

PHYSICAL MONITORING AND EVALUATION OF THE  
LOST MAN CREEK DAM REMOVAL

1991 Progress Report

Submitted By:

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## I. Introduction

The upper dam on Lost Man Creek was originally built in 1936 to serve as a water source for the Prairie Creek Fish Hatchery. The concrete dam structure was approximately 7.3 meters long by 17.4 meters wide by 2.1 meters high. Cement wing walls were located adjacent to the dam face on each stream bank. Following a large flood event in 1955, the pool upstream of the upper dam filled in with sediment and was no longer functional. In 1955, the upper dam was replaced by another dam lower on Lost Man Creek which currently serves to divert water for hatchery operations (Redwood National Park, 1989).

In August 1989, Redwood National Park removed the upper hatchery dam on Lost Man Creek. Sediment stored behind the dam was excavated and the spoils deposited in a stable location in the middle of the right bank terrace. The decision was made to remove the dam because: 1) the dam structure posed a safety hazard to park visitors, 2) National Park Service Guidelines for Dams and Appurtenant Structures (NPS-40) requires dams which are not essential for environmental preservation, management or operation of parks and do not have any purpose be removed, and where feasible, impounded areas restored (Redwood National Park, 1988), and 3) the dam was a partial barrier to migrating adult salmonids, in particular Chinook Salmon.

Concern was raised about potential effects of dam removal releasing sediment into the lower reaches of Lost Man Creek and impacting the aquatic habitat and the operation of the county fish hatchery dam. Redwood National Park initiated a monitoring program to evaluate effects of dam removal on lower Lost Man Creek.

## II. Study Objective

The objective of this study was to monitor and evaluate physical changes in channel geometry and morphology as a result of removing the upper hatchery dam on Lost Man Creek.

## III. Study Area

The 12.4 mi<sup>2</sup> Lost Man Creek basin is located in north coastal California four miles north of Orick, California (Fig. 1). Lost

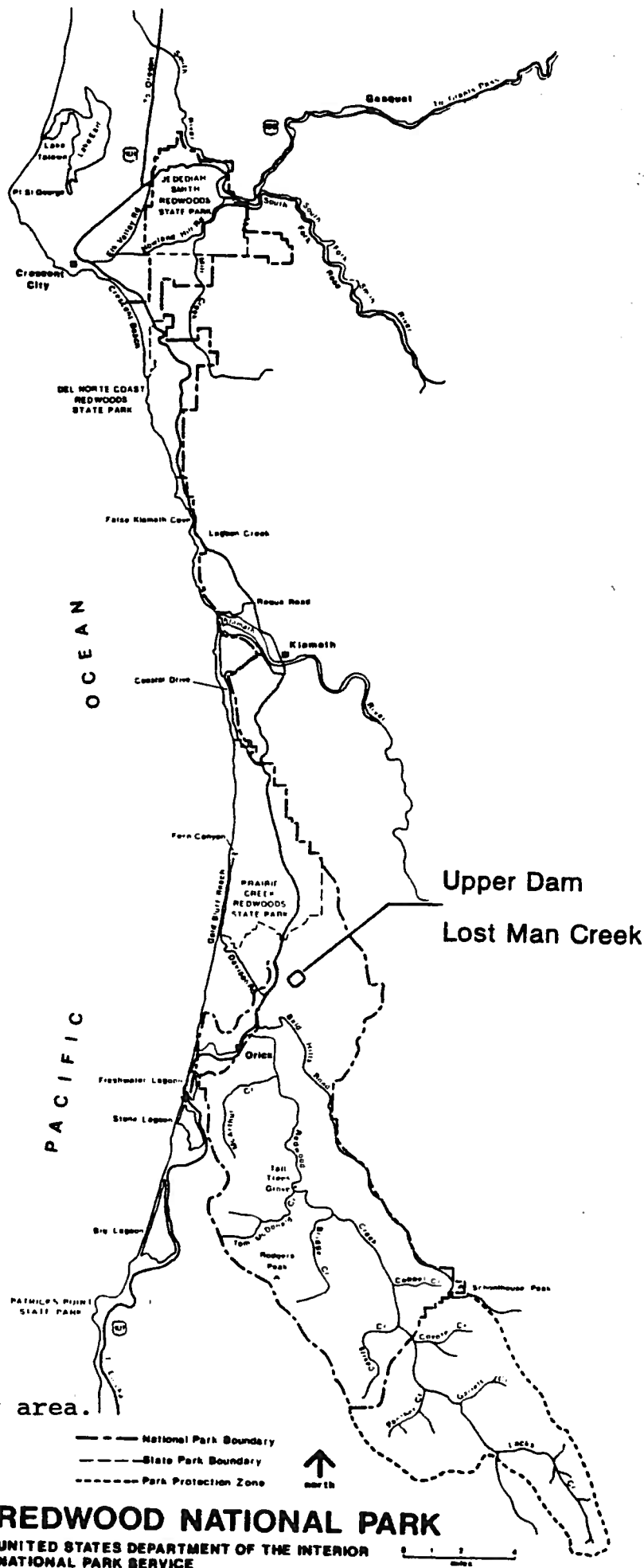


Figure 1. Study area.

Man Creek is a tributary of Prairie Creek in the Redwood Creek watershed. The upper hatchery dam was located 0.5 km upstream of the confluence of Lost man Creek with Prairie Creek (Fig 2.).

Average annual rainfall in the Prairie Creek basin is 174 cm (68.6 in) measured at the Prairie Creek Fish Hatchery. At least 80% of the rainfall occurs during moderately intense winter storms between October and March. Rainfall during summer months is uncommon. Since 1985, the Prairie Creek watershed has experienced below normal rainfall.

Bedload transport rates in Lost Man Creek from 1973 to 1975 were measured at a station located in the upper one-third of the Lost Man Creek basin. Annual bedload transport rates of 153 m<sup>3</sup> (318 tons/year) were measured at the gaging station or about 459 m<sup>3</sup> (adjusted by drainage area from gaging station data) at the dam site. This represents an estimate of bedload transport for Lost Man Creek during two high flow years. More recently, winter flows have been lower, Consequently, bedload transport has probably been much less (less than 229 m<sup>3</sup>/year).

#### IV. Methods

A channel marker system was set up along the length of Lost Man Creek between the confluence with Prairie Creek upstream to the picnic grounds bridge. Every 50 m a marker was nailed into a stream bank tree and markers were referred to by the following numbering system: 00+00 is the distance in meters from the mouth of Lost Man Creek where the "+" sign separates the hundredths place from the tenths place. Monitoring sites were tied into the channel marker system.

A total of 14 cross sections were monumented on Lost Man Creek and extend from 4+50 (X/S 1) to 16+65 (X/S 14). Cross sections were surveyed pre and post-dam removal in 1989 and throughout the 1989-1990 winter. To document changes in the surface sediment size distribution due to dam removal, pebble counts were measured on selected cross sections in the summers of 1989 and all cross sections in the summer of 1990. Sediment size was measured along five transects perpendicular to the stream channel and spaced a quarter-channel width apart. A total of 100 rocks were chosen at random and the median axis measured.

Longitudinal profiles of the lower 2.42 km of Lost Man Creek were surveyed in 1987 and 1990. The channel profile extended from the Lost Man Creek picnic grounds bridge downstream to the confluence with Prairie Creek. In addition, local adjustments in channel gradient following dam removal were monitored throughout the winter of 1989-1990 by repeated longitudinal profile surveys along a 500 m long reach in the immediate vicinity of the dam. The streambed profile extended from a large redwood log spanning the channel (14+00) to the riffle crest downstream of Pool F (10+50).

