RIPARIAN REVEGETATION IN CALIFORNIA

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ABSTRACT.

The USDA Soil Conservation Service has been involved in the planning and implementation of riparian revegetation projects throughout California. The goal of riparian revegetation encompasses one or more of the following objectives: (1) improve fish and wildlife habitat, (2) enhance visual resources, and (3) stabilize eroding banks. The complexity of revegetation efforts varies from planting willow cuttings along channel banks to designing and installing multispecies plant communities that require irrigation systems. The paper will review techniques and results, and case studies will be discussed.

INTRODUCTION

Riparian systems are among the most important wildlife habitat types in the western United States. This importance is measured in the great diversity of wildlife species associated with riparian areas. Of the 379 known terrestrial wildlife species in the Blue Mountains of Oregon, 280 are either directly dependent on riparian systems or use them more than any other habitat type (Thomas 1979). Although riparian values have been recognized for years, the value of riparian systems to wildlife has been documented only recently. Over 85% of the papers written on riparian systems have been published in the last decade (Motroni 1980).

The importance of riparian systems to birds is widely recognized. The highest avian population densities in North America were recorded for riparian systems along the Verde River in Arizona (Carothers et al. 1974). Although it is commonly known that riparian areas are important for breeding birds, recent research indicates that winter populations are equal to or greater than summer populations (Szaro 1980).

There have been fewer studies of other zoological taxa in relation to riparian systems. Riparian areas are of value to mammals, reptiles, and amphibians. Almost all amphibians depend on aquatic habitats for reproduction and many species are restricted to riparian environments (Brinson et al. 1981).

Riparian systems are important to anadromous and resident fish. Riparian vegetation moderates water temperature by providing shade in the summer and insulation in the winter (Meehan et al. 1977). Riparian vegetation supplies habitat for terrestrial insects--a food source to most species of fish. The vegetation is also a source of organic detritus for aquatic ecosystems.

Riparian vegetation has other values indirectly related to wildlife. The vegetation may act as a filter that decreases the amount of sediment reaching the aquatic environment (Meehan et al. 1977). The vegetation is also important in preventing bank erosion or stabilizing eroding banks. Another important asset of riparian systems, particularly in urban areas, is their aesthetic value. The linear corridors of green vegetation add diversity to an often flat topography. Riparian systems have been altered, degraded, and lost throughout the west. A nationwide survey indicates that they make up less than 2 percent of the land area in the United States and that, on a national average, 70 percent of the acreage has been altered (Brinson et al. 1981). The national average deemphasizes the loss of riparian vegetation on the Sacramento River in California, where 98 percent of the vegetation has been removed.

Many factors, both man induced and natural, can cause the loss or degradation of riparian systems. Foremost are modification for flood control, water diversions, and inundation associated with construction of reservoirs. During the last 150 years, 192,000 miles of waterways were altered by human activities (Little 1973).

The most important management goal for riparian systems is to protect those that remain. Where this concept conflicts with other resource uses, mitigation should consider on-site restoration of riparian systems. Unfortunately, the "how to do it" literature regarding riparian restoration, revegetation in particular, is limited. An attempt was made to fill this void at the 1981 conference on California riparian systems (Gray, in press).

The Soil Conservation Service (SCS) has a varied role in riparian systems management. SCS assists private landowners and agencies with conservation plans that often highlight the value of properly managing riparian systems. Plant materials, particularly willows (*Salix spp*) and various annuals, are recommended to assist in stabilizing eroding banks. Bank stabilization plantings often have been used in conjunction with structural measures in the Emergency Watershed Protection Program (EWP) after severe winter flooding. Riparian revegetation also has been used to mitigate adverse impacts to riparian systems associated with flood protection projects.

CASE STUDIES

The case studies discussed below provide an overview of the scope of SCS riparian revegetation projects in California. Early SCS revegetation efforts used non-native species of plants or species not considered riparian. These plants were selected primarily because of their availability and proven success in establishment. Emphasis now has moved toward the use of native species. Reconstruction of the vertical structural diversity of the canopy and understory is also considered.

A major consideration in riparian revegetation projects is availability of water. The distribution of riparian plants is the result of a moisture gradient. Some species need continued inundation; others need only periodic flooding. A high water table is needed to sustain the plants through the summer in California. When planning a revegetation project, the moisture requirements of each species must be considered. In many cases the soil moisture is lacking and irrigation becomes necessary during establishment. Plant selection must emphasize more xeric adapted species.

