

## CALIFORNIA DEPARTMENT OF TRANSPORTATION RIPARIAN RESTORATION PROJECTS IN SAN DIEGO COUNTY

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The California Department of Transportation has been involved with riparian establishment in San Diego County since 1981. During this time, two sites have been established on the San Diego River, in 1982 and 1985 (6.2 and 9 acres respectively), and one on the Sweetwater River in 1986 (2 acres). Another two sites (7.2 and 4.7 acres) are in the final design stages, and are expected to be installed on the San Luis Rey River in the winter of 1988-89.

The procedure for developing a riparian mitigation site is typically a complex series of steps that require an evaluation of the existing landform, ownership easements, local climatic conditions, in addition to biological factors concerning the species present, any new desired species, and the extent of biological disturbance already in evidence. The process in Caltrans is further complicated by operation procedures within a large governmental agency with its many divisions of labor and review by many people.

This paper discusses various procedures, situations and findings stemming from the establishment and maintenance of the three riparian restoration sites that have been established by Caltrans in coastal San Diego county.

### METHODS

Selection of the locations for the three restoration sites were made by Caltrans management. As examples, the 8/15 (i.e., the intersection of Interstate 8 and Interstate 15) one of the San Diego River projects was selected solely because the area needed to be lowered for hydrological purposes, the Morena Street site was City of San Diego property and was used so that acquisition of land was not necessary, the Sweetwater site was selected as it did not conflict with the planned development along the river by the landowner.

Species selection was determined after field inspection of adjacent areas with existing riparian habitat, and then determining which species were desired, available, and amenable to planting or replanting. The Sweetwater River site was designed specifically as habitat for the endangered Least Bell's Vireo, *Vireo bellii pusillus*. The species selection and quantities were largely governed by the U.S. Fish and Wildlife Service using the then current data base for describing the habitat of the species. The two San Diego River sites were developed to enhance or augment existing riparian vegetation in the immediate vicinity. No specific species habitat was considered in the creation of the designs but rather, an emphasis was placed upon increasing the diversity of the riparian habitat adjacent to the site and augmenting the overall habitat for the location.

In creating riparian habitat, a critical part of the design is to use existing topography or to create new topography to provide both a minimal and an optimal water availability, as well as some minimal protection from expected maximum water flow. This requires an evaluation of the existing landform, and usually then designing a new topography to be created by earthwork that will not harm existing or downstream biota.

Final elevation levels on the San Diego River were determined from elevation data taken from engineering design maps. In the case of the Sweetwater River site, the final excavated elevation was finalized by field inspection with the Corps of Engineers and U.S. Fish and Wildlife Service.

Because normal water flow variations posed a risk problem, all sites were irrigated through the first summer and fall. In the case of the Sweetwater River site, irrigation continued through a second year.

Material used included cuttings, rooted cuttings and 1, 5, and 15 gallon container plants supplied by a local nursery. Hydroseeding was done at all sites. At the Sweetwater site, the small container plants were covered with pots to prevent painting by the hydromulch. This was done to prevent potential loss of plants that might have been too heavily coated with the mulch mix. A general rather than a site specific seed mix developed for erosion control by the landscape architect was used on the 8/15 site. Only one seed mix was used throughout the construction and mitigation sites to facilitate ease of contract monitoring. The Morena Street and Sweetwater projects had individualized mixes to attain the goals of the desired habitat being created.

Container plants were installed into planting holes slightly larger than the plant container of each plant, and no augering was performed on any of the sites.

Mature trees were salvaged from the construction area prior to construction activity, and the twenty-two "tree plugs" (6 feet in diameter and four and one-half feet deep), were installed in the western-most one-quarter acre of the Sweetwater site.

All sites required earthwork to create the desired topography, and only the Morena Street site had areas left at original grade, with only brush clearing needed to prepare the site.

### Site Descriptions

The 8/15 site comprises 6.2 acres, located in the northeast quadrant of the intersection of Interstate 8 and 15. East of Rancho Mission Road on the north side of the San Diego River, it continues both east and north approximately 3,000 feet. Previously, the site was 10 to 14 feet higher in elevation and covered with exotic grasses and bushes and typical roadside debris. A condominium development is on the adjacent property. A sewer easement is on a portion of the northern border in between the site and the condominiums. The dominant vegetation is willow woodland with a small number of cottonwoods appearing at the higher elevations on the south side of the river. Many of the cottonwoods were removed by the Interstate project.