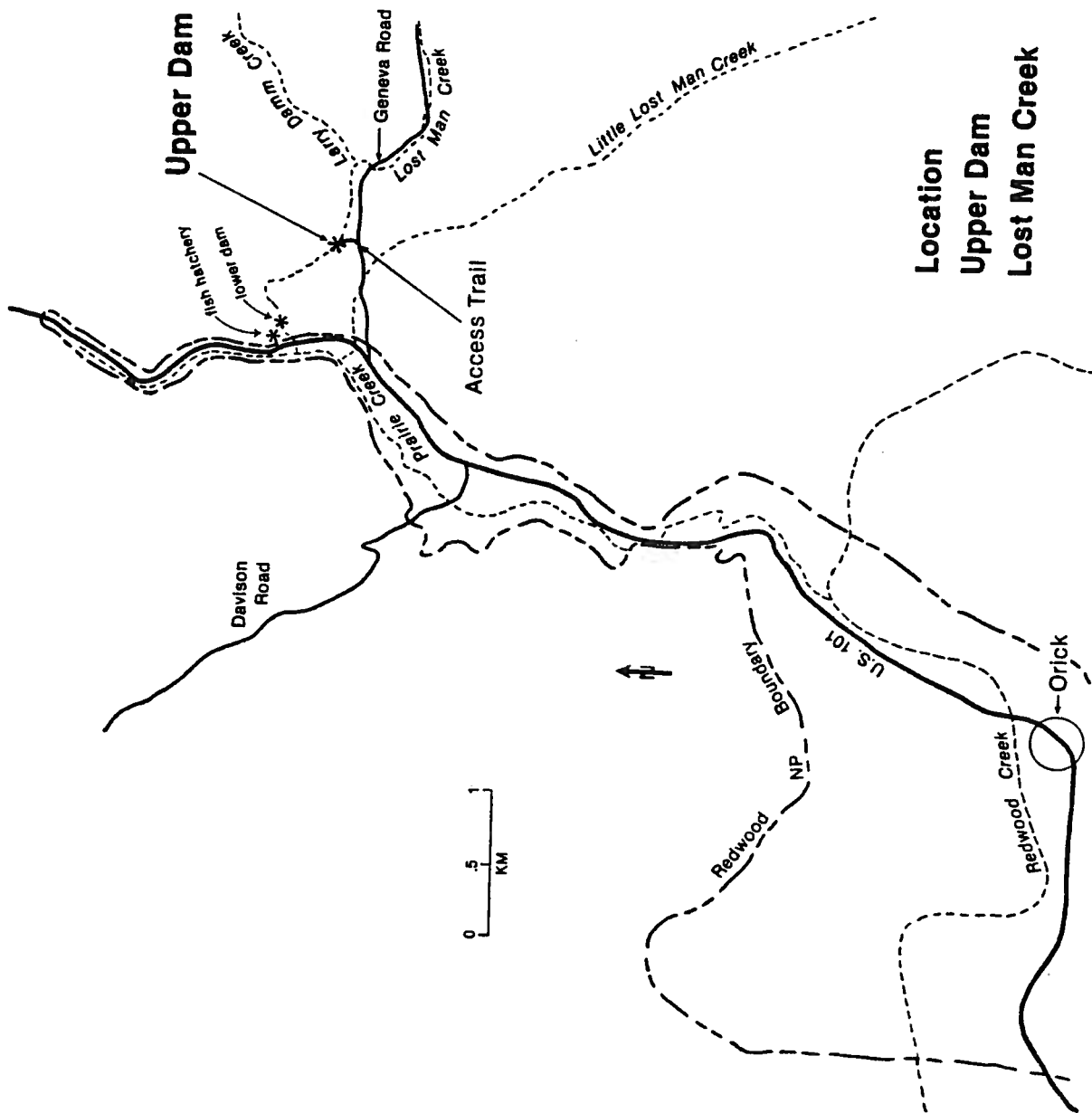


Figure 2. Location of the upper hatchery dam on Lost Man Creek.

Residual pool depth of eight pools in the lower Lost Man Creek were monitored pre-dam removal and following the first winter. The residual pool depth was determined by measuring the deepest point in the pool and the depth of the downstream riffle crest controlling pool volume. The difference in depth equalled the residual pool depth.

Figure 3 shows the location of ten channel cross sections and three pools monitored in the vicinity of the dam.

## V. Results and Discussion

Cross section plots for pre- and post-dam removal and following the first winter are presented in Appendix A and channel changes are quantified in Appendix B. The dam removal and channel excavation extended from Cross Sections 4 upstream to Cross Section 8.

Evaluation of cross section changes during the winter of 1989-1990, indicate that Cross Sections 8 through 11 scoured and Cross Sections 3 through 4 filled. The total volume of sediment scoured out of the upper reach ( $610 \text{ m}^3$ , Cross Sections 8 - 11) was deposited immediately downstream in the excavated area ( $719 \text{ m}^3$ , Cross Sections 3 - 7). The extra  $100 \text{ m}^3$  was probably derived from upstream erosion of the channel bed.

Sediment size distribution plots and  $D_{50}$  values for pre-dam removal (1989) and following the 1989-1990 winter (1990) are presented in Appendix C. Table 1 presents  $D_{50}$  values at cross sections prior to dam removal in 1989 and following the 1989-1990 winter. The  $D_{50}$  is the particle size diameter in millimeters at which 50 percent of the sample is finer. Pebble count data indicate the sediment size distribution increased in the area upstream of the dam (Cross Section 7 - 10) and in general decreased downstream of the dam.

Longitudinal profiles in the immediate vicinity of the dam also show the channel thalweg scoured over the winter of 1989-1990 (Fig. 4). The original channel gradient prior to dam removal was 0.23 percent in the reach upstream of the dam and 0.67 percent in the reach immediately downstream of the dam. Excavation of impounded sediment increased the gradient to 1.09 percent within this reach and created a local drop in base level. The change in base level and oversteepened channel gradient caused nickpoint migration to develop. The nickpoint started in the excavated reach and proceeded to scour upstream about 400 m over the winter. By the end of the 1989-1990 winter, the channel downcut and the gradient decreased to 0.76 percent.

The longitudinal profiles of the lower 2.42 km of Lost Man Creek need distance adjustments between the 1987 and the 1990 survey (Fig. 5) to align pool-riffle features. The distance adjustments are minor and did not affect the calculation of the gradient on lower Lost Man Creek. The longitudinal profile data indicate that the channel gradient of the lower 2.42 km of Lost Man Creek did not

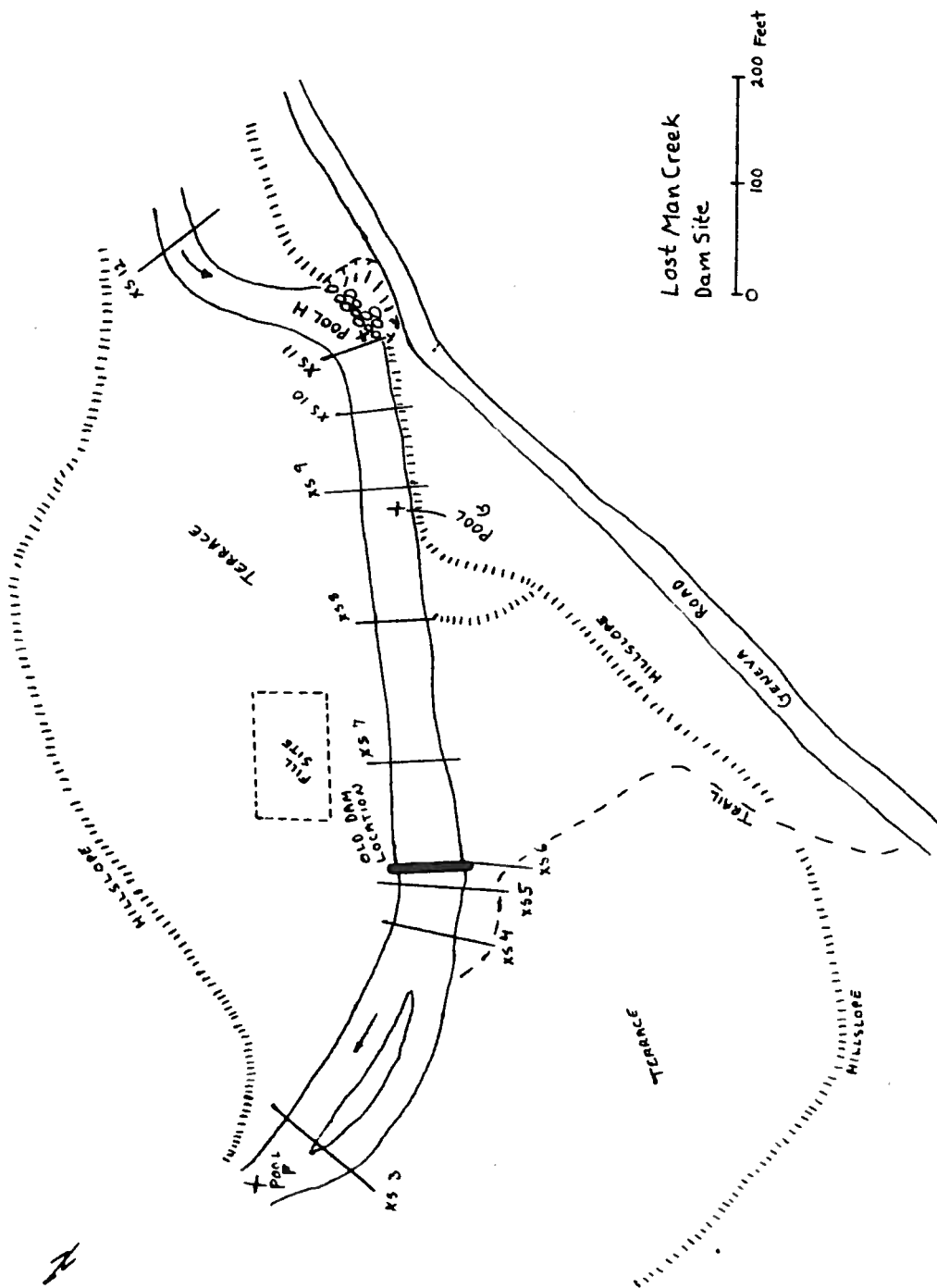


Figure 3. Location of cross section and residual pool monitoring sites in the vicinity of the upper hatchery dam.

**Table 1. Change in  $D_{50}$  size at Lost Man Creek Cross Sections, Pre-Dam Removal (1989) and Following the First Winter (1990).**

| X/S # | $D_{50}$ (mm) |      | Percent Change<br>in Size |
|-------|---------------|------|---------------------------|
|       | 1989          | 1990 |                           |
| 1     | 22            | 18   | -18 %                     |
| 2     | 24            | 42   | 75 %                      |
| 3     | 38            | 28   | -26 %                     |
| 7     | 15            | 27   | 80 %                      |
| 9     | 31            | 50   | 61 %                      |
| 10    | 21            | 36   | 71 %                      |

