MONTANA DEPARTMENT OF FISH AND GAME

FISHERIES DIVISION

JOB PROGRESS REPORT

State: Montana Title: Southwestern Montana Fisheries Study

Project No.: F-9-R-22 Title: Evaluation of Stream Improvements on

Job No.: II-a Prickly Pear Creek

Period Covered: July 1, 1973 to June 30, 1974 (Field Work: July 1 - January 31, 1973)

ABSTRACT

Rock and soil berms were constructed at the toe of four steep eroding banks to stop soil erosion along the relocated channel of Prickly Pear Creek. Blanket rip-rap was used to protect the highway grade from stream erosion. Willow (*Salix* sp.) shoots were planted in the spaces between the large rocks at the water level to speed up the revegetation process. In the spring of 1971, 100 shoot were planted on two rip-rap sections. In the spring of 1973, an additional 182 shoots were planted in the same area. In December, 1973, 167 shoots remained alive in the two areas. A third area had been left to natural seeding and only 3 live willows were present.

Natural seeding in areas where good soil quality existed accounted for re-establishing dense vegetation on the berms and back slopes of the experimental areas.

Population estimates indicate that trout numbers have returned to procon-struction (1967) levels with 79 rainbow trout (*Salmo gairdneri*) and 90 brown trout (*Salmo trutta*) per acre weighing 13 and 17 pounds per acre, respectively. Sucker (*Catostomus catostomus* and *Catostomus commersoni*) populations remain at a level 59% below the preconstruction numbers.

BACKGROUND

The Prickly Pear Creek study was initiated in 1965 to document the condition of the fishery and stream channel prior to construction of interstate Highway 15 seven miles south of Helena. A continuous 3,300 foot channel change was proposed for Prickly Pear in that area. To mitigate the loss of natural channel, the stream was artificially meandered in the flood plain to retain its original length. Prior to construction, the average depth and width were 1.4 and 26.4 feet, re-spectively, and spacing of successive pools was every 6.6 times the average stream width, or a pool every 180 feet (Elser, 1968).

Fish population estimates indicated that suckers made up 62.1 percent of the total number and 78.6 percent of the total weight. Trout comprised 37.9 and 21.5 percent of the total numbers and weight, respectively. Rainbows were the most abundant trout species (Elser, 1968).

Physical parameters and fish populations have been measured in three post-construction years; 1968, 1969 and 1970. The man-made channel was 3 percent (3,150 to 3,250 feet) longer than the natural channel it replaced. Construction reduced average width, depth and thalweg depth by 4 percent (26 to 25 feet) 28.6 percent (1.4 to 1.0 feet) and 21.8 percent (2.3 to 1.8 feet), respectively, except for a slight increase in average thalweg depth (1.9 to 2.0 feet) in 1970. The pool riffle periodicity has undergone adjustment toward the 6.6 stream widths of the original channel. In 1968, the first year after construction, spacing was 15.7 widths or a pool every 380 feet. The periodicity had adjusted to 8.8 widths in 1969 and 7.8 widths (a pool every 196 feet) in 1970 (Elser, 1971).

The sucker:trout ratio of 2:1 by numbers and 3:1 by weight remained unchanged immediately following construction; however, brown trout became the most abundant game fish in weight and numbers per acre (Elser, 1971). The most significant change in the fish population came in a reduction of the total standing crop. Numbers and weight of fish per acre were reduced by 45.8 percent (432 to 234) and 51.2 percent (168 to 82 pounds per acre), respectively, between 1967 and 1968. Population estimates in 1969 were 228 fish per acre weighing 78 pounds per acre.

Woody vegetation which existed in the area of the new Prickly Pear Creek channel was removed during construction and banks of the new channel were left steep and easily erodable (Elser, 1969). Attempts in 1969 to replace the vegetation which was lost met with little success due to bank sloughing in many areas. This report describes an experimental method employed to halt bank sloughing. In 1971, another attempt was made to speed up revegetation of the man-made channel.

OBJECTIVES

The Prickly Pear Creek Study in 1971 included the following:

1. Experimentation with rock and soil berms as a method of controlling stream bank erosion.

2. Determination of which naturally occurring shrub species can be successfully transplanted to speed up revegetation of a denuded area.