The Morena Street Site is about nine acres in size (also on the San Diego River), approximately 4.5 miles to the west of the 8/15 site, near the outlet of the San Diego River flood control channel to the ocean. The ocean is approximately 1 mile to the west, and tidal fluctuation effects can be seen at the mitigation site.

Interstate 8 is immediately to the south, open space riparian occurs to the west and north. A proposed city street is planned for the northeast corner of the site and several baseball fields are along the eastern edge.

The site design included willow, sycamore and cottonwood groves as well as more upland species at the higher portions of the site. A small island was created around existing riparian habitat at the mouth of a side pond just off of the mainflow of the San Diego River. The pond was excavated 8 feet lower than adjacent areas with steep slopes on three of the sides and a very shallow slope tapering into the willow woodland area on the east. Not all of the nine acre site was planted, and much of the site was left intact with existing riparian vegetation.

The Sweetwater River site is a two acre site downstream of California State Route 94, on the south side of the river. The site is long and narrow, and was excavated down 5 to 8 feet. Inland sage scrub plant community is on the south, and dense willow woodland is to the north. This stretch of the Sweetwater River is habitat used by the endangered Least Bell's Vireo. An existing electrical power line and its easement crosses the site which restricted the species and number of desired plants in the design. In addition, a one-eighth acre rocky outcropping was uncovered during grading which further prevented the amount of desired plants. As this site was in active use for illegal trash dumping, a five-strand barbed wire fence was installed to thwart such activities. While this has not prevented all pedestrian traffic, it has effectively eliminated vehicle traffic and significant refuse dumping.

## RESULTS

### The 8/15 site

This site was established in June 1982 and is the oldest of the three. The development of this site has been retarded due to several incidents. First the elevation levels used by the engineer were not correct, and the excavation was thus excessive and resulted in a final elevation that was approximately 3 feet too low. This has resulted in unexpected and frequent flooding even during minor storm events. This frequent flooding has removed the loamy soil and deposited sand in its place, and this has resulted in an almost total loss of the one gallon and a significant number of the five gallon size plants. Fortunately the 15 gallon size plants were staked and only a few individuals have been lost.

During the following year, to control Woolly white fly, the County Department of Agriculture determined that there was a need to remove the understory vegetative debris from the adjacent mature riparian vegetation. Regrettably, access to the area was gained by creating a road through the restoration site. The subsequent traffic compacted the soil and has retarded plant growth. It was not until the fourth year that there has been substantial plant growth in the road, and many areas are still bare.

While exotics have been present on the site from the beginning of the restoration, they are now retarding if not preventing a desired emergence of preferred species. The first exotics were included in the generalized seed mix, including four species of clover (*Trifolium*) and these dominated the non-tree flora during the first two years. Prior to the clover creating a dense mat there was a large population of Castor-bean, *Ricinus communis*. This was controlled by hand removal during site visits, and once by a California Conservation Corps crew. Large stands of giant reed frequently occurs along the San Diego River and its spread into bare newly graded or disturbed areas is a common occurrence. Following the onset of unexpected flooding, many clusters of giant reed (*Arundo donax*) became established from vegetative parts and now presents a control problem.

The cottonwood trees (*Populus fremontii*) which dominate the restoration design have grown approximately 5 feet per year. Fifteen gallon trees were between 6 to 8 feet tall at the time of planting, and after five years, they had increased to between 30 to 35 feet. Some trees which had fallen during the flood allowed the establishment of many trees along the length of the primary stem. This growth variation was encouraged and selected trees were buried to create a more heterogeneous appearance and less of a park-like aspect to the site. The slower growing sycamore, *Platanus racemosa*, has averaged a little less than 3 feet of growth per year.