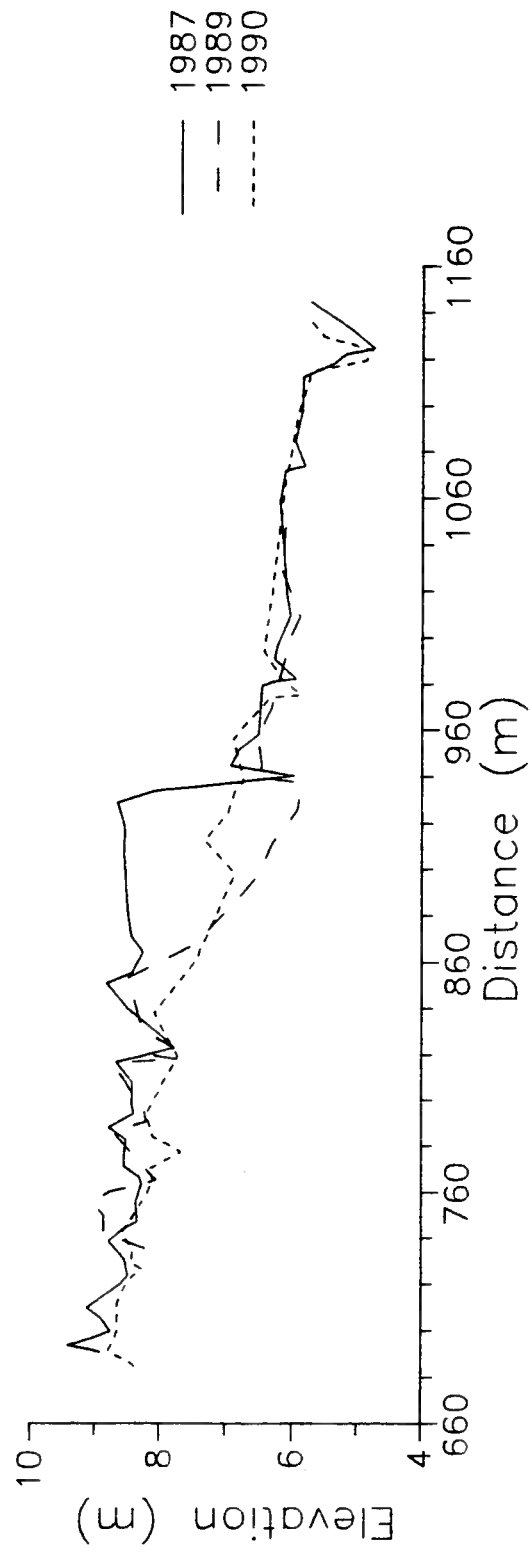


Figure 4. Longitudinal profiles of the 500 m reach near the upper hatchery dam site show scouring of the channel gradient following the 1989-1990 winter.

# Lost Man Creek Longitudinal Profile

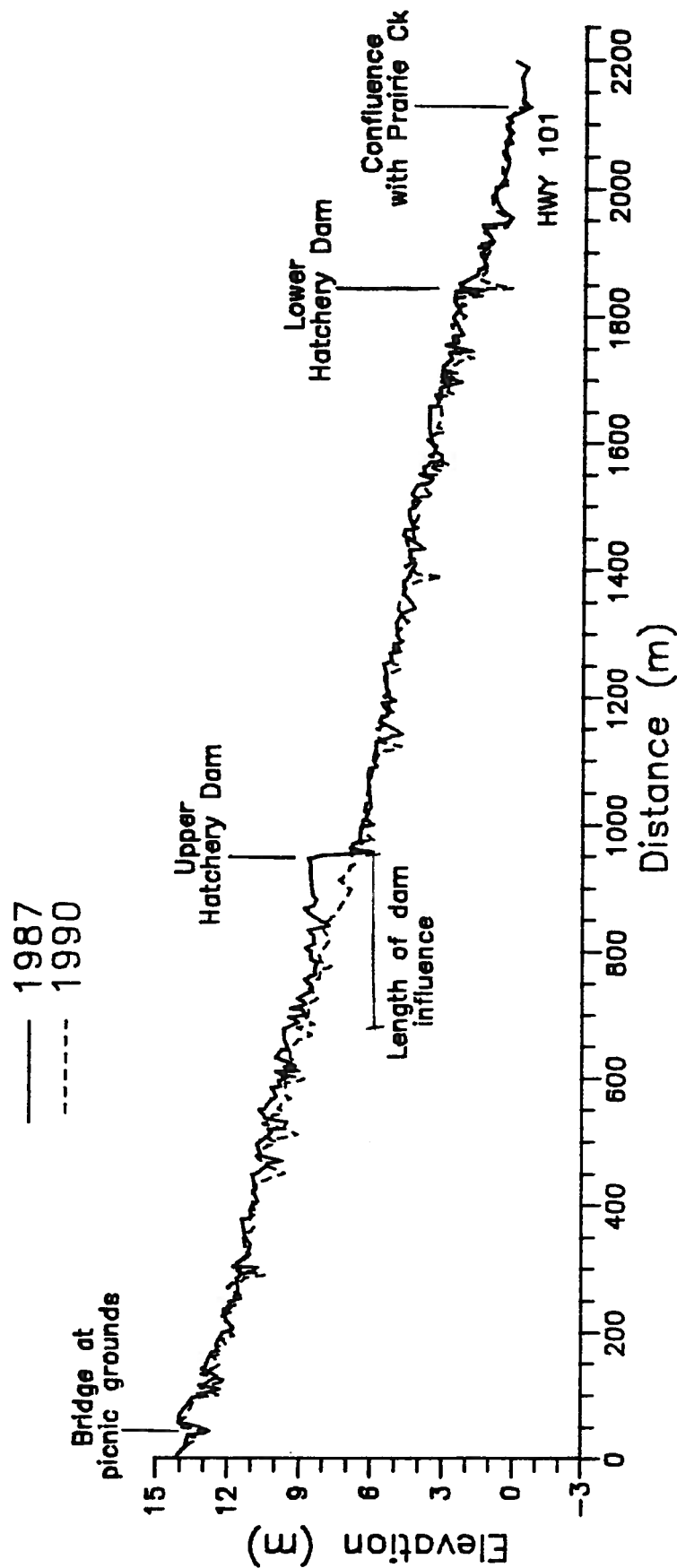


Figure 5. Longitudinal profiles of the lower 2.42 km of Lost Man Creek show channel gradient from the picnic grounds bridge downstream to the confluence did not change significantly. Adjustments in channel gradient occurred in the immediate vicinity near the upper hatchery dam site.

change from the summer of 1987 (0.63 %) to the spring of 1990 (0.63%). Dam removal caused only localized changes in channel gradient. Future analysis of the longitudinal profile will determine changes in pool-riffle morphology and longitudinal trends in aggradation and degradation along the streambed. Residual pool depths of all eight pools were measured pre-dam removal and post winter 1989-1990 and results are presented in Table 2. Pools A - F are located below the dam structure and pools G and H are located in the aggraded reach immediately upstream of the dam. Three pools below the dam (pools D - F) decreased in residual pool depth. The change in depth in two of the pools was due to the removal of woody debris during winter flows. The pools were formed by scour around large woody debris and the loss of woody debris caused changes in pool configuration and a decrease in pool volume.

During removal of the dam, the downstream most extent of silt deposition in the channel was located at pool F (190 m downstream of the old dam site). It was also the only pool downstream of the dam that showed filling over the 1989-1990 winter as a direct result of dam removal.

Pools G and H located in the reach immediately upstream of the dam both filled over the 1989-1990 winter. This reach experienced the most dramatic channel adjustments over the 1989-1990 winter. The channel morphology and pattern changed as the stream downcut. In pool G, the thalweg shifted away from the pool.

#### IV. Preliminary Conclusions

In August 1989, the upper hatchery dam was removed on Lost Man Creek. A total of volume of 1,694 m<sup>3</sup> of sediment was excavated from the channel and placed in a stable location in the middle of the right bank terrace. This accounted for about 44 percent of the total volume of sediment impounded behind the dam.

As a result of dam removal and excavation of impounded sediment, the channel cross sections in the immediate vicinity of the dam increased in channel cross-sectional area (Fig. 6) and were up to 50 percent wider and up to 2.6 m deeper. Channel excavation created a sediment basin with a high sediment deposition efficiency.

The 1989-1990 winter season had lower than normal rainfall. As a result, the channel adjustments observed due to dam removal have been under very low flow events. A local drop in base level combined with a steeper channel gradient caused a nickpoint to migrate upstream during winter flows. However, downcutting appeared to be localized in the reach upstream of the dam. Following the first winter storms the channel began to scour, exposing bedrock and large boulders in the streambed. Channel morphology changed significantly from a simple pool-riffle morphology to a high gradient riffle, as head cut erosion migrated upstream. Channel adjustments caused extensive undercutting and

**Table 2. Residual Pool Depths in Lost Man Creek, Pre-Dam Removal (1989) and Following the First Winter (1990).**

| Pool Name                                                                | Channel Marker | 1989 Residual Pool Depth | 1990 Residual Pool Depth | Change in Depth |
|--------------------------------------------------------------------------|----------------|--------------------------|--------------------------|-----------------|
|                                                                          | (m)            | (m)                      | (m)                      | (m)             |
| Pool A                                                                   | 2+71           | 1.44                     | 1.52                     | -0.08           |
| Pool B                                                                   | 2+79           | 1.24                     | 1.24                     | 0.00            |
| Pool C                                                                   | 2+94           | 0.38                     | 0.45                     | -0.07           |
| Pool D                                                                   | 3+77           | 1.05                     | 0.89                     | 0.16*           |
| Pool E                                                                   | 6+77           | 0.95                     | 0.34                     | 0.61*           |
| Pool F                                                                   | 9+65           | 1.19                     | 0.96                     | 0.23            |
| Pool G                                                                   | 12+75          | 0.81                     | 0.36                     | 0.45            |
| Pool H                                                                   | 13+17          | 0.75                     | 0.50                     | 0.25            |
| * Large woody debris controlling pool depth was removed by winter flows. |                |                          |                          |                 |

