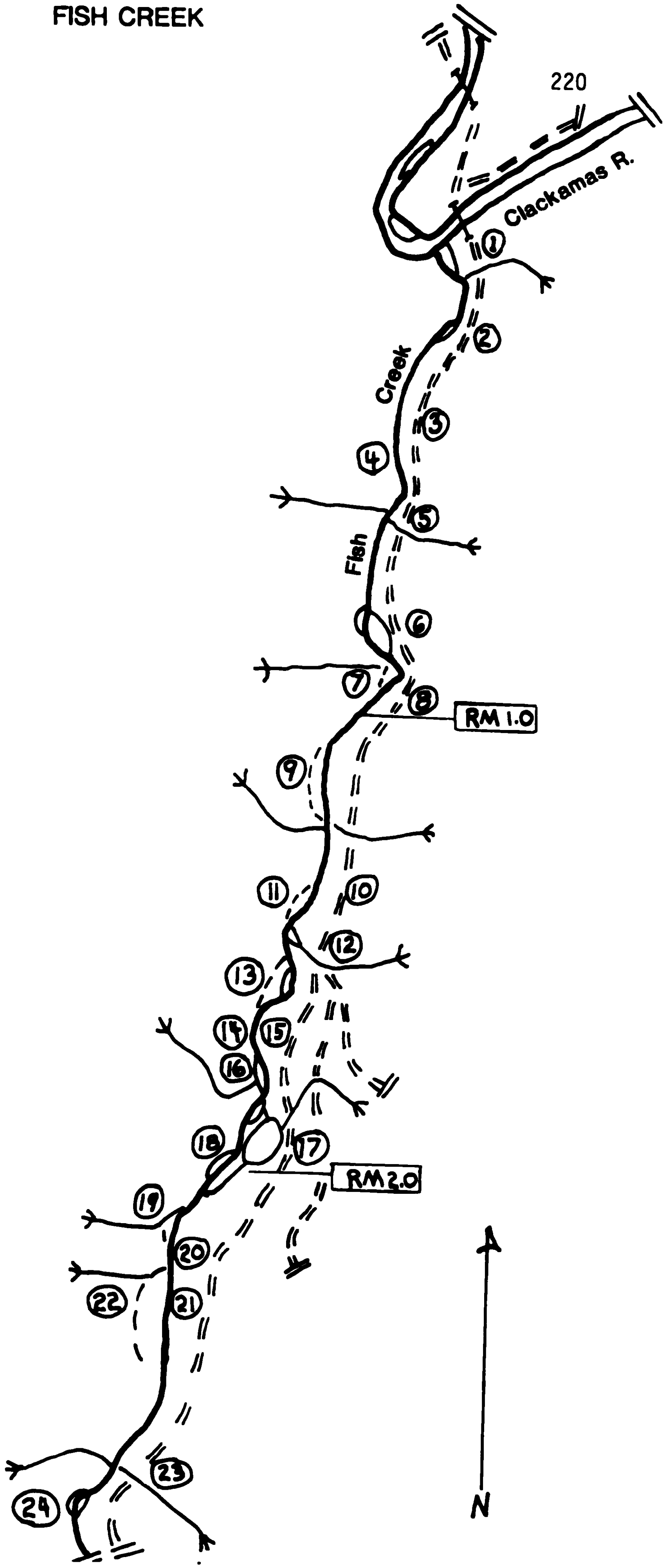
This **edge at** RM **3.85** (Site #37) appears to provide excellent overwinter **rearing habitat.** introducing large woody debris upstream **of** Its present **location could extend** the usab l e port ion of this high qual ity habitat.

Blasting/excavating coho rearing ponds on terrace tributaries, such as this at RM 2.6 (Site #23), Is a project opportunity identified at 8 sites.

This alcove at RM 2.1 (Site #20) was one of nine identified during the survey. Excellent equipemtn access and the large (about 1,000' long) floodplain terrace with numerous old channel braids at this site make It a good starting point for fioodpialn excavation to create backwater rearing ponds.