It was anticipated that various ecological forces, such as water flow and root activity would modify the otherwise graded flat surface to create more microhabitat diversity, and thus, encourage an increase in plant diversity. A significant contribution to the important increase in microhabitat diversity, has been made by the fifteen gallon plants. Remaining erect even after the larger flooding episodes, these trees have provided obstructions that have trapped floating vegetative debris, thus increasing the deadfall and leaf litter on the site. The accumulated material has created small eddy spots, and these via localized scouring and deposition events have increased the topographic relief diversity. In addition, the shade provided by the larger trees has encouraged the establishment of understory plants which are not typically found in direct sunlight. However, after five years, several open, sandy and rocky areas still exist that are very hot and dry in the summer and fall. During the last two years, several small cottonwood volunteers have become established in these more open areas thereby tending to reduce the amount of bare area.

While a young restoration site typically lacks or is very poorly represented in leaf litter and deadfall habitats, a significant amount of the deadfall and litter present has been trapped during flood flows. As the cottonwoods and other trees begin to fill out and mature, more litter and dead fall will occur to help cover the current bare spaces between trees. Increased shade and understory plants will rapidly change the appearance of the site.

### Morena Street Site

This site near the mouth of the San Diego River was established in 1985. At the ocean terminus of the San Diego River watershed, the proximity to the ocean is thought to have influenced the development of this site by presenting a salinity problem for developing root systems thus reducing survival rates of desired species. The site is also subject to rapid and frequent river flooding. Flooding problems have been compounded by water sculpturing, resulting in a large shallow impoundment in the eastern portion of the site.

An additional negative factor has been the presence of a sewer line in the center the site, which has resulted in isolated voids in the plantings. Safety and other engineering restrictions required leaving the sewer pipe above ground area untouched and thus essentially unplanted along its length with the exception of small shrubs such as California buckwheat, (*Eriogonum fasciculatum*), and deerweed, (*Lotus scoparius*).

A small deep water pond off the San Diego River main channel occurs near the center of the site, which has a large stand of cattail *Typha latifolia* around the perimeter with a broader stand along the shallow eastern side. Eastward of this area numerous willow plants have volunteered among the regular one gallon plantings.

The western most parcel of the site was planted primarily with cottonwoods. This area was grubbed to remove the previous existing exotic vegetation. But, a failure to remove the seeds, roots and rhizomes has been very expensive in terms of supplemental and maintenance efforts and has also resulted in a reduced growth rate (an average of 1.7 ft per year). Increases in salinity, however, may have had an even more deleterious, as significant amounts of giant reed and other weeds have overgrown the less competitive plantings.

The southern parcel was not only planted in Sycamores, Cottonwoods, but also representative plants selected from Coastal Sage Scrub and Mixed Chaparral communities. The planting of these representative species was an experimental feature of the project to determine if the typical bare spots and areas, primarily due to hot and dry soil surfaces (atypical of riparian areas) could be prevented. It was hoped that these species would be able to provide a desired microhabitat regime by acting as an intermediate growth, which while at first well adapted, would then be reduced and eventually extinguished by increasing riparian species competition as the riparian growth per se expanded via increasingly modifying the hot and dry soil condition as the riparian growth itself expanded. But, the lack of grading on this parcel also resulted in an immediate lush growth of exotics dominated by garland chrysanthemum, *Chrysanthemum coronarium*.

A seed mix with a plantain, *Plantago insularis*, as the species of greatest interest was designed to help evaluate the effectiveness of a non-mechanical method of controlling weed species that frequently invade newly created restoration sites. This site was also used as a test for a plantain, *Plantago insularis*, as a ground cover and weed control. An application rate of 50 pounds per acre yielded varying percentage cover from 20% to about 90%. Areas subjected to fast moving flood waters and eventual ponding did very poorly, areas not exposed to these factors generally had denser clusters of the plant. The areas where plantain became established were graded and not just grubbed. The lack of an existing seed bed and roots encourage the establishment plantain, and at least in some areas, plantain populations significantly reduced or prevented objectionable numbers of weedy species originating from seed. Little plantain became established in ungraded areas with dense exotic populations.