Revegetation associated with modified channels must be hydraulically compatible with designed channel capacity. Certain plants, particularly woody vegetation, can create obstacles to irrigation or flood water flows within the channel.

Riparian plantings are often done on sites that no longer receive periodic flooding. These sites require relatively drought tolerant species that need supplemental irrigation during establishment. Irrigation costs may be the single most expensive cost of revegetation projects.

Our existing knowledge, in conjunction with the limitations discussed above, often prevents the establishment of completely native climax riparian plant communities. These plantings still satisfy many objectives of riparian revegetation but do not replace the natural plant community.

CUYAMA RIVER

Over two miles of streambank on the Cuyama River in Santa Barbara and San Luis Obispo counties were protected by an EWP project. About 18,000 feet of pipe and wire fencing were installed in front of a specially constructed earth embankment.

Woody cuttings of saltcedar (*Tamarix pentandra*) and athel (*Tamarix aphylla*) were planted behind the pipe and wire. Athel cuttings were planted at the toe of the earth embankment on a 3-foot spacing. Three feet up the side of the embankment, saltcedar cuttings were planted on a 3-foot spacing. An additional 12,000 feet of river bank were shaped and planted in the same manner.

The construction was completed in September 1979. All disturbed areas were direct seeded, fertilized, and mulched. A total of 25 acres of levee were planted with 120 pounds per acre of barley, 12 pounds per acre of quailbush (*Atriplex lentiformis*), and 12 pounds per acre of fourwing saltbush (*Atriplex canescens*). About six acres were planted with desert saltbush (*Atriplex polycarpa*). All disturbed areas were fertilized with 16-20-0 fertilizer at 500 pounds per acre and mulched with 2 tons of straw per acre.

About 10,500 saltcedar cuttings were harvested in Kern County and about 9,000 athel cuttings in Fresno County. Saltcedar and athel were chosen for planting because of their ease of establishment. Embankment material was mostly riverbed gravel and sand and had a very low water holding capacity.

The woody cuttings were collected in late February 1980 and planted in March 1980. Four to 5-foot holes, 1½-inch in diameter, were drilled with power augers. The cuttings were immediately placed in the holes, then tamped and watered to eliminate air pockets around them.

This site has been periodically spot checked and, based on these spot checks, it is estimated that less than 20% of the woody cuttings remain alive. This low survival rate is a function of several factors. The area receives less than 10 inches of rainfall and the Cuyama River is intermittent. Because of the harsh environmental site conditions, the plantings were to have been irrigated with temporary irrigation systems. It is likely that inadequate water was applied in some areas. The site was also slightly damaged by flooding in 1980, and suffered substantial additional damage in 1982.

CARMEL AND SALINAS RIVERS

Twenty-seven EWP projects were completed on the Carmel and Salinas rivers in Monterey County after January 1978 storm damage. These projects were designed to repair streambanks that were damaged from high flows. Construction work on these projects ran from August 1978 to September 1979. Each project included bank protection consisting of loose rock riprap or wire gabion baskets filled with rock.

The upper slopes above the rock or basket protection were seeded with blando brome (*Bromus mollis*) at a rate of 6 pounds per acre and Briggs berley (*Hordeum vulgare*) at a rate of 120 pounds per acre. This area was fertilized 16-20-0 fertilizer at 500 pounds per acre and mulched with 2 tons of straw per acre.

The lower slopes were planted with willow (*Salix spp.*) cuttings and false bamboo (*Arundo donax*) cutting on 3-foot spacing. These species were used because they occurred on or near the site and cuttings were easily obtainable. Some information was available in SCS plant sheets on planting willow cuttings. No information was available on the use of false bamboo cuttings, but this material was planted to determine if it would be useful.

Some mule fat (*Baccharis viminea*) cuttings were accidentally included in some plantings. These cuttings appeared to have a good rate of survival.

The soils on these sites generally were coarse, with poor water retention qualities. Bank shaping was often done using material from the river bottom that was gravelly sand to loamy sand. Annual rainfall in the project areas ranges from 15 to 25 inches. The Salinas River is a perennial river at the project sites because of controlled water releases from reservoirs. The Carmel River flows most of the year in the project area, but usually goes dry for a period in the summer.

Planting holes were difficult to make between the loose rock riprap, and were made with a steel bar or a water jet. The water jet is a piece of steel pipe attached to a hose and water supply. 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 willow 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.