FISH CREEK

Site	RM	Description/Project Option
1	0.0	300' long x 100' wide (15' water width) sidechannel. Excavate pools and berm inlet.
2	0.15	50' long x 8' wide sidechannel. Drop trees.
3	0.4	Pull log and rootwad into channel.
4	0.5	Blast pools in bedrock.
5	0.55	Excavate pools in 100' long x 15' wide boulder bar below eastern trib. Pull logs around west trib. into channel.
6	0.85	1984 sidechannel enhancement site. 700' long x 8 wide. Reduce inlet and add structure.
7	0.9	Excavate ponds on 200' long terrace.
8	0.95	Blast pools in bedrock.
9	1.1	Excavate 600' long dry western sidechannel, 30' long eastern boulder bar, and drop trees.
10	1.5	30' long x 10' wide existing alcove.
11	1.55	Excavate 300' long x 20' wide dry western sidechannel and drop logs.
12	1.55	Drop logs along 100' east edge between tributaries.
13	1.6	Excavate 400' long x 10' wide dry western sidechannel.
14	1.7	Pull west bank logs into stream.
15	1.7	Construct berms or drop logs in 50' long x 20' wide east edge.
16	1.8	300' long x 20' wide tributary - fed western sidechannel. Berm inlet and excavate ponds on tributary terrace.
17	1.95	1983 beaver pond (270' x 180'w). 150' long x 35' wide east mainstem braid. Drop logs.
18	2.0	300'l x 20'w sidechannel with alcove at head. Drop logs.
19	2.05	350' long x 20' wide tributary-fed western sidechannel. Excavate pools.
20	2.1	12 square yard alcove and 1,000' long x 200' wide floodplain terrace. Excavate old braids in terrace.
21	2.3	Drop logs along 100' long x 15' wide east edge.
22	2.3	55,800 square foot floodplain terrace 1985 beaver pond #2 enhancement site.
23	2.6	Blast potholes or excavate rearing ponds in tributary alluvial area 100' long x 30' wide.
24	2.7	Three braids, 20' wide x 75' long each. Drop logs in east braid.



FISH CREEK

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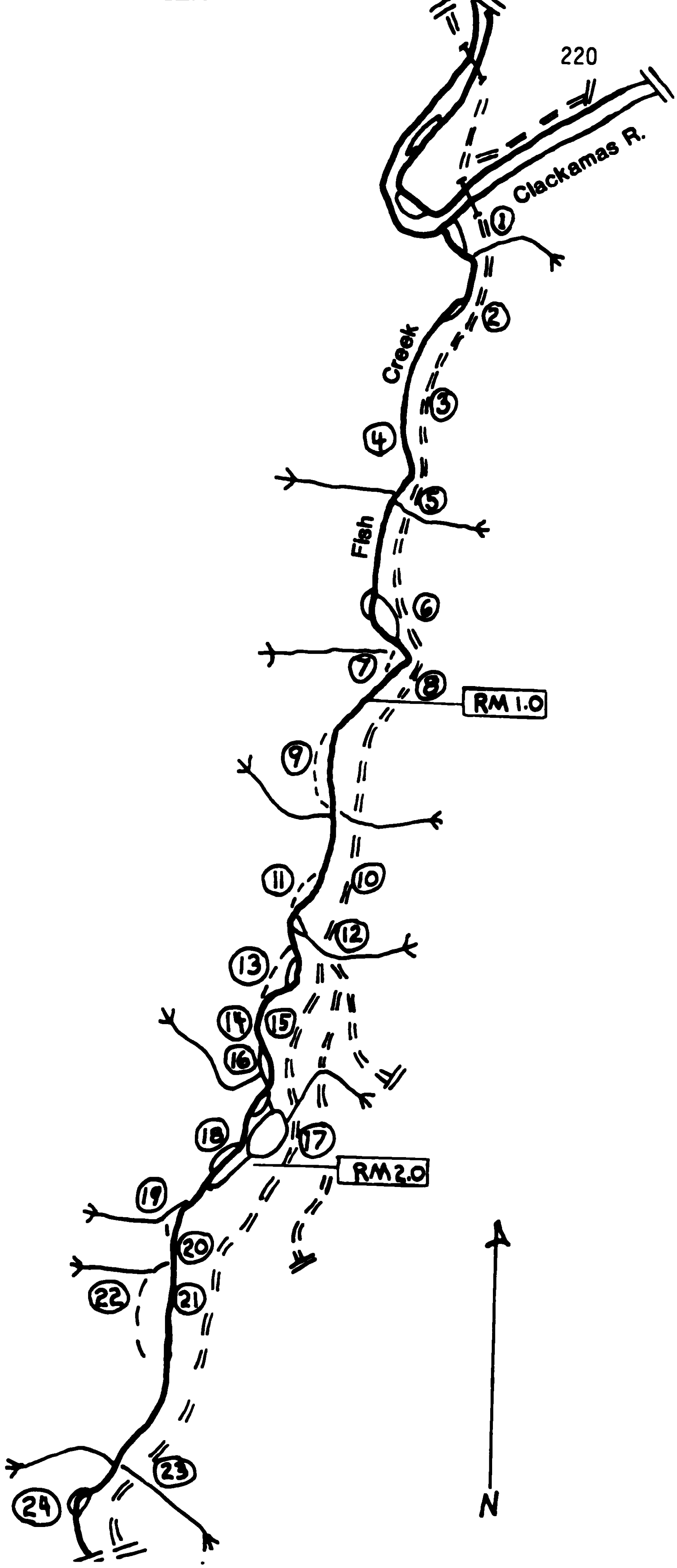
10	1.5	30' long x 10' wide existing alcove.
11	1.55	Excavate 300' long x 20' wide dry western sidechannel and drop logs.
12	1.55	Drop logs along 100' east edge between tributaries.
13	1.6	Excavate 400' long x 10' wide dry western sidechannel.
14	1.7	Pull west bank logs into stream.
15	1.7	Construct berms or drop logs in 50' long x 20' wide east edge.
16	1.8	300' long x 20' wide tributary - fed western sidechannel. Berm inlet and excavate ponds on tributary terrace.
17	1.95	1983 beaver pond (270' x 180'w). 150' long x 35' wide east mainstem braid. Drop logs.
18	2.0	300'l x 20'w sidechannel with alcove at head. Drop logs.
19	2.05	350' long x 20' wide tributary-fed western sidechannel. Excavate pools.
20	2.1	12 square yard alcove and 1,000' long x 200' wide floodplain terrace. Excavate old braids in terrace.
21	2.3	Drop logs along 100' long x 15' wide east edge.
22	2.3	55,800 square foot floodplain terrace 1985 beaver pond #2 enhancement site.
23	2.6	Blast potholes or excavate rearing ponds in tributary alluvial area 100' long x 30' wide.
24	2.7	Three braids, 20' wide x 75' long each. Drop logs in east braid.