3. Estimation of fish population numbers in the area affected by construction.

PROCEDURES

A front-end loader was used to pick up rock and soil in the areas of severe bank erosion and construct low, flat berms along the water's edge at the toe of four of the eroding banks. Rocks were placed along the face of each berm to keep them from washing away. The banks were then sloped with a tractor-mounted backhoe.

Shrub experiments were conducted on the surface of the berms and backslopes. The berms ranged in length from 36 to 146 feet long. Berms one and two were divided into experimental plots of 60 square feet each; berms three and four were not divided. Each plot received a different species or treatment of a species to be evaluated. Treatment consisted of spring plantings, summer plantings, vertical or horizontal shoot cuttings and rooted stock. Eight of the 14 experimental plots were planted prior to spring runoff, and six were planted in early summer, after all plants were fully leafed. Horizontal shoot cuttings consisted of an eight to

ten inch section of main stem including one branch. The section of main stem was laid in a trench and covered with soil so that the branch protruded from the soil. Vertical shoot cuttings were taken from branches which had soft pliable bark and a terminal bud. Cuts were made at a 45° angle to expose a large surface area to the soil for root production. A steel rod was used to make a hole in the soil as deep as possible (12 to 18 inches) to prevent damaging the cut end of the shoot (Jensen, 1971).

Outside bends along the toe of the highway grade were rip-rapped during construction to control erosion. Soil was placed in the interstices between large rocks to provide a place for experiments with revegetation of a large-rock rip-rap area.

Fish populations were sampled using 0-500 variable voltage direct current electrofishing equipment and the population estimates were made by the mark and recapture method. Procedures used in population sampling and data analysis are described by Vincent (1971).

FINDINGS

Erosion Control

The techniques used in controlling erosion along an altered section of Prickly Pear Creek have proved satisfactory (Workman, 1972). By artificially meandering the new channel, original channel length was retained. In observations up and down stream from the alterations, no changes in the erosion and deposition patterns can be found. This indicates that the stream has adapted to its new channel without having to make adjustments in stream morphology in areas unaffected by highway construction.

After construction was completed, erosion began in some areas where riparian vegetation had been destroyed and where the banks had been left unprotected. Low, flat, rock and soil berms were constructed along the toes of four of the eroding banks and the banks were sloped (Workman, 1972). The technique has had at least four positive effects: (1) soil has been stabilized; (2) natural invasion of wild plants has been enhanced; (3) stable areas were provided for transplanting wild plants to speed up the revegetation process; and (4) aesthetics of natural streambanks were preserved to a greater extent than if blanket rip-rap had been used.

Blanket rip-rap was used to control erosion along outside bends where the stream was a potential threat to the highway grade. These areas will be discussed in the Vegetation and Recommendations sections.

VEGETATION

The response of vegetation in the study areas seemed to be controlled by soil quality, once the soil had been stabilized. The source of vegetation was primarily natural seeding (Figures 1 and 2).

The soil in study area one consisted of sandy loam. Proceeding downstream, study area two was mostly clay which became hard and impermeable during the summer. Areas three and four were composed of clay with large amounts of partially decomposed granite (Figures 3 and 4).

In the summer of 1972 and 1973, vegetation from natural seeding became so dense in areas of good soil quality (areas one and two) that it became impossible to

Figure 1. Top bank along berm one in the summer of 1971.

