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AN EVALUATION OF STREAMBANK REVEGETATION IN THE EMERGENCY WATERSHED PROTECTION PROGRAM

The attached article "Emergency Measures For Streambank Stabilization: An Evaluation" by Ronald F. Schultze and Glenn I. Wilcox summarizes an evaluation conducted on revegetation work done on 29 EWP (PL-216) projects from 1978 through 1982 floods. Some recommendations are made for improving woody revegetation success on streambank stabilization projects.

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EMERGENCY MEASURES FOR STREAMBANK STABILIZATION: AN EVALUATION[1]

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Abstract,--Severe storms of 1978 through 1983 caused considerable damage to streams in California. The Soil Conservation Service used several mechanical and revegetation techniques to stabilize streambanks and re-establish riparian vegetation. Results of evaluations made on 29 projects are discussed and recommendations made to improve success.

INTRODUCTION

After going through two of the driest years on record (1975-1976), California was hit several years in a row with severe storms. In 1978, 1979, 1980 and 1982, stream channels and debris basins were filled with debris and sediment, grade stabilization structures were damaged or washed out, highways and bridges were washed out, and severe erosion occurred on levees and streambanks.

To safeguard lives and property, the Soil Conservation Service (SCS) may be requested by sponsors to undertake emergency measures to retard runoff and reduce soil erosion and sedimentation. Emergency Watershed Protection funds were requested by the SCS on April 25, 1978 (see 7CFR624 for program administration rules). Through this program the Soil Conservation Service may provide technical and financial assistance to local sponsors whenever fire, flood, or other natural disaster causes serious damage in a watershed. In stream work, the project is designed to return the channel to its original capacity and to stabilize the bank. Therefore, most of the streambank stabilization projects are small and designed to protect only severely eroding spots. If unprotected, there could be damage to adjoining property or accumulation of sediment downstream. The sediment reduces stream channel capacity and can cause the stream to overflow its banks endangering life and property.

When the Soil Conservation Service began to work on the Emergency Watershed Protection program in 1978, SCS had never attempted such a program on such a large scale. The Soil Conservation Service examined 1,100 sites in 13 southern California counties. From these, 316 projects qualified for assistance and were completed. Debris and sediment was removed from 131 miles of clogged stream channels and 38 debris basins, over 100 miles of streambanks and 325 miles of levees were repaired. One hundred sixty-three grade stabilization structures were repaired and 149 were constructed. Some of this work would not be eligible under current program criteria.

In 1979, 1980 and 1982, California was again hit by heavy winter storms. Fifty-five additional projects were completed in those years. From 1978 through 1982, a total of 371 projects were completed costing about $62.6 million. Estimated benefits from the work amounted to $1.5 billion. This includes value of land and improvements that had a potential of being damaged in the future from moderate storms.

In the 1978 program, very little revegetation work was done in southern California, but in San Luis Obispo and Monterey Counties, considerable revegetation was done. In the following years revegetation was nearly always included and it is now required on all stabilization projects. Many of the jobs were streambank stabilization projects, designed to stabilize banks or levees that were severely eroded and unstable as a result of flooding. Structural measures usually included bank shaping, gabions, concrete sacks and rock riprap or pipe and wire revetment. Revegetation work was done using various grasses, legumes, shrubs and trees. Numerous methods were used; many were successful and some were not so successful. Except for a couple of projects that included irrigation, maintenance was not required on any of the vegetative plantings.

Having a large number of projects in which revegetation was an important component provided an excellent opportunity to evaluate the emergency approach to riparian revegetation. Information from the evaluation is being used to improve specifications for future streambank stabilization and riparian revegetation work.

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EVALUATION

In 1983, an evaluation was conducted of revegetation work done on 29 projects in California's central coast area (SCS Area 5). Nine of the projects included seeding of only herbaceous vegetation. Twenty projects included herbaceous and woody vegetation. Plant species used in the revegetation work are listed in Table 1. Some projects had only one species planted, usually either barley or 'Blando' brome. One project included barley, three shrub and two tree species. The most common planting combination was 'Blando' brome and willow. Incidentially, 'Blando' brome and 'Zorro' annual fescue are two plants developed by the SCS Plant Materials Center at Lockford, California, for their superior performance in erosion control plantings.

Table 1. Plants used in revegetation work.