### Sweetwater River Site

A two acre site planted specifically to replicate the habitat of the Least Bell's Vireo, the Sweetwater River site has had a mixed history of successes and unexpected discoveries. A very specific 404 permit from the U.S. Corps of Engineers required Caltrans to plant in densities and sizes to duplicate the then current knowledge of vireo habitat, and this the first time such habitat recreation had been attempted. Approximately 24,000 cuttings per acre plus container sizes were put into the site. Planting was in late April-early May, after unexpected delays resulting from administrative procedures and project construction timing conflicts.

While there was no intent to test storage methods, these delays led to new information about willow cutting storage. The various delays produced a situation in which if the supplier obeyed only a special contract specification that required that no more than 24 hours elapse between cutting collection and planting, the collection of cuttings taken too late in the season. The supplier, knowing that the delays would preclude both cutting and planting within specification constraints, collected some cuttings at the appropriate time of the year (which for San Diego, is January through early February) and then refrigerator stored the cuttings. After slightly more than two months storage the cuttings (which were at least 24 inches long and marked by using a different color sealant for latter identification) were planted along with cuttings taken after the desired time of season but, as required, planted within 24 hours of cutting.

At the end of the first growing season, the willows had grown to an average height of about five and one-half feet (ranging from 5 to 6 feet). While there was no significant growth differences between survivors, there was a highly significant difference in survivorship between late-season non-stored cuttings and early season refrigerator stored cuttings. Approximately 95% of the stored cuttings survived in contrast to only a 10% survival of late season cuttings that were not refrigerator stored.

Another species suitable for weed control and groundcover, is the everlasting cudweed, *Gnaphalium californicum*. A very good cover of cudweed was observed over most of the site. No documentation can be found of its being put on the site. It is likely that either the hydroseeding machine was contaminated or a small amount was added in error from some other job being done by the contractor.

Mature plant transplanting was explored as a technique for possible use in later mitigations by Caltrans. Twenty-two tree spade grabs were taken from the alignment of a new bridge on the Sweetwater River. Thirty-seven trees of *Salix gooddingii* and *S. lasiolepis* and a large shrub (*Baccharis glutinosa*) that would otherwise have been removed and discarded during bridge construction were moved onto a one-quarter acre portion of the restoration site. The trees ranged in height from 9 to 42 feet, with an average of 20 feet, and had a maximum diameter at breast height of 6.5 inches. The trees were watered after transplanting, and no other treatment (such as pruning, fertilizing et cetera) was provided. Wilting was observed during the first few days after transplanting followed by a return to pre-transplanting vigor, with no leaf drop or other noticeable effects. After two years only one transplanted tree has died.

As a result, it is concluded that transplanting mature willows, at least in this size and age class, by tree spade grab is effective as evaluated on the basis of mortality.

A supplemental planting was conducted in the spring of 1987 to compensate for the higher than expected mortality of late collected cuttings. Rooted cuttings were used to reduce the risk of further unanticipated losses. The density of planting was also substantially changed based upon habitat data which had been collected since the original planting program was designed. The supplemental planting, was scheduled to take place in early April, did not occur until late May due to construction problems and coordination tasks which required suspension of the existing contract.

When work was resumed, the slope created by excavating the site was planted with species typical of vicinity hillside slopes. While the slope has many of the topographical qualities of a hillside, it is located in the bottom of a drainage and therefore subject to freezing temperatures during the winter months, which was discovered later when the cause of death of the planted laurel sumac was determined. Unexpected and difficult to predict freeze prone areas is one of the problems encountered when engaged in restoration biology in coastal San Diego County.

## DISCUSSION

Despite various problems within and adjustments of the original designs, the three sites provide or show sound evidence that they will provide desired habitat values that did not exist before the planting programs. Although the

sites are not of the highest desired quality or at planned levels, indications are that plant growth and maturation will produce desired or acceptable levels for the 8/15 and Sweetwater sites.

### **Grading**

All of the restoration sites required grading to provide an acceptable planting elevation from the existing groundwater levels. The 8/15 site was the first restoration project conducted by Caltrans District 11 (District 11 includes San Diego, Imperial and the eastern two-thirds of Riverside counties). It was also the first site designed by the district biologist.