FISH CREEK

Habitat Description and Project Options

Site #1 RM 0.0

Description - 300' long channel braid on 100' wide bar east of mainstem. Largest pool at time of survey was 15' wide x 50' long x 1' deep pool in middle of braid. Tributary from east about 50 feet upstream of braid inlet flowing about 6 cfs. Equipment access Is good.

Project Option - Construct berms with backhoe up sidechannel to increase rearing area. Build short berm deflector above mouth of tributary to create gravel deposition, protect edge down to sidechannel, and deflect flows away from sidechannel. Deepen and add cover to the large pool on the sidechannel. could also berm inlet to sidechannel to control flows. An existing natural deflector on east mainstem at mouth could be enhanced with additional boulders to create stilling area just off Clackamas mainstem.

Site #2 RM 0.15

Description - 50' long x 8' wide gravel bottomed sidechannel east of mainstem on outside meander bend. Three foot wide boulder/alder bar separates from mainstem. About 100' upstream of inlet a natural deflector log has accumulated 5 square yards of spawning gravel.

Project Option - Could drop additional trees at inlet to deflect high flows. Also could add additionel boulders to exlsting bar for same purpose.

Site #3 RM 0.4

Project Option - Douglas-fir rootwad and log (15+ feet long) on east bank could be pulled into channel with chainsaw wench and cabled to maple trees to create alcove.

Site #4 RM 0.5

Project Option - Blast pools in bedrock along west edge.

Site #5 RM 0.55

Description - Tributaries enter mainstem from each bank. Tributary has 80' long cedar log on upstream bank and 20' log and rootwad downstream.

Eastern tributary has large boulders at the mouth. 100' long x 15' wide boulder bar along east edge below tributary.

Project Option - Pull both logs on west bank into channel and cable to create alcoves around tr ibutary. Enlarge boulder berm upstream of eastern tributary and excavate sidechannel In downstream boulder bar to create protected still water area.

Site #6 RM 0.8 - 0.9

Description - 1984 sldechannel enhancement site. Excavated 700'l x 8'w eastern sidechannel. 300'l x 20'w western sidechannel.

Project Option - Reduce flows at Inlet and add structure to excavated sidechannel to increase pool rearing area.

Site # 7 RM 0.9

Description - Potential sldechannel area, about 200'long, on western inside meander terrace. Across from mouth of 1984 sldechannel enhancement site. High flows at time of reconnaissance prevented surveyor access. Appears to be fed by a tributary.

Project Option - Excavate rearing ponds along terrace tributary.

Site #8 RM 0.95

Project Option - Blast edge pools in bedrock along east malnstem.

Site #9 RM 1.0 - 1.3

Description - Boulder bar on eastern inside meander 100' long x 20' wide, just below tributary. Alder covered smal l boulder bar (20' wide) and dry sidechannel (600' long) on west outside bend, also below a tributary.