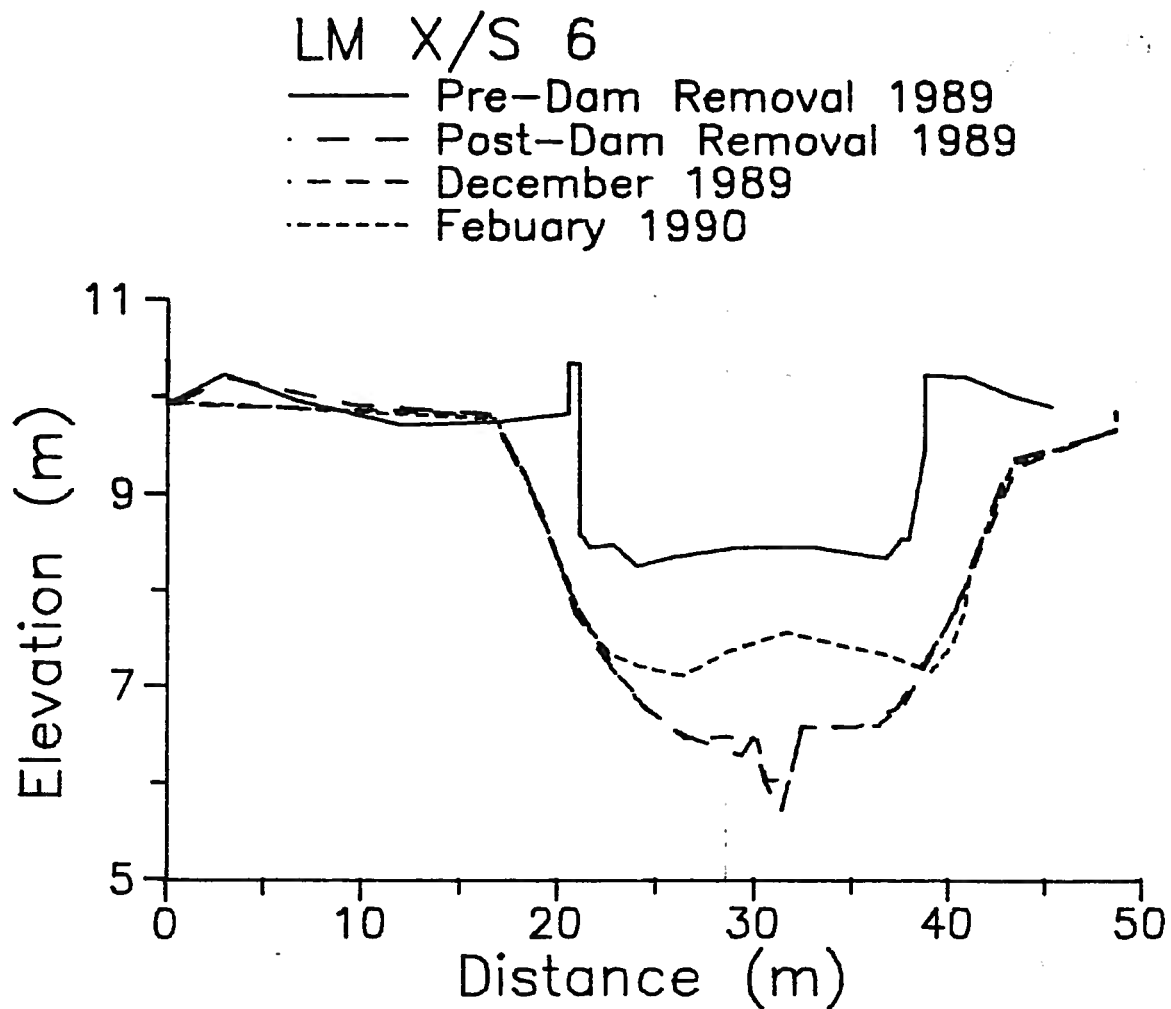


Figure 6. Channel cross section area increased almost 100 percent following dam removal and channel excavation.

bank erosion in the reach upstream of the dam. Stream bank alders fell or slid as a block into the channel. In addition, the mean particle size increased in the scouring reach. This increase was expected because excavation locally increased the channel gradient which increased the stream power and the ability to locally transport larger particle sizes. In addition, scour removed finer sediment and exposed underlying coarser bed material.

Lost Man Creek is recovering from past logging and road construction activities in the watershed. Removal of the dam assists in the natural recovery of the stream and helps restore 1.8 miles of stream for salmonid spawning and rearing habitat. Although low rainfall and winter flows have persisted throughout the study period, the channel is adjusting its gradient and morphology following the removal of the dam.

Minimal sedimentation appears to have occurred downstream of the dam. Residual pool depth of only one in three pools monitored downstream of the dam had a loss of pool volume directly related to the dam. Channel adjustments appear to be highly localized. The volume of sediment scoured in the upstream reaches appears to have deposited immediately downstream causing extensive channel filling and a slight increase in the riffle elevation in the first downstream riffle of the dam.

The Environmental Assessment estimated channel recovery and the development of pool-riffle morphology to take three to eight years under normal flow conditions. Based on the study results, this time period seems reasonable.

#### IIV. Plans for Future Work

Annual cross section surveys, pebble counts and residual pool depths will continue to be monitored over the next five years.

Longitudinal profiles distances from 1987 and 1990 need to be adjusted for more detailed analysis of changes in pool-riffle morphology and changes in pool depth.

#### IIIV. References

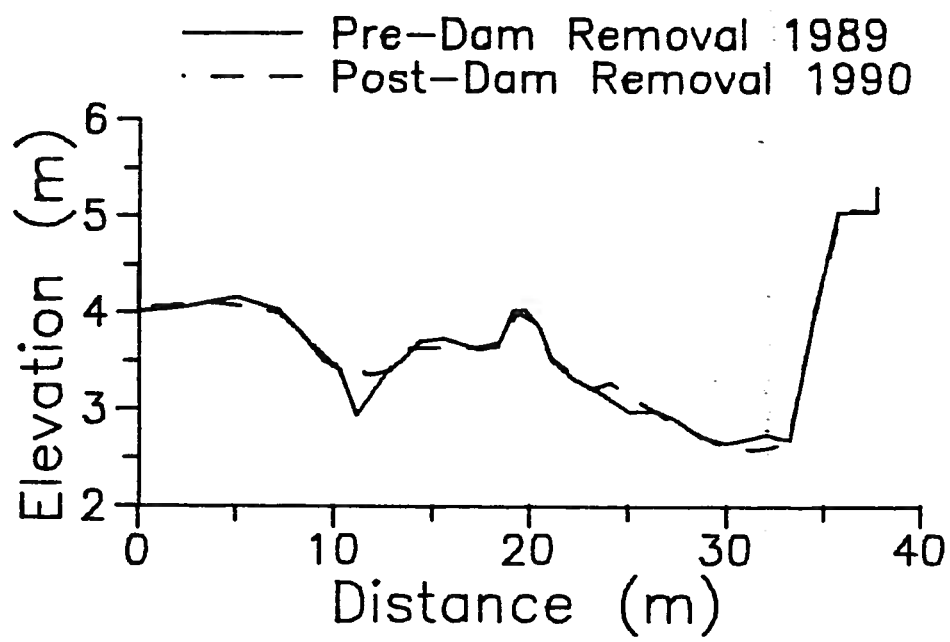
Redwood National Park. 1988. Environmental Assessment: Upper Dam Removal, Lost Man Creek. Redwood National Park. Arcata. CA. 28 p.

## APPENDIX

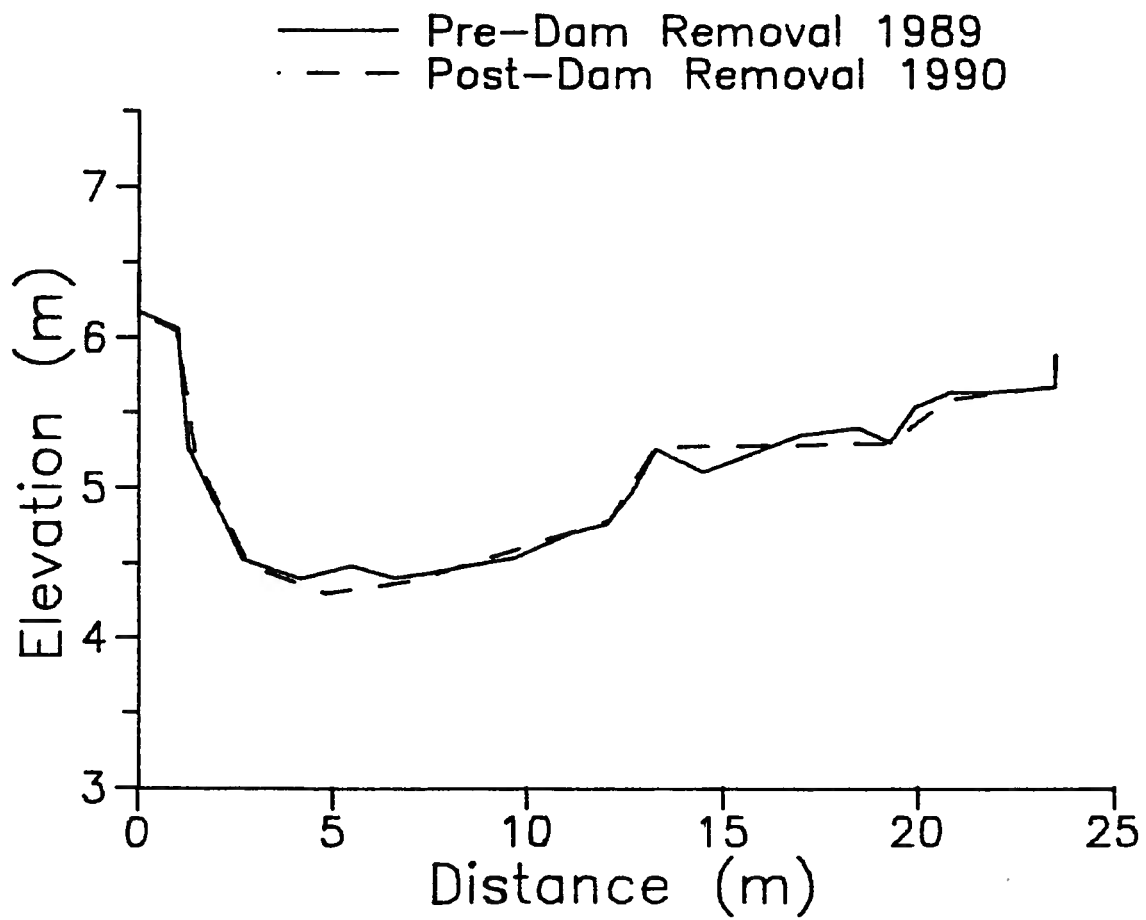
### Appendix A

Each cross section is plotted showing the channel configuration for the earliest record (solid line) and the most recent cross section surveys (dashed lines). Both axes are in meters. The x-axis is the distance measured from the left end point (that is, the left pin distance equals 0.0 meters). Consequently, the channel cross section is viewed looking in the downstream direction. The y-axis is the elevation measured above an arbitrary datum.