Cuttings usually were planted in four or more rows. On most of the Salinas and Carmel River sites, only the upper two or three rows of willow cuttings were successful and are growing well. The lower rows of willow cuttings on these sites no longer are present. It appears that these cuttings were either drowned out by high winter flows soon after planting or scoured out during the high flows. Revegetation failures were associated with the failure of the loose rock or gabion basket to protect the bank and the plantings.

One site that was evaluated on the Carmel River in July 1983 had three rows of willows growing through wire baskets. Eight rows of willows were originally planted. These willows were about 16 feet tall and provided about 75 percent cover on the slope. Other vegetation accounted for about 15 percent cover and about 10 percent of the slope was bare.

One of the sites evaluated on the Salinas River in July 1983 had three rows of willows growing through wire baskets. Seven rows of willow and false bamboo were originally planted. The willow and bamboo were about 20 feet tall. The willows provided about 80 percent cover on the slope, false bamboo about 5 percent, and other vegetation accounted for about 15 percent of the vegetative cover.

APTOS CREEK

About 1,000 feet of streambank were protected on Aptos Creek following damage that occurred in January 1982. Repair work began in the summer of 1982. The banks were sloped at 2:1 and a toe trench was constructed. Filter fabric was laid in the trench and up the slope. The filter fabric is a woven sheet of plastic fibers installed to allow water to move out of the soil but to hold the soil in place. Holes were made through the filter fabric and into the soil using a metal bar. The willow cuttings were inserted through the filter fabric and into the soil. The loose rock riprap was placed over the filter fabric and willow cuttings. Willow cuttings were selected because they are relatively easy to plant, they are native, and they were readily available near the job site.

The project area receives an average annual rainfall of over 20 inches per year, and Aptos Creek has a perennial flow. The soil in and along the creek is loamy sand to sand.

Willow cuttings were collected onsite and planted in late November and early December of 1982. Two rows with 3-foot spacing were installed on the entire length of this project. Disturbed areas above the rock were seeded with blando brome at 18 pounds per acre, fertilized with 500 pounds of 16-20-0 fertilizer per acre, and mulched with 2 tons of straw per acre.

This site was reviewed in July 1983. Less than 5 percent of the 300 willow cuttings planted were evident on the lower 450 feet of this project. These willows had to grow through almost 3 feet of loose rock. The lower reach is subject to daily tidal inundation. The cuttings may not have survived the brackish conditions or may have drowned because they were planted too low on the slope.

The areas seeded above the loose rock were covered with about 35 percent blando brome, 20 percent barley, 5 percent ryegrass, and 20 percent other species. Automobile and foot traffic accounted for the bare areas.

About 330 willow cuttings were planted on the upper 550 feet of this project; 114 cuttings (about 36 percent of those planted) were observed growing on the July 1983 review. The willow growth was about 18 inches above the rock riprap and was well distributed through the work area.

The remaining area, above the loose rock riprap, had little vegetation cover (about 6 percent) even though blando brome was planted. This area had been disturbed by equipment and new fill since the blando brome had been planted.

SANTA CLARA RIVER

An existing levee was damaged on the Santa Clara River in Ventura County as a result of 1980 storms. About 3,500 feet of embankment were rebuilt and protected with loose rock riprap.

Willows were collected onsite and planted in four rows with 3-foot spacing along 800 linear feet of levee. One row of willows was planted right at the toe of the levee, one row was planted three feet into the channel, and two rows were planted three feet and six feet up the slope of the levee. Planting was completed in March 1981. Willows were selected for planting because they are native, cuttings could be taken from nearby trees, and they are relatively easy and inexpensive to plant.

The Santa Clara River is perennial at the project site, but surface water could be near the site or far removed on the other side of the river channel. The soil at the project site is mostly gravelly sand riverwash material. Annual rainfall in the area is 15 to 20 inches.

A site review in July 1983 revealed that the upper two rows of willows formed a uniform and solid stand of vegetation 8 to 10 feet tall. The lower two rows of cuttings were gone. High water flows at the toe of the levee apparently had scoured away the lower two rows of cuttings.

LLAGAS CREEK

A complex riparian revegetation project is being designed and constructed by SCS along Llagas Creek in the Santa Clara Valley. Ten miles of riparian woodland will be installed during the next few years.

The Llagas Creek watershed project has a history that dates to the 1950s. The project was planned, partially built, halted by the National Environmental Policy Act, replanned, and then stopped by public opposition. Major environmental concerns surfaced. Public agencies strongly objected to the significant loss of riparian habitat which would result from the proposed channel modifications.