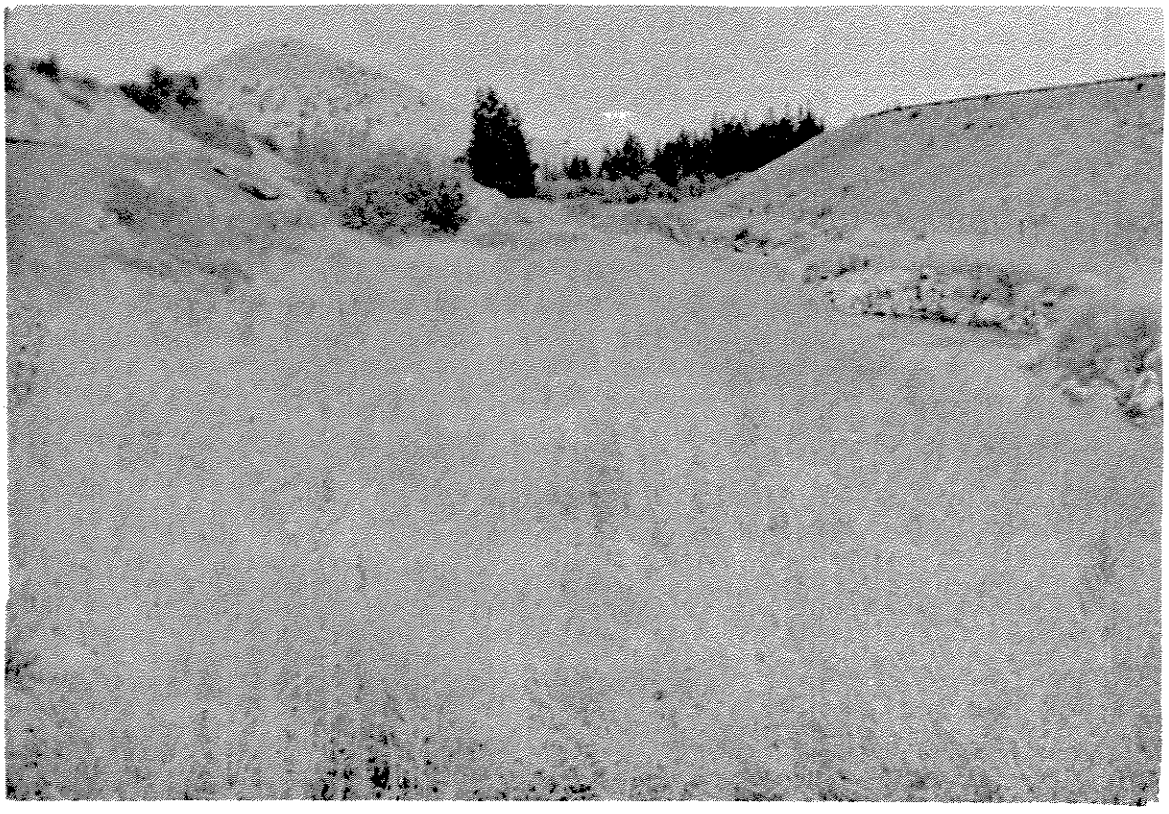
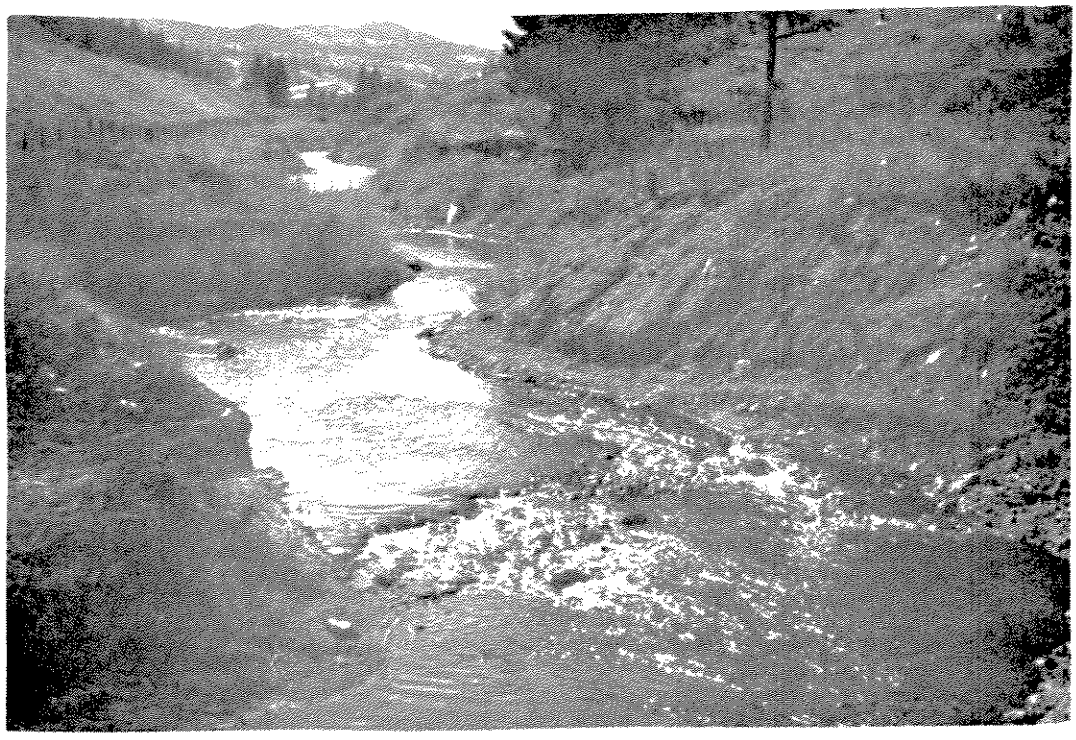


Figure 2. Top bank along berm one in the summer of 1972.