Common Name	Scientific Name	Number of Projects
Annual ryegrass	Lolium multiflorum	1
Barley	Hordeum vulgare	7
'Blando' brome	Bromus mollis	23
Creeping red fescue	Festuca rubra	1
'Zorro' annual fescue	Vulpia myuros	1
Rose clover	Trifolium hirtum	6
Mule fat	Baccharis viminea	1
Elderberry	Sambucus sp.	1
Willow	Salix spp.	18
Cottonwood	Populus fremontii	2
Saltcedar	Tamarix pentandra	1
Athel	Tamarix aphylla	1
Desert saltbush	Atriplex polycarpa	1
Fourwing saltbush	Atriplex canescens	1
Quailbush	Atriplex lentiformisl	

Of the 29 projects, 22 were one acre or less in size. The largest project was on about four miles of stream with 42 acres revegetated.

California's mediterranean climate produces high winter stream flows and very low summer flows; some creeks, however, have a perennial low flow, while others are intermittent with no flows in the summer. These flow characteristics influence selection of measures suitable for streambank stabilization work at a given site. In the areas selected for this evaluation there were four types of structural measures with which riparian revegetation was compatible. They included bank shaping only and bank shaping or levee construction coupled with other measures, such as pipe and wire revetments, rock filled gabion (wire) baskets and rock riprap. Concrete, concrete sacks and grouted rock are much less compatible with revegetation. The following is a brief description of revegetation methods used in the four types of projects.

Bank shaping only--Bank shaping without other structural measures was used in four projects. Two of the projects involved land slips that filled streams, and the two others involved removal of stream sediment. These projects were seeded with herbaceous plants, such as 'Blando' brome (6 lbs/ac) or barley (120 lbs/ac), fertilized with 16-20-0 fertilizer (500 lbs/ac), and mulched with straw (2 tons/ac) after sediment and debris were removed from the streambed and the banks reshaped.

Pipe and wire revetment--Five projects used pipe and wire revetment. Pipe and wire revetment was usually placed parallel to the toe of a levee or shaped bank, with cross fences tied into the bank at intervals along the length of the project. Woody cuttings were usually planted at three feet centers along the toe of the bank behind the pipe and wire revetment. A few projects had additional cuttings planted on the streamside of the pipe and wire. Cuttings were usually inserted into soil using a steel bar or water jet. The water jet is a piece of steel pipe attached to a hose and water source. Water is controlled with a spigot at the top of the pipe. As the water is turned on, the pipe is pushed into the ground. The woody cutting is inserted alongside the water jet. As the jet is pulled out it washes soil around the cutting and eliminates air pockets. This method also waters the cutting as it is planted. The upper slopes of the banks and levees were usually seeded with herbaceous plants. In one project the upper slopes and top of levees were direct seeded with three species of Atriplex, each at 12 lbs/ac, in addition to barley.

Gabions--Gabions are wire baskets that are filled with rock. Two types of gabion structures were used. One type, used to protect vertical banks, consisted of baskets that were three feet wide, by three feet high and six feet long; the other type, for slope protection, consisted of 'blanket' baskets, one foot thick. Three projects were the vertical type. With these, vegetation could only be planted in the streambed outside the toe of the structure or above the structure where there was suitable soil, but little water. Six projects had the blanket type. A steel bar had to be pushed through the rock and into the soil before woody cuttings could be inserted. In the gabion blanket projects woody cuttings were usually planted with three or four rows (3 or 6 feet spacing) up the slope. An additional three or four rows were planted out from the gabion toe into the streambed, often in sandy material.

Rock riprap--Rock riprap was used on ten projects. Riprap is a layer of large rock (maximum diameter ranged from two feet to three feet) placed on a shaped slope (usually 2:1). One of two methods was used for planting woody cuttings. The first, and most difficult, was done after the rock was laid. A steel bar or water jet was inserted through the rock and into the soil. The cutting was then inserted through the rock. The second method was to plant cuttings in the shaped bank and then place rock on top of the cuttings. Where filter fabric was used under the rock, the cutting had to be inserted through the filter fabric. Two or three rows of cuttings were planted up the slope. One project had streambed material (mostly coarse sand) placed on top and in front of the rock riprap with willow cuttings planted in that material. The upper two rows were planted through the rock riprap. Except for these upper two rows all the other cuttings and sand were washed away by subsequent stream flows.