In 1980, SCS agreed to reevaluate the project and prepare a final environmental impact statement. Major efforts were made to identify points of opposition and incorporate public opinion. Wildlife biology and landscape architecture were incorporated into the planning process. SCS biologists and Santa Clara Valley Water District environmental planners met with the California Department of Fish and Game to determine methods of minimizing impacts to fish and wildlife. It was determined that the loss of wildlife habitat by the project must be mitigated.

Riparian habitat to be lost or damaged as a result of construction activities was identified. Habitat lost in the early 1970s also was inventoried by use of aerial photos taken in the 1960s. The quality, quantity, location, and type of habitat were documented.

Saving as much existing mature riparian habitat as possible became the primary design objective. Bands of trees and shrubs are to be retained by one-sided construction techniques. Scenic oxbows, the remains of the meandering s-curved creek, are being preserved along with their rich, diverse habitat. Water will be restored to the oxbows by directing water through them.

The design of a new riparian community may be very complex. The design objective is to recreate a riparian woodland that mimics the natural community in appearance, plant diversity, and wildlife value. The new design must short-circuit the natural selection process and compress the time it takes to establish a viable riparian habitat.

In the present mitigation projects, native species of trees, shrubs, vines, and wildflowers indigenous to the project site are being used to recreate the diversity of the destroyed riparian vegetation. In most cases the planned species diversity exceeds what existed previously. Most of the existing riparian systems have been drastically altered by human activities over the last century through various land use changes.

Several installation methods are being studied: broadcast and spot seeding, planting of rooted cuttings, and planting of nursery grown stock. Growth rates will be compared with trees in normal planting pits and in pits with the soil profile broken by an auger. It is hoped that the plants in the augered group will exhibit superior growth rates as a result of tap roots reaching groundwater faster.

Many of the planting sites require supplemental water for establishment. Drip and flood irrigation methods are being evaluated. Since the first two years are critical to the survival of newly established plants, SCS will be responsible for maintenance during that period. The local sponsors will continue to irrigate the plantings for an additional three years.

DISCUSSION

The problems that face future riparian revegetation projects are varied but are not insurmountable. A primary consideration that limits the amount and diversity of revegetation attempts is money. Establishment costs depend upon the type of revegetation project undertaken. The complexity, and therefore cost, can range from just placing willow cuttings in a stream bank to planting nursery grown trees and shrubs with permanent irrigation support systems. Once the plants are in the ground the maintenance can also vary from none to intensive efforts for pest control, replacement of diseased plants, and maintenance of the irrigation systems. Establishment is a special problem in urban areas where vandalism can result in loss of both plants and irrigation systems.

The cost of reestablishing riparian revegetation can range from a few hundred dollars to over $10,000 per acre, but is a necessary expenditure if we want to replace these valuable systems. The high cost emphasizes the need to maintain existing riparian habitat whenever possible. As our knowledge increases the cost hopefully will be reduced, which will help to promote wider use of riparian revegetation as a feasible mitigation or enhancement measure.

The loss of riparian vegetation is often the result of channel enlargement for flood control or irrigation projects. Revegetation associated with channels modified for these purposes must be hydraulically compatible with the designed channel capacity. Certain kinds of vegetation within channels create obstacles to water flows. Project planning should include engineers and riparian revegetation planners at a very early stage to resolve differences between vegetation and designed channel capacity.

Riparian revegetation projects may not duplicate natural plant succession and, therefore, will not lead to reestablishment of the "natural" climax community. This should be considered carefully during planning, and then monitored during establishment to identify problems.

It should be emphasized that riparian revegetation will not immediately replace aesthetic and biological values lost. Temporal delays in biological productivity of these systems should be a major consideration in documenting channelization impacts. Wildlife in revegetated areas may take time to respond since the vertical diversity of the ecosystem may not be restored for 15 to 30 years. Avian populations may rapidly reestablish themselves in revegetated areas. Unless artificial nesting sites are created, cavity nesting birds will not be able to recolonize the area until the system fully matures and some trees begin to die. Other vertebrates less mobile than birds will take longer to reestablish in revegetated areas, if they return at all.

Opportunities are available to enhance our knowledge of riparian revegetation through close cooperation between various groups and agencies. The pooling of resources becomes increasingly important when financial limitations exist. Cooperative field trials of riparian revegetation projects would benefit all involved and reduce cost. Riparian revegetation attempts, whether successful or not, should be well documented. These projects must be carefully evaluated to provide information for future revegetation projects. This information must be made available to other workers if riparian revegetation efforts are to become an integral part of mitigation proposals.

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