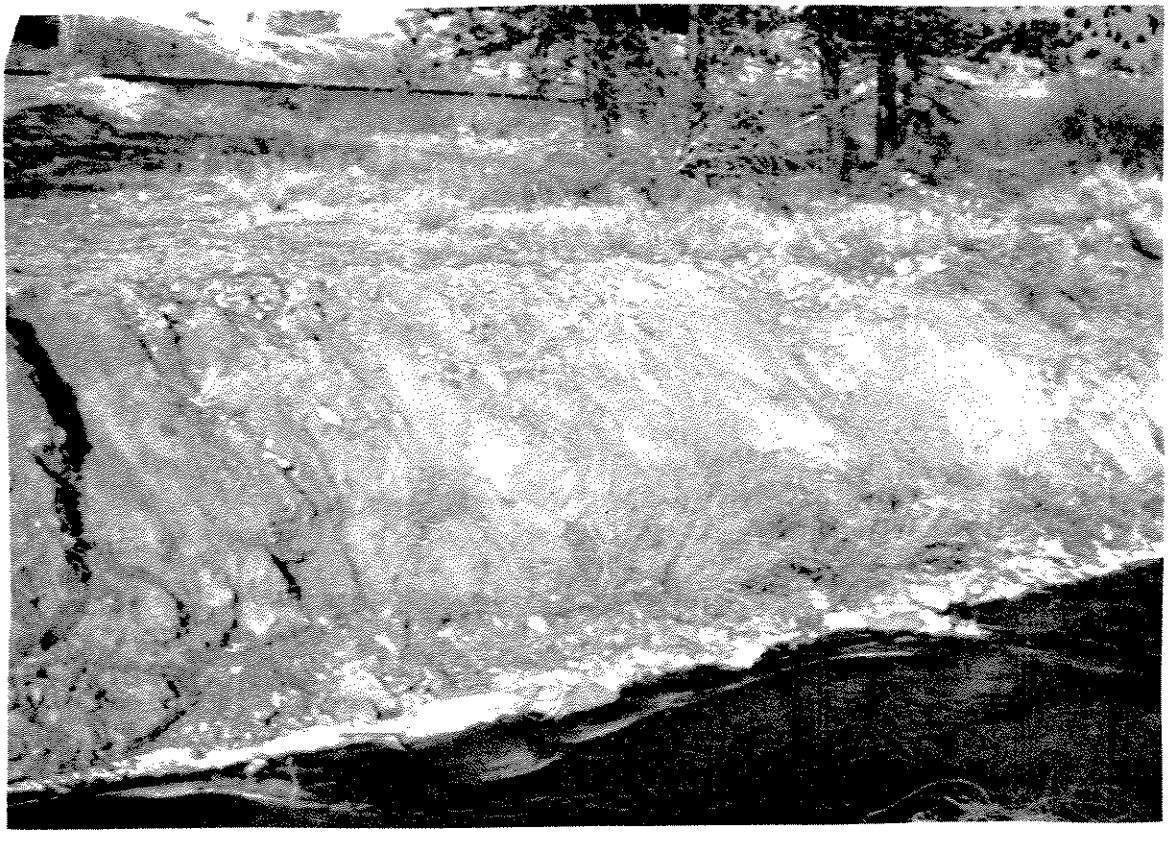


Figure 3. Berm 3 (above) and berm 4 (below) in the summer of 1972

