

RIPARIAN RESTORATION AND WATERSHED MANAGEMENT: SOME EXAMPLES FROM THE CALIFORNIA COAST¹

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Abstract: Managing and restoring watersheds often involves re-creation of riparian habitats. The natural functions of riparian forest natural to slow flood water, stabilize stream banks and trap sediments can be used in restoring disturbed creek systems. The State Coastal Conservancy's wetland enhancement program is preserving wetlands on the California coast through repair and management of watersheds. Examples from rural and urban areas illustrate how riparian restoration can be integrated into watershed projects.

The coastal wetlands of California have dwindled in acreage to one-fourth of their former extent. While much of this loss has come from diking, filling, and dredging development, indirect filling from sedimentation is a major problem. With the passage of the California Coastal Act in 1976, the direct filling of wetlands became severely restricted. However, indirect filling is a largely unregulated and ubiquitous problem involving large land areas, many government jurisdictions and all sorts of land uses.

What does the sedimentation of coastal marshes have to do with riparian habitats? There is a very direct relationship. The California State Coastal Conservancy through its efforts to restore and preserve coastal wetlands has had to look upstream into watersheds and stream systems to find the sources of sediment and reduce erosion problems. The following two examples demonstrate how the preservation and restoration of riparian systems helps protect coastal marshes and estuaries.

Buena Vista Lagoon

The Problem

Buena Vista Lagoon lies in northern San Diego County. Its small 20 square mile watershed is linear in shape; the upper half lies in the city of Vista and the lower half, as well as the lagoon, lie in the cities of Oceanside and Carlsbad.

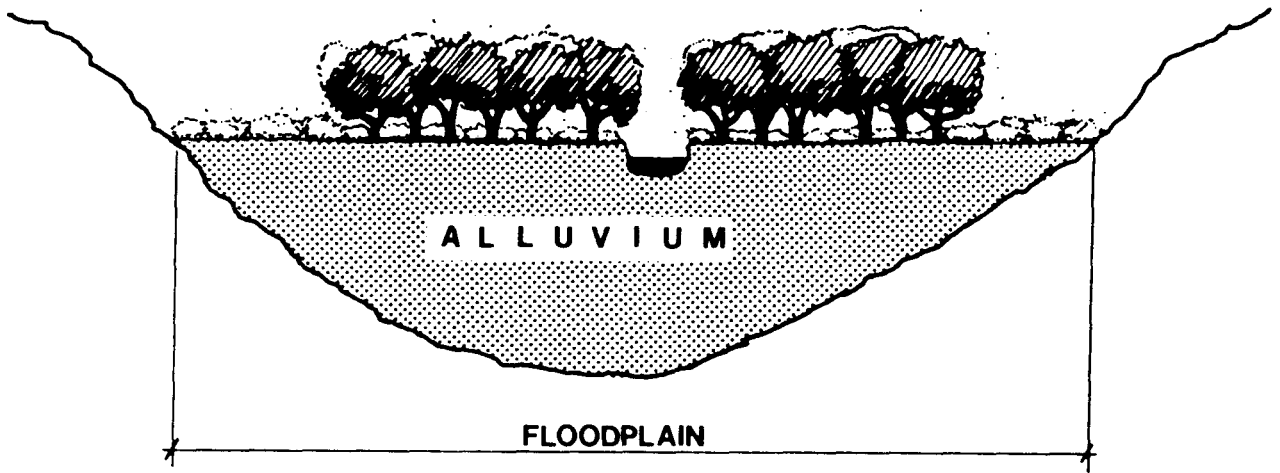
The lagoon originally was a tidal system which probably closed off from the tides during the summer months. The beach berm at the lagoon mouth, remained in its natural state allowing the lagoon to open and flush out sediment during winter floods. During the 1940's the basic hydrology of the lagoon changed – housing was developed on the beach berm, the lagoon mouth location was fixed and a weir was placed at the mouth. The weir created a freshwater lagoon and maintained a consistent water level in the lagoon for aesthetic reasons. Unfortunately these changes, combined with the construction of three road crossings in the lagoon, created a perfect settling basin for sediment.