Miscommunication, differences of opinion, informed and otherwise, ultimate decision authority phenomena, and divisions of labor within Caltrans lead to some unacceptable design features specifications and design changes. Examples include elevation data used in developing grading plans and subsequent earthwork that precluded the objective. In this case, the resident engineer in charge of the interchange and restoration project did stop the grading and notified the district biologist. As a result, it was learned that a final site elevation is best determined by site inspection and not a reliance upon other information or data such as grading plans.

If a design is formulated based upon adjacent vegetation, topography, and location, due to microclimate irregularities, errors may occur unless it is known what the climatic conditions were when that vegetation was established. Unless grading plans require otherwise, the grading of restoration sites, will tend to have a very flat slope. This flatness is largely the result of grading equipment and "flat thinking" by both engineers and earthwork equipment operators. While such thinking has its engineering and economic values, it produces an atypical ecological component. As an example of problems that result from such grading, this flatness is very difficult to maintain without resulting in ponding, flat or slight slopes are easily disrupted by the deposition of even minor amounts of soil or debris. A more varied topography with channels and drainage patterns is preferred.

### **Contract plans and specification**

Precise and detailed plans are needed to obtain bids from potential landscape contractors, and under appropriate supervision landscape contractors can very efficiently install plants to meet horticulture standards. But, the establishment of a restoration site is not as predictable or sure as building a bridge or culvert, or as controlled as most horticultural conditions. Thus, restoration work requires adaptiveness and flexibility to maximize the chances for success. Two incidents illustrate this problem. One case was the specification constraint which called for willow cuttings to be taken no more than 24 hours in advance of planting—assuming, of course, that the collection of cuttings would be done at the appropriate time of year. However, the contract was late in starting because of unusual administrative procedures resulting in a two month project delay. As construction supervisors did not compensate for this change in the schedule, as the supplier of the material was still obligated to stay with the 24 hour specification, a risk factor was introduced. And due to unavailability it was far too late to change plant specifications to rooted cuttings. The second case was the delay in getting supplemental planting into the ground. This resulted from the suspension of the entire bridge contract of which the restoration work was a part. Following these events the practice has been changed to put revegetation projects on separate contracts when possible, a review of specifications immediately prior to project advertisement, and to then monitor project progress in case changes may be required.

### **Site restrictions**

Two sites had physical restrictions to the restoration design. While some of these restrictions can be identified prior to work, some restrictions, such as subsurface rock which can severely impact a design, cannot always be determined in advance without extensive soil coring. All three sites used were determined by Caltrans management on the primary basis of costs, convenience, and/or political expediency, rather than biological reasons. In contrast, of the three sites only the 8/15 site had acceptable restrictions from a biological perspective and would have been selected by the biologists.

### Groundcover Testing

Two groundcover species may be able to help in controlling the establishment of some exotic species. Continued testing of these and other species is needed in exploring ways to reduce maintenance costs and increase survivorship of desired species. The key in species selection may not always be a matter of native species versus non-native species, but the rate of establishment from seed compared to exotics may have to govern selection criteria as the specific situation may require.

### Growth rates

While growth rate information is highly desirable, not many restoration sites are being monitored. And, sites where monitoring has been required, the sites were only recently established and while the information collected, it has not been reported. Unusual circumstances exist where data is being collected but reports are not being written as the developer refuses to pay for the report preparation. As a consequence, there is a lack of comparative data, and growth rate information is primarily subjective. In the case of the three projects, the species planted seem to be responding in a similar way as nearby specimens of similar height except for the Morena Street site where there is believed to be some saltwater influence.

### Irrigation

All the sites were irrigated. The 8/15 and Morena Street sites were irrigated through the first summer and fall after planting. The Sweetwater site has been watered automatically and has been in operation for two years to ensure the survival of the extensive replacement planting. Due to the abundance of water the plants dropped roots to existing groundwater within the first growing season. The growth data collected from the Morena Street site indicates that growth is very limited during the winter and early spring, thus eliminating the need for watering during the time period before the plants can come out of winter dormancy and into the natural rainfall pattern period.