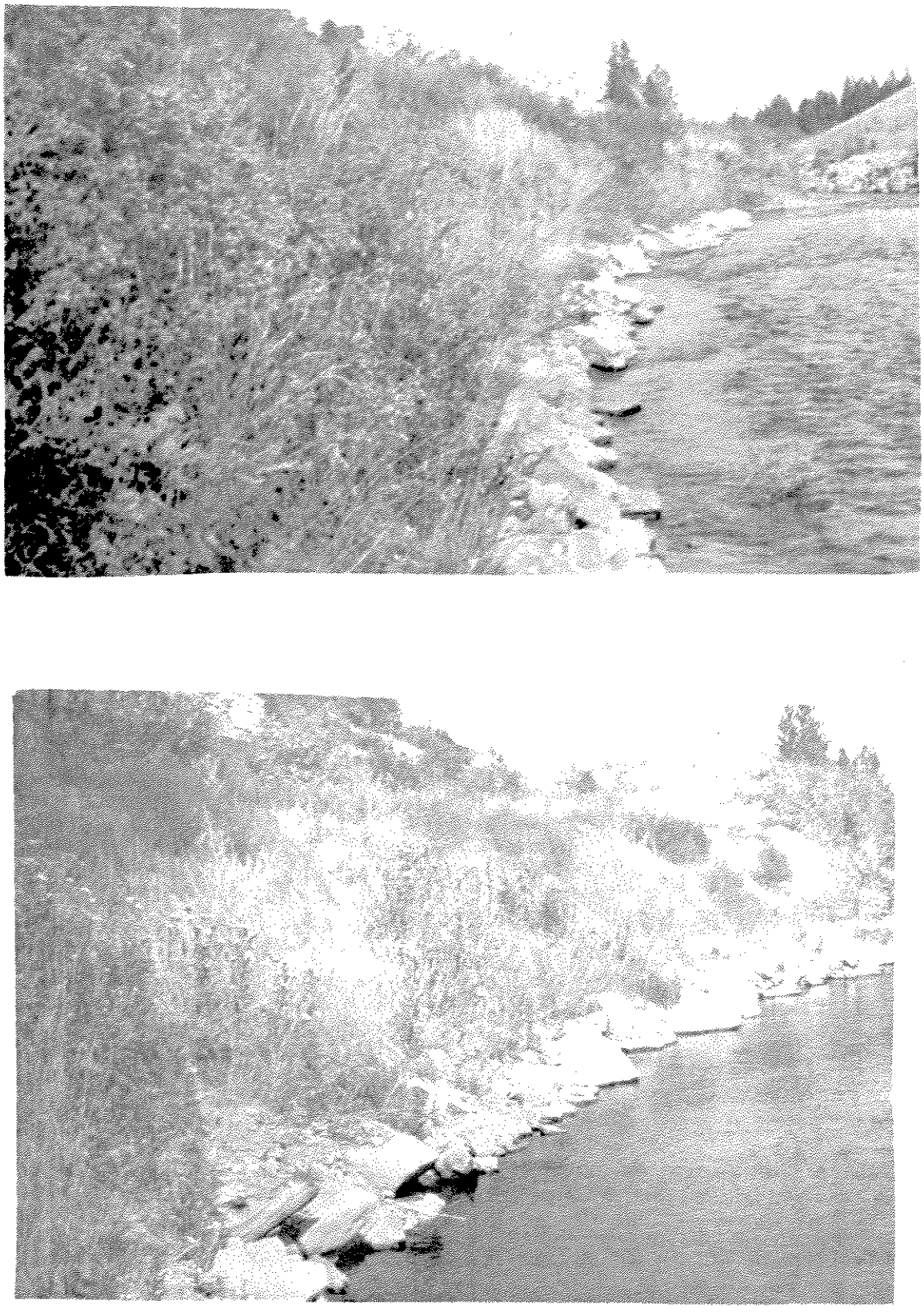


Figure 4. Study area one (above) and area two (below) in the summer of 1972.