LM X/S 1



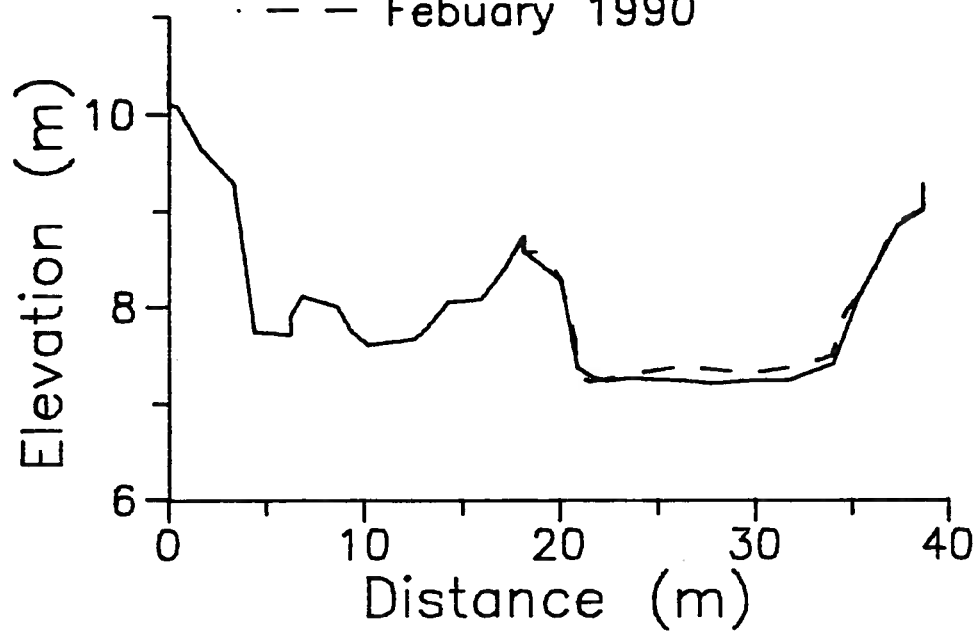
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LM X/S 3

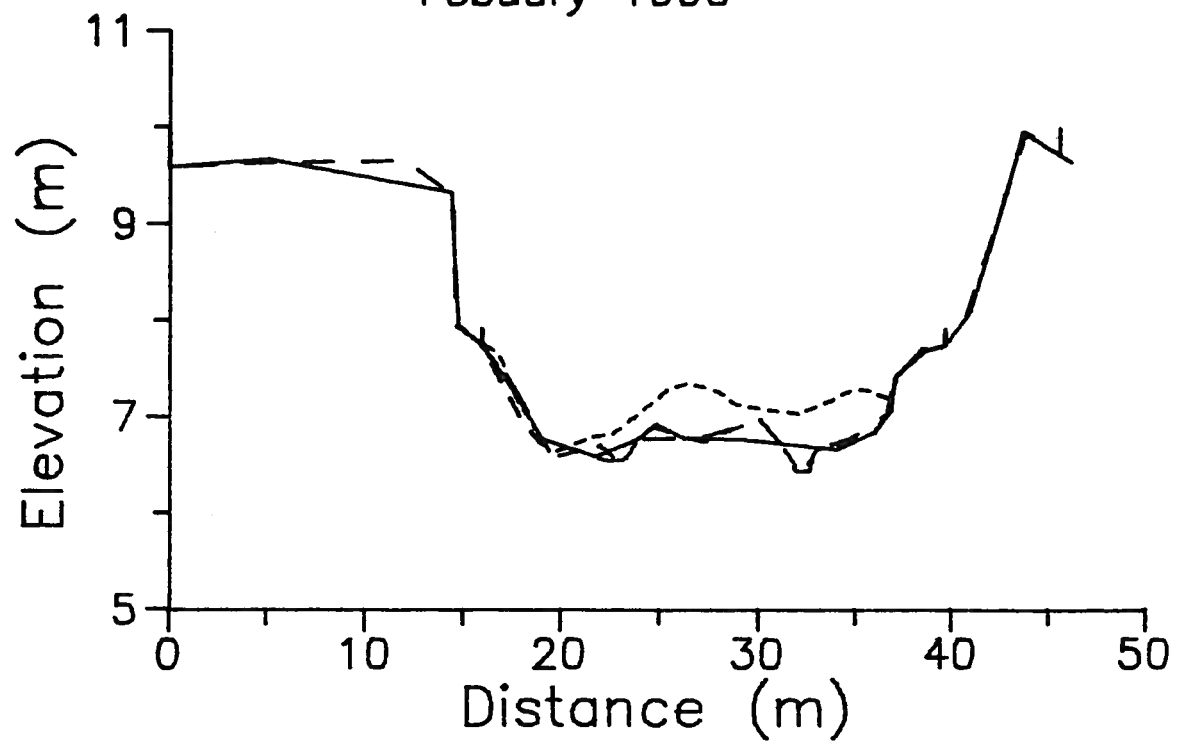
— Pre-Dam Removal 1989

- - February 1990



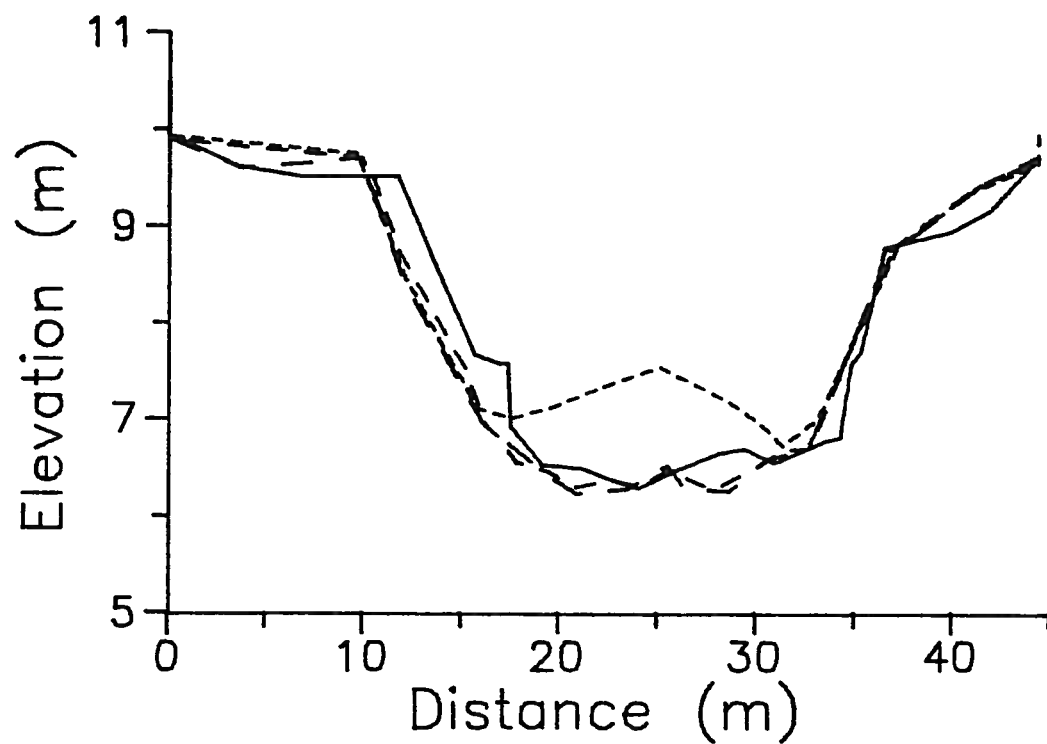
LM X/S 4

— Pre-Dam Removal 1989  
- - - Post-Dam Removal 1989  
- - - December 1989  
- - - February 1990



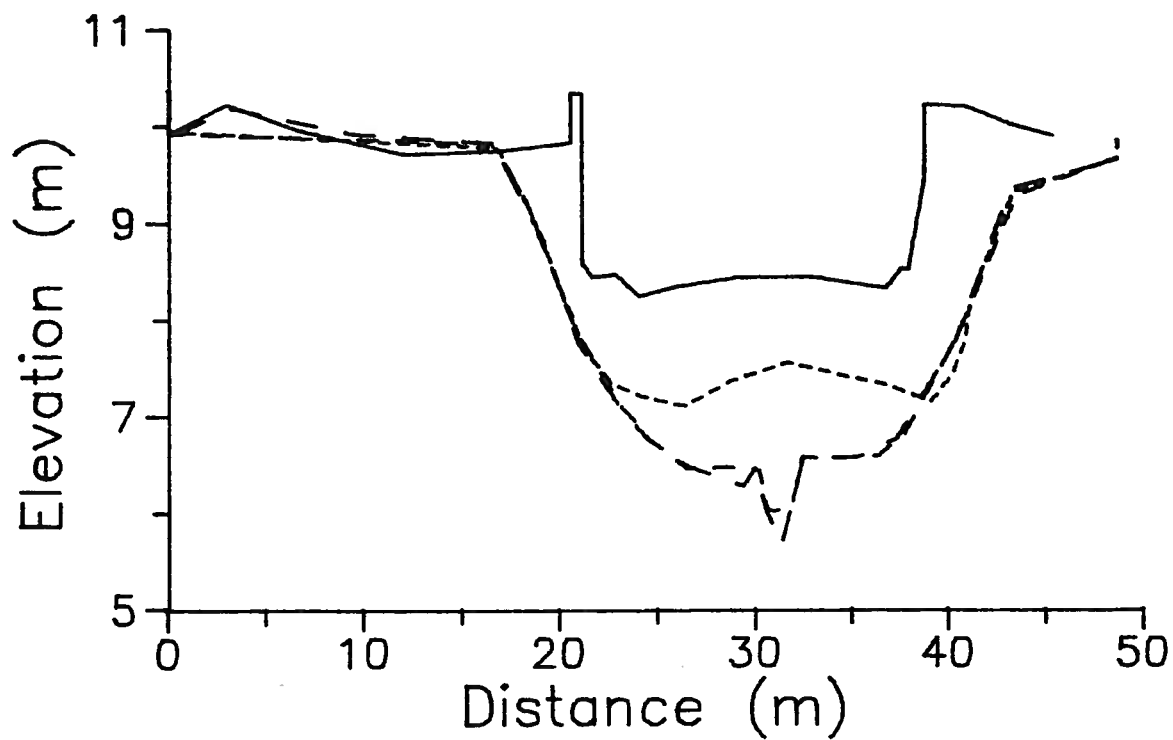
LM X/S 5

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- - - Post-Dam Removal 1989  
- - - December 1989  
- - - February 1990