Irrigation is seen as a cure-all, and too much watering can be a problem. A site in Fallbrook (not a Caltrans project) has been heavily watered all summer maintaining near surface saturation. This has resulted in root systems near the surface, but not a depth needed to exploit normal water availability. Excavation of several the root systems revealed the deepest root of trees four to five feet in height was no deeper than 14 inches which is not acceptable for the site. Deep infrequent watering is a necessary condition to encourage deeper roots, a natural response of the plants to a falling available water level.

### Exotics

Exotics in restoration sites will be a continual problem especially in temperate southern California where climatic conditions so closely approximate the climate of origin for many non-natives. The lack of grading on portions of the Morena Street site led to the thick growth that occurred almost immediately following planting. Natural invasion will also be a continual management problem due to the abundance of propagules from adjacent vegetation and often water transport from over more distant areas during high rainfall periods. The flooding of 8/15 enabled the establishment of several isolated stands of giant reed and castor-bean. After five years the 8/15 site still has a weed problem, especially of giant reed. It is very important that these plants be controlled at the earliest possible time. In some cases chemical treatment should be considered. Properly applied, both *i.*Roundup; and *i.*Rodeo; has had 100% effectiveness in killing giant reed.

### Tree transplanting

Successful transplantation of *Salix gooddingii*, *Salix lasiolepis* and *Baccharis glutinosa* indicates that mature plants can be effectively incorporated into restoration designs. The cost of this technique should be evaluated against the

overall objectives of the restoration project. Results to date suggest continued experimentation with large specimen plants should yield more efficient and less costly techniques.

#### Habitat structure

A restoration site goes through many different phases of development. After initial planting and seeding, the site is mostly bare ground. Depending upon the design, trees and other plants may only be one to five feet tall and several feet apart. This condition results in higher soil temperatures, and greater rates of evaporation that encourage the development of undesirable species. But, as the desired plants mature, increasing shade encourages the invasion or establishment of understory species, until hopefully, the desired species came to dominate the site. This is a gradual process and may take several years. In the case of the 5 year old 8/15 site, the understory plants began appearing after the third year. The ability to create a closed or nearly closed canopy will control the rate, if not the rate and extent of understory vegetation on a site. Leaf litter and deadfall resulting from a closed canopy will provide valuable microhabitats in a riparian system. The paucity of these components can retard the "completeness" of a site. The moisture held by the leaf litter can aid greatly to the establishment of an understory and other important groups of an ecosystem (i.e., decomposers). A design strategy which may be helpful in establishing understory is to create spots of denser plantings. This can create an area which at the onset should be continually in shade rather than shaded for only a short period during the day. Another microclimate design option can be via a variable topography which will concentrate moisture. This variation in soil moisture will help provide habitat for the other ecosystems groups in the riparian ecosystem. The effects of this condition was dramatic on the 8/15 site where along the base of a slope, a dense concentration of willow and *Baccharis* plants has become established by volunteers and plantings.

The establishment of a riparian habitat is a complex operation that includes such factors such as elevation, densities, species composition, microdrainage, and contract specifications that both govern or affect the project all must come together in a coordinated effort if one is to maximize chances of success. Depending upon the maintenance commitment and the ability to do supplemental planting, the design may be over planted to compensate for an anticipated level of mortality. This was done on the Sweetwater site, but as discussed earlier, it was not expected to have as many problems and thus such a high overall mortality. Compounding this biologically difficult task are the problems associated with communication among individuals, divisions, and contractors involved in the creation of the restoration site. Not all contingencies can be anticipated, therefore it is extremely important to have personnel prepared, willing and able to make appropriate design and specifications changes quickly. While the landscape architect has many responsibilities in the development of restoration plans it is still absolutely necessary to have a biologist originate the key elements of the design, establish limitations and objectives, and also be actively involved in the development of the standard and contingency specifications. The biologists' responsibility and authority to respond as needed must continue with the implementation, especially if changes are required or anticipated during installation.

Much has been learned about riparian restoration from the three San Diego sites described. While still in the early learning process, many of the major problems have been identified and appropriate safeguards or procedures implemented. Site specific details are being tested at the present time.

But, much is still to be learned. Continued monitoring of these sites and of the future San Luis Rey river sites will add to our understanding of the approach and possible techniques for riparian restoration.