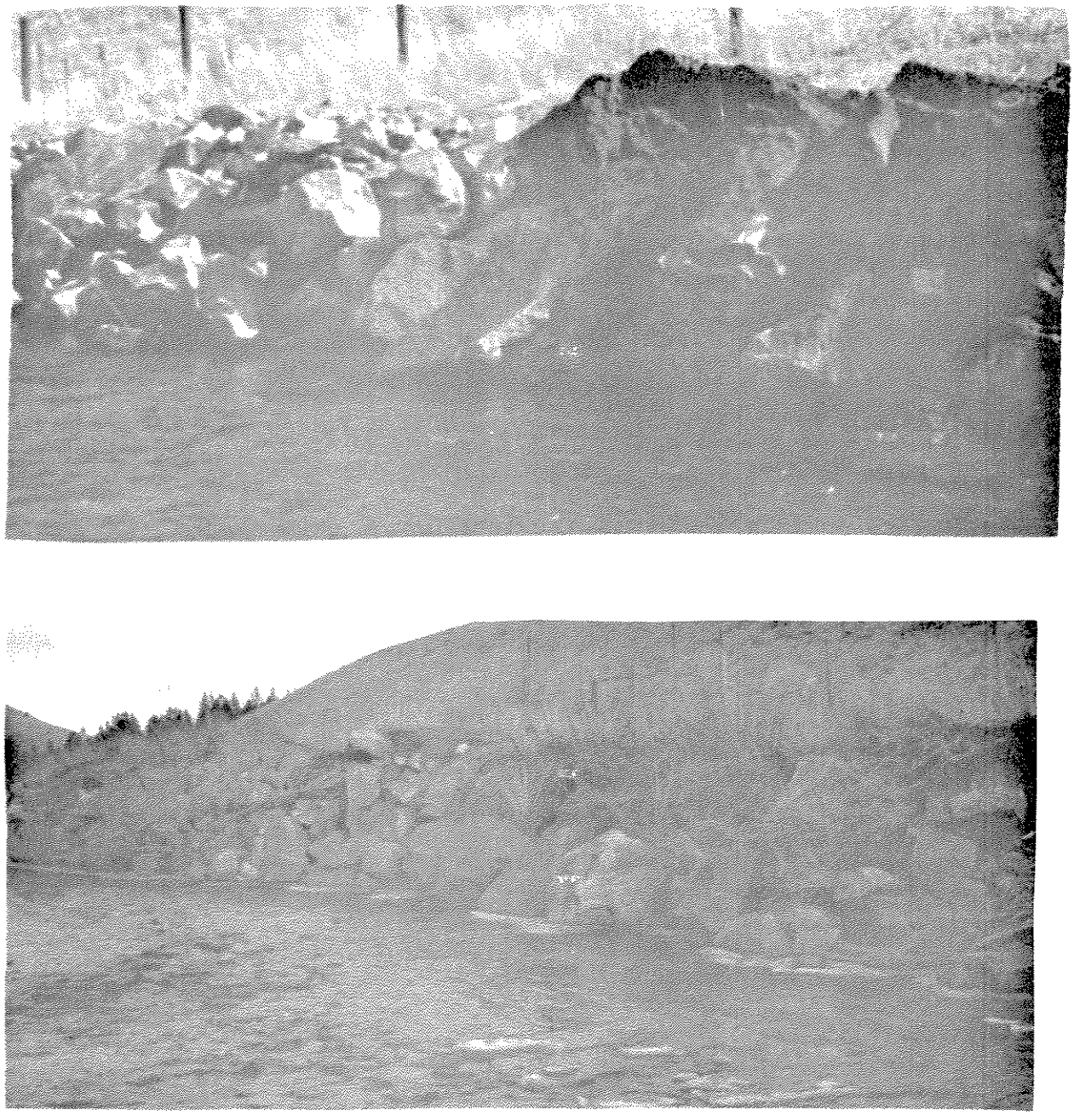


Figure 5. Rip-rap area B (above) in 1971 before completely covered with soil. Rip-rap area B (below) in 1972.

inventory the experimental plants (Figure 4). This indicates that more emphasis should be placed on methods of stabilizing streambanks and improving the soil, so that natural seeding has an advantage, rather than on transplanting to revegetate denuded areas.

Blanket rip-rap was placed on the outside bends of the new channel to protect the highway grade. In 1971, soil was placed on three rip-rap areas and worked into the spaces between the rocks. Fifty native willow shoots were planted on each of rip-rap areas A and B (114 and 146 feet long, respectively). Area C (140 feet long) was left to natural seeding. In April, 1973, an additional 62 and 120 willow shoots were planted on rip-rap A and B, respectively. In December, 1973, 91 willows were still surviving on Area A, 76 on Area B and only 3 could be found on Area C, which had been left for natural seeding. The apparent high degree of success of these transplanted willows can be attributed to the abundance of moisture in the soil adjacent to the stream at water level and to the time of year they were planted (April). The soil which was mechanically placed on the rip-rap and worked into the spaces between the rocks was washed away, except for that which remained above water line (Figure 5). This technique appears to have no beneficial effect because soil placed between the rocks was not held tightly enough to withstand high water during the spring runoff. Soil placed on the rip-rap was a mixture of loam and clay on all three areas. The willows were planted in spaces protected from the direct force of high water where the shoots could be pushed into moist soil near low water level.