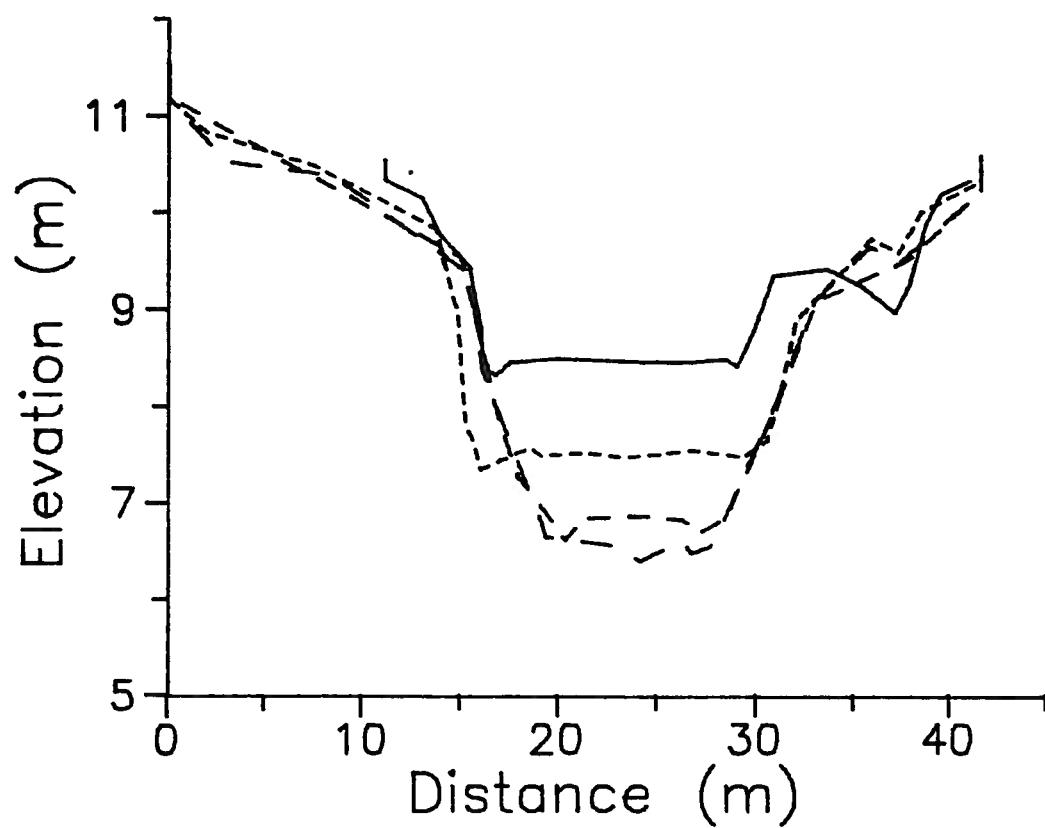
LM X/S 6

— Pre-Dam Removal 1989  
- - - Post-Dam Removal 1989  
- - - December 1989  
- - - February 1990



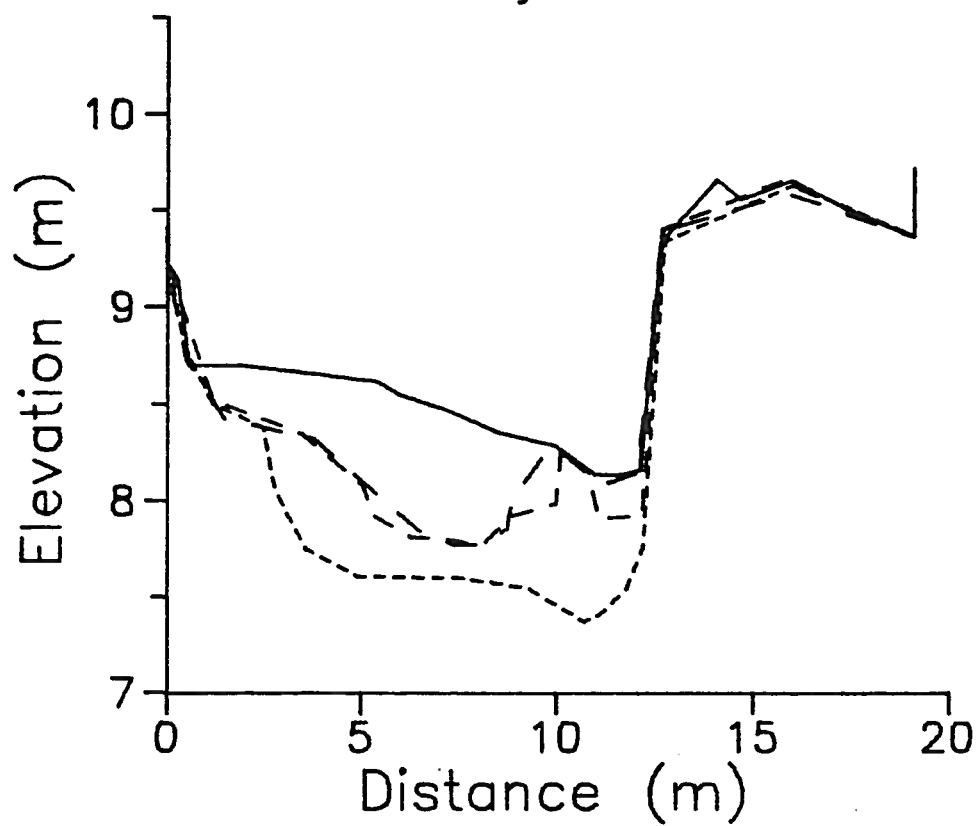
LM X/S 7

— Pre-Dam Removal 1989  
- - Post-Dam Removal 1989  
- - - December 1989  
..... February 1990

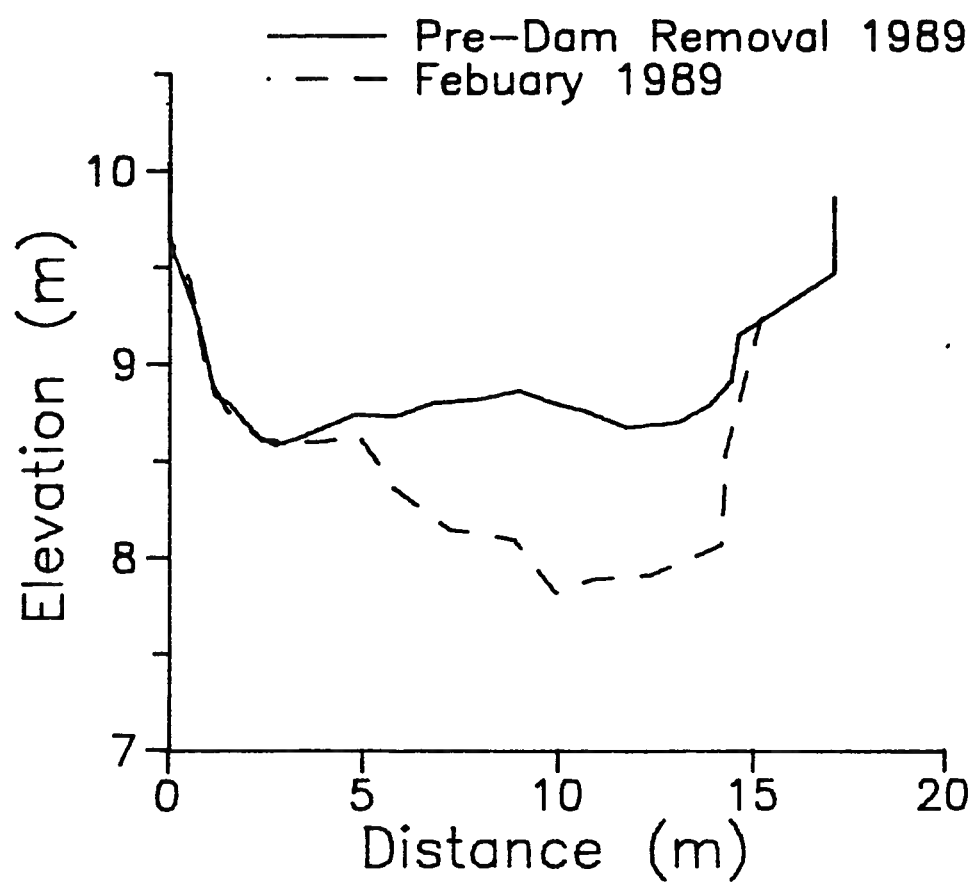


LM X/S 8

— Pre-Dam Removal 1989  
- - - Post-Dam Removal 1989  
- - - December 1989  
- - - February 1990