Concurrent with these changes in the lagoon, the watershed was dramatically altered. The mainstem of Buena Vista Creek has perennial waterflow making an environment suited for dense riparian growth. The natural floodplain served to slow floodwaters and sieve out heavy sediments. The floodplain gradually builds up sediment protecting the lagoon from rapid filling. During the 1950's – 70's much of the Buena Vista Creek floodplain was developed with a primary focus on creek "improvements" – concrete channels to drain water as quickly as possible off the development site. These channels not only have no sediment retention qualities, they serve to greatly accelerate stormwater flow rates. In addition to altering the creek, development resulted in the paving of many square miles of the lagoon watershed. The overall effect of both changes was an enormous increase in the peak volume of stormwater and a loss of natural floodplain.

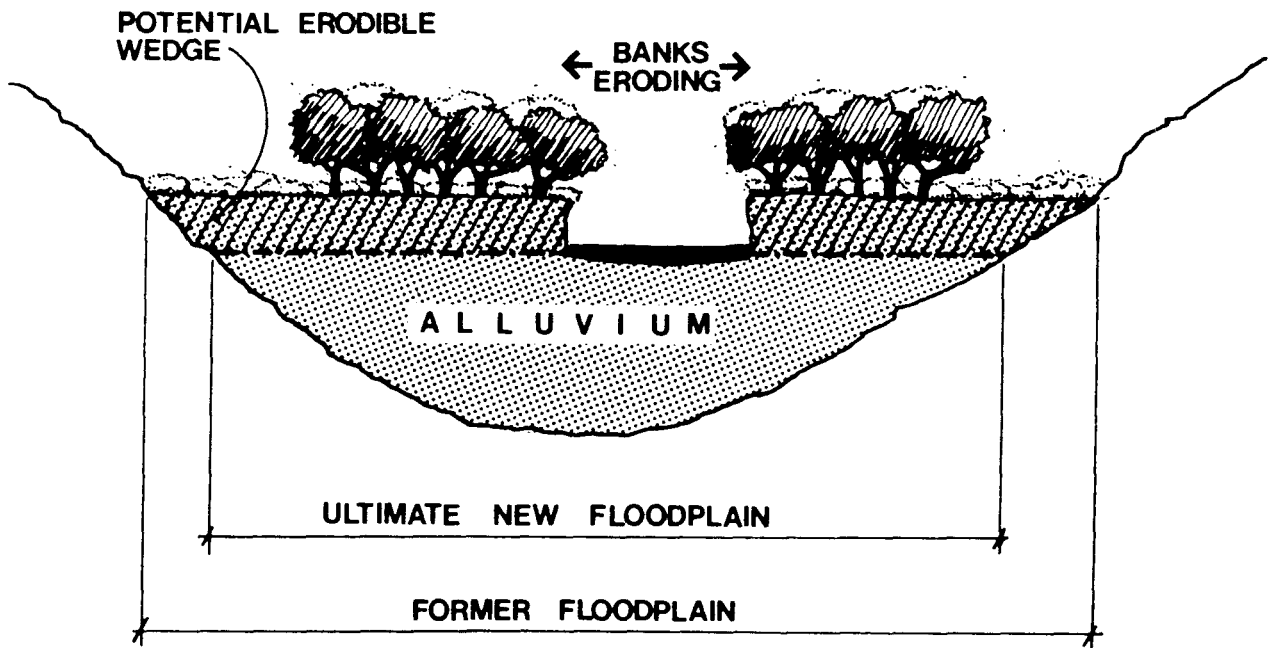
This dramatic transformation altered the hydrologic balance of the watershed. The increased volume of stormwater eroded a 20 foot gully in the channel toppling riparian trees and moving tons of sediment downstream. As the stream system attempts to regain a balance with this increased water volume, this gully will widen and deepen causing trees to be undercut and fall over. An arroyo will eventually form particularly if development progresses (Figure 1).

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AGGRADING STREAM
 SEDIMENT IN EXCEEDS SEDIMENT OUT



DEGRADING STREAM
 SEDIMENT OUT EXCEEDS SEDIMENT IN

Figure 1- Arroyo Formation.

In 1978-79, a series of large storms filled the eastern basin of the lagoon with sediment and brought an outcry from local citizens. The California Department of Fish and Game which owns the lagoon spent over one million dollars to dredge out the muck; however, the lagoon still retains much of the sediment it received.