Fish Populations

Since highway construction was completed in 1968, fish populations have remained at a level approximately 50 percent less than preconstruction (1967), until 1971 when an increase of 31.0% was seen in the trout numbers. An increase of 33.1% was seen in the trout population numbers between 1971 and 1972 (Table 1). This increase brought the trout population up to a density slightly higher (6.3%) than the preconstruction population. The increases probably reflect stabilizing of the stream bottom after being disturbed by construction machinery. The total pounds of trout in 1972 (30 pounds) was still below the preconstruction level (36 pounds).

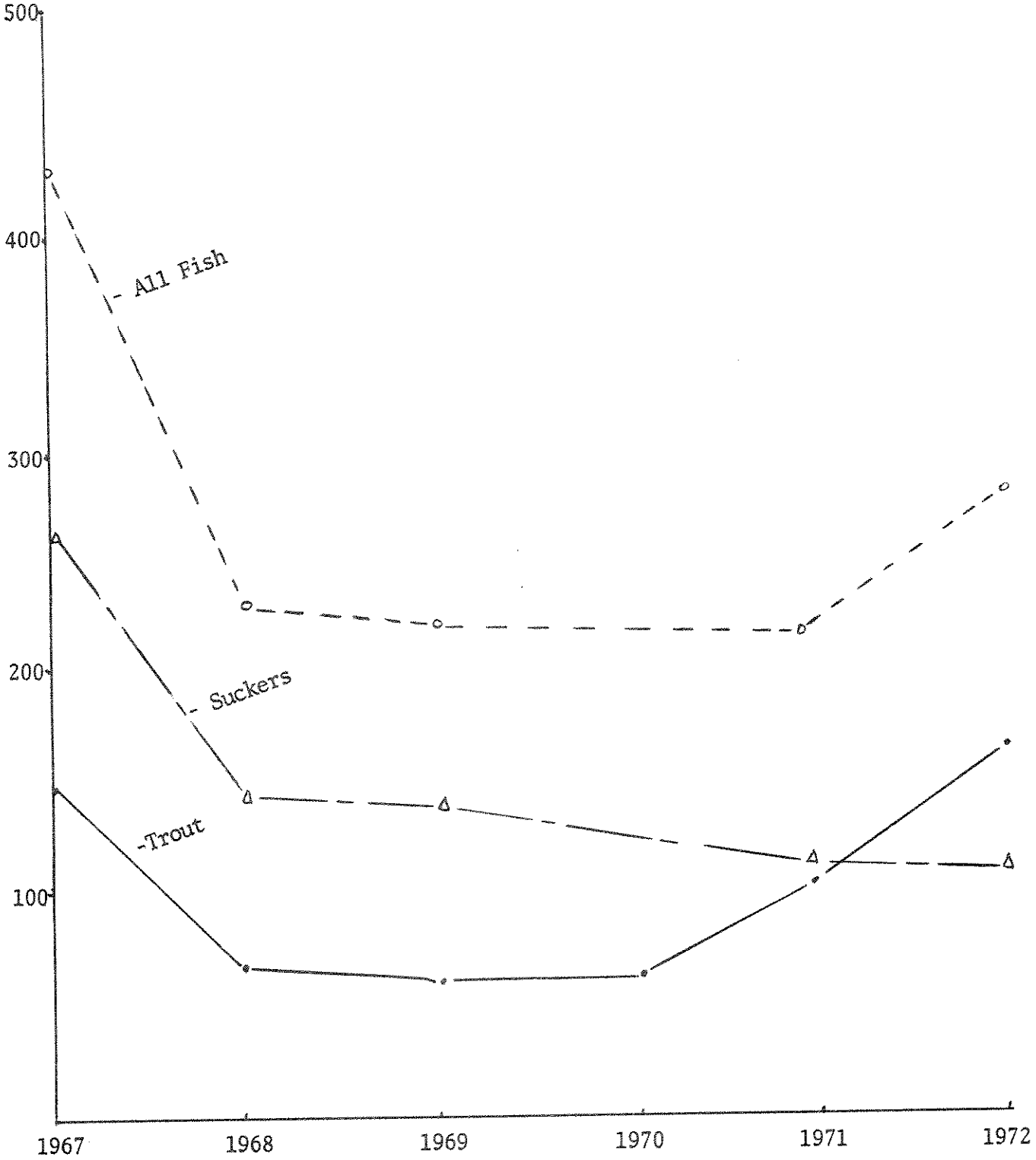
Over the past several years, Prickly Pear Creek has been stocked with catchable sized rainbow trout. In 1971, this practice was discontinued. Studies conducted by Vincent, (1972), indicate that stocking catchable rainbows where resident stream populations exist is detrimental to the wild population. This could also help explain the trout population increase between 1971 and 1972. The sucker populations remain 59.0% below preconstruction level in numbers and 59.8% below weight (Table 1). The total standing crop of fish in the altered section of Prickly Pear Creek remains below preconstruction levels primarily as a result of the near disappearance of white sucker and the decline in longnose sucker numbers.