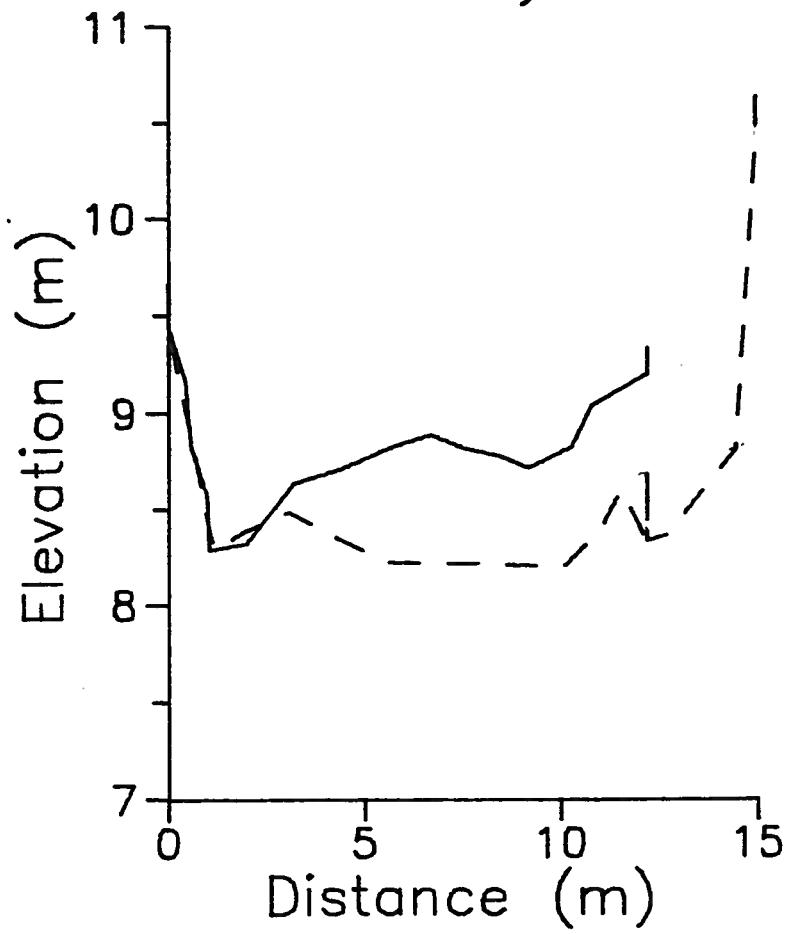
LM X/S 9



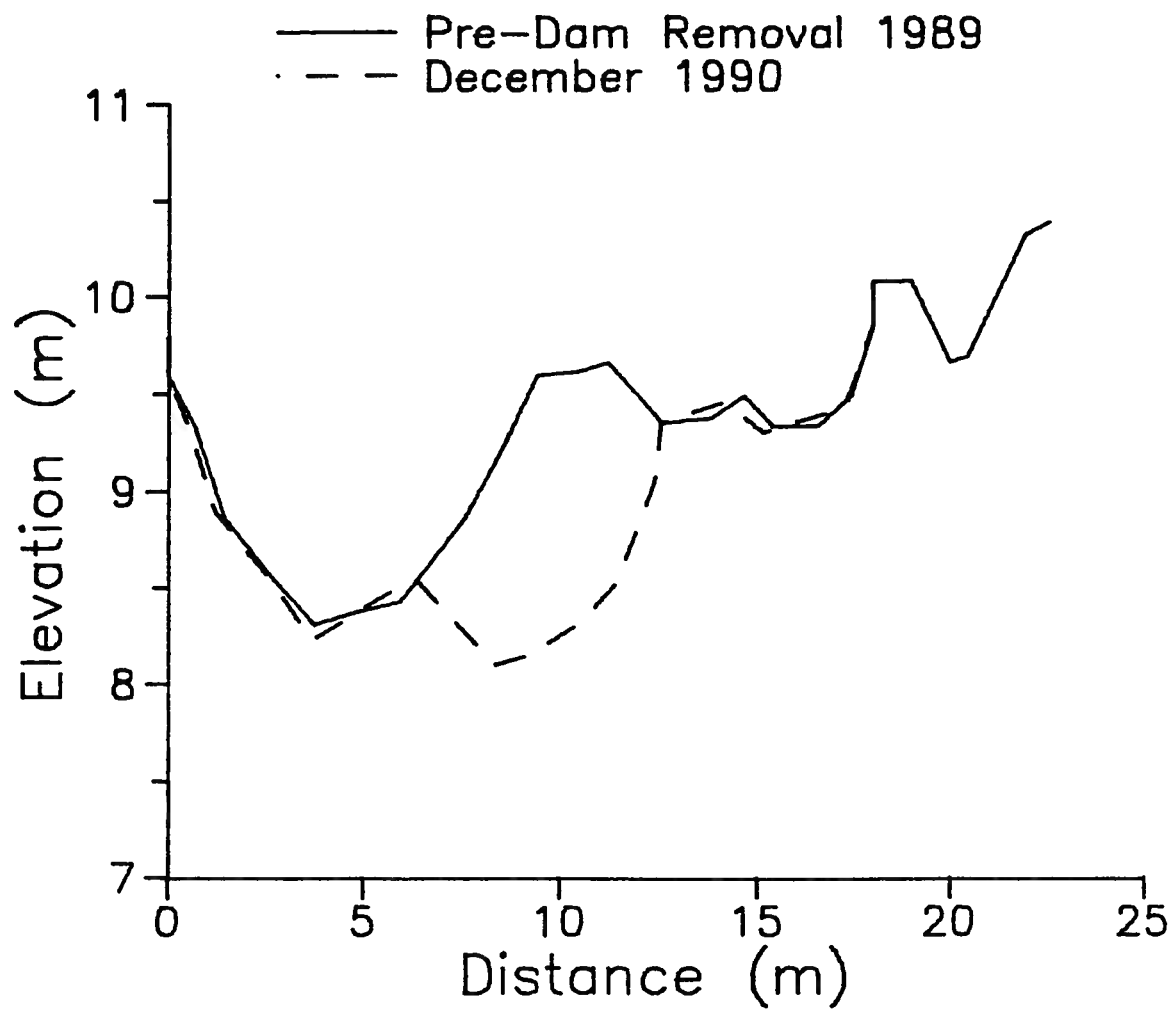
LM X/S 10

— July 1989

- - February 1990



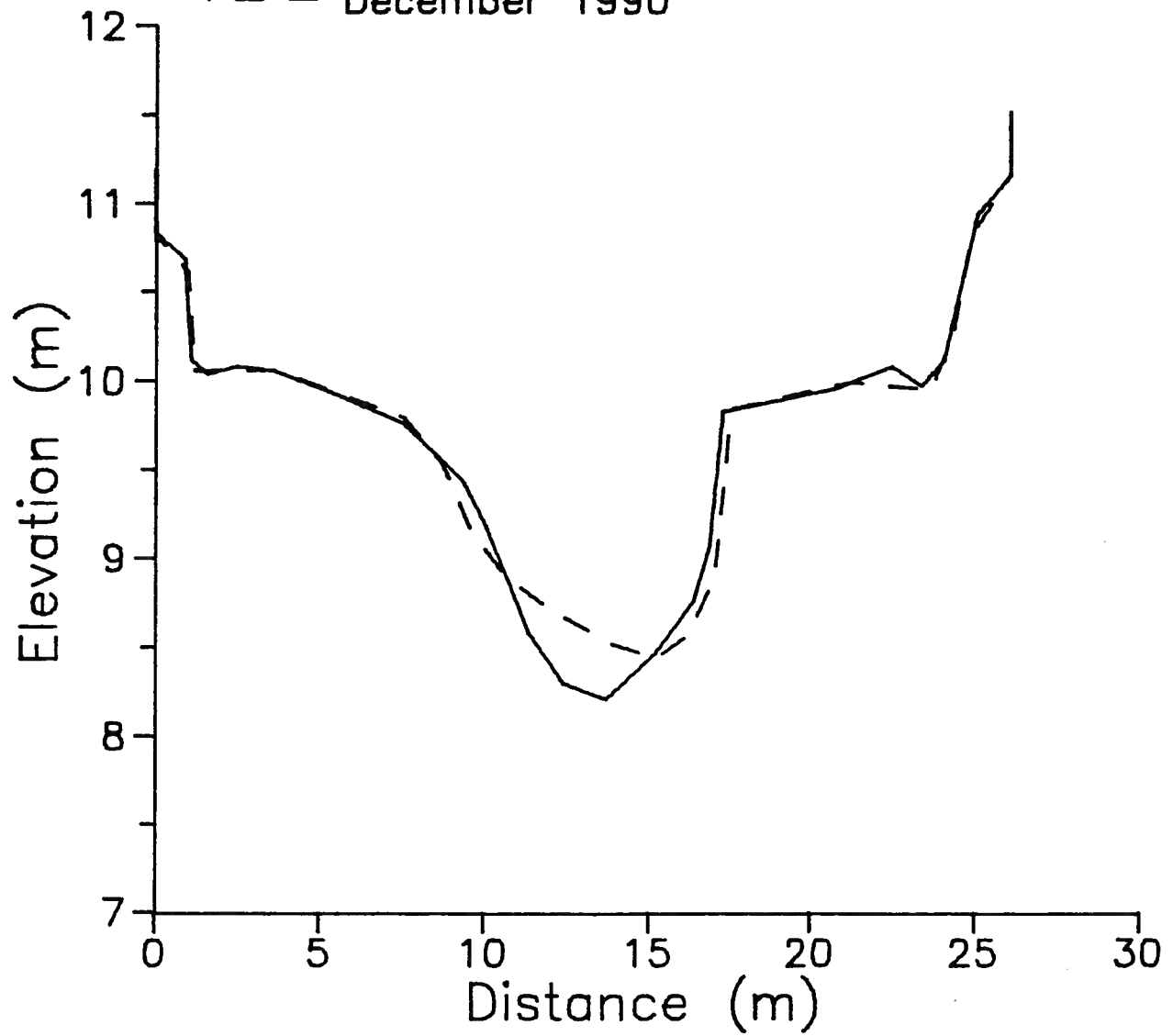
LM X/S 11



LM X/S 12

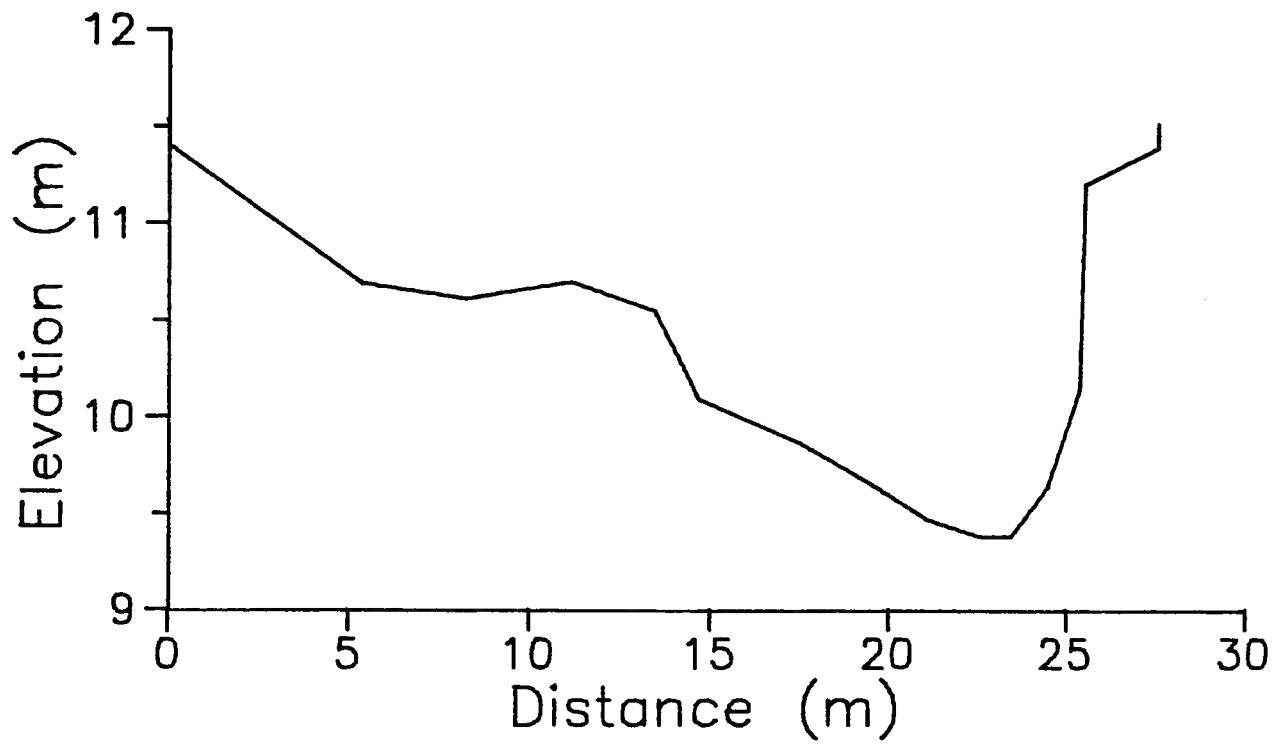
— Pre-Dam Removal 1989

- - - December 1990



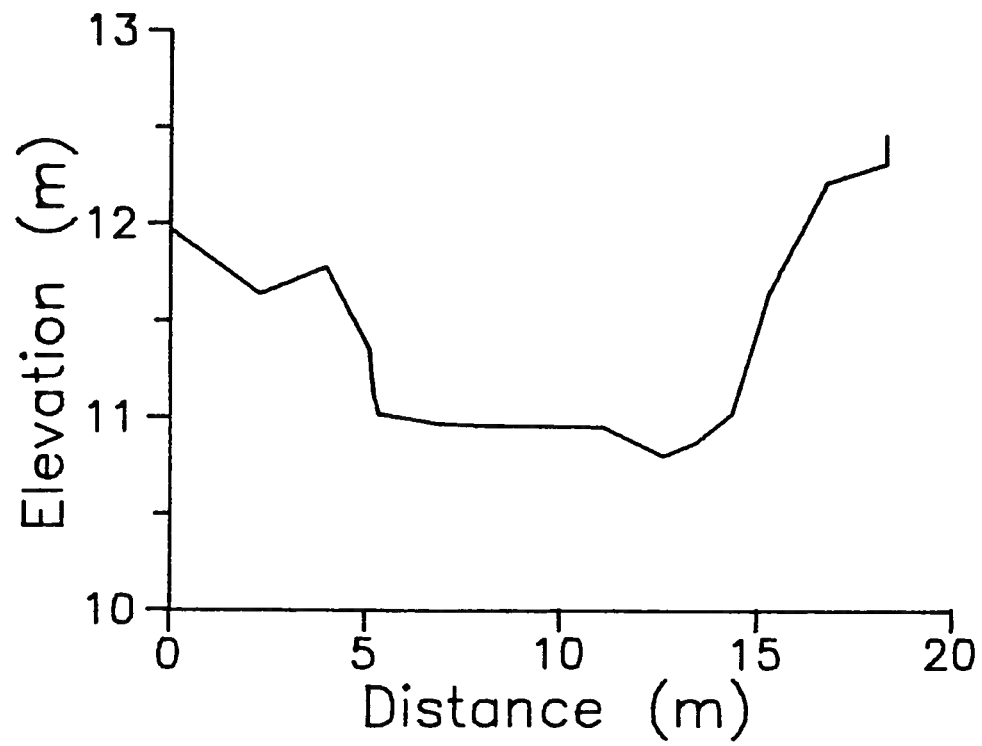
LM X/S 13

— Post-Dam Removal 1990



LM X/S 14

— Post-Dam Removal 1990



Summary of Channel Changes October to December 1989.

Change in Streambed Area

| Cross<br>Section<br>Number | Year<br>Estab | Cross<br>Section<br>Dist<br>(m) | Change<br>in Thal<br>Elev<br>(m) | Scour<br>(-)<br>(m <sup>2</sup> ) | Fill<br>(+)<br>(m <sup>2</sup> ) | Net<br>Change<br>in Area<br>(m <sup>2</sup> ) | Channel<br>Width<br>(m) | E <sub>c</sub> <sup>*</sup><br>(m) | Absolute<br>Change<br>(m) |
|----------------------------|---------------|---------------------------------|----------------------------------|-----------------------------------|----------------------------------|-----------------------------------------------|-------------------------|------------------------------------|---------------------------|
| 4                          | 7/89          | 45.60                           | 0.016                            | 0.88                              | 0.38                             | -0.50                                         | 20.2                    | -0.02                              | -0.02                     |
| 5                          | 7/89          | 44.40                           | 0.040                            | 0.33                              | 1.78                             | 1.45                                          | 24.9                    | 0.06                               | 0.06                      |
| 6                          | 7/89          | 48.70                           | 0.338                            | 0.48                              | 0.89                             | 0.41                                          | 20.2                    | 0.02                               | 0.02                      |
| 7                          | 7/89          | 41.65                           | 0.216                            | 0.38                              | 2.47                             | 2.09                                          | 17.9                    | 0.12                               | 0.12                      |
| 8                          | 7/89          | 19.12                           | 0.001                            | 1.04                              | 0.23                             | -0.81                                         | 11.9                    | -0.07                              | -0.07                     |

\* Mean Change in Streambed Elevation.

Summary of Channel Changes December 1989 to February 1990.

Change in Streambed Area

| Cross<br>Section<br>Number | Year<br>Estab | Cross<br>Section<br>Dist<br>(m) | Change<br>in Thal<br>Elev<br>(m) | Scour<br>(-)<br>(m <sup>2</sup> ) | Fill<br>(+)<br>(m <sup>2</sup> ) | Net<br>Change<br>in Area<br>(m <sup>2</sup> ) | Channel<br>Width<br>(m) | E <sub>c</sub> <sup>*</sup><br>(m) | Absolute<br>Change<br>(m) |
|----------------------------|---------------|---------------------------------|----------------------------------|-----------------------------------|----------------------------------|-----------------------------------------------|-------------------------|------------------------------------|---------------------------|