Since bank stabilization projects are to provide protection and stabilize severely eroding spots on streams, part of the evaluation was to determine if the structural and vegetative measures achieved this purpose. We were pleased to find that structural measures on 24 projects achieved their purpose with only minor damage even though there were severe storms following their installation. Five projects had significant damage caused by subsequent storms. Two of these projects were on land slips. These slips were treated by removing sediment and debris from the stream, shaping the lower banks and revegetating. They continued to by unstable. Three projects that were comprised of pipe and wire revetment and vegetated with herbaceous and woody vegetation were severely damaged by subsequent storms. Experience indicates they probably would have been more successful if the vegetation could have had a chance to become established before being hit by heavy stream flows.

The vegetation on 14 projects became established and did a good job. Vegetation on eight projects had only fair establishment. Vegetation planted on seven projects had poor establishment or completely failed.

In most cases, herbaceous plantings performed as expected. In riparian revegetation work there are advantages to using barley. It provides good first-year cover for erosion control and, after it dies, provides some structural support for the soil. Barley does not reseed itself; in this more stable evironment, therefore, native and naturalized plants can re-invade the site without competition from an introduced species.

In most areas, willows continue to be the plant of choice because they are usually locally available, easily established, provide more stability to the site than many other woody plants, and grow rapidly. Another plant that grows in a somewhat drier zone than willow and that has features similar to willow is mule fat. This plant was mistaken for willow and planted on a couple of sites. It has done well and can be found along many California streams.

The key element to most projects was stabilization of the site. Even though in some cases the plants failed, the sites were stabilized and provided suitable areas for revegetation by volunteer plants. In addition, where planted vegetation did well, especially willows, there was a buildup of sediment in the site and numerous invading plant species were becoming established.

From our evaluation there seemed to be several reasons for failure or poor success of plantings. Heavy rainfall and runoff before plants become established were probably the leading causes. Some plants such as willow were planted in unstable sandy streambed material and were washed out by heavy runoff before they had a chance to become established. Some plantings, including some willow and some cottonwood plantings, were too low in the streambed and were drowned out. Some willow cuttings were planted through gabion baskets perpendicular to stream flow and were broken off by high stream velocities. Some willow cuttings were planted under a layer of riprap that was to deep (probably greater than three feet) and they couldn't grow up through it. Woody plantings on some high droughty sites, such as levees built from riverbed materials (sand and gravel), did not get proper watering and dried up.

Eroding streambanks that are treated with pipe and wire revetments, gabion blankets or loose rock riprap will often naturally revegetate. Based on our evaluation, however, we strongly recommend that herbaceous and woody plantings be included with these kinds of structural measures. Plantings give the planner a choice of vegetation to achieve a desired purpose rather than relying on chance from natural revegetation. Revegetation is usually much more rapid with plantings. Wildlife and aesthetic values return to the site more rapidly.

RECOMMENDATIONS

The evaluation was done, primarily to determine if revegetation measures accomplished their purpose and the reasons for success or failure. Nearly all the projects provided adequate protection for severely eroding and unstable streambank sites. Once structural measures have been installed, there can be a natural influx of volunteer vegetation. However, the healing process, quality of restored wildlife habitat, and establishment of a more aesthetically pleasing site can be speeded up by revegetation work.

The following recommendations may be useful in designing future projects that combine structural and vegetative measures for streambank restoration:

1. Willow cuttings can best be planted under rock riprap that is three feet or less thick. They can be planted through filter fabric under the rock.

2. Don't plant woody cuttings where they will be submerged for prolonged periods.

3. Willow or similar cuttings can be planted through gabion blankets (1 foot thick) if at least two feet length of cutting is inserted into soil below the gabion blanket. Slope the cuttings slightly downstream.

4. Planting woody cuttings in pipe and wire revetment will work well.

5. Planting multiple rows of cuttings up the bank slope will allow those in most suitable locations to become established.

6. Don't plant into streambed beyond toe of the bank if streambed is unstable sand and gravel.

7. Some narrow channels may become choked with willow - but this would likely occur naturally - therefore, maintenance may be necessary on some sites to ensure desired stream capacity.

8. Locally available native woody plants, such as willows, mule fat and cottonwood, can usually be found that are suitable for the revegetation

work.

9. Success of plantings in somewhat droughty sites can be significantly improved by irrigation through the first year.

10. The water jet method of planting woody cuttings seems to be the best method of installation.