RECOMMENDATIONS

In situations where stream channels must be altered or relocated, future maintenance problems can be deminished by retaining or transmitting the physical characteristics of the original stream channel into the altered channel. Stream discharge and sediment load are not permanently changed in highway construction, therefore, it is necessary to maintain the same width, depth, meander wave length and gradient characteristic of the original channel in order to maintain stability in the river system (Hsieh Wen Shen, 1971).

Stream channel stability is one of the deciding factors in trout carrying

FIGURE 6. Population estimates by number for the altered section of Prickly Pear Creek from the years 1967 through 1972.



capacity as is indicated by the trend in fish numbers over the years of this study (Figure 6).

Where highway construction will result in the relocation of a stream channel, it is recommended that the new channel be artificially meandered to retain its original length.

TABLE 1. Estimated fish populations for Prickly Pear Creek, pre- (1967) and post-construction (1968, 1969, 1970, 1971, 1972), expressed as numbers per acre, with pounds per acre in parentheses. Confidence intervals at 80% level for the number estimates.

Species	1967	1968	1969	1970	1971	1972
Rainbow Trout	98 (12)	31 (4)	19 (4)	37 (5)	47 (5)	79 (13)
Brown Trout	61 (24)	47 (13)	55 (15)	41 (11)	66 (9)	90 (17)
Longnose Sucker	234 (125)	128 (59)	147 (53)	* *	116 (59)	112 (53)
White Sucker	39 (7)	28 (6)	7 (6)	*	*	*
Total Trout	159 (36)	78 (17)	74 (19)	78 (16)	113 (14)	169 (30)
Confidence interval (±)	20	3	8	10	17	7
Total Suckers	273 (132)	156 (65)	154 (59)	*	116 (59)	112 (53)
Confidence interval (±)	20	7	29		26	30
Grand Total	432 (168)	234 (82)	228 (78)		229 (73)	281 (83)

* Insufficient data for a population estimate.

It is recommended that an attempt be made to adapt the berms described in this project to larger streams. One such design for a large river would be: rip-rap below the water surface and extending approximately 2 feet above the water level of the average annual flow of the stream. The top of the rip-rap would form a ledge which would serve as a catchment area for any soil which might slough off the unprotected portion of the bank during high water and storms. The ledge, covered with soil would be exposed except during high water and would provide an area where natural seeding could take place. If soil quality were poor in the area, fertilizer could be applied or better top soil could be hauled in. The emphasis would be on stabalizing the stream bank in a manner such that natural vegetation would have the advantage and could cover the scars and eventually shade the stream. Blanket rip-rap does not afford that advantage.

LITERATURE CITED

Elser, A. A. 1968. Evaluation of Stream Improvement Structures on Prickly Pear Creek and the East Gallatin River. Job Completion Report, Federal Aid in Fish and Wildlife Restoration Acts, Montana Project No. F-9-R-15. Job V.

Shen, Hsieh Wen. 1971. River Mechanics, V-1. I, Shen, Fort Collins, Colorado.

Vincent, R. 1971. River Electrofishing and Fish Population Estimates. Progressive Fish-Culturist, Vol. 33, No. 3, p. 163-167.

Vincent, R. 1972. Evaluation of River Fish Populations. Job Progress Report, Federal Aid in Fish and Wildlife Restoration Acts, Montana Project No. F-9-R-20, Job III-a.

Workman, D. L. 1972. Evaluation of Stream Improvements on Prickly Pear Creek. Job Progress Report, Federal Aid in Fish and Wildlife Restoration Acts, Montana Project No. F-9-R-20, Job II-a.

Waters referred to:

Prickly Pear Creek 17-6032-1

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