| 3                          | 7/89          | 38.70                           | 0.020                            | 0.09                              | 1.46                             | 1.37                                          | 15.0                    | 0.09                               | 0.09                      |
| 4                          | 7/89          | 45.60                           | 0.172                            | 0.01                              | 6.27                             | 6.26                                          | 20.2                    | 0.31                               | 0.31                      |
| 5                          | 7/89          | 44.40                           | 0.452                            | 0.07                              | 11.98                            | 11.91                                         | 24.9                    | 0.48                               | 0.48                      |
| 6                          | 7/89          | 48.70                           | 1.095                            | 0.53                              | 12.38                            | 11.85                                         | 20.2                    | 0.59                               | 0.59                      |
| 7                          | 7/89          | 41.65                           | 0.730                            | 2.84                              | 8.52                             | 5.68                                          | 18.3                    | 0.31                               | 0.31                      |
| 8                          | 7/89          | 19.12                           | -0.397                           | 4.19                              | 0.00                             | -4.19                                         | 11.9                    | -0.35                              | -0.35                     |
| 9                          | 7/89          | 17.12                           | -0.770                           | 6.91                              | 0.05                             | -6.86                                         | 14.7                    | -0.47                              | -0.47                     |
| 10                         | 7/89          | 14.99                           | -0.117                           | 5.00                              | 0.04                             | -4.96                                         | 12.7                    | -0.39                              | -0.40                     |
| 11                         | 7/89          | 18.02                           | -0.211                           | 6.00                              | 0.17                             | -5.83                                         | 12.6                    | -0.46                              | -0.46                     |
| 12                         | 8/89          | 26.09                           | 0.230                            | 0.68                              | 1.18                             | 0.50                                          | 8.8                     | 0.06                               | 0.06                      |

\* Mean Change in Streambed Elevation.

## Appendix C

Plot of the sediment size distribution at cross sections. Sediment size distribution pre-dam removal is plotted with a solid line and the size distribution following the 1989-1990 winter is plotted with a dashed line. The x-axis is the cumulative percent less than a given particle size and the y-axis is the log of the class size in millimeters.