Sediment Control Plan

Sedimentation-periodically dredge it from the lagoon, or find and correct the source of the erosion. The Conservancy chose the second option and has thus become involved in riparian habitat restoration. The primary reason for this choice lies in a rule of sediment transport/the quantity of sediment transported in a creek is an exponential function of the quantity of stormwater flow. Consequently, the greatest control of sediment into Buena Vista Lagoon can be achieved by reducing peak flows of stormwater. This concept was the product of a comprehensive watershed plan prepared by Applegate and Associates that involved extensive computer modeling and evaluation of cost-effective control measures. The Conservancy plan recommends two primary measures to reduce the cause of sediment movement-urban stormwater flows: detention of stormwater, and creek-restoration.

Stormwater Detention

Our studies showed that increased urban peak storm flows had dug a 20 foot deep gully in Buena Vista Creek. This massive hole was a primary source of sediment to the lagoon. If no changes were made complete build-out of the watershed would cause further down-cutting and widening of this gully with loss of riparian habitat and rapid filling of the lagoon.

The plan recommends the construction of several large stormwater detention basins in the watershed. These basins consist of a small dam or a road crossing with a restricted outlet. The basin allows water to pond during storms and to be slowly released. The computer model showed installation of these basins alone would produce an estimated 20 percent reduction in sediment deposition in the lagoon.

Creek Restoration

The model for the plan predicts the most cost effective way to lower storm flows to restore those areas of remaining unimproved creek to function as a natural floodplain. The basic idea is to rebuild the creek to a fully vegetated channel with a series of drop structures which create small hydraulic drops and slow water flow. The natural function of the riparian forest in slowing water is used and the acreage of riparian habitat increased throughout the creek corridor. Because portions of the remaining creek channel cross developed

areas, the channel dimensions must be reduced and the side slopes made relatively steep (2:1 and 3:1). The installation of the detention basins is an integral part of the creek restoration. The flood flows would be lowered enough by the basins to allow for a fully vegetated channel in a confined area (Figure 2). The width restriction requires use of dense plantings of tree species over the entire slope using an irrigation system. The engineering design also incorporates a high channel roughness coefficient so that the channel bottom may be planted and maintained with tree species. Channel maintenance will involve hand cutting of trees over a certain diameter; no dragline work in the channel is envisioned. While this maintenance scheme may seem excessive, it is the only way to have the channel continuously slow stormwater. Were half the channel to be drag-lined, the hydraulic characters would be changed and waterflow would accelerate, diminishing the channel's intended purpose. The model for the plan predicts that the combination of the detention basins and creek restoration could reduce sedimentation to the lagoon by 45 percent (Figure 3).

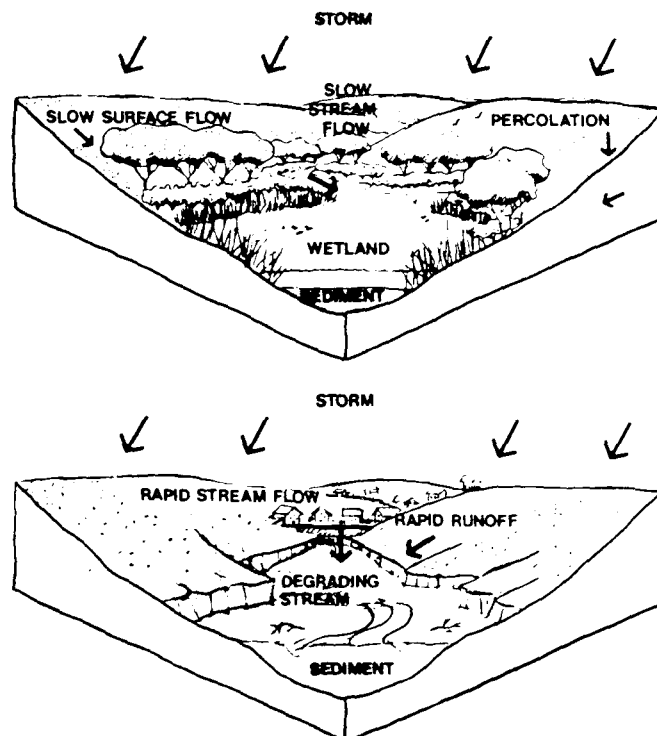


Figure 3— Comparison of a natural watershed where water flows and sediment are in balance and an urban area where impervious surfaces cause increases in water flow, upsetting the balance and resulting in sedimentation of the wetland and loss of riparian forest.

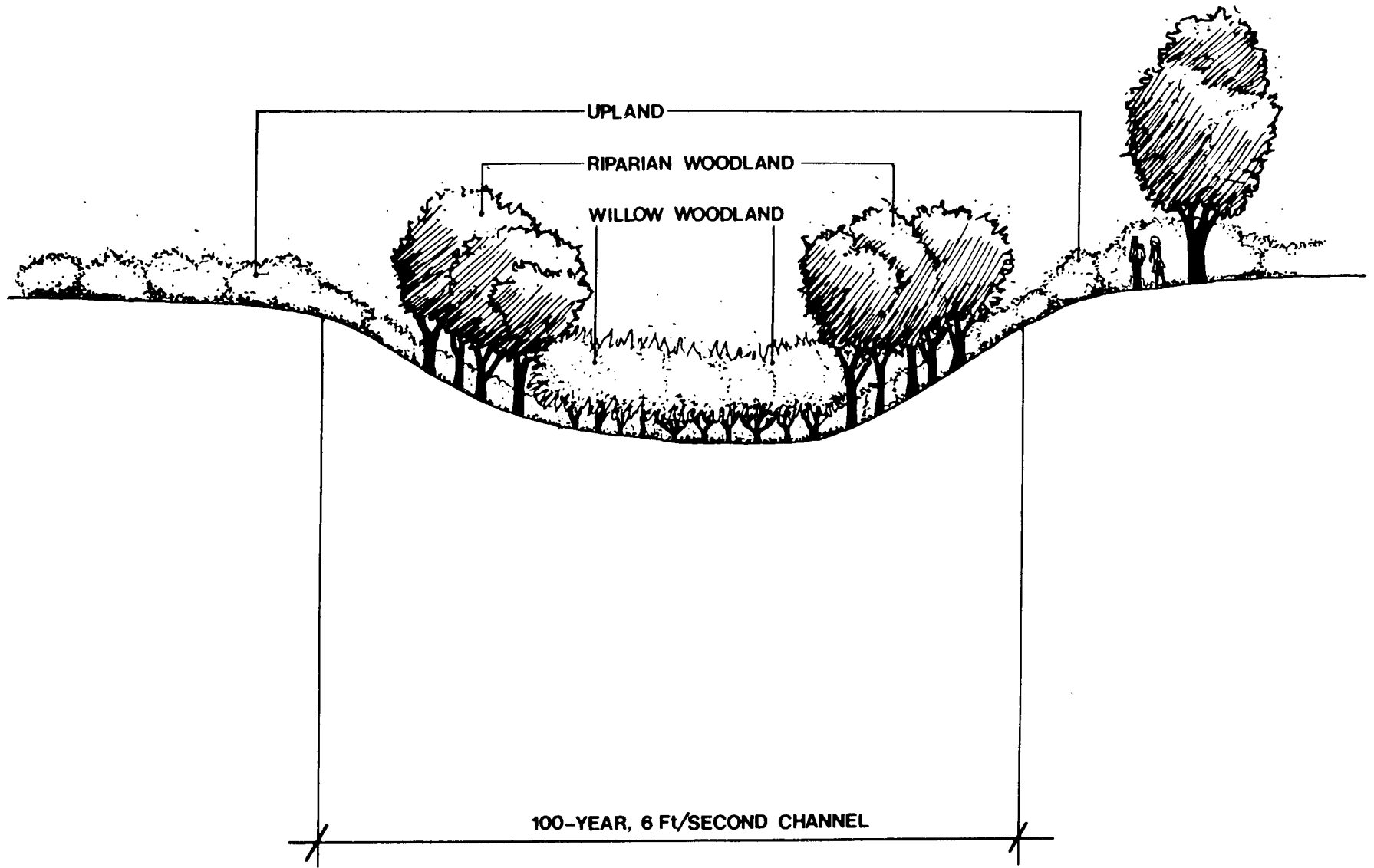


Figure 2— Cross Section of Proposed Enhanced Buena Vista Creek Channel

This channel design is revolutionary and downright frightening to many civil engineers used to the standard trapezoidal cement channel. The mathematical calculations inherent in this design are complex and use the current state of the art in hydraulic and hydrologic modelling. But this design will serve as a model for many of the surrounding communities whose waterways and wetlands suffer the same problem. In addition, the local government intends to re-develop its downtown facing onto this green corridor, an encouraging trend.

A final recommendation of the plan is to preserve a large riparian forest along the lower creek near the lagoon. Preserving natural floodplain even when it involves expensive acquisition is a more cost-effective sediment control measure than dredging and disposing of spoils from the lagoon.

The Conservancy is currently implementing the plan recommendations by having detailed creek designs prepared in conjunction with the city of Vista. Several of the detention basins have been built or are under construction. The local government has cooperated in using this vegetated channel design largely because of the permit requirements of the Army Corps of Engineers and streambed alteration agreement Terms of the California Department of Fish and Game requiring riparian mitigation.

The Conservancy intends to maintain highly accurate records for design, construction, and maintenance costs for this channel for comparison with standard hard lined channels. Through the implementation of this plan the life of Buena Vista Lagoon will be extended by at least a hundred years, and Buena Vista Creek will become a restored riparian habitat.

Tomales Bay

The Problem

Tomales Bay is one of the largest estuaries in California. Its 223 square-mile watershed is composed of agricultural land, dairies and cattle ranches. However, despite the differences in land use, the Tomales Bay watershed suffers from many of the same problems as that of Buena Vista Lagoon. The two primary tributaries, Lagunitas Creek and Walker Creek, have filled Tomales Bay with tons of sediment and the deltas of these creeks continue to grow at the rate of 35-50 feet per year (Figure 4). The source of this sediment can be traced to historic and present land uses.

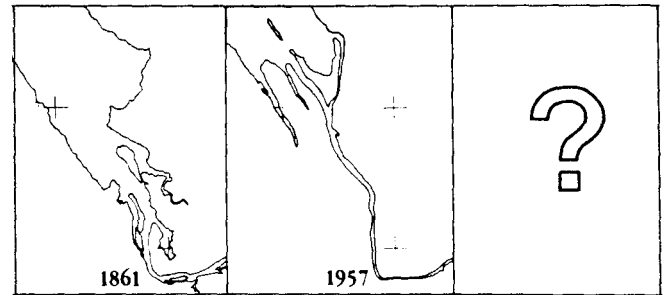


Figure 4— The Lagunitas Creek delta progressively stretches into Tomales Bay at the rate of 50 feet a year.

In the last 200 years, the Tomales Bay watershed has undergone a number of significant changes. When the first Europeans arrived, its watershed was largely native grassland with some tracts of redwood forest oak woodland and many streams lined with riparian forest. The thick rooted native perennial bunchgrasses stayed green year round and created a thick mulch over the soil. The Spanish first introduced cattle to Tomales Bay in the early 1800's. The American influx to California brought dairy farms, sheep grazing, and potato farms. By the turn of the century, intensive grazing had practically eliminated the native grasses. Introduced annual grasses from southern Europe, North Africa and Australia, were adapted to heavy grazing and replaced the native prairie.

The displacement of native perennial grasses has had a major effect on the hydrology of the watershed. The dense perennial grasses screened the soil from surface erosion and provided a dense fertile mulch which retained moisture. Annual grasses do not provide as much erosion protection; the mulch washes away and the soil layer becomes thinner and less productive. These changes result in greater surface runoff during storms, higher soil erosion rates, and less storage of water in the soil. Higher peak flood flows occur during winter storms eroding channels and under cutting riparian forest. Summer flows in creeks are lower reducing the ability of riparian species to survive and recolonize denuded areas. Through time, the form and structure of the streams feeding Tomales Bay has significantly altered.

Historic and continued activities that have contributed to the accelerated erosion of the watershed include:

- Livestock trampling of streambanks and grazing of riparian seedlings has denuded many streams and caused streambank erosion.
- Extensive logging began in the 1860's, which exposed the soil to direct erosion and thinning of the soil

mantle, as well as initiated landslides on steep slopes. Such landslides can remain active for long periods and contribute very high volumes of sediment to stream courses.

- Extensive potato farming occurred in the Tomales area during the late 1800's. Tilling of the soil for crop cultivation caused a major increase in surface erosion.
- Poorly located roads often initiate landslides, improperly designed road culverts frequently cause the formation of gullies.
- Overgrazing loss of native grasses and compaction of soils increase the rate of water runoff resulting in increased peak storm flows. These increased flows have caused severe arroyo formation along Walker Creek with nearly complete loss of riparian habitat.
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If current sedimentation rates continue, the tidal volume of Tomales Bay would be reduced by 10 percent over the coming 50 years. This would be a significant amount in terms of the physical size of the bay.

Erosion Control Plan

The Conservancy, working in conjunction with the Marin County Resource Conservation District, a local agency which undertakes soil erosion control projects, completed erosion control plans for the two main tributaries to Tomales Bay. As with Buena Vista Lagoon, the expense of removing accumulated sediment from Tomales Bay, far exceeds the cost of controlling the sources of erosion. Consequently the Conservancy has focused on repairing the causes of erosion, a task which involves extensive riparian revegetation. These plans surveyed each subwatershed, mapping erosion problems and their prospective repairs. The Conservancy has granted over \$1,200,000 dollars to implement these plans.

Lagunitas Creek, which drains the southern portion of the watershed carries large sediment loads. Its watershed includes some agricultural land, state park land and many rural residential developments. Sediment comes from inadequately drained roads, gullies, streambank failures and intensive uses such as horse corrals next to the creek.

Walker Creek, which drains the northern portion of the watershed, is almost entirely agricultural land. Erosion occurs in the channel itself; the creek is wide and braided with 15 foot vertical banks and limited riparian forest, despite year-round releases from an upstream

reservoir. The Walker Creek watershed also shows highly compacted soils, numerous large gullies and roads with inadequate drainage.

Repair of many erosion sites has involved a great deal of riparian revegetation often combined with structural stabilization measures. In many instances water flows or erosion problems are too great to be stabilized with plantings alone; rock or other hard surface stabilization is required to accompany plantings.

Repair of large gullies, which can erode tons of sediment in a single storm is a major component of the plans for both creeks. Gully repairs typically consist of rock, concrete or redwood checkdams-small structures which produce a staircase of small hydraulic drops within the gully and significant slowing of water flows. Once the water is slowed and its erosive force lowered, each stair step fills in with sediment. Willow sprigs are planted along side walls and headcuts. Willow can grow in near vertical areas and is easy to establish. The gully is then fenced to exclude livestock so that riparian plants can get a firm hold. Often road repairs accompany gully repair as inadequate road drainage or poorly located or graded roads can cause gullies to form. Riparian vegetation alone can be used to stabilize smaller, less incised gullies.

Streambank stabilization and revegetation, is a major component of the program, on Walker Creek the it there it will be a three-step-process. Until the problem of increased peak stormflows is solved, riparian vegetation along the creek will continue to be undercut and wash away. The easiest way to slow channel downcutting may be the installation of large concrete checkdams (grade stabilization structures) which produce a hydraulic drop and slow water as do small checkdams. These checkdams will be located in the upper tributaries. Along the lower portions of the channel rock riprap bank stabilization combined with riparian plantings will be used. Simultaneously, range management plans for ranches in the watershed are being discussed with landowners. The purpose of these plans is to alter the concentration of livestock on already compacted soils through cross-fencing of pasture, development of additional water supplies, fertilization planting of native bunchgrasses and year-round rotation of livestock. If overall vegetative cover can be increased through these measures the stormwater percolation may increase and peak stormwater flows be reduced. Once the erosive problems along the creek are reduced, intensive planting and exclusionary fencing can begin. Establishment of a thick riparian forest will be aided by the year-round flow of water and should greatly help to stabilize steep banks and reduce sediment deposition in Tomales Bay.

Since the completion of the Lagunitas Creek restoration project in 1986 our monitoring has compared the

many different types of repair measures installed. Many of the most successful repairs combine some structural control measure (small checkdam rock riprap) and planting. Deep incised gullies are now forests of willows and Tomales Bay receives less sediment. The repairs on Walker Creek are in their third year and are expected to take another three to four years to complete.

Conclusions

The State Coastal Conservancy through our mandate to preserve and enhance coastal wetlands in California has become involved in extensive restoration projects in coastal watersheds. Our studies and experience have found that repairing the sources of erosion is a more cost effective strategy than attempting to dredge sediment from the estuary or wetland. The repairs cited in the two examples involve stabilizing the stream system using riparian forest and limited structural control measures. Watershed management and use of the natural function of riparian forest to slow water and trap sediment is a new strategy in preserving coastal wetlands. As the Conservancy continues to implement these types of projects this strategy will benefit both the riparian and coastal wetland resources.

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