COMPREHENSIVE WATERSHED MANAGEMENT SOLUTIONS TO NONPOINT SOURCE POLLUTION IN THE SALINAS VALLEY & PAJARO RIVER BASIN

State Water Resources Control Board - 319h Grant
Final Report

WATERSHED INSTITUTE
CALIFORNIA STATE UNIVERSITY MONTEREY BAY
MOSS LANDING MARINE LABORATORIES
November 1997

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Prepared for:

Central Coast Regional Water Quality Control Board
1995 319h Grant Contract #5-069-253-0

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Preface

The FY 1995 319h grant has successfully supported Watershed Institute initiatives to obtain and restore Salinas Valley wetlands which re-establish important ecological functions, including the control of non-point source pollution (NPSP). These restoration activities have encouraged the development of working relationships with the other interested groups in the region including the Natural Resources Conservation Service, NOAA's Water Quality Protection Program, the EPA, the Watershed Initiative of the State Water Resources Control Board and Central Coast Regional Water Quality Control Board, and Sustainable Conservation. These relationships will further the efforts to manage and restore Salinas Valley watersheds by developing partnerships and agreements to coordinate regional programs and ensure the most effective use of limited financial resources.

The first quarter report for the 319h grant focused on restoration site planting activities and water quality monitoring results. The second quarter report focused on planting activities and plant survival, progress in securing long term restoration site agreements, and developing positive incentives programs. The third quarter report reviewed restoration activities on a site by site basis, reported additional steps toward achieving a regional restoration model and presented future restoration plans of the Watershed Institute. In addition, the third quarter report reviewed new funding sources which will bridge the gap between demonstration projects begun by this grant project and regional restoration activities proposed in the 1997-98 319h grant. This final report will provide an overview of the partner 205j restoration plan for the Salinas Valley and review all activities and data produced throughout the grant period.

Introduction

The Salinas Valley

The Salinas River and its surrounding watersheds have been heavily impacted by agricultural and urban development. Thousands of acres of natural wetlands have been filled and ditched, reducing water quality, flood protection, and the ground water recharge necessary to forestall saltwater intrusion; the most severe and pressing environmental problem in the Monterey Bay. After saltwater intrusion, non-point source pollution (NPSP) is the most important environmental problem in Monterey Bay and throughout much of the state (Stephenson et al 1980). Agricultural lands which use fertilizers and pesticides to maintain profitability, are associated with higher levels of NPSP in adjacent waterways than any other landscape in the state (Watkins et. al, 1984, Ladd et. al, 1984). Within the Salinas Valley, farm chemicals drain into a ditch system which empties directly into the Monterey Bay National Marine Sanctuary. Urban runoff also contributes to NPSP and is becoming a greater issue around the City of Salinas. Reversal of these problems and restoration of the watershed should result in the re-establishment of historical benefits including freshwater wetland filters, a high level of biodiversity, and land owner buy-in.

The goals of this program are to reduce NPSP using restored or created wetland and

riparian habitat as water quality management areas (WMA), which involve low-cost, highly effective ecological engineered watershed restoration techniques reviewed in the complimentary North Salinas Valley watershed restoration plan (AMBAG 1997). Significant improvement to water quality in the Monterey Bay area can be accomplished by restoring the historic drainage system through re-establishment of natural hydrology and vegetation (AMBAG 1997). The entire wet corridor from riparian habitats to low marshes, ponds and fringing natural habitats will act as WMAs. The project is part of a comprehensive and adaptive watershed management plan where implementation and planning proceed together, and are integrated with public education and monitoring.

Use of Demonstration sites

The Watershed Institute has initiated restoration activities in the Pajaro, Moro Cojo and Salinas watersheds, working with various types of land owners to restore and enhance local wetland habitat. The intent of demonstration sites is to document the success of using restored native wetland habitat to enhance water quality and flood protection in ways which benefit the private land owner. Restoration activities have been pursued in drainages adjacent to dairy, agriculture and grazing lands, on city and county land, federal land, and on private residential parcels; all directed at increasing native wetland habitat and water quality by returning degraded drainages to a more natural state. The success of restoration activities will be shared with other local land owners to increase their understanding and participation in restoration activities. Information gained from the monitoring of these sites will better help to adapt restoration techniques to the needs of land owners and requirements of the landscape. Once the success of restoration activities on individual land parcels is well documented as an accepted Best Management Practice, regional application of such techniques will be easier to support.

The Watershed Institute

This 319h grant has supported the restoration activities begun by Moss Landing Marine Labs. Through support of the Regional Water Quality Control Board (205j and 319h grants) and the Department of Defense, the Watershed Ecological Outreach Program (WEOP) at Moss Landing Marine Laboratories has grown into an integrated institute within the Environmental Systems Science and Policy (ESSP) department of the newly formed California State University Monterey Bay. This transition from a restoration group to The Watershed Institute has allowed us to realize the full intent of comprehensive restoration activities. The comprehensive restoration activities of the Watershed Institute include on-ground restoration of local wetlands, restoration education at grades 1-12 and College, restoration monitoring and research projects, and initiating local and state policy changes. All activities performed by Watershed Institute staff are crucial to the long term management, enhancement and restoration of the Monterey Bay area watersheds.

Through work of the Watershed Institute and work partners, the Return of the Natives (RON) and Creative Environmental Conservation (CEC), these demonstration projects

have become community centers for teaching and environmental education, local native species diversity centers, a gateway to the higher education system of CSU Monterey Bay, and a successful CSUMB service learning program. A Watershed Education Scholarship through the ESSP science department has been developed to encourage student participation in restoration programs. The progressive goals and directives of the Watershed Institute have ensured public buy-in and stewardship of their local restored wetland habitat. This grant, in addition to restoring over 40 acres, has planted the seed for sound watershed planning and restoration throughout the region and is directly linked to ongoing restoration efforts on over 100 additional acres as well as hundreds of acres in the negotiation process. All areas were selected as key demonstration projects and strategically partnered to expand wet corridor restoration throughout the watershed.

It is clear from the Watershed Institutes early success that coordinated efforts between land owners, policy makers, scientists, students and agency staff are crucial to improving the local water quality and wetland habitat. The Watershed Institute plans to continue instigating restoration projects which increase wetland habitat and public buy-in.

Planning Restoration Activities in the Salinas Valley

An historical wet corridor map of the Salinas Valley (Fig. 1) has been produced as part of the 1995 AMBAG 205j planning grant to help direct restoration activities. Historic creeks, sloughs and lakes of the lower Salinas Valley have been recreated as an overlay (GIS layer) of a recent geo-rectified infrared photo (base layer of Fig. 1). Information from this map layer is based on the historic "Map of drainage areas in the vicinity of Salinas, California" by Lou Gare, Civil engineer, City of Salinas, 1906. Additional information of historic and present drainage patterns was gained by studying water flow during the 1995 flood, documented by infrared and land based photos and reported in the 1995 Watershed Institute Flood Report. Water flow during the 1995 flood revealed information on the historic drainages better than most maps. The first step in restoring wetlands and riparian corridors is to identify the historic wet areas and review historical drainage patterns.

Present drainage conditions (Fig. 2) reveal the large loss of wetlands in the Salinas Valley. Land adjacent to these drainages however remain primarily in use for agriculture or grazing purposes. As land use changes, there is still great potential for restoring vast amounts of the historic drainage system.

The Northern Salinas Valley Watershed Restoration Plan (AMBAG 1997) identified specific areas to direct future restoration activities (Fig. 3), based on current and historic water drainage patterns, adjusting this coverage for those present land uses which

prohibit possible restoration activities. These present land uses include urban, commercial, and agricultural development, river levies, and permanent drainage diversions. The development of this drainage plan can direct where future restoration sites are located and to direct future urban development away from restorable wetland areas with high flooding potential. This plan is not intended to direct aggressive actions toward present land owners, but to identify land which has significant restoration potential and help direct basin management plans toward including watershed restoration as a Best Management Practice.

Watershed Restoration Plan Excerpt from North Salinas Valley Wetland Restoration Plan (AMBAG 1997).

The historic wet corridors of the lower Salinas Valley (Fig. 1) included a broad riparian corridor along the Salinas River, old river channels harboring dense marshes like San Jon Slough (Blanco Drain area) and Alisal Slough; and a series of lakes, marshes, and riparian habitats from the Moro Cojo Slough to the City of Salinas. The Tembladero Slough connected most of these lakes and flowed seasonally as a creek supporting salmon and steelhead runs on many of its tributaries (Fig. 1). This dynamic watershed was ditched, diked and drained many decades ago (Gordon 1996, Fig. 2). Goals of the restoration plan are to return portions of the Salinas Valley to a functioning creek and wetland system supporting many native plant and animal species and improving water quality by filtering pollutants (Fig. 3).

The restoration plan for these wet corridors must work within the physical constraints and existing conditions in the valley. With this information, a GIS guidance layer has been produced to direct future restoration projects (Figure 3). The Watershed Institute has been most effective at restoring wetland and riparian habitat by working site by site in cooperation with the land owners (Fig. 4). Positive incentives for restoration are already working on lands with lower economic value. The restoration plan first targets the wetland areas used for grazing and fallow farm land in the Moro Cojo Slough (Fig. 5) and secondarily the riparian corridors than drain grazing land along the valley hillsides. No implementation can proceed without land owner permission (see land owner agreements).

Major Restoration Tasks

Watershed Institute restoration projects are currently in progress throughout the Salinas Valley. Each restoration project follows an order of tasks to ensure success. The most difficult and important task is developing an agreement with the land owner to restore a portion of the property. To secure an agreement with the land owner, the goals of the project and positive incentives for restoration must be outlined. Specific restoration activities to take place are also developed at this juncture as outlined in the local restoration guidance documents (Moro Cojo Restoration and Management Plan 1997, Natividad Creek Park Restoration Plan 1994, AMBAG 1997).

Once restoration activities are outlined, on the ground restoration is begun and include

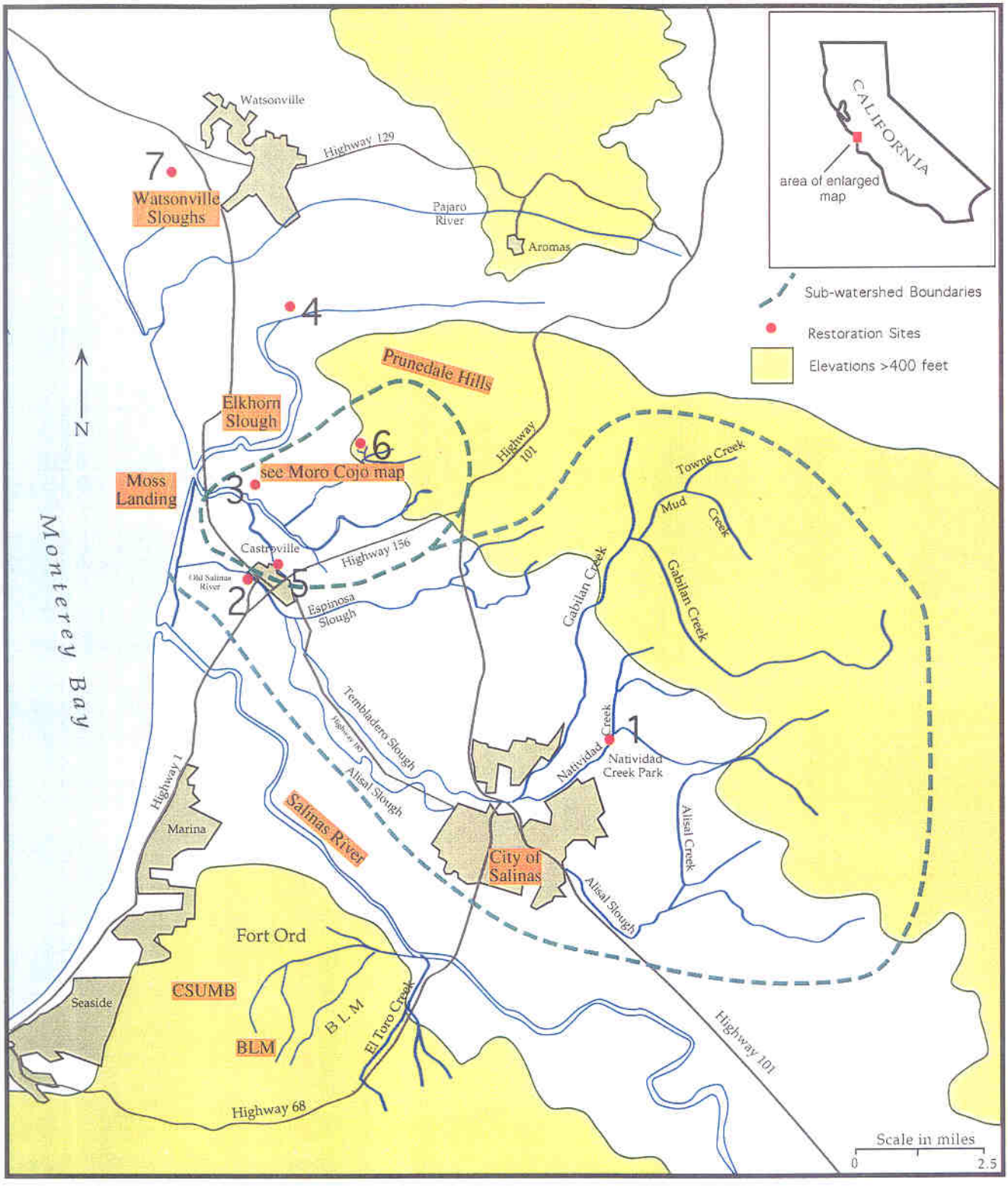


Figure 4. Location of current restoration sites.

#1 Natividad Creek Park
#2 Mo's Tembladero
#3 Moon Glow Dairy
4 Porter Ranch
#5 Castroville Slough/Chapin
#6 Walker Valley
#7 Hansens Slough

Figure 5. Targeted sites in Moro Cojo Slough for future restoration.

land form and hydrology modifications, weed control, and native plant establishment. To determine if the goals of the project are achieved and all restoration activities are successful, a monitoring program is begun at the onset of the project. Aspects which are monitored include improvement to water quality, native plant survivorship and growth, plant succession and weed control, and animal use patterns. The goals of the monitoring program are to assess restoration success and identify problems with restoration activities to help guide future efforts.

Land Form Changes

The first on-the-ground task is modifying land forms to a more natural state allowing water to flow over low, broad areas and create ponds whenever possible. Existing channelized areas have been modified by placing hay bales, sediment, and wetland plants within the channel to divert water, creating broad, shallow wetland areas. In areas where water must remain within the drainage channel, the edges of the ditch are graded to a gentler slope and the sediment deposited in an earthen berm set back from the area targeted for restoration. The result is a significant increase in channel volume and much greater flood protection for the adjacent land with berms stabilized against erosion by planting native plants. The greater channel volume of this broadened channel system increases surface water retention, ground water recharge, flood storage, water quality, and biodiversity.

Non-Native Weed Control

The need for non-native invasive weed control varies considerably with different land use practices and with duration of standing water on a site. In general, invasive weed control is easier in wet areas in comparison to adjacent upland habitats. There are two common invasive plant categories in the wet corridors: large herbaceous plants and annual rye grass. Both groups can be reduced by mowing and herbicide application. The most common herbaceous plants are non-native species including poison hemlock, wild radish, and mustard. Mowing is timed to minimize seed production in the non-native species which have the highest negative impact on colonization of native flora. Hemlock, when abundant, is always the first species targeted. This species forms a tall, dense mono-specific stand and is an aggressive colonizer of newly disturbed sites. Wild radish and mustard can form similarly dense, mono-specific stands and are rapid invaders. Control of invasive plants is rarely successful without replacing them with native species. Otherwise, the removal of one weed is followed by the colonization of another. When weed control activities are timed correctly, non-natives can be minimized while encouraging native plant establishment.

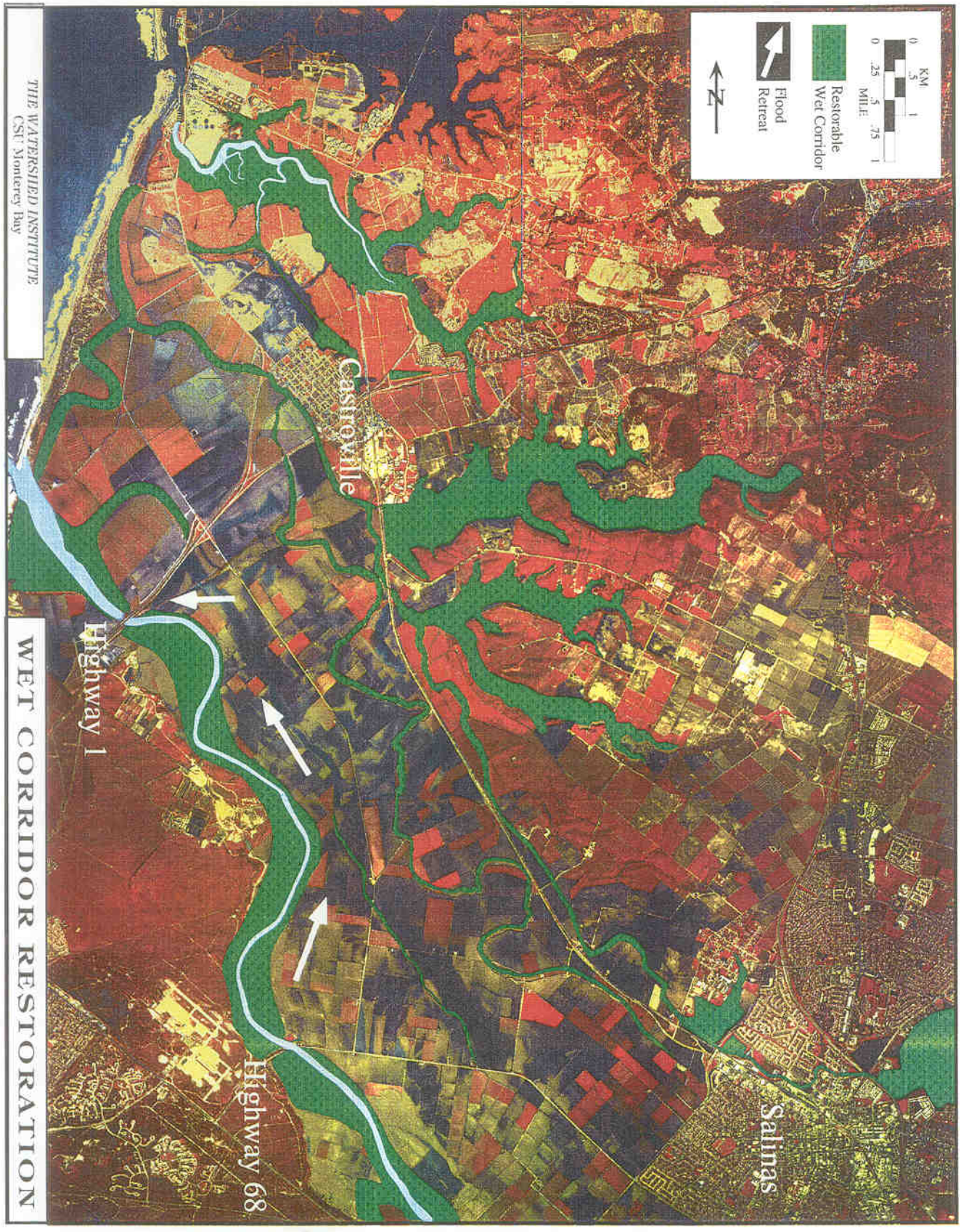


Figure 3. Targeted sites for future restoration. Identification of all possible restorable drainage areas of the Salinas Valley not impacted by permanent landuse practices (roads, housing development, etc.).