Project Option - Excavate sidechannel In eastern boulder bar and pull boulders In shal low riffle at head forward to berm Inside pivot of meander and create backwater eddy. Drop trees to sort gravel, and enhance ex 1 st ing natural berm at tributary mouth with additional boulders.

Cross channel with backhoe to west slde and excavate 0.1 mile long sldechannel in alder covered boulders. Leave alder Island to protect sidechannel. Tributary at sidechannel head flowing l-2 cfs could be diverted Into sldechannel.

Site 10 RM 1.5

Description - 30' long, 4'dbh log creating 10' wide x 30' long alcove backwater pool habitat on east edge. Three square yards spawning gravel.

Site 11 RM 1.55

Description - 20' wide x 300' long aider/boulder edge and sidechannel west of ma instem on inside meander bend. Fifteen feet wide x 30' long boulder alcove at head.

Project Option - Excavate channel with backhoe and drop logs **across inlet** and along channel to protect during high flows.

Site 12 RM 1.55

Description - Two east bank tr ibutar ies 30' apart w ith gravel substrates al ong 100' long x 10'wide mainstem edge.

Project Option - Drop logs along edge to deflect high flows and capture gravel.

Site 13 RM 1.6

Description - 400' long x 40' wide alder/boulder bar along west side inside meander. Presently flowing 5' wide x 100' long in outside channel. inside channel is present but dry - bedrock wall above inlet deflects flows away from inlet.

Project Option - Open longer (400') inside channel at inlet by capturing flows with perforated pipe, boulder berm, or log s I I I or iented perpend icul ar to mainstem flows.

Site 14 RM 1.7

Descript ion - Blowdown logs on west bank above highwater on inside meander.

Project Option - Pull 2-3 logs from bank into stream and cable to create alcove hab itat.

Site 15 RM 1.7

Description - Boulder edge protected at head by logjam. East bank. 20'w ide x 50' long.

Project Option - Berm construction/log introduction to increase pool area.

Site 16 RM 1.8

Description - West bank 20' wide boulder/gravel bar 300' long with flowing s idechannel . Tributary with documented coho spawning (Everest and Sedell, 1984) entering middle of sidechannel across floodplain terrace. Blowdown above inlet capturing spawning gravels and protecting 10x40' alcove against high flows.

Project Option - Berm sidechannel inlet to deflect high flows. Berm sidechannel and tributary to increase pool area and capture gravels. Could also excavate rearing ponds on floodplain terrace along tributary.

Site 17 RM 1.95

Description - 1983 beaver pond enhancement site (270'1 x 180'w pond).150' long x 35' wide east mainstem braid with constructed sill log at mouth deflecting flows Into main channel. 100'1 x 10'w boulder/gravel edge along east mainstem next to pond.

Project Option - Drop logs along mainstem braid and edge to deflect high flows.

Site 18 RM 2.0

Description - 300' long x 20' wide west sidechannel with excellent spawning and rearing LWD alcove at head.

Project Option - Drop cedar trees into sidechannel below LWD alcove.

Site 19 RM 2.1

Description - Beaver pond tributary (3-4 cfs) feeding west sidechannel 350' long x 20' w ide. High flows at time of survey prevented access. East edge stump creating 4 square yard alcove.

Project Option - Excavate rearing ponds in west sidechannel upstream of tributary entrance, berm downstream pools.

Site 20 RM 2.2

Description - 12 square yard alcove on E. edge. Very wide (200 + feet) floodplain area about 1,000 feet long with old channels and good spur road access.

Projec Op ion - Enlarge alcove by excavating back into. floodplain. May be able to excavate inlet Into old channel braids.

Site 71 RM 2.3

Description - 100' long x 15' wide boulder/alder east edge on outside meander.

Project Option - Drop logs to protect against high flows.

Site 22 RM 2.25-2.45

Descript ion - Heavy b l owdown along western terrace. Prev ious l y surveyed for enhancement work. 2,000'l x 30'w sidechannel on 55,800 square foot floodplain terrace.

Project Option - Second beaver pond enhancement site (planned for 1985).

Site 23 RM 2.6

Description - Eastern tributary flowing about 3 cfs, providing some coho rearing on floodplain. Western tributary with large boulder upstream, and good downstream pool.

Project Option - Could blast pot holes, construct log sii is to increase coho rearing in aiiuvlai area (100'long x 20'w) of eastern tributary.

Site 24 - RM 2.7

Description - Three braids on major bend. Best overwintering in east braid, inside meander, 20' wide 75' long. West bank Is eroding. 30' long x 30' high exposed sol I s on bank face.

Project Option - Drop trees into east braid. Riparian toe of eroding west bank.

Site #25 - RM 2.9

Description - Western tributary with large boulder and good pool at mouth.

Project Option - Drop log at tail of pool.

Site #26 - RM 3.1

Description - 500' long x 50" wide dry high flow braid east side. Aider covered bar. Outside meander Just below roadfill.

Project Option - Excavate inlet.

Site #27 RM 3.1 - 3.2

Description - Three major braids 0.2 miles long x 100' wide creating excellent spawning and overwintering habitat. LWD structure is abundant, especially recent (1983 ice storm) blow-down at lower end of western braid. Recent blowdown may be unstable.

Project Option - Drop trees into upper to middle section of eastern braid to improve gravel sorting.

Site #28 - RM 3.25

Description - 200' long x 5' wide alder east edge.

Project Option - Drop logs to deflect high flows.

Site #29 - RM 3.4

Description - 12' wide, 300' long western sldechannei with main Inlet (highwater) 200' up from tail of channel. Mostly dewatered dur ing mean high flow. Downstream of outside meander. Boulder alcove (12 sq. yards) at head of sidechannel. Valley terrace 150' wide x 0.15 miles long west of present sidechannel has old channel braid 6' deep against far western sideslope, 150' from stream edge.

Project Option- Excavate one or both inlets to 300' sldechannei to capture mean highwater flows. Could also excavate about 150' long x 6' deep Inlet Into old channel braid 0.15 miles long against western sideslope.

Site #30 - RM 3.5

Description - 30' long x 10' boulder/alder east edge.

Project Option - Drop trees or arrange boulders to protect against high flows.

Site #31 - RM 3.55

Description - 50' long x 10' wide log-protected east edge and alcove habltat.

Site #32 - RM 3.6

Description - 100' long x 20' wide east boulder/alder edge at dispersed site campground. Excel lent access. Nine square yard alcove upstream of edge below a bedrock pool with 4 sq. yards spawning gravel at tall.

Project Option- Drop trees or rearrange boulders in channel to protect edge. Could also excavate backwater eddies into bank. Educat ional / Interpretat ion display at campsite could explain work, importance of LWD, etc. Drop logs into alcove to protect against high flows and retain more gravel.

Site #33 - RM 3.6

Description 0.15 mile long x 200' wide western valley bottom terrace with 2 cfs tributary crossing lower end.

Project 8' Option - Create coho rearing ponds by blasting/excavation. tributary mouth into mainstem may require steep pass access. Could also build boulder groin upstream of tributary mouth to retain gravels introduced by trib.

Site #34 - RM 3.65

Description - Tributary fed east edge. 50' long x 20' wide small boulder/alder alluvial area at mouth of tributary with standing pools.

Project Opt on - Drop logs to protect during high flows.

Site #35 - RM 3.65

Description - 30' w ide x 300' long LWD - protected west edge rearing/overwintering habitat on inside bend. Excel l ent hab i tat, log protected at upstream end.

Site #36 - RM 3.75

Description - 200' long x 30' w ide smal l boulder west edge habitat on downstream end of inside bend.

Project Option - Drop trees to collect gravels and protect edge during high flows.

Site #37 - RM 3.8

Description - Excellent 200' long x 35' wide east edge overwintering habitat. Downstream tributary entering logjam protected alcove.

Project Option - Construct berms below tributary mouth to collect gravel and increase pool habitat. Drop trees above existing logjam to protect upstream edge.

Site #38 - RM 4.0

Description - Old channel braid 30' east of mainstem in valley bottom terrace area (0.2 mi x 50') with standing water at time of survey. Below campground. 250' long x 30' wide east boulder/alder edge habitat at campground.

Project Option - Divert upslope portions of intermittent tributaries at lower end of terrace onto main terrace and old channel braid. Blast/excavate rearing ponds. Drop logs along existing edge to deflect high flows. Educational/interpretational display.

Site #39 - RM 4.0

Description - West bank LWD alcoves 100' long x 15' wide x 3-4'deep.

Site #40 - RM 4.05

Description - East channel braid 250' long x 30' wide (15' underwater width).

Project Option - Drop logs to deflect high flows.

Site #41 - RM 4.05

Description - West bank LWD alcove 30' long x 15' wide.

Site #42 - RM 4.1

Description - '84 project - dynamite logs providing excellent east alcove cover and flow protection 5' wide x 15' long.

Site #43 - RM 4.2

Description - 200' long x 75" wide highflow braid with logjam at mouth diverting flows.

Project Option - Partial logjam removal or excavation into east bank to improve inlet.

Site 644 - RM 4.3

Description - 50' long x 20' wide boulder east edge below constructed boulder berms.

Project Option - Drop logs to protect against high flow.