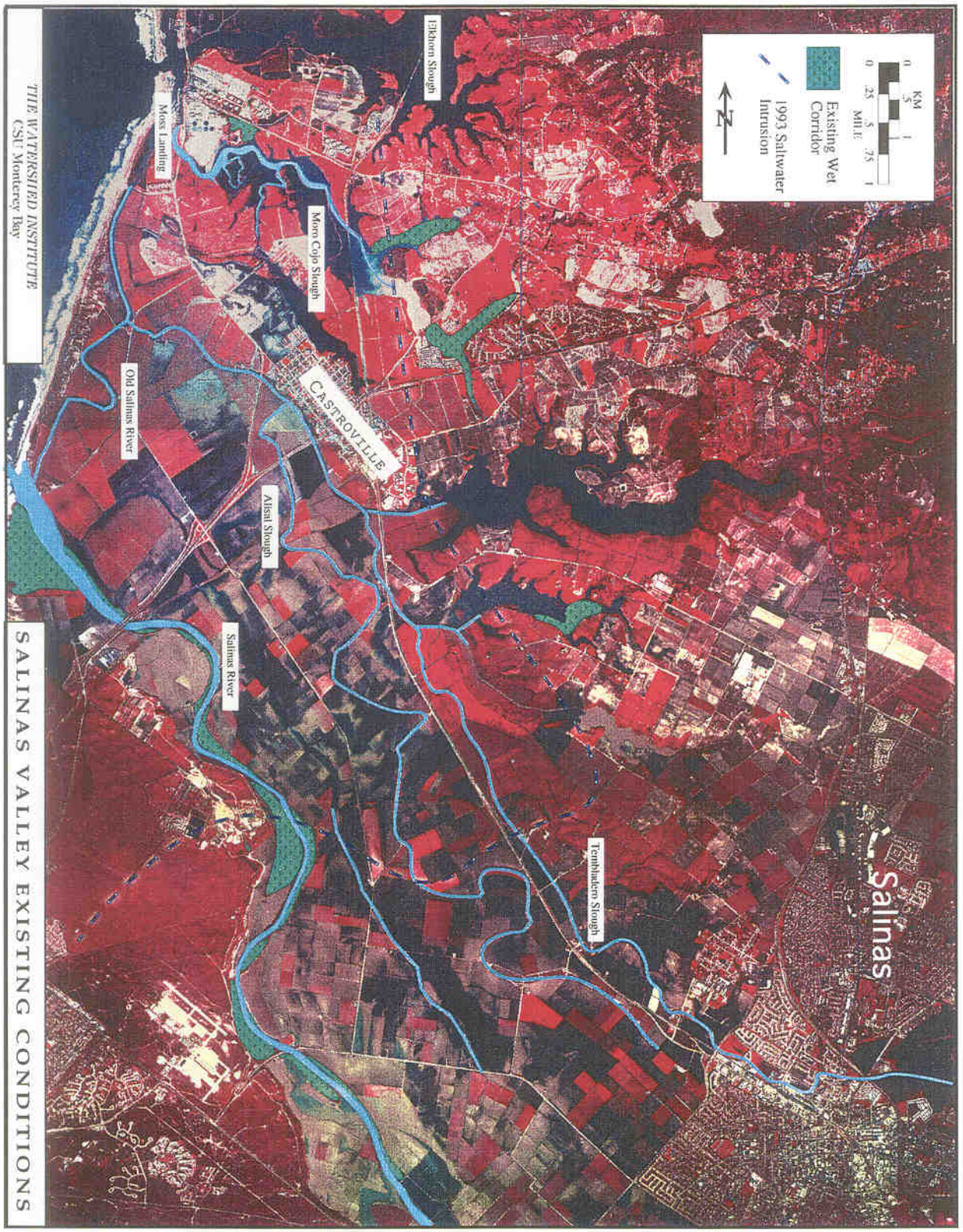


Figure 2. Existing conditions of wet corridors of the Salinas Valley.

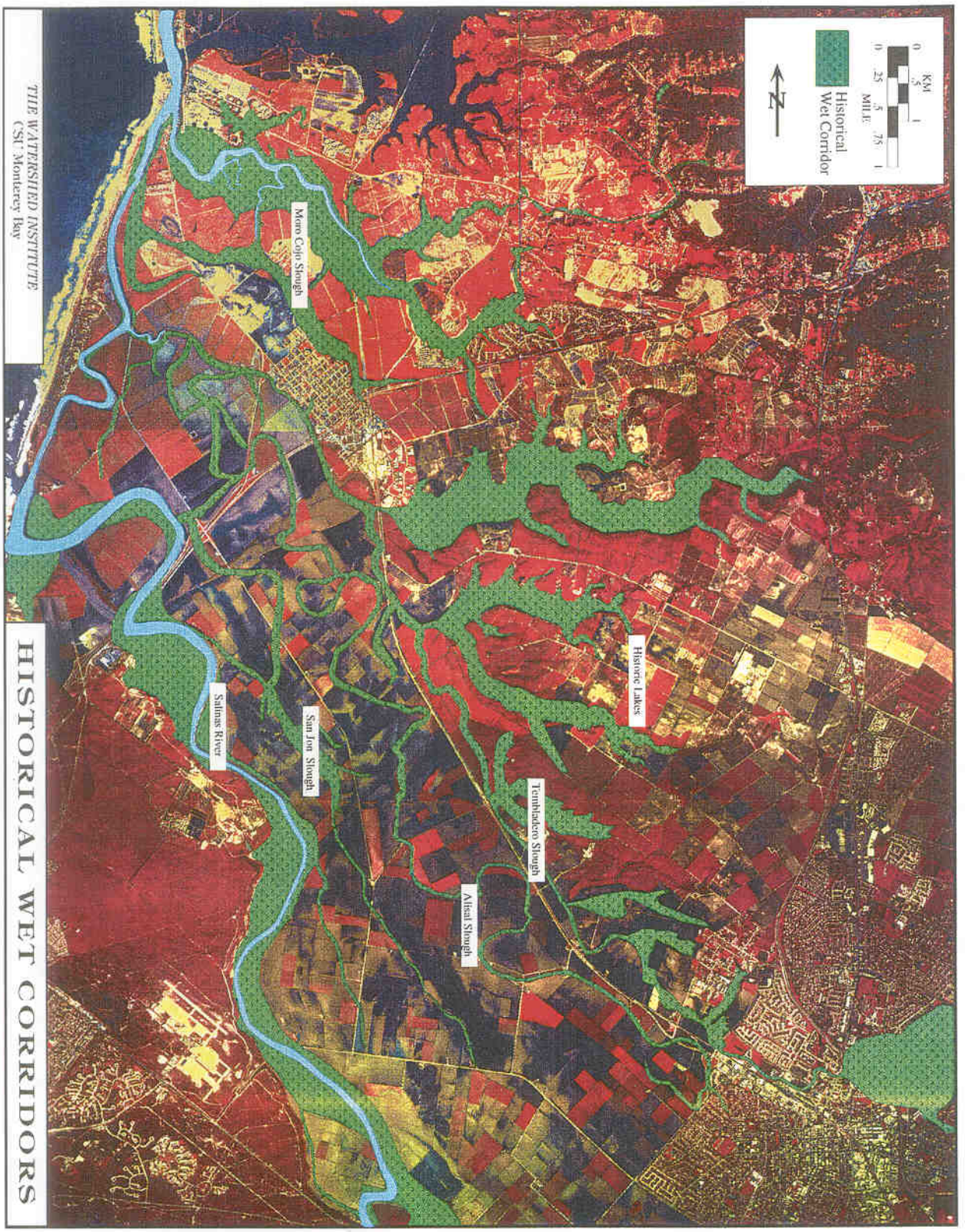


Figure 1. Historical Wet Corridors of the Salinas Valley.

Native Plant Establishment

The best method of establishing native plants is to mimic natural systems. This begins by spreading seeds of both early and late successional species, which will replace the exotic invasive species. In addition to broadcasting or drilling seeds, restoration sites are planted with a mix of native trees which usually include species of willows, cottonwoods, sycamore, maple, elderberry, creekside dogwood and several species of willow. These are often irrigated by drip lines or water truck during the first year after planting. The riparian trees grow to form a tall dense canopy within five years. Their large canopies shade out most invasive non-native weeds, and are thus another weed control strategy. Other native species planted from nursery stock include sedges, rushes, and grasses such as creeping wild rye and salt grass which spread rapidly from established root stock. In general, invasive non-native weed control and native plant establishment occur together to shift the plant community to native early successional species. A comprehensive restoration plan was prepared by the Watershed Institute for the Natividad Creek Park Restoration Plan (1994), and is used as a guidance document for native planting activities for restoration sites with similar habitats and drainage patterns.

Watershed Education -Return of the Natives

The Return of the Natives (RON) Restoration Education Project has been active in the Moro Cojo Slough Area of Monterey County for two years. The activities have centered around out-reach with the neighboring schools from the North Monterey County Unified School District. Specifically, RON has worked with the North Monterey County High School and Gambetta Middle Schools in restoring lands adjacent to these schools. Teachers in the district have attended RON teacher training enabling them to complete native plant landscaping projects on their school grounds.

In concert with the Watershed Institute restoration team, RON has been very active with the restoration of the arm of the Moro Cojo immediately adjacent to North Monterey County High School. Together with science faculty from the high school, RON and Watershed Institute staffs have collaborated on the implementation of the long term restoration plan for the school's site. This collaboration has been possible because of the enthusiasm of the science faculty who see the restoration as a piece of their on-going life science curriculum and as a place for student research projects. Five members of the science faculty have participated in the yearly RON teacher training and are active in the RON network. Teacher, Tracy Matfin, is the project coordinator for the school faculty.

Troy Challenger became the first CSUMB service learning student to work with the North Monterey County High School. Troy and six high school science students served as the Fall 1996 student leadership component of the restoration team. It is hoped that in the future more CSUMB service learning students will be able to work with the school restoration team, as their weekly presence on campus serves as a catalyst to action.

Restoration efforts at the high school have been made more effective by the donation of a

propagation greenhouse by the Monterey Bay National Marine Sanctuary. Students use the greenhouse to propagate plants for on-site restoration (Moro Cojo Slough) and for other Watershed Institute restoration projects.

Because the 1996-97 winter rainy season was intense yet short, curtailing late plantings of grasses and wildflowers in areas which could not be readily served by drip irrigation systems, the only major RON planting on the Moro Cojo took place in early December. Over the course of several days, over 120 students participated in planting over 150 trees and shrubs on the grassy slopes which drain into the slough. Served by a drip irrigation system, these plants are being monitored by the science classes.

As an added benefit to the RON partnership with North Monterey County High School, 60 general science students were able to travel to the Fort Ord Public Lands and participate in the restoration of an extremely eroded historic trail system. Here, too, the students were working with RON staff and with Americorps volunteers.

Weather limited the involvement of students from Gambetta Middle School in the Moro Cojo restoration project. Several early sessions were canceled because of excessive mud, while later sessions were canceled because of lack of rain. Nonetheless, Gambetta students assisted in spreading and stomping down hay to prevent erosion in a Watershed Institute restoration site immediately adjacent to their Castroville School campus.

Every spring RON and the Watershed Institute sponsor a Symposium in Restoration Ecology for High School Students. North Monterey County High School students have consistently participated in this day-long event on the CSUMB campus. Taught by CSUMB and Moss Landing Marine Lab faculty and students, this symposium takes students out to several restoration sites on the Ft. Ord Public Lands. Because of their involvement in the symposium several North Monterey County High students, including Maya Kedzior and Patrick McMillian were inspired to participate in the summer long Watershed Institute Restoration Internship Program.

The Community Foundation for Monterey County has awarded RON money in support of the 1997 Summer Restoration Internship Program. The Moro Cojo Slough is one of the three targeted watersheds for this summers work. As a result, RON staff accompanied by RON Restoration Interns will be working on restoration projects in the Slough. As a follow-up to their summer work, RON Restoration Interns will become contact points in their respective schools responsible for informing and recruiting other students to assist in plantings and other restoration efforts around their schools.

Land Owner Agreements and Positive Incentives

There are numerous steps in the process of gaining trust, buy-in and finally land owner agreement to perform watershed restoration on their private land. The final goal of the process is to restore wet corridors throughout the Monterey Bay and ensure that these projects are self sustaining and receive proper long term protection. However, each step in the process towards this goal is valuable and adds benefits to the environment and public understanding of the importance of watershed restoration. A signed easement ensuring permanent conservation of wetland areas is the ultimate goal but may not be widely realized for many years to come. Additional steps, both by the land owners and by policy makers, must be taken before proper incentives and legal rights are provided to make such easements mutually beneficial. The Watershed Institute in partners with Sustainable Conservation and the Natural Resources Conservation Service is working to provide some of these incentives which will allow for permanent conservation of restored wet corridors. Until these steps are taken, the Watershed Institute maintains the argument that a handshake agreement between a land owner and the restoration groups is a good faith agreement by all parties and should be respected as such. Without such good faith agreements and demonstration restoration projects, the goal of restoring significant portions of the local watersheds will not be realized.

Positive Incentives

The development of positive incentives for private landowners to permit restoration activities include; conservation easements, long term management agreements, and good faith agreements.

We have continued to work closely with our partner, Sustainable Conservation, in gaining permission to restore key parcels of private land, and to develop positive incentives for landowners which grant permission for restoration activities on their properties. Since most holdings in the Salinas Valley are in private hands, it is critical that restoration agencies develop positive relationships with landowners. Farmers here are acutely aware of the environmental problems facing them -- salt water intrusion, NPSP, and topsoil loss, limited flood storage -- and are beginning to work more closely with land management agencies and nonprofit groups to achieve common goals in watershed protection.

Agreements

Our work in the past year has been summarized in a report by our partner, Sustainable Conservation (Sustainable Conservation 1996). This work was funded by both 319h and the Packard Foundation in 1995-1996.

Sustainable Conservation has developed a model incentives and access program for watershed restoration: "tailoring access strategies for different types of landowners". The strategies were developed from interaction with many landowners in the Salinas Valley, all working to streamline and improve methods needed to develop the relationships and

agreements needed to conduct restoration activities.

These model properties include: The Moss Landing Heritage Center, Elkhorn Slough Foundation East, Jimenez, Guerrero, Coke Farms, United States Fish and Wildlife Service (USFWS) National Wildlife Refuge Salinas River Restoration, and Salazar Farm properties. A complete review of the partnerships and incentive programs are outlined in the 1996 Sustainable Conservation final report. Of these properties the Watershed Institute has begun restoration of the Salinas River and Moss Landing Heritage Center Properties but are not supported by this grant.

Wetland Restoration Projects

Each restoration site undertaken by the Watershed Institute follows the general guidelines of the Moro Cojo Restoration and Management Plan (1997), Natividad Creek Park Restoration Plan (1994) and Northern Salinas Valley Watershed Restoration Plan (1997).

Restoration projects done by the Watershed Institute follow a chain of activities beginning with landowner contact and progress to planning, restoration action and follow up activities. Restoration work begins with Phase 1 activities which include land form and hydrologic changes, weed control and initial native species planting as described above. Phase 2 activities include additional native species planting and monitoring to determine the success of Phase 1 activities. Reviewing water quality and plant survivorship data enables the Watershed Institute to determine problems and develop solutions which ensure the long term sustainability of the restoration site after restoration activities have ended. Phase 2 restoration activities address the long term sustainability of restoration sites using previous Phase 2 successes and site specific problems documented from the monitoring program. The Watershed Institute has marked several wetland restoration sites as Demonstration Projects. These Demonstration Projects target areas which differ in land use, ownership, water quality impacts, drainage patterns, and habitat type. Restoration activities implemented at these sites also differ dependent on varying goals and agreements developed with the land owners.

The Watershed Institute is involved in over 20 ongoing restoration projects and is actively planning several others. This requires the staff of the Watershed Institute to be involved with all stages and phases of restoration throughout the year. Events and timelines are driven by seasonal requirements creating a dynamic environment for restoration and education but a difficult one to document as a logical chain of events. Therefore this report will review all activities presently being conducted by the Watershed Institute and list restoration sites at which they occur. Only restoration activities within the Salinas/Moro Cojo watershed are funded by the FFY 1995 319h grant but review of other Demonstration Projects within the Pajaro watershed is needed to clearly describe the various restoration activities within different watersheds and the water quality improvements occurring in wetlands adjacent to different land uses and drainage patterns. Therefore water quality and ecological monitoring and land owner agreement activities were also done in the Pajaro River Basin.

All land form and ecological restoration activities have been completed as scheduled for the 319h grant. Ongoing maintenance and continued planting of all restoration sites (Phase 2) are being accomplished using additional restoration funds received from EPA and Caltrans.

The need and feasibility of directing the majority of 319h funds towards areas which received signed easements is still an issue of debate. However a majority of funds from this 319h grant have been allocated to projects on land guaranteed to be left in perpetuity. The areas which have been restored by the Watershed Institute using 319h funds are listed and described individually (Table 1) including dollar amounts. Restoration activities totaling $19,900 have been spent at the Moon Glow Dairy restoration site with the signed easement dated October 9, 1995 by PG&E. No Restoration activities have been done on the Tottino Site (Ocean Mist Farms easement) because of the lengthy process involved in securing such agreements, but activities are planned for the future. The Natividad Creek Park Restoration Project is located on land owned by the City of Salinas and therefore does not need a signed easement to ensure restoration activities are left in perpetuity. A majority of restoration and monitoring funds (61.5%) were allocated to the Natividad Creek and Moon Glow Dairy restoration sites totaling $53,150. As a note, of the twenty restoration sites under way by the Watershed Institute, none have been disturbed by the land owner since being restored, suggesting that good faith agreements are an effective method of gaining access to restorable wetland areas.

Restoration sites will be reviewed separately and a list of activities is included in Table 1. Site locations are shown in figure 4.

Table 1. Restoration Sites - Review of Activities

Restoration Site	Land Form Modifications	Restoration Preparation and Maintenance	Trees Planted	Shrubs/Grasses Planted	Monitoring Activities
Natividad Creek	• Channel widening • Pool creation • Hay berms	• Weed control • Drip irrigation	• Willow • Cottonwood • Dogwood • Sycamore	• See Natividad Creek report for complete list	• Water quality • GIS mapping • Plant growth and survivorship
Mo's Tembladero Slough	• Channel widening • Grading	• Weed control • Drip irrigation • Straw	• Alder • Willow • Cottonwood	• Monkey flower • Blackberry • Lupine, sage • Grass seeds and seedlings	• Water quality • Plant survivorship
Moon Glow Dairy	• Fencing • Hay berms	• Soil amendment • Drip irrigation • Straw mulching	• Willow • Cottonwood • Dogwood • Box elder	• Grass seeds and seedlings	• Water quality • GIS mapping • Plant survivorship
Porter Ranch	• Fencing • Hay berms	• Straw mulching • Watering	• Willow • Cottonwood	• Grass seed • Lupine • Monkey flower	• Water quality • GIS mapping • Plant survivorship
Castroville Slough/ Chapin Property	• Decommission channel • Channel widening • Hay berms	• Straw • Watering • Weed control by mowing and chemicals	• Oak • Willow • Cottonwood • Dogwood • Box elder • Sycamore	• Elderberry • Sage, lupine • Grass seed	• Water quality • Weed control
Walker Valley	• Channel widening • Pool creation	• Weed control • Watering	• Willow • Cottonwood • Dogwood • Sycamore	• Monkey flower • Sage, lupine • Blackberry • Coyote bush • Grass seed and seedlings	• Water quality • Recharge study
Total Restoration Efforts	• 5 miles of fencing • 1600 hay bales • 100 hours of tractor time	• 300 straw bales • 200 hours tractor time • Extensive drip irrigation system on three sites	• 5000 willow • 1000 cottonwood • 100 dogwood • 75 sycamore • 100 box elder • 300 oak	• 5000 greenhouse plants • 30 bags of grass seed	• Over 80 water quality samples • Photo documentation • GIS mapping of plants on three sites

Table 1 (Cont.) Restoration Sites - Review of Funding for Task Activities by Restoration Site

Restoration Site	Acreage & Land Owner Agreement	Task # 5 Land Form Modifications	Task # 6a Restoration Preparation and Maintenance	Task # 6b Trees Shrubs/Grasses Planted	Task # 7 Monitoring Activities
Natividad Creek	• 12.5 Hectares • City of Salinas	• 50 % of task funds • $12,250	• 40% of Task Funds • $4,000	• 40% of Task Funds • $8,000	• 30% of Task Funds • $9,000
Mo's Tembladero Slough	• 0.5 Hectares • Local land owner handshake agreement	• 5% of Task Funds • $1,225	• 10% of Task Funds • $1,000	• 10% of Task Funds • $2,000	• 5% of Task Funds • $1,500
Moon Glow Dairy	• 3.25 Hectares • PG&E and local land owner with 2 signed easements	• 20% of Task Funds • $4,900	• 30% of Task Funds • $3,000	• 15% of Task Funds • $3,000	• 30% of Task Funds • $9,000
Porter Ranch	• 2 Hectares • Local land owner handshake agreement	• 10 % of Task Funds • $2,450	• 5% of Task Funds • $500	• 5% of Task Funds • $1,000	• 5% of Task Funds • $1,500
Castroville Slough/ Chapin Property	• 1.5 Hectares • Local land owner required restoration	• 5% of Task Funds • $1,225	• 10% of Task Funds • $1,000	• 5% of Task Funds • $1,000	• 15% of Task Funds • $4,500
Walker Valley	• 0.25 Hectares • Residential conservation easement in development	• 10 % of Task Funds • $2,450	• 5% of Task Funds • $500	• 25% of Task Funds • $5,000	• 15% of Task Funds • $4,500
Total Restoration Efforts	• 20 Hectares • 2 Easements • 1 required restoration • 2 handshake agreement • 1 residential agreement • 1 City agreement	• 100% Task Complete Including • 5 miles of fencing • 1600 hay bales • 100 hours of tractor time	• 100% Task Complete Including • 300 straw bales • 200 hours tractor time • Extensive drip irrigation system on three sites	• 100% Task Complete Including • 5000 willow • 1000 cottonwood • 100 dogwood • 75 sycamore • 100 box elder • 300 oak	• 100% Task Complete Including • Over 80 water quality samples • Photo documentation • GIS mapping of plants on three sites

Restoration Activities: Site by Site

Natividad Creek Park 12.5 Hectares

The Natividad Creek Park restoration was completed in partnership with the City of Salinas Parks Department. Restoration activities funded in part by this 319h grant include: extensive use of hay bales to slow and pool water throughout the one mile long drainage, planting of thousands of willow cuttings to redirect water flow as hay bales deteriorate and planting of other native wetland species which have created a dense, high diversity vegetated corridor. Restoration activities within this park have increased citizen education and buy-in to this neighborhood project, created a wet corridor which remains wet for months after the end of the rainy season and is populated by a high diversity of native species (See Appendix 1 for photo documentation).

Mo's Tembladero Slough Restoration 0.5 Hectares

The Mo's Tembladero Slough restoration site is being done with cooperation from a local Castroville land owner and is a step towards gaining local support for restoring the Tembladero and Castroville sloughs. Restoration activities have been funded entirely through this 319h grant and include; weed and trash removal, land grading, planting of native trees and shrubs. This project has successfully established the first restoration site along the highly degraded Tembladero Slough (See Appendix 1 for photo documentation).

Moon Glow Dairy 3.25 Hectares

The Moon Glow Dairy Restoration is a working partnership with the Moon Glow Dairy and PG&E to restore a wet drainage adjacent to the Moro Cojo Slough. Extensive efforts are underway to gain access to an additional parcel of land which will successfully connect this restored wetland to the Moro Cojo Slough. Restoration activities have been funded entirely through this 319h grant and include fence building to permanently exclude cattle from all of the acquired parcels, planting native species of trees and wetland grasses, and weed control. Extensive native sedges responded immediately to cattle exclusion and became a dominant plant within the restoration areas several months after fencing (See Appendix 1 for photo documentation).

Porter Ranch 2 Total Hectares

The Porter Ranch restoration was completed in partnership with local cattle grazers to become a successful demonstration of the benefits of excluding cattle from upland drainage corridors. Restoration activities included extensive use of hay bales to slow and pool water and stop erosion, planting of numerous native species of trees and grasses and constructing several miles of electric fencing to exclude cattle grazing (See Appendix 1 for photo documentation).

Castroville Slough/Chapin Property 1.5 Hectares

The Chapin Property restoration has been done in partnership with local Castroville land owners. Restoration activities funded entirely through this 319h grant include the decommissioning of drainage channels from the City of Castroville, creating physical berms to spread water over a wide area adjacent to the Castroville Slough drainage channel, two years of weed control successfully reducing poison hemlock and radish populations, and planting several species of native grasses, shrubs and trees. This restoration drainage is included in future plans documented in the Moro Cojo Restoration and Management Plan (1997) and the Northern Salinas Valley Watershed Restoration Plan (AMBAG 1997) and all restoration activities to date have followed these plan guidelines (See Appendix 1 for photo documentation).

Walker Valley 0.25 Hectares

The Walker Valley restoration was completed in partnership with a local resident owning a parcel which includes a portion of the upland drainage of the Moro Cojo Slough. This restoration has successfully demonstrated the restoration potential of the upland creeks located on residential property. Restoration activities funded entirely through this 319h grant include the decommissioning of a drainage channel, creating a wetland pond, creating a porous driveway to improve the flow of water, planting of numerous species of trees, shrubs, and wetland grasses (See Appendix 1 for photo documentation). The red legged frog and tiger salamander, both listed as endangered species, have been observed at this three year old restoration site. Much of the water flowing onto the restoration site has pooled and percolated into local aquifers; additional ground water recharge studies are scheduled.

Overall Restoration Activities

A list of species (Table 2) planted at demonstration sites is presented as reviewed above and photo documentation of planted areas is presented for each restoration site within Appendix 1. Overall, a total of 20 hectares (50 acres) of wetland and riparian habitat are being restored and 11,675 native trees, shrubs, and grasses have been planted within the Tembladero and Moro Cojo watersheds as of December 1996.

Watershed Restoration Monitoring Program

Water Quality Monitoring

The primary goal of this water quality monitoring program is to determine the effectiveness of restored wetlands as a biological filter of non-point source pollution by creating a water quality database for those areas before (or during) and after restoration. To determine improvements to water quality, it was necessary to take samples at the point of input into a restoration area, and at the exit point. Sample sites were designated above and below four restoration areas, and at three of the areas an additional site was included

Table 2. Native Species Planted at Restoration Sites

Species Name	Common Name
Trees	**Trees**
Acer macrophyllum	big-leaf maple
Acer negundo	box elder
Aesculus californica	buckeye
Alnus rubra	red alder
Cornus sessilis	creekside dogwood
Juglans californica	California black walnut
Myrica californica	wax myrtle
Platanus racemosa	sycamore
Populus balsamifera ssp. trichocarpa	black cottonwood
Quercus agrifolia	coast live oak
Quercus douglasii	blue oak
Quercus lobata	valley oak
Salix laevigata	red willow
Salix lasiolepis	arroyo willow
Umbellularia californica	bay laurel
Graminoids	**Graminoids**
Bromus carinatus	California brome
Carex spp.	sedge
Deschampsia cespitosa	tufted hairgrass
Elymus glaucus	blue wildrye
Festuca californica	California fescue
Hordeum brachyantherum	meadow barley
Juncus effusus	tall rush
Juncus patens	blue-green rush
Juncus phaeocephalus	iris-leaved rush
Juncus spp.	juncus
Leymus triticoides	creeping wildrye
Leymus mollis	dune ryegrass
Melica imperfecta	oniongrass
Nassella pulchra	purple needlegrass
Poa douglasii	sand-dune bluegrass

Species Name	Common Name
Shrubs	**Shrubs**
Arctostaphylos pajaroensis	pajaro manzanita
Artemisia californica	California sagebrush
Artemisia douglasiana	mugwort
Baccharis pilularis	coyote bush
Baccharis salicifolia	mulefat
Ceanothus gloriosus	ceanothus
Ceanothus thyrsiflorus	blue blossom
Cercis occidentalis	western redbud
Eriogonum giganteum	buckwheat
Fremontodendron californicum	flannelbush
Heteromeles arbutifolia	toyon
Lupinus arboreus	yellow bush lupine
Mimulus aurantiacus	sticky monkey flower
Prunus ilicifolia ssp. ilicifolia	holly-leafed cherry
Rhamnus californica ssp. californica	California coffeeberry
Ribes speciosum	fuchsia-flowered gooseberry
Romneya coulteri	Coulter's matilija poppy
Rosa californica	California wild rose
Rubus ursinus	California blackberry
Salvia mellifera	black sage
Sambucus mexicana	blue elderberry
Symphoricarpos albus var. laevigatus	snowberry
Wildflowers	**Wildflowers**
Achillea millefolium	yarrow
Eschscholzia californica	California poppy
Lupinus nanus	sky lupine
Sisyrinchium bellum	blue-eyed grass

Note: Species identified using The Jepson Manual:Higher Plants of California. 1993. Edited by James Hickman

at the middle of the water course through the restoration. For example, water quality has been measured at the Natividad Creek Park restoration (Fig. 6) at the point of input (above restoration), half way through the restored waterway (middle restoration), and at the restoration drainage exit point (below restoration). By comparing differences in water quality parameters among monitoring stations, the impacts of a restored vegetated drainage can be assessed. Sites without an identified input or exit area, such as at the headlands of a watershed, were not included in this sampling program. An EPA approved Quality Assurance Project Plan (QAPP) has been prepared to document all monitoring procedures performed within this document (Watershed Institute 1997).

Restoration areas included in the monitoring program are Natividad Creek Park, Hansen Slough, Moon Glow Dairy, and Walker Valley Creek (Fig. 7). Castroville Slough was included as the reference location. The reference area along the Castroville Slough is presently an unvegetated drainage channel similar to the Watershed Institute restoration sites before restoration activities began. Additional measurements were taken periodically, at the Salinas and Pajaro rivers and the Mo's Restoration on the Tembladero Slough, to gain background information on other local drainage areas. More extensive monitoring of drainage systems not under active restoration was determined to be an inappropriate use of resources by the Technical Advisory Committee. By re-directing monitoring efforts toward appropriate restoration locations, the monitoring program was able to increase the number of samples at restoration sites from the projected 40 to 64 samples for the 1995-1996 season.

Water Quality Monitoring Control Site

Castroville Slough was sampled during the 1995-1996 rain season to compare with restored wetland areas. The channel flows into the Moro Cojo Slough and is of a similar length to restoration areas. The Castroville Slough has been designated for future restoration activity and these data are additionally useful as historical information for future restoration projects.

Water Quality Monitoring During the 1996-1997 Winter Season

Water quality monitoring during the 1995-1996 rain season demonstrated variable but significant water quality improvements due to filtering processes occurring within the restored wet corridors. The significant filtering potential of the Hansen Slough Restoration project warranted further monitoring. This site was selected for additional water quality and hydrological modeling during the 1996-1997 season. These additional monitoring activities were an attempt to address filtering processes, hydrologic flow characteristics, and restoration size as important factors to be considered when planing future restoration activities, aimed at improving water quality. Sample collection was also scheduled at the other restoration sites for both early and late season rain events. Because of the unusually strong and early storm season and changes in restoration site plant populations, results of the 1996-1997 season's monitoring program were incomplete. Some interesting and unexpected outcomes however, were documented.

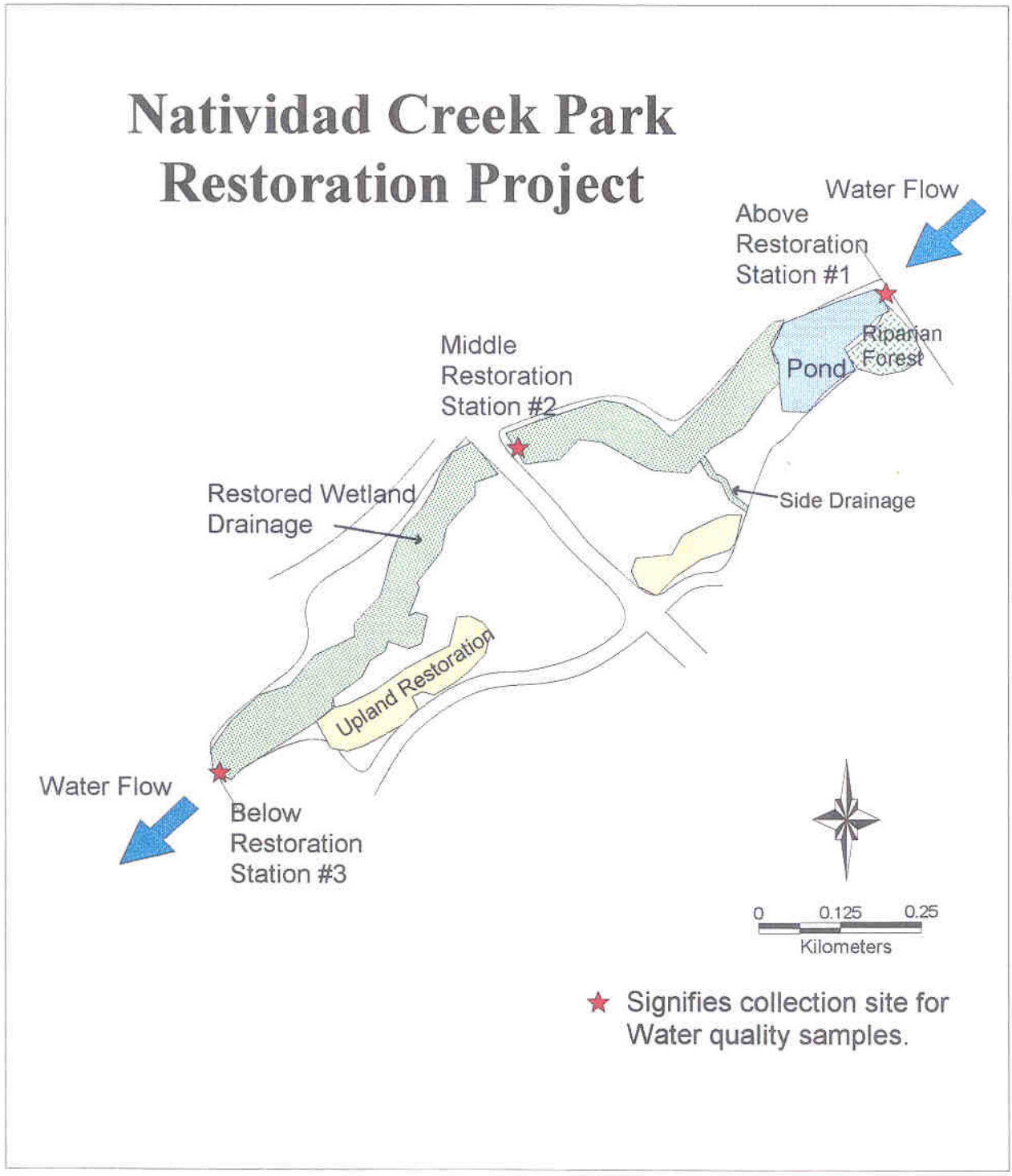


Figure 6. Water quality monitoring stations at Natividad Creek Park.

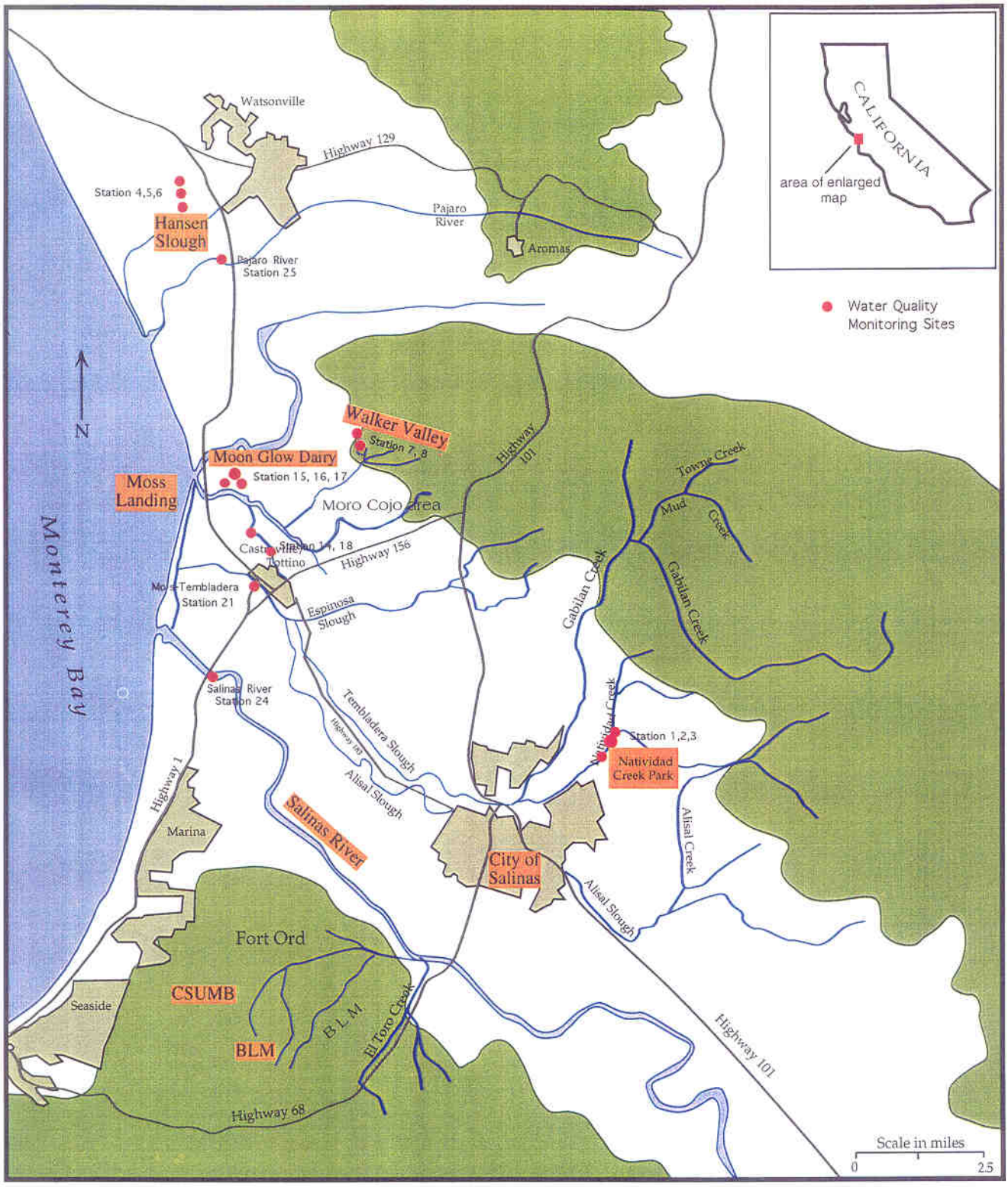


Figure 7. Map of water quality monitoring stations.

Methods:

Water samples were collected from designated locations with a five liter container for in-field measurements and a one liter bottle for nitrate analysis in the laboratory. A Solomat Multiparameter Water Quality Probe field meter (Neotronics) was used to measure temperature (°C), conductivity (µS), pH, turbidity (NTU), and oxygen concentration (ppm) on site. Water samples for nitrate analysis, were centrifuged to remove most particulate matter, filtered with a 1 micron filter and frozen at -18 °c until the time of analysis. Nitrate measurements were made at Moss Landing Marine Labs using the cadmium column reduction method and estimated as µMoles and converted to ppm NO3.

Full methods are reviewed in the EPA approved QAPP (Watershed Institute 1997).

Database Review

All data are presented in the accompanying database table and database description (Table 3). Oxygen concentrations at all locations ranged from 1ppm to above saturation (+10ppm). Highest oxygen levels were generally associated with a spill-way which increased water mixing, and lowest levels were often associated with contaminated runoff. Increased alkalinity (>8.0) and low conductivity were measured in areas with cattle runoff. Temperature differed little between monitoring stations and most between dates.

Turbidity and Nitrate Measurements

Hansen Restoration
1995-1996 Season

Turbidity measurements at the Hansen Restoration (Fig. 8) decreased as water passed through the area. Turbidity decreased by as much as 50 fold from the monitoring station above the restoration to the station below the restoration. These decreases in turbidity were continuous throughout the winter rain season with one exception on February 29. This increase in turbidity in the upper half of the restoration was due primarily to physical berms successfully rerouting creek flow which caused some stream bed carving.

Nitrate concentrations also decreased as water passed through the Hansen Restoration area during all sample dates. Nitrate levels entering this restoration site exceeded 140 ppm but levels in water leaving the area never exceeded 40 ppm, and were frequently below 5 ppm. Nitrate concentrations decreased steadily through the restoration area during all dates but increased slightly at the middle station on January 31.

Table 3. Water Quality Database (1995-1997).

STA_NUM	STATION	Location	DATE	Time	REF_NO	OXYGENppm	OXYGEN%sat	PH	TEMP	CONDUCT uS	CONDUCTppt	TURBIDITY	NO3_UM	NO3_PPM
10	CALCAGNO	UPPER	12/12/95		67.0							20.3	176.5	9.18
12	CALCAGNO	ARTICHOKE FD	12/12/95		68.0							131.7	2955.1	153.67
14	CASTROVILLE SLOUGH	CHANNEL	12/12/95		69.0							724.0	1307.6	68.00
17	DAIRY	LOWER	12/12/95		70.0							32.4	76.1	3.96
4	HANSENS	UPPER	12/12/95		61.0							1614.0	2697.5	140.27
5	HANSENS	MIDDLE	12/12/95		62.0		Data Not Collected					566.0	2086.7	108.51
6	HANSENS	LOWER	12/12/95		63.0							162.0	732.2	38.07
1	NATIVIDAD	UPPER	12/12/95		64.0							93.1	156.9	8.16
2	NATIVIDAD	MIDDLE	12/12/95		65.0							88.7	342.0	17.78
3	NATIVIDAD	LOWER	12/12/95		66.0							97.9	134.8	7.01
18	TOTTINO	MARSH	12/12/95		60.0							56.1	430.0	22.36
7	WALKER VALLEY	UPPER	12/12/95		71.0							61.4	575.3	29.92
14	CASTROVILLE SLOUGH	CHANNEL	1/16/96		78.0	3.33		7.15	14.6	499.0		234.0	382.6	19.90
15	DAIRY	UPPER	1/16/96		84.0	10.17		7.98	14.7	757.4		230.0	29.1	1.51
16	DAIRY	MIDDLE	1/16/96		83.0	1.03		8.34	14.8	2.8		1150.0	5.2	0.27
17	DAIRY	LOWER	1/16/96		82.0	8.48		7.48	14.3	177.8		50.7	90.1	4.69
4	HANSENS	UPPER	1/16/96		72.0	7.99		7.78	14.5	1251.0		1063.0	3046.3	158.41
5	HANSENS	MIDDLE	1/16/96		73.0	3.75		7.19	14.3	1086.5		691.0	2037.2	105.93
6	HANSENS	LOWER	1/16/96		74.0	4.25		6.97	12.8	915.1		115.0	10.7	0.56
21	MO'S		1/16/96		81.0	5.95		7.58	13.6	1029.3		836.0	496.1	25.80
1	NATIVIDAD	UPPER	1/16/96		75.0	9.28		7.27	13.6	577.0		1020.0	1580.3	82.18
2	NATIVIDAD	MIDDLE	1/16/96		76.0	8.06		7.09	13.4	555.4		903.0	1561.2	81.18
3	NATIVIDAD	LOWER	1/16/96		77.0	8.20		7.16	13.7	602.0		814.0	1745.0	90.74
18	TOTTINO	MARSH	1/16/96		79.0	9.78		8.06	14.1	8.1		64.0	3884.0	201.97
19	TOTTINO	CHANNEL	1/16/96		80.0	6.89		7.41	14.3	681.5		177.0	298.9	15.54
4	HANSENS	UPPER	1/24/96		88.0	9.2		7.50	11.8	574.7		1776.0	780.6	40.59
5	HANSENS	MIDDLE	1/24/96		89.0	5.7		7.21	11.6	1057.0		813.0	347.5	18.07
6	HANSENS	LOWER	1/24/96		90.0	6.4		7.03	10.7	876.3		24.6	28.2	1.47
1	NATIVIDAD	UPPER	1/24/96		85.0	8.6		7.24	11.0	717.0		190.0	952.0	49.50
2	NATIVIDAD	MIDDLE	1/24/96		86.0	9.0		7.55	11.2	608.0		93.0	537.9	27.97
3	NATIVIDAD	LOWER	1/24/96		87.0	8.6		7.61	11.7	628.0		68.6	333.2	17.33
14	CASTROVILLE SLOUGH	CHANNEL	1/31/96		98.0	6.6		7.93	13.3	274.0		1016.0	460.3	23.94
15	DAIRY	UPPER	1/31/96		99.0	6.6		7.21	12.7	207.1		356.0	253.6	13.19
16	DAIRY	MIDDLE	1/31/96		101.0	3.6		7.01	12.4	560.7		601.0	141.3	7.35
17	DAIRY	LOWER	1/31/96		100.0	5.7		7.40	12.1	689.4		92.5	24.4	1.27
4	HANSENS	UPPER	1/31/96		91.0	6.8		7.48	11.9	527.5		1660.0	286.9	14.92
5	HANSENS	MIDDLE	1/31/96		92.0	5.3		7.17	11.8	430.6		851.0	388.5	20.20
6	HANSENS	LOWER	1/31/96		93.0	4.1		6.96	11.6	6.3		632.8	144.5	7.51
21	MO'S		1/31/96		104.0	6.1		7.41	12.3	405.1		1083.0	451.5	23.48
1	NATIVIDAD	UPPER	1/31/96		94.0	7.1		7.35	13.3	150.8		287.0	95.6	4.97
2	NATIVIDAD	MIDDLE	1/31/96		95.0	6.2		7.24	11.9	333.6		1088.0	555.9	28.91
3	NATIVIDAD	LOWER	1/31/96		96.0	6.4		7.32	12.5	268.2		787.0	400.5	20.83

Table 3. Water Quality Database (1995-1997).

STA_NUM	STATION	Location	DATE	Time	REF_NO	OXYGENppm	OXYGEN%sat	PH	TEMP	CONDUCT uS	CONDUCTppt	TURBIDITY	NO3_UM	NO3_PPM
18	TOTTINO	MARSH	1/31/96		103.0			7.65	12.6	766.1		879.0	729.3	37.92
19	TOTTINO	CHANNEL	1/31/96		102.0			7.78	13.2	560.6		1096.0	949.7	49.38
7	WALKER VALLEY	UPPER	1/31/96		97.0	6.3		7.00	11.5	447.6		76.7	1195.2	62.15
15	DAIRY	UPPER	2/19/96		112.0			7.09	14.7	201.3		582.0	203.0	10.56
16	DAIRY	MIDDLE	2/19/96		113.0			7.30	14.7	346.1		142.0	6.5	0.34
17	DAIRY	LOWER	2/19/96		114.0			7.23	14.8	426.7		111.0	22.8	1.19
4	HANSENS	UPPER	2/19/96		106.0			7.00	14.6	571.4		1506.0	384.8	20.01
5	HANSENS	MIDDLE	2/19/96		107.0			7.12	14.5	655.8		1413.0	213.1	11.08
6	HANSENS	LOWER	2/19/96		108.0			6.97	14.6	503.3		47.4	29.8	1.55
1	NATIVIDAD	UPPER	2/19/96		109.0			7.48	15.1	131.7		485.0	82.9	4.31
2	NATIVIDAD	MIDDLE	2/19/96		110.0			7.08	14.6	367.4		470.0	402.6	20.94
3	NATIVIDAD	LOWER	2/19/96		111.0			7.57	14.8	306.9		687.0	325.6	16.93
7	WALKER VALLEY	UPPER	2/19/96		115.0			7.12	14.5	228.4		68.7	117.4	6.10
8	WALKER VALLEY	LOWER	2/19/96		116.0			6.96	14.3	246.7		94.1	108.2	5.63
14	CASTROVILLE SLOUGH	CHANNEL	2/29/96		127.0	7.76		6.68	13.8	818.0		130.0	542.5	28.21
15	DAIRY	MID-UPPER	2/29/96		121.0	5.69		8.17	13.6	4.6		830.0	11.3	0.59
16	DAIRY	MIDDLE	2/29/96		122.0	2.47		7.85	13.1	3.0		666.0	9.0	0.47
17	DAIRY	LOWER	2/29/96		123.0	2.64		7.90	12.7	3.4		410.0	5.0	0.26
4	HANSENS	UPPER	2/29/96		118.0	10.73		7.54	13.0	737.1		641.0	155.2	8.07
5	HANSENS	MIDDLE	2/29/96		119.0	8.64		7.40	13.4	780.3		898.0	143.7	7.47
6	HANSENS	LOWER	2/29/96		120.0	5.14		7.07	12.1	488.8		81.9	45.2	2.35
21	MO'S		2/29/96		128.0	8.95		7.43	11.7	1013.2		266.0	1311.3	68.19
1	NATIVIDAD	UPPER	2/29/96		124.0	10.70		7.50	12.7	527.6		81.0	214.6	11.16
2	NATIVIDAD	MIDDLE	2/29/96		125.0	9.98		7.65	12.8	530.4		64.9	220.6	11.47
3	NATIVIDAD	LOWER	2/29/96		126.0	10.20		7.79	13.0	534.5		63.0	220.6	11.47
19	TOTTINO	CHANNEL	2/29/96		129.0	9.90		7.64	11.8	3.1		80.0	751.0	39.05
7	WALKER VALLEY	UPPER	2/29/96		129.5	10.72		7.73	13.2	342.8		10.8	115.0	8.06
8	WALKER VALLEY	LOWER	2/29/96		130.0	8.67		7.19	12.3	329.3		24.8	101.4	5.27
1	NATIVIDAD	Upper	10/29/96		135	13.70		7.14	14.3	495.9	0.170	98.0	966.8	50.35
2	NATIVIDAD	Middle	10/29/96		136	14.50		7.11	12.8	528	0.190	118.0	483.4	25.18
3	NATIVIDAD	Lower	10/29/96		137	9.20		7.06	13.9	305	0.100	305.0	164.5	8.57
4	HANSEN	Upper	10/29/96	8:50	134								966.8	50.35
1	NATIVIDAD	upper	11/17/96	2:40	140	8.40	81.60	7.02	15.4	528.8	0.166	1328.0	859.4	44.76
2	NATIVIDAD	middle	11/17/96	2:50	141	8.14	79.9	7.00	15.1	485.8	0.152	1218.0	832.0	43.33
3	NATIVIDAD	lower	11/17/96	3:00	142	8.09	76.50	7.09	15.2	460.8	0.143	980.0	691.5	36.02
4	HANSENS	upper	11/17/96	12:10	143	7.64	75.0	7.79	15.0	970.2	0.326	2029.00	143.7	7.48
5	HANSENS	middle	11/17/96	12:20	144	2.68	23.40	7.00	14.7	1005.0	0.338	610.0	561.5	29.24
6	HANSENS	lower	11/17/96	12:40	145	5.22	47.8	6.16	14.0	944.5	0.317	641.0	924.8	48.17
7	WALKER VALLEY	upper	11/17/96	9:40	146	10.65	100.8	6.16	15.1	78.3	0.021	39.1	65.5	3.41
8	WALKER VALLEY	upper west	11/17/96	9:30	147	10.60	99.1	7.42	13.9	381.7	0.120	206.0	528.4	27.52
14	CASTROVILLE SLOUGH	channel	11/17/96	4:15	148	8.39	80.0	7.59	15.4	424.0	0.131	1090.0	1020.5	53.15
15	DAIRY	upper	11/17/96	10:10	149	7.98	74.10	7.04	14.2	586.2	0.186	2189.0	1101.1	57.35

Table 3. Water Quality Database (1995-1997).

STA_NUM	STATION	Location	DATE	Time	REF_NO	OXYGENppm	OXYGEN%sat	PH	TEMP	CONDUCT uS	CONDUCTppt	TURBIDITY	NO3_UM	NO3_PPM
16	DAIRY	middle	11/17/96	10:00	150	5.81	50.8	8.09	15.0	2104.0	0.783	3000.0	18.6	0.97
17	DAIRY	lower	11/17/96	10:20	151	9.97	113	7.33	14.3	140.1	0.040	120.0	67.7	3.53
18	TOTTINO	channel	11/17/96	4:30	152	8.33	80.2	7.74	15.3	620.3	0.198	1138.0	859.4	44.76
21	MO'S	channel	11/17/96	4:00	153	7.20	67.80	7.68	14.6	329.5	0.100	980.0	402.8	20.98
4	HANSEN	upper	11/22/96	9:45	174	9.74	98.20	7.56	15.8	708.2	0.228	1750.0	191.6	9.98
5	HANSEN	middle	11/22/96	10:00	175	3.29	33.10	7.37	16.1	901.5	0.298	1198.0	1.9	0.10
6	HANSEN	lower	11/22/96	10:30	176	5.30	48.9	6.70	15.3	627.0	0.199	53.9	502.0	26.15
1	NATIVIDAD	upper	12/5/96	9:40	165	10.51	99.5	7.98	11.0	444.2	0.142		939.9	48.95
2	NATIVIDAD	middle	12/5/96	13:12	166	8.25	79.90	7.64	10.8	175.0	0.051		214.8	11.19
3	NATIVIDAD	lower	12/5/96	10:10	167	9.04	92.70	7.94	11.1	172.2	0.050		120.8	6.29
4	HANSENS	upper	12/5/96	9:15	162	10.20	94.00	12.60	13.4	6088.3	0.219	2039.0	495.4	25.80
5	HANSENS	middle	12/5/96	9:30	163	4.55	41.6	11.80	13.4	780.7	0.253	1255.0	535.1	27.87
6	HANSENS	lower	12/5/96	3:00	164	5.81	55.10	11.02	13.1	715.3	0.229	42.3	25.2	1.31
7	WALKER VALLEY	upper west	12/5/96	10:20	160	10.04	88.50	8.25	11.3	275.0	0.084	101.0	496.8	25.88
14	CASTROVILLE SLOUGH	channel	12/5/96	11:10	168	9.97	98	9.77	14.7	451.9	0.143		1208.5	62.94
15	DAIRY	upper	12/5/96	10:50	172	7.64	69	11.93	12.5	447.6	0.139	792	924.8	48.17
16	DAIRY	middle	12/5/96	10:30	171	7.01	62	15.18	14	3920	2.060	2332	178.4	9.29
17	DAIRY	lower	12/5/96	11:10	169	10.44	94	12.70	13.4	124.2	0.034	68.9	56.1	2.92
18	TOTTINO	marsh	12/5/96	11:30	161	8.25	86.2	8.43	12.4	468.0	0.148		886.2	46.16
21	MO'S	channel	12/5/96	10:50	170	7.32	74.00	8.69	12.0	1349.6	0.480		1289.1	67.14
4	HANSEN	upper	1/20/97	8:20	177								136	7.08
5	HANSEN	middle	1/20/97	8:40	178								109.1	5.68
6	HANSEN	lower	1/20/97	9:00	179								21.4	1.11

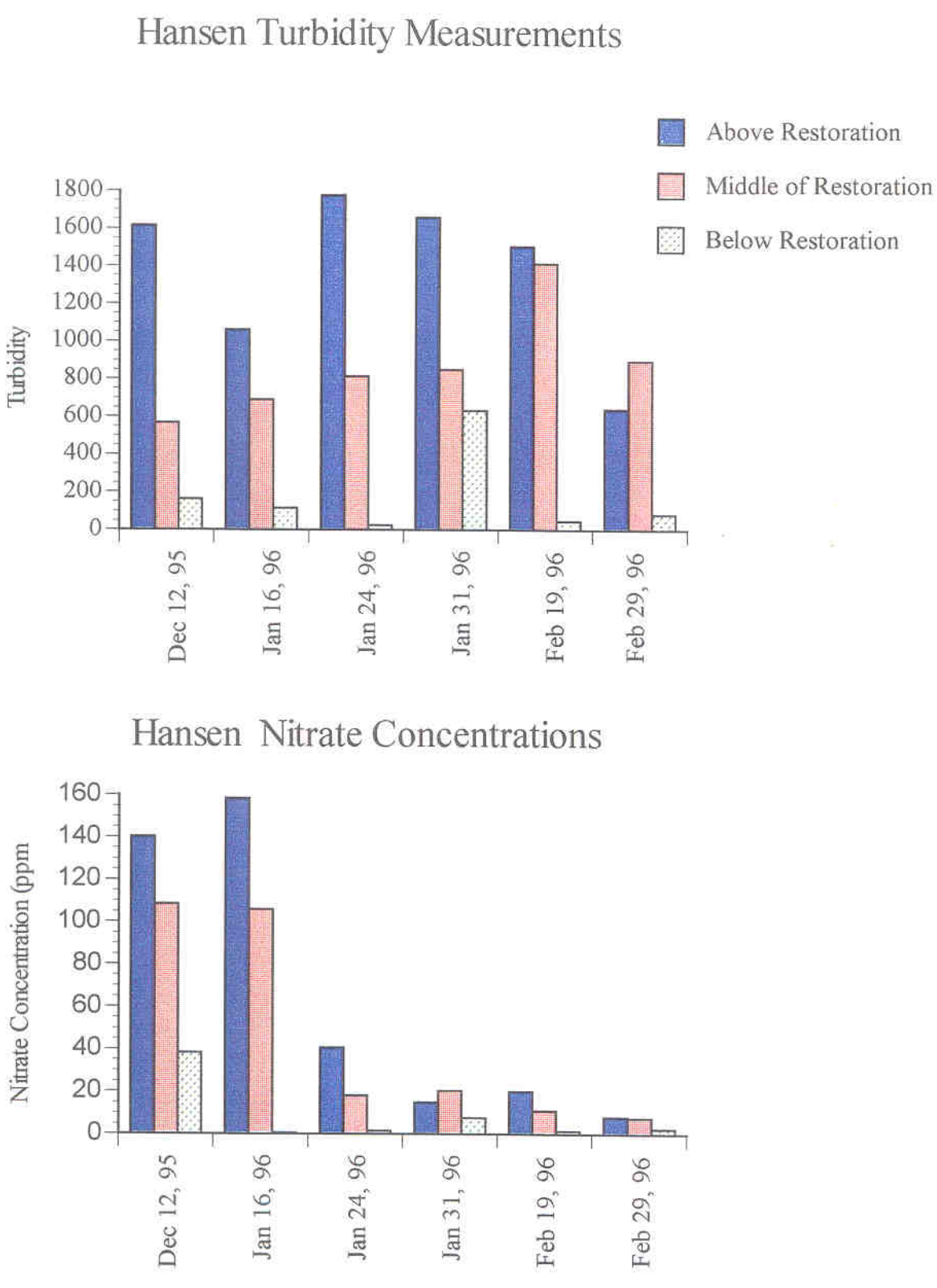


Figure 8. Turbidity and nitrate levels in Hansen Slough 1995-1996.

1996-1997 Season

Measured turbitity was again high during the 1996-1997 season in water at the point of input into the restoration and decreased significantly as the water flowed through the system (Fig. 9). Measured turbidity exceeded 500 NTU at the lower station during one rain event but were approximately 50 NTU on later dates. While the restoration site has successfully filtered sediment from the upper watershed, this accumulated sediment is causing problems for native plant establishment and raising the elevation of a portion of the restoration site. Therefore hillside stabilization and a retention pond are being planned for the upper drainage to better protect the restoration site from these extreme sediment loads.

Nitrate concentrations between 50 and 10ppm were measured at the point of input. These concentrations were lower than in the previous year. Decreases in nitrate concentrations, similar to the previous season, were not documented during all rain events as was measured during the previous season. Significant increases in nitrate concentration were measured between the upper and lower monitoring stations during the November 17 and November 22 rain events, suggesting remobilization of nitrates from the restoration site. Subsequent decreases in nitrate concentration to below 5ppm were measured on later rain events.

Previous studies have documented the leaching of nitrates from restored wetlands. Field observations found the central portion of the restoration site was devoid of live plants. It was apparent that the increase in water flowing over this portion of the restoration site for a longer seasonal duration had created significant anoxic conditions, able to kill all plants growing in that area. Most of the plants previously growing in this portion of the restoration site were however, not native wetland species. It is evident that as the sediment chemical characteristics change, only the tolerant native wetland species will be capable of growing in this area. Therefor additional planting activities are scheduled to increase the native vegetation and increase filtering potential of the entire restoration site.

Natividad Creek Park Restoration
1995-1996 Season

Turbidity measurements (Fig 10) decreased as water passed through the Natividad Restoration site during the first two significant rain events. Levels increased however, during the next two rain events. This increase may be due to input from degraded side drainage systems along the length of the Natividad Restoration and continued rerouting of flow within the widened basin. Both possibilities suggest that this restoration site was not yet at full filtering potential.

Nitrate concentrations were commonly greater at the middle restoration station than above the restoration further suggesting inputs of degraded water were being added to the drainage along its length. Nitrate concentrations were often less at the monitoring station

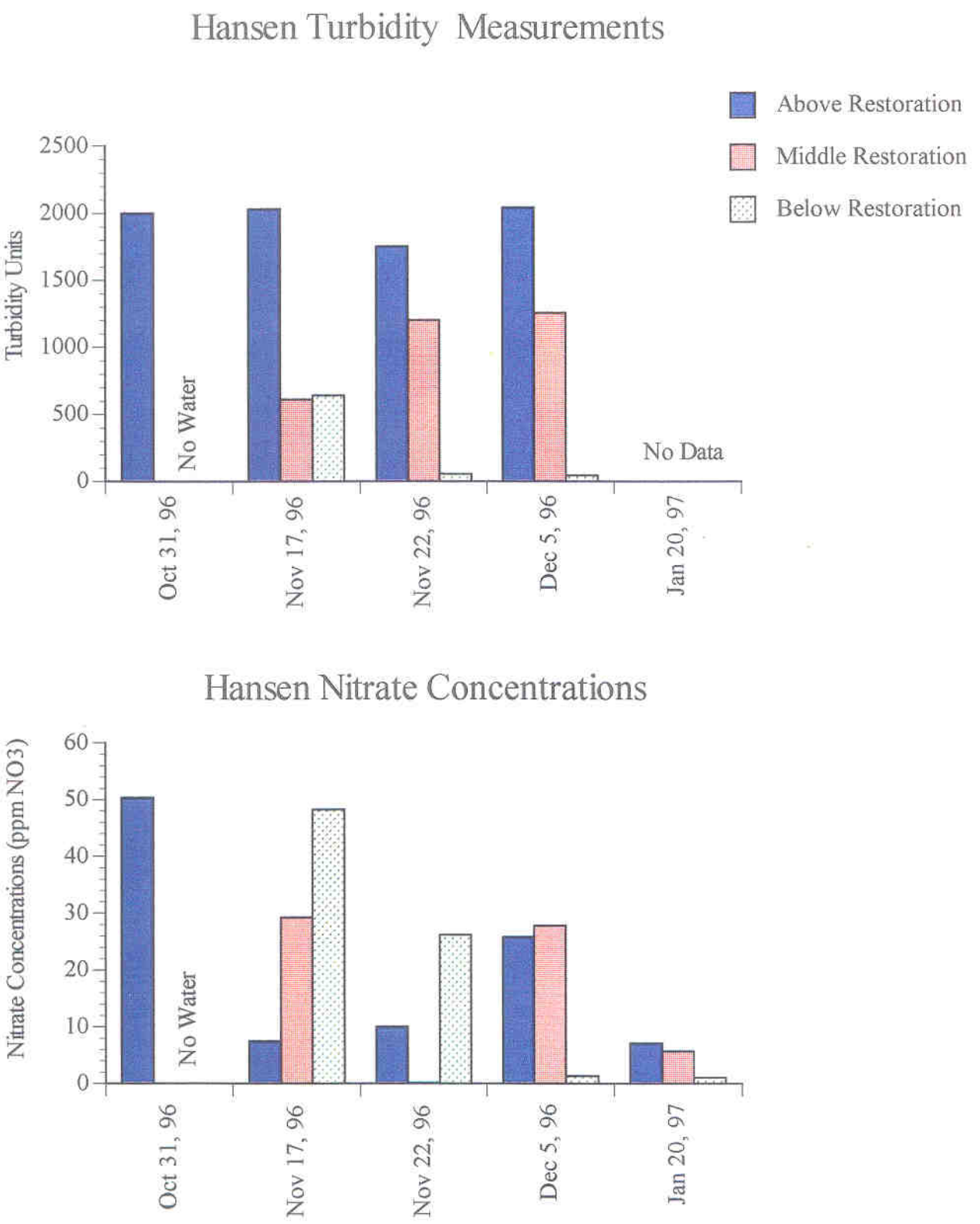


Figure 9. Turbidity and nitrate measurements at Hansen Slough 1996-1997.

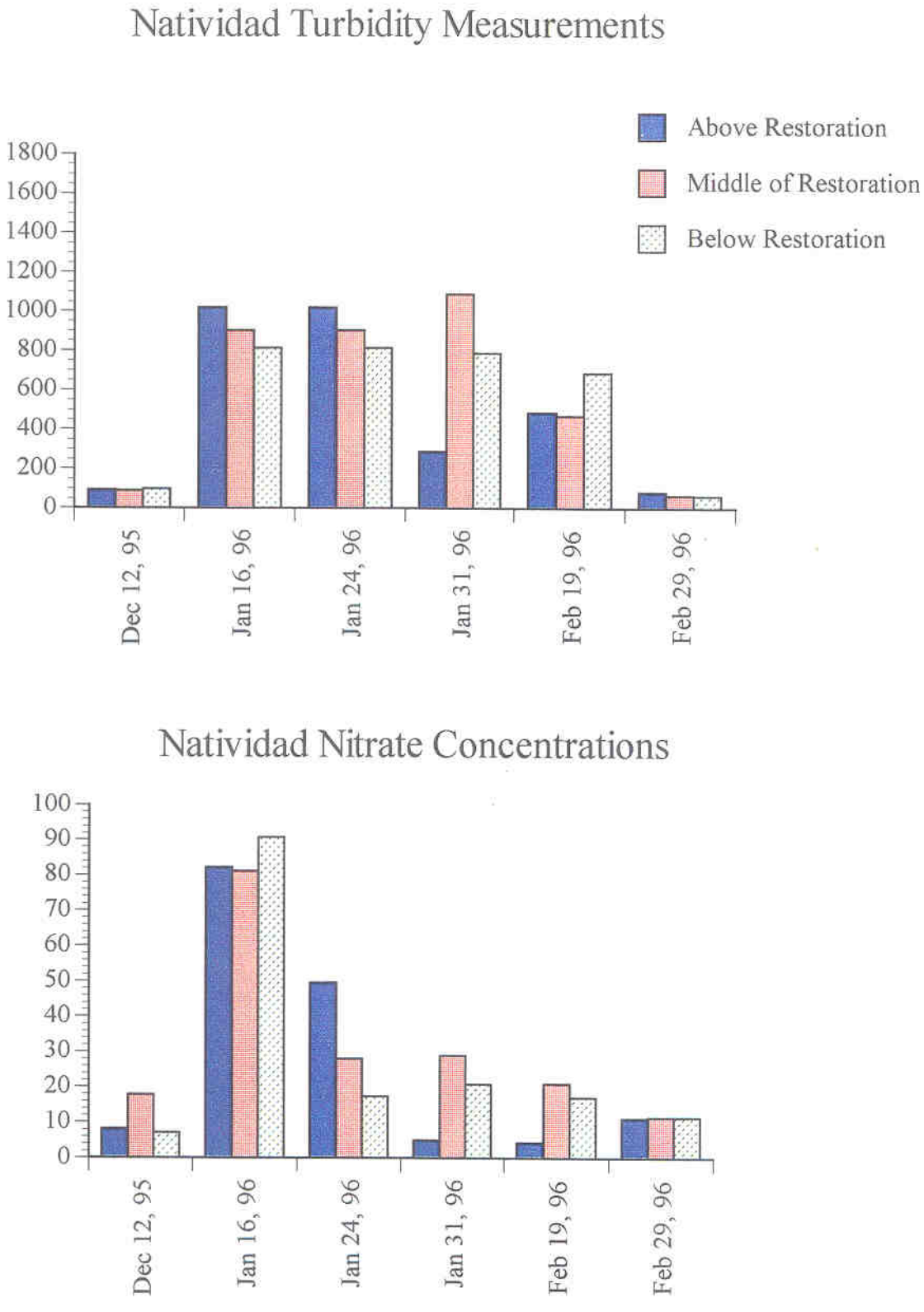


Figure 10. Turbidity and nitrate measurements at Natividad Creek Park 1995-1996.

below the restoration than the middle restoration station suggesting some filtering by the dense vegetation of the lower Natividad drainage was occurring.

1996-1997 Season

Turbidity measurements varied during the three sampling dates of the 1996-1997 season (Fig. 11). Decreases were measured between the upper and lower stations on two events. Turbidity did increase between the middle and lower monitoring site and may be due to re-routing of channel flow or additions from side drainages. Field surveys found little evidence of channel scouring and noted over 90% cover of native vegetation throughout the Natividad Creek Park Restoration drainage. This suggests that increased turbidity between the middle and lower stations may be due to side drainage inputs and upland housing and park development.

Nitrate concentrations were measured at the input site to be approximately 50ppm and decreased as water passed through the restoration site during all dates of 1996-1997 season. Filtering through the restoration site decreased nitrate concentrations from 50 to below 10ppm during two rain events suggesting the increased density of native vegetation has increased the filtering capabilities of this system compared to the previous year. Any nitrate inputs from side drainages were negated by decreases from wetland filtering.

Moon Glow Dairy Restoration
1995-1996 Season

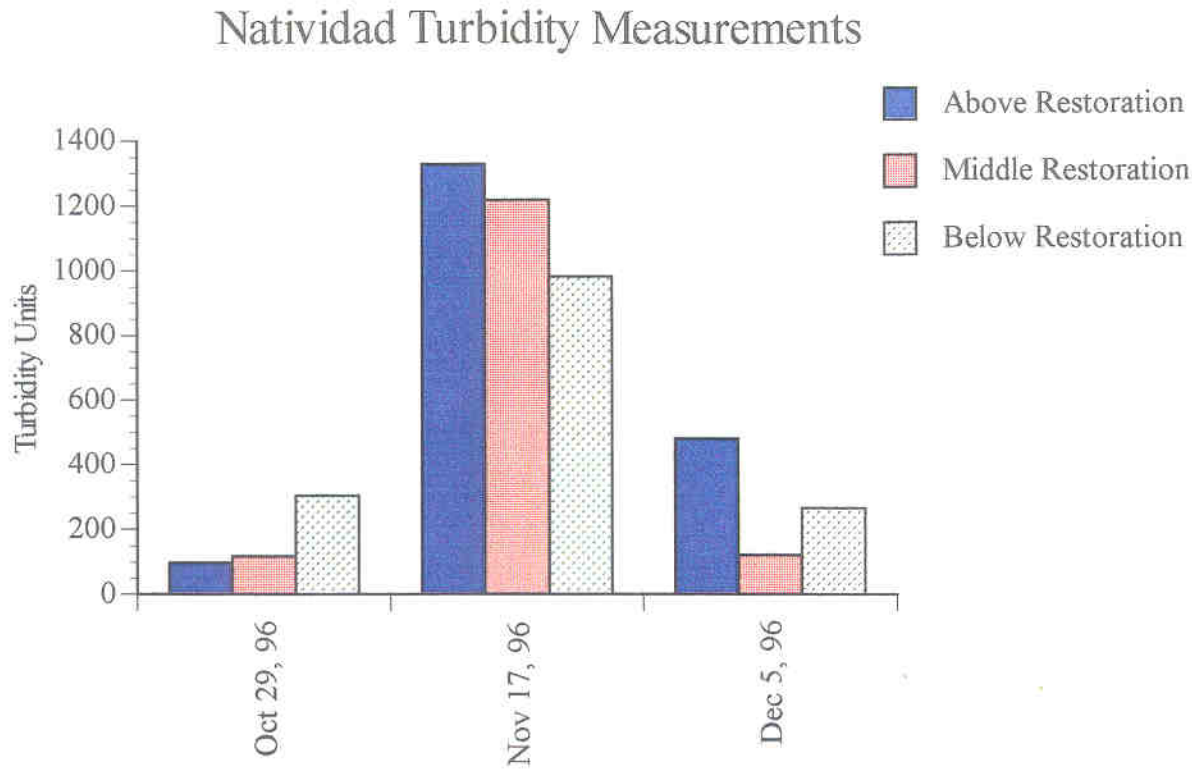
Turbidity measurements (Fig 12) were often greatest at the middle restoration monitoring station due to significant runoff from the dairy entering at this location. Measurements were consistently below 100 NTUs at the lower drainage but filtering trends were variable due to the multiple input points from both dairy and agriculture runoff.

Nitrate measurements were surprisingly low at all monitoring locations, but highest levels were from agriculture runoff into the upper restoration area. While effluent from the dairy was pungent, nitrate levels were below 1ppm on the Jan. 31 sampling date. Other forms of nitrogen such as ammonia or urea may have been very high but were not analyzed. Further analysis is warranted for this site.

1996-1997 Season

Turbidity measurements during the 1996-1997 season exceeded 2000 NTU at the upper and middle monitoring sites on one or both dates (Fig 13). Turbidity measurements in water flowing from the dairy were above 3000 NTU (the highest measured value in this study) but levels were below 100 NTU in water flowing out at the lower site, suggesting that large quantities of sediment are being filtered by this newly established wetland.

Nitrate concentrations were considerably higher at the upper monitoring station which receives water from adjacent agriculture parcels. Nitrates declined to below 10ppm and



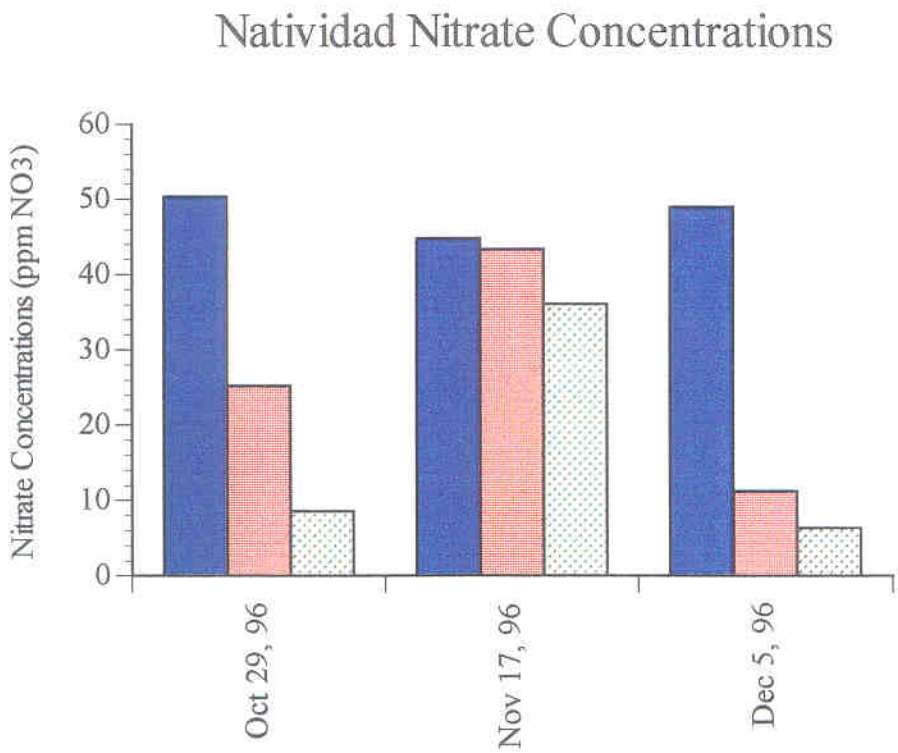


Figure 11. Turbidity and nitrate measurements at Natividad Creek Park 1996-1997.

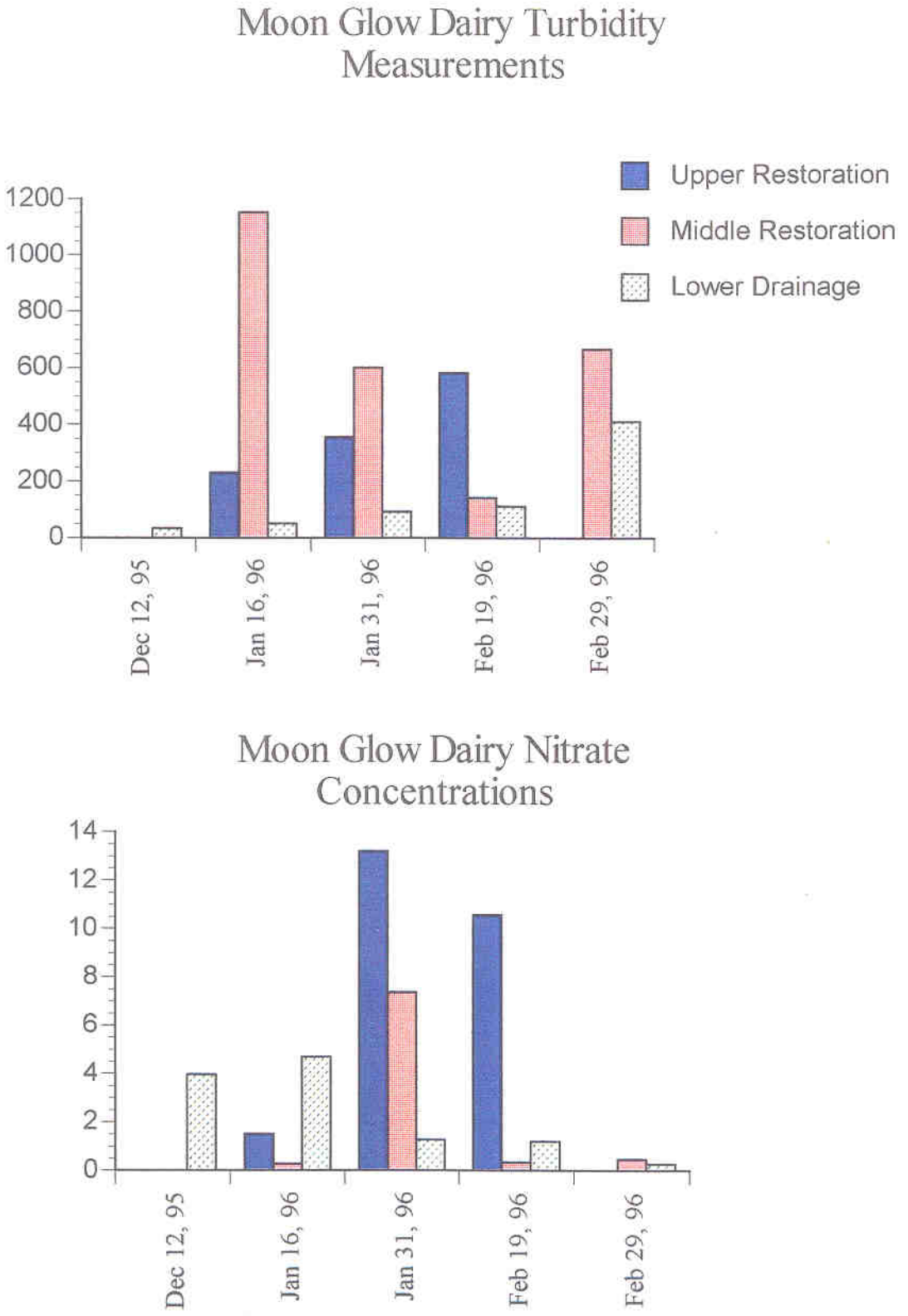


Figure 12. Turbidity and nitrate measurements at Moon Glow Dairy 1995-1996.

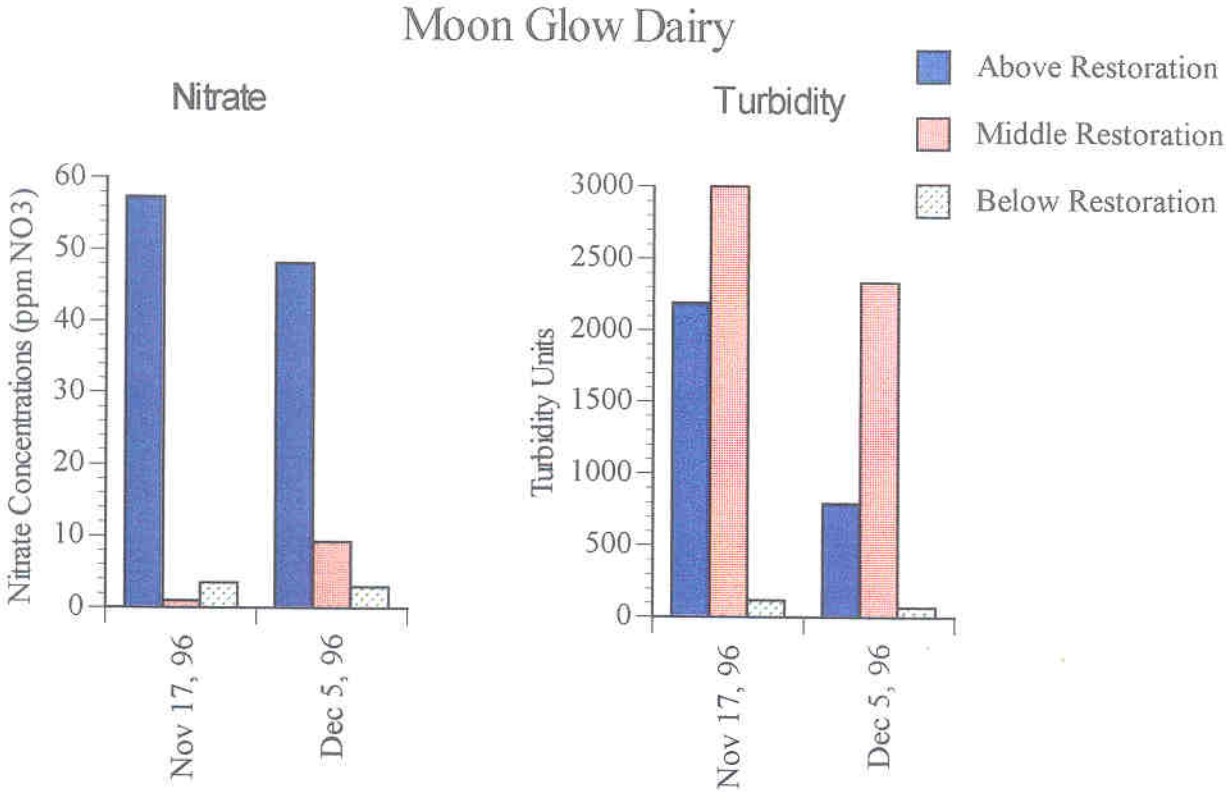


Figure 13. Turbidity and nitrate measurements at Moon Glow Dairy 1996-1997.

remained low at the middle and lower monitoring sites. Due to the short rain season, ammonia and urea measurements scheduled for the later season at the middle restoration site were not possible.

Walker Valley Restoration
1995-1996 Season

All water flowing into the restoration area soaked into the wetland area before reaching the lower end of the site. All sediment and nitrates were therefore absorbed into the system until February 19 when flow first reached the lower end of the restoration site (Fig 14). Turbidity levels increased during the last two sampling periods as water re-routed itself through the new wetland area. Nitrate levels during February were much lower than the previous periods, and no increases in nitrates were measured during later flows, suggesting that previous nitrate loads were absorbed by the restored wetland system. Slight decreases in nitrate levels were measured during later rain periods.

1996-1997 Season

No comparisons could be made between the upper and lower monitoring stations because on all monitoring dates water was completely absorbed by the restoration site. Additional sampling dates were scheduled for later rain events, but because of the unusually short rain season, sampling was not conducted during the single event where water flowed through the system.

Castroville Slough Reference Site
1995-1996 Season

The data from this reference location indicate that this unvegetated drainage ditch lacked the ability to filter or improve water quality (Fig 15). Turbidity levels remained similar at the two reference stations on all three dates demonstrating no filtering of sediment loads. Nitrates however increased considerably from the upper to the lower reference locations.

1996-1997 Season

Turbidity measurements at this reference location remained constant during the two measured rain events (Fig 15). Nitrate measurements decreased slightly but remained above 40ppm, demonstrating no filtering potential.

Water Quality Monitoring: Bivalve Tissue Samples

Results from the bivalve tissue bioaccumulation study are presented in Table 4. The overall pattern comparing concentrations of pesticides in tissue from clams outplanted at the upper drainage to those in the lower drainage suggests a significant reduction of the highest concentration chemicals in Natividad Creek. A more complex situation

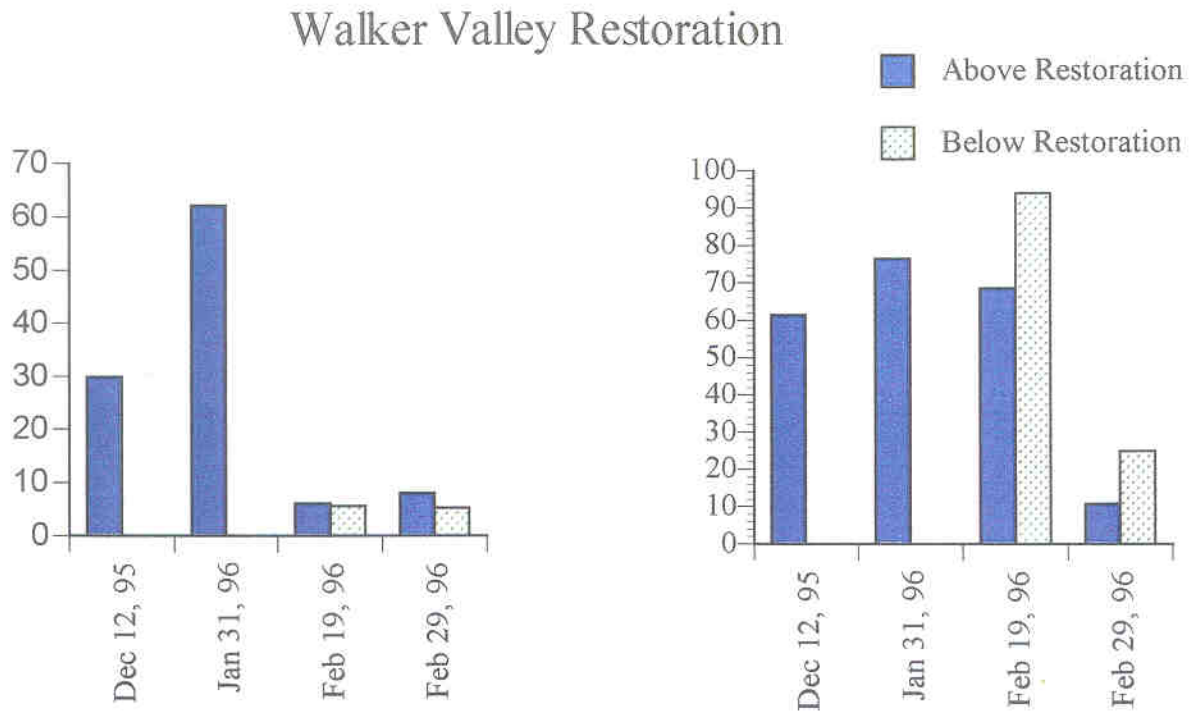


Figure 14. Turbidity and nitrate measurements at Walker Valley 1995-1996.

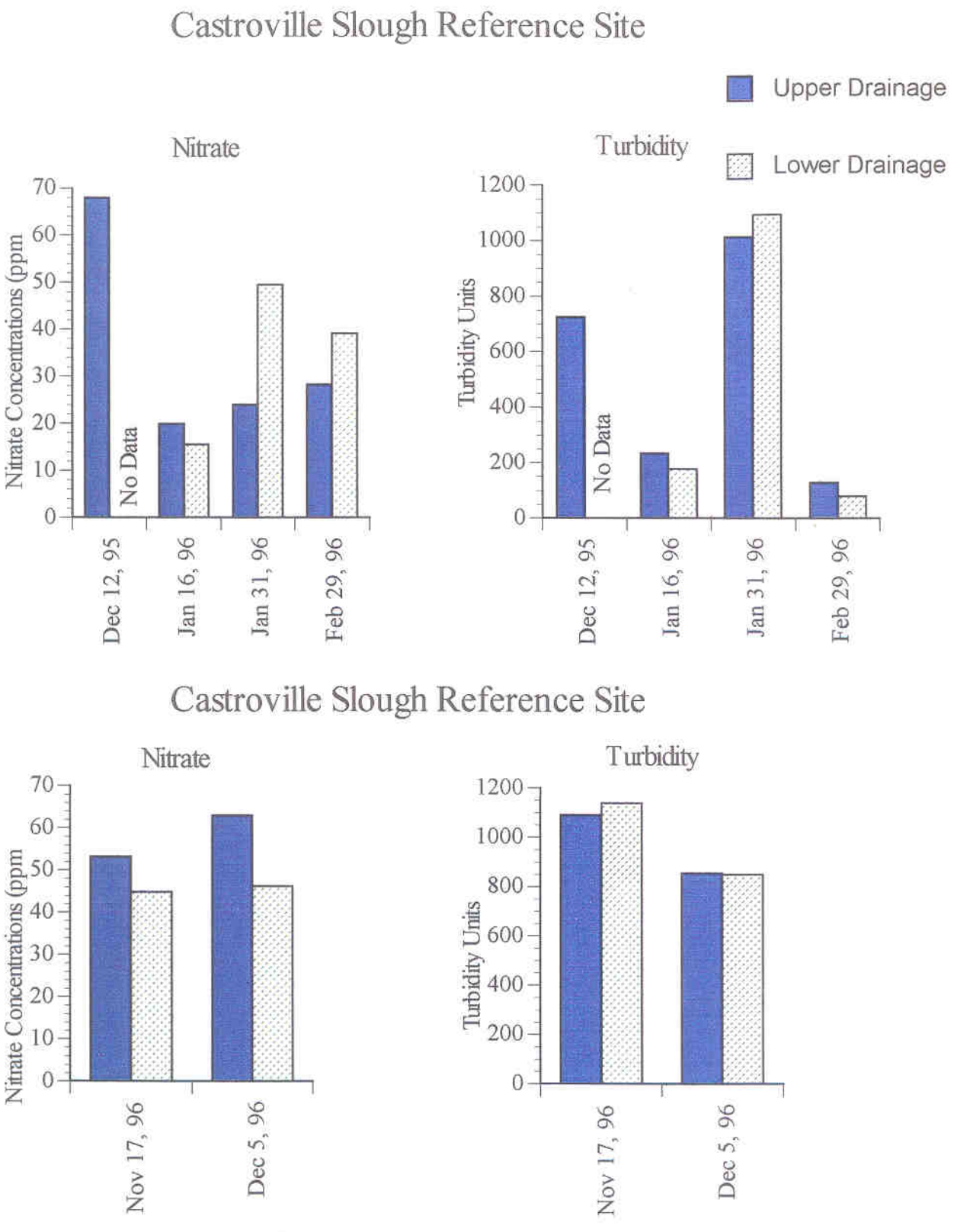


Figure 15. Turbidity and nitrate measurements at Castroville Slough Reference 1995-97.

Table 4: *Corbicula* Tissue Dry Weight Pesticide Results in ng/g

STATION	Hansen Slough - Upper	Hansen Slough - Lower	Natividad Creek - Upper	Natividad Creek - Lower
IDORG	96001	96002	96003	96004
DATE	3/1/96	3/1/96	3/1/96	3/1/96
SOWEIGHT	5.06	5.01	4.99	5.05
SOMOIST	84.2	91.4	91.47	92.4
PESBATCH	95.14	95.14	95.14	95.14
SODATAQC	-5	-5	-5	-5
ALDRIN	nd	2.65	1.40	nd
CCHLOR	8.81	24.1	36.6	49.2
TCHLOR	4.10	17.7	45.3	33.1
ACDEN	1.17	3.87	nd	2.32
GCDEN	nd	1.52	nd	nd
CLPYR	712	179	399	572
DACTH	3370	689	189	345
OPDDD	9.81	21.7	109	170
PPDDD	22.8	29.3	324	325
OPDDE	nd	72.0	48.9	6.33
PPDDE	86.8	2750	1970	231
PPDDMS	nd	nd	nd	nd
PPDDMU	nd	25.0	nd	nd
OPDDT	nd	477	305	19.0
PPDDT	4.25	692	1250	696
DICLB	nd	nd	nd	nd
DIELDRIN	119	237	681	578
ENDO_I	nd	19.2	18.9	20.8
ENDO_II	nd	nd	nd	nd
ESO4	nd	30.4	55.9	83.6
ENDRIN	11.2	nd	27.1	27.7
HCHA	nd	nd	nd	nd
HCHB	nd	nd	nd	nd
HCHG	nd	nd	nd	nd
HCHD	nd	nd	nd	5.93
HEPTACHLOR	nd	nd	nd	nd
HE	nd	nd	nd	6.25
HCB	1.42	9.69	6.55	1.97
METHOXY	nd	nd	nd	nd
MIREX	1.00	1.30	nd	nd
CNONA	nd	9.58	30.0	15.0
TNONA	5.61	37.3	44.3	32.5
OXAD	-9	-9	-9	-9
OCDAN	nd	nd	nd	nd
TOXAPH	377	374	3140	2340
Total DDT	124	4042	4007	1447
Total Chlor	12.91	41.8	81.9	82.3
Total Endo	0	19.2	18.9	20.8

Signifies major decrease in concentration from upper to lower station

Signifies major increase in concentration from upper to lower station

is occurring in Hansen Slough. In Natividad Creek, all chemical concentrations above 1000 ng/g (DDE, DDT, Toxaphine) were higher at the upper station than the lower. Similar trends were observed in Hansen Slough (Dacthal and Chlorpyrifos) with the important exclusion of DDT and its congeners. DDT compounds in Hansen Slough were found in much higher concentrations at the lower station, suggesting that an additional source of DDT is impacting the system, either from side drainages or from historic contamination in the Watsonville Slough adjacent to the site. The concentrations of DDT congeners at the lower Hansen station (Total DDT 4042 ng/g) are some of the highest values measured in the region for fresh water clams (Mussel Watch 1996). It is evident that historic pesticides are still extremely prevalent within the system and are passing through the drainages during winter storms.

Chemicals of lower concentration vary between stations but cannot be used for comparison because the lack of replication cannot distinguish differences between station variability and sample error. Therefore only chemicals of high concentration (>1000 ng/g, Clpyr 712 ng/g is included because of the notable difference between stations) could be compared between wetland stations.

Further studies are warranted and will be developed with assistance of the Water Quality Review Committee being developed by TAC members.

Water Quality Review

Wetland restoration activities described in this report have demonstrated the ability to improve water quality. Both nitrate and sediment concentrations decreased in some instances as water passed through a restored wetland system. The Hansen Slough Restoration site decreased nitrate and sediment loads 30 fold during multiple rain events of 1995-1996, with concentration leaving the lower end of the restoration below all water quality standards. As sediments became more anoxic, characteristic of wetland systems, the non-native plant community died, causing nitrates to leach into the system and decrease filtering potential.

The Natividad restoration showed little filtering potential during the first year while native plant abundance was low. With the establishment of dense native plant communities filtering of sediment and nitrate concentrations increased substantially. These two restoration sites demonstrate the importance of native plant establishment within vegetated wet corridors for water quality improvements. Comparisons to the unrestored Castroville Slough further suggest the establishment of native plants can have an important impact on water quality and have demonstrated their effectiveness as Best Management Practices for nutrient and sediment water quality problems.

Ecological Monitoring

Ecological monitoring of restoration projects has focused on plants as the best indicators of restoration success. Growth, survivorship and size of planted trees were measured annually near the end of the growing season and are relocated at all future monitoring dates using a global positioning system (GPS). The cover of major plant groups is measured from aerial or balloon photographs taken during peak green biomass at the end of spring each year. At the same time, more detailed measurements of plant cover and number are collected along line transects in major habitat types and the entire area is surveyed for the total number of plant species. The general development of plant communities and habitat is also documented in photographs and video taken at key overlooks and in representative habitat types. All ecological monitoring stations are located with GPS and data are being stored in a GIS database (Table 5).
Survivorship of planted vegetation was first determined by tagging all plants with ground markers and returning at a later date to assess health. With the new improvements of compact GPS equipment, we are able to document the exact position of all native plants and return to that position in the future without the need for ground markers. With this new technology we have been able to enter individual plants into a GIS Database for long term monitoring and graphical representation of all native plants. This has enabled us to document growth and survivorship as well as species density and abundance. Presently, survivorship has been estimated (Table 5) and growth will be measured as monitoring continues through the next few years. Location of all planted vegetation are presented with preliminary base map layers for Natividad Creek Park and Hansen Slough (Figure 16&17), and will be included in a region-wide GIS format as additional layers are created.

Each restoration site undertaken by the Watershed Institute follows the same native plant monitoring guidelines. The location of all native wetland trees and shrubs were documented using a Trimble Pro-XL TDC1 GPS unit that ran in real time and gave sub-meter accuracy. The location of the vegetation was recorded in Universal Transverse Mercator (UTM) coordinates. At the time the location was taken, other parameters were measured as well. The height of the tree was measured in meters from the ground to the top of the canopy using a pole that was marked off in centimeters. The width of the canopy diameter was measured in meters at the fullest part of the canopy from tree branch tip to tree branch tip. The base diameter was measured at two inches above the ground, and was measured in millimeters using calipers. The health of the tree was recorded in one of four categories: healthy, unhealthy, almost dead, dead. The original planting size of tree or shrub was recorded. For example, one gallon, five gallon, rose pot, cone, or cutting. The presence of drip irrigation for watering was recorded using the following perimeters: drip at the present time, dripped in the past, never dripped, or drip irrigation was present but there was a problem with it. Any other problems were noted at this time. All data was analyzed and corrected in Pathfinder Office software once returning to the office. All data will be input into a TNT MIPS GIS software in the spring of 1997.

Table 5. Number and Survivorship of Native Species Planted at Restoration Sites

Tree and Shrub Species	Natividad Creek Park				Hansens Slough				Moonglow Marsh		
	# planted in 1995	# planted in 1996	Total planted	% Survivorship as of June 1996	# planted in 1995	# planted in 1996	Total planted	% Survivorship as of June 1996	# planted in 1995	# planted in 1996	Total planted
Acer macrophyllum, Big-leaf maple	6	7	13	92.30%		2	2	0%			
Acer negundo, Box elder	32	51	83	98.80%	20	25	45	40%		4	4
Aesculus californica, Buckeye	39	63	102	98.10%						11	11
Alnus rubra, Red alder	55	20	75	98.70%	50	32	82	18.30%		4	4
Arctostaphylos pajaroensis, Pajaro manzanita		9	9	66.70%							
Artemisia californica, California sagebrush	9	16	25	96%							
Artemisia douglasiana, Mugwort	2		2	100%							
Baccharis pilularis, Coyote bush	26	42	68	100%	108	34	142	0.70%			
Baccharis salicifolia, Mulefat	3	18	21	100%		7	7	100%			
Ceanothus gloriosus, Ceanothus		7	7	100%							
Ceanothus thyrsiflorus, Blue blossum	6	10	16	100%							
Cercis occidentalis, Western redbud		2	2	100%							
Cornus sessilis, Creekside dogwood	42	238	280	94.30%	15	36	51	21.60%		29	29
Eriogonum giganteum, St. Catherine's Lace		15	15	47.70%							
Fremontodendron californica, Flannelbush		2	2	100%							
Heteromeles arbutifolia, Toyon		46	46	82.60%							
Juglans californica, California black walnut		2	2	100%							
Lupinus arboreus, Yellow bush lupine	2		2	100.00%							
Mimulus aurantiacus, Sticky monkey flower		41	41	85.40%							
Myrica californica, Wax myrtle		5	5	80%							
Platanus racemosa, Sycamore	40	64	104	97.10%		34	34	55.90%		3	3
Populus balsamifera, Black cottonwood	66	24	90	98.70%	50	141	191	47.60%		35	35
Prunus ilicifolia, Holly-leafed cherry	0	4	4	100%							
Quercus agrifolia, Coast live oak	55	84	139	99.30%						10	10
Quercus douglasii, Blue oak		2	2	100%							
Quercus lobata, Valley oak	2	46	48	100%							
Rhamnus californica, California coffeeberry	2	42	44	100%							
Ribes speciosum, Fuschia-flowered goosebe	8	35	43	93%							
Romneya coulteri, Coulter's matilija poppy		3	3	38%							
Rosa californica, California wild rose	5	62	67	98.50%							
Salix spp., Willow	1030	515	1545	NA	1000	1074	2074	NA		76	76
Salvia mellifera, Black sage	10	17	27	92.30%							
Sambucus mexicana, Blue elderberry	27	89	116	96.60%	20	25	45	11.10%			
Symphoricarpos albus, Snowberry		7	7	95.70%							
Umbellularia californica, Bay laurel		10	10	90%							
Total Number Planted	**1467**	**1598**	**3065**		**1263**	**1410**	**2673**			**172**	**172**

Grass, Sedge and Wildflower Species planted as rosepots or cones unless otherwise noted	# planted in 1995	# planted in 1996	Total planted	% Survivorship not yet determined	# planted in 1995	# planted in 1996	Total planted	% Survivorship not yet determined	# planted in 1995	# planted in 1996	Total planted
Achillea millefolium, Yarrow		1625	1625								
Artemisia californica, California sagebrush		98	98								
Bromis carinatus, California brome					50 lb		50 lb				
Carex obnupta, Sedge		950	950								
Deschampsia cespitosa, Tufted hair grass		1075	1075								
Elymus glaucus, Blue wildrye		2500	2500								
Elymus glaucus, Blue wildrye (seed)		50 lb.	50 lb.								
Eschscholzia californica, California poppy		850	850								
Festuca californica, California fescue		180	180								
Hordeum brachyantherum, Meadow barley		1200	1200		50 lb		50 lb				
Juncus effusus, Tall rush		1000	1000			113	113				
Juncus patens, Blue-green rush		1175	1175								
Juncus phaeocephalus, Iris leaved rush		520	520								
Melica imperfecta, Oniongrass, Melic		150	150								
Nassella pulchra,Purple needlegrass, (*Stipa*)		1645	1645								
Romneya coulteri, Matilija poppy		250	250								
Sisyrinchium, bellum, Blue eyed grass	50	150	200								
Total Number Planted	**50**	**13368**	**13418**		**100lb**	**113**	**100 lb,113**				

Table 5 cont. Number and Survivorship of Native Species Planted at Restoration Sites

Tree and Shrub Species	Walker Valley #planted in 1995	Walker Valley #planted in 1996	Walker Valley Total planted	Mo's #planted in 1995	Mo's #planted in 1996	Mo's Total planted	Porter # planted in 1995	Porter # planted in 1996	Porter Total planted
Acer macrophullum, Big leaf maple							10	6	16
Acer negundo, Boxelder					3	3			
Aesculus californica, Buckeye	1	1	2					5	5
Alnus rubra, Red alder	15		15		5	5	18		18
Arctestaphylos pajaroeysis, Pajaro manzanita									
Artemesia californica, CA sagebrush							15		15
Artemesia douglasiana, Mugwort									
Baccharis pilularis, Coyote bush	98		98					102	102
Baccharis salicifolia, Mulefat									
Ceanothus gloriosus									
Ceanothus thyrsiflorus, Blue blossum	4		4						
Cercis occidentalis, Western redbud									
Cornus sessilis, Creekside dogwood	1	2	3		8	8	10		10
Eriogonum giganteum, St. Catherine's Lace									
Fremontondendron californica, Flannelbush									
Heteromeles arbutifolia, Toyon	4		4		1	1	2		2
Juglans californica, California black walnut									
Lupinus arboreus, Yellow bush lupine									
Mimulus aurantiacus, Sticky Monkey					12	12			
Myruca californica, Wax myrtle	2		2	3		3			
Platanus racemosa, Sycamore	4		4	12		12	15		15
Populus trichocarpa, Cottonwood	18	7	25	20	5	25	515	125	640
Prunus ilicifolia, Holly leafed cherry									
Quercus agrifolia, Coast live oak	5	5	10	5		5	31	65	96
Quercus douglasii, Blue oak									
Quercus lobata, Valley Oak									
Rhamnus califiifornica., Coffeeberry					12	12	5		5
Ribes speciosum, Fuschia gooseberry	3		3						
Romneya coulteri, Matilija poppy									
Rosa calironica, California wild rose									
Salix spp., Willow	21	6	27	15	15	30	837	417	1254
Salvia mellifera, Black sage	2		2						
Sambucus mexicana, Elderberry	9		9		7	7	45	9	54
Symphoricarpus albus, Snowberry									
Umbelluluna californica, Bay laurel									
Total Number Planted	**187**	**21**	**208**	**55**	**68**	**123**	**1503**	**729**	**2232**

Grass, Sedge and Wildflower Species planted as rosepots or cones unless otherwise noted	# planted in 1995	# planted in 1996	Total planted	# planted in 1995	# planted in 1996	Total planted
Achillea millefolium, Yarrow					6	6
Artemesia californica, CA sagebrush						
Bromis ssp.						
Carex obnupta, Sedge	98		98			
Deschampsia cespitosa, Tufted hair grass						
Elymus glaucus, Blue wild rye						
Elymus glaucus, Blue wild rye (seed)						
Eschscholzia californica, Ca poppy						
Festuca californica, California Fescue	7		7			
Hordeum brachantherum , Meadow barley						
Juncus effusus, Tall rush	33		33	50	50	100
Juncus patens, Blue-green rush				50	50	100
Juncus phaeocephalus, Iris leaved rush						
Melica imperfecta, Oniongrass, Melic						
Nesselia pulchra,Purple Needlegrass, (stipa)				98		98
Romneya coulteri, Matilija poppy						
Sisyrinchium, bellum, Blue eyed grass	10 lb.		10 lb.	20	10	30
Total Number Planted	**10 lb, 138**		**10 lb, 138**	**218**	**116**	**334**

Figure 16. Natividad Creek Park planted vegetation.

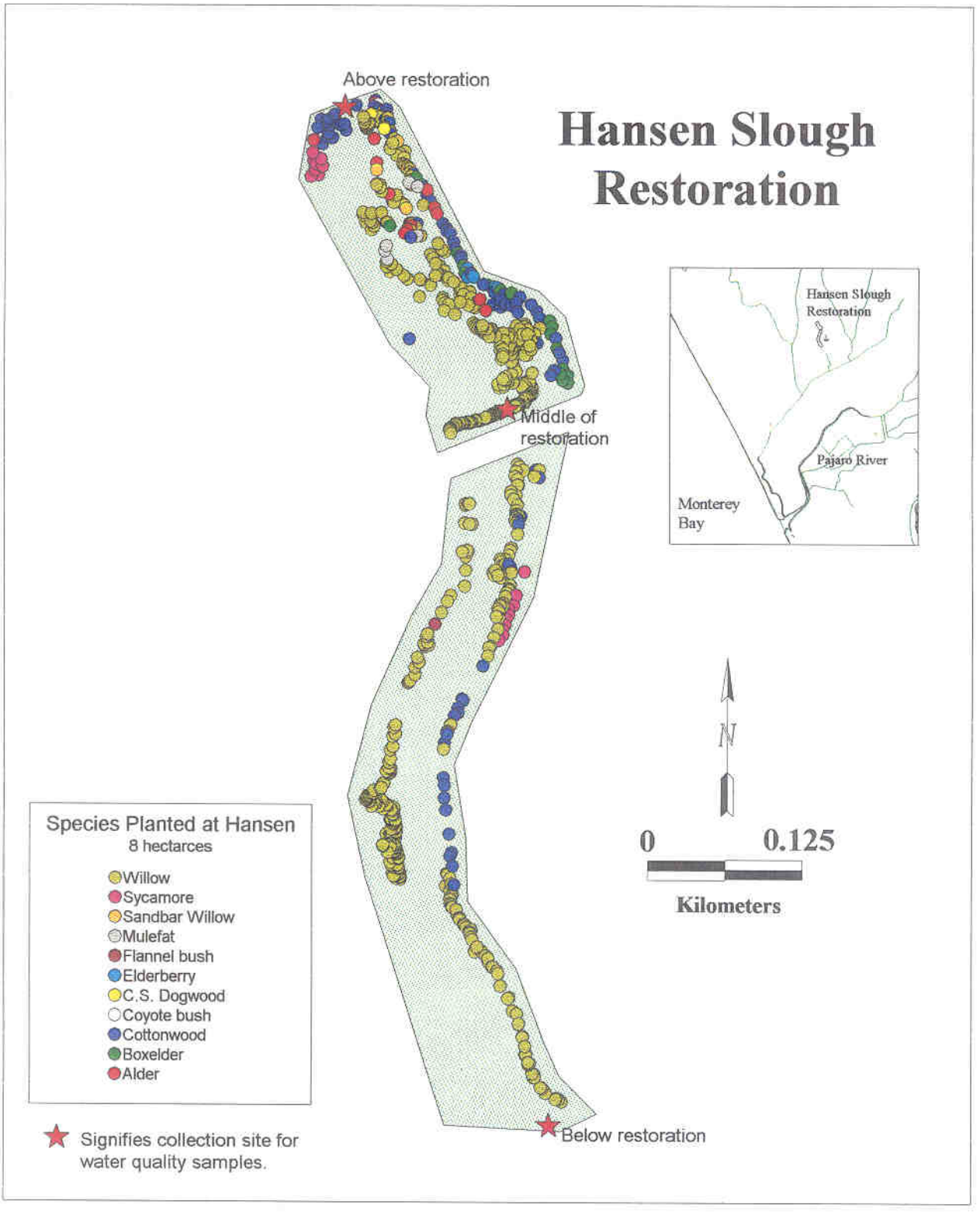


Figure 17. Hansen Slough planted vegetation.

Restoration Success and Plant Survivorship - Site Specific Results

Natividad Creek Park Restoration

Significant effort has been expended by the Watershed Institute, the City of Salinas, the Return of the Natives program (RON) and public volunteers to reach the high degree of success of the Natividad Creek Park Restoration project. Much of the restoration success is due to the student and community volunteers who were dedicated to this project. This site has been visited by over 1200 elementary and high school students through the RON Program. These students have helped grow native trees, shrubs, grasses, sedges, and wildflowers in school green houses provided by the RON program and planted them at the Natividad Creek Park. The increased number of plants and the thousands of volunteer hours have helped Natividad Creek Park be a model project for the City of Salinas and the Salinas Valley.

Over 14,000 native wetland trees, shrubs, grasses, sedges and rushes have been planted at Natividad Creek Park. The location of all trees and shrubs have been documented in the spring of 1996 using GPS equipment. At this time, the canopy height of the tree, canopy diameter, base diameter and general health of the plant was noted.

The Natividad Creek Restoration site has achieved an overall plant survivorship of over 90% (Table 5). The high survivorship is due to the significant care given to all plants through continued maintenance and the placement of a drip irrigation line which allowed constant watering during the first year, critical for some plant species. GIS mapping depicts the large number of species which have been planted throughout the riparian corridor and upland hillsides during the 1995 and 1996 seasons (Fig. 16). The ability to give such care is due to funds provided by the City of Salinas to maintain and preserve all plant materials as well as supplying a local source of irrigation water not available at other restoration sites.

Aerial photographs were taken at 5,000 ft in October of 1996 and again in March of 1997, several of which are presented in Appendix 1. These photographs will be used, along with vegetation data to create a GIS database in the spring of 1997. Survivorship will also be determined for the shrubs and trees in the spring of 1997.

Hansen Slough Restoration

The success of the restoration efforts at Hansen Slough is a direct result of our ability to redirect water from a drainage channel, causing it to flow over a broad, historic wetland corridor. Restoration goals have been directed towards creating an initial wetland habitat through planting primary colonizing trees and controlling dominant weed populations, creating a habitat capable of self sufficient community development. Most literature has demonstrated the ecological and economical success of restoration projects which initiate a natural succession pattern. Such succession patterns proceed naturally with only minor oversight and maintenance required. While this restoration project may take 20 years to

be fully restored, it will require little additional effort after the next weed control season.

The plant survivorship at Hansen Slough was much lower than at the Natividad Creek restoration. Probable causes of lower plant survivorship included lack of drip irrigation and unavoidable native tree losses from mowing to control weed populations. Survivorship estimates did not include willow trees because individual trees could not be identified within willow groves. This caused the survivorship totals to be much lower than otherwise would have been estimated (Table 5). Preliminary GIS mapping however depicts the large number of native plants and willow groves which have survived through 1996 (Fig. 17). As the weed populations are controlled this year, additional trees will be planted in areas which demonstrated superior survivorship for those species.

Such trial and error planting techniques appear to be a good method of restoration, because individual plants (especially willows) are inexpensive compared to maintenance and watering costs, and natural site characteristics must ultimately dictate the habitat structure.

The central region of the Hansen Slough Restoration site experienced a complete die off of all plant materials during the winter of 1996-1997. This die off of non-native plants suggest a change in habitat towards a wetland system with increases in anoxic sediment conditions. Additional native planting is scheduled for this region to increase native plant numbers and increase wetland filtering potential which should benefit water quality.

Aerial photographs taken with a balloon have been taken of the wetland site in the winter of 1995, spring of 1996 and will be taken again in the spring of 1997. Photographs are being digitized to document succession patterns within this wetland environment. An aerial photograph taken from 3000 ft was flown in the late winter of 1996 and again on March 28, 1997. These photographs will be digitized and along with all tree and shrub species data collected with GPS equipment will be input into a GIS database this spring. Several balloon and land based restoration photographs are presented in Appendix 1.

Moon Glow Dairy

Restoration efforts are still in the first year of implementation at this site. Most efforts have been directed toward keeping grazing cattle out of the wet corridors using wire fence. Fences were first erected in February while water was still present at the sight. Immediately after cattle were excluded, native rushes and sedges re-establish. After seven months of cattle exclusion this site has already developed a significant wetland habitat. Some wetland trees were planted this season but survivorship was low because planting did not occur until March (Table 5). Additional activities next season will include planting additional wetland grasses, shrubs and trees.

Restoration at the dairy centered around the building of barb-wire fences to exclude cattle from the wetland parcels. The perimeter of the fences were walked and recorded using Trimble GPS equipment. These data will be used in conjunction with parcel maps and

aerial photos that were taken in the late fall of 1996 to build a GIS database at the site.

Aerial photographs of the site have been taken in the spring of 1996 using a balloon and the area will be photographed in this manner again in the spring of 1997 to document succession of native wetland species within the fenced in wetlands. Several balloon and land based restoration photographs are presented in Appendix 1.

Walker Valley Property

This restoration effort is at the end of its third year and has developed a dense riparian community. Willow and cottonwood trees have grown to become dominant shade trees, helping to establish the riparian habitat. Little action is planed for the future other than minimal weed control. This property is a good example of how native riparian species can be used as landscaping to enhance the beauty of a residential property. As well as increasing the visual beauty of the sight and improving water quality passing through the property, new populations of frogs and other amphibians have been observed including the red legged frog and tiger salamander.

A total of 70 native wetland trees and shrubs have been planted at this site as well as hundreds of sedges and rushes (Table 5). All trees and shrubs were documented as above using GPS equipment. A subset of these will be revisited in the spring of 1997 to document restoration success at this site.

Aerial photographs have been taken of this site in the winter of 1995, spring of 1996 and will be taken again in the spring of 1997. Photographs are being digitized to document succession patterns within this wetland environment. An aerial photograph taken from 3000 ft was flown in the late winter of 1996 and again on March 28, 1997. These photographs will be digitized and along with all tree and shrub species data collected with GPS equipment will be input into a GIS database this spring. Several balloon and land based restoration photographs are presented in Appendix 1.

Mo's Tembladero Restoration

664 native wetland trees, shrubs, sedges and rushes have been planted at this restoration site (Table 5). All species were flagged when planted to aid in future identification. The location of all trees and shrubs will be taken using GPS equipment in the spring of 1997. Survivorship will be determined at this time. A subset of the trees and shrubs will be monitored to determine health and growing rates at this site.

Permanent ground photo points have been established to document the succession and restoration efforts along the Tembladero Slough. Photographs were taken in the spring and winter of 1996 and again on March 28, 1997. Selected photographs will be digitized and input into the GIS database in the spring of 1997.

Porter Ranch Property

The Porter Ranch restoration has centered around the exclusion of cattle from upland drainages. Seven exclusion corridors have been constructed with electrical fence and 420 hay bales have been used to slow down and pool the water that is running through the drainages. Over 1000 native tree and shrubs have been planted as well within the areas to slow down the erosion (Table 5).

To determine survivorship as well as document the effects of grazing on these species, the locations of all plants were recorded in the winter of 1996. All parameters were measured as well as the documentation of any significant grazing. A subset of these species will be relocated using GPS in the spring of 1997. Measurements will be taken relating to current canopy diameter, height and base diameter, as well as the health of the plant and the effects of grazing.

Permanent ground photo points have been established for all exclusion corridors as well as other areas of special interest. Pictures were taken in the spring of 1996 and will be taken at the same time in 1997. Aerial photographs were taken of the site in the spring of 1996 as well as the late fall of 1996. Photographs were taken at 3000 ft and were digitized into the GIS program for this property. These photos are being used to document the changes that are occurring at the site. A second aerial flight was flown on March 28, 1997 and pictures were taken again at 3000ft. These photographs will be input into the GIS database to document succession and success of the cattle exclusion areas in the spring of 1997. Several balloon and land based restoration photographs are presented in Appendix 1.

Castroville Slough/Chapin Property

90 native wetland trees and shrubs were planted on this property in the winter of 1996/1997. 20 pounds of a native seed mix were thrown on the site as well (Table 5). In 1997 all trees and shrubs will be visited to determine survivorship and a subset of these species will be measured for canopy height, canopy diameter, base diameter, and general health. The location of the subset will be documented using GPS equipment and will be entered into a GIS database that will be created in the spring of 1997.

Aerial photographs were taken of this site in October of 1996. Balloon aerial photographs were taken in the spring of 1996 as well. These types of photographs will be used in addition to the GIS database to document the success and succession of native wetland species at this restoration site. Several balloon and land based restoration photographs are presented in Appendix 1.

Bird Surveys of Restoration Site

Bird surveys were done in the spring of 1996 at three restoration sites (Table 6). Surveys were done by walking the entire sites and counting all birds found within or flying above the restoration area. Surveys were also done on adjacent property of two sites (Hansen, Moon Glow Dairy) which were not yet restored, to begin comparisons of bird habitat use.

A total of 41 species were observed at all sites during the bird surveys with a maximum of 14 species being seen at any one restoration or control site. The restored areas had fewer birds and less diversity than the control areas adjacent to the restored sites. The Hansen Control area had 14 species present and the greatest number of individuals, and the control area of Moon Glow dairy had a greater number of species and individuals in comparison to the restored portions. Natividad Creek Park had the greatest number of species and the greatest number of individuals present of all restored areas. The density and diversity of birds found in the control areas may have been influenced by cattle grazing occurring on those sites increasing the amount of disturbed ground cover and increased food available for spread cattle feed. The use by wetland species, however, was much greater in the restored wetlands and included mallard ducks and great egrets found only in the restored areas.

Additional plant and animals surveys are scheduled for the spring 1997, including bird population studies and plant succession experiments using various weed control activities. Insect studies addressing the role of wetland habitat in agricultural pest management will also be addressed in the future.

Table 6. Results of Bird Surveys at Restoration Sites

Common Name	Species Name	Moonglow			Hansen		Natividad
		So.	No.	Ctrl.	Restored	Ctrl.	Restored
American goldfinch	*Carduelis tristis*						3
Black phoebe	*Sayornis nigricans*					1	
Black-crowned night heron	*Nycticorax nycticorax*				1		
Black-shouldered kite	*Elanus caeruleus*				1		
Brewer's blackbird	*Euphagus cyanocephalus*			3		4	6
Brown towhee	*Pipilo fuscus*				2		
Brown-headed cowbird	*Molothrus ater*			2		5	
Bushtit	*Psaltriparus minimus*						15
California quail	*Callipepla californica*				5		
Cinnamon teal	*Anas cyanoptera*		4		5		
Cliff swallow	*Hirundo pyrrhonota*						12
Common raven	*Corvus corax*				2		
Common snipe	*Gallinago gallinago*			1			
Common yellowthroat	*Geothlypis trichas*				8		
Dowitcher	*Limnodromus sp.*	1		18			
European starling	*Sturnus vulgaris*					10	
Great egret	*Ardea alba*	1	1				
House finch	*Carpodacus mexicanus*	1			5	14	4
House sparrow	*Passer domesticus*					33	
Killdeer	*Charadrius vociferus*			10		9	
Least sandpiper	*Calidris minutilla*			12			
Lincoln's sparrow	*Melospiza lincolnii*				3		
Mallard female	*Anas platyrhynchos*	3	3				4
Mallard male	*Anas platyrhynchos*	1	2				
Mallard-Mexican integrade	*Anas platyrpynchos*		1				
Marsh wren	*Cistothorus palustris*						2
Mourning dove	*Zenaida macroura*						1
Northern oriole	*Icterus galbula*					4	1
Orange-crowned warbler	*Vermivora celata*				2		
Purple finch	*Carpodacus purpureus*					2	2
Red-tailed hawk	*Buteo jamaicensis*				1	1	
Red-winged blackbird	*Agelaius phoeniceus*	5	7	6	50	64	95
Ring-necked pheasant	*Phasianus colchicus*						1
Rock dove	*Columba livia*					62	
Sandpiper	*Calidris sp.*			7			
Song sparrow	*Melospiza melodia*				12		4
Tricolored blackbird	*Agelaius phoeniceus*						10
Turkey vulture	*Cathartes aura*					1	
Western sandpiper	*Calidris mauri*			1			
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*					5	
Yellowlegs	*Tringa sp.*			1			
Total Number of Individuals		**12**	**18**	**61**	**97**	**215**	**160**
Total Number of Species		**6**	**6**	**10**	**13**	**14**	**14**

Technical Advisory Committee

First TAC Meeting

The first meeting of the joint 205j 319h Technical Advisory Committee was held on July 29, 1996. The committee reviewed previous planning work in the complimentary 205j contract and the water quality data collected by this monitoring program during the 1995-1996 rain season. In addition the TAC agreed to continue to review the 319h contract activities as a joint 205j-319h committee.

Issues raised during this meeting included the need for hillside riparian restoration as a method of flood control and water quality improvements, particularly for ground water. Additional concerns were raised about land access processes and the ability to fulfill the requirement of the 319h contract to gain two conservation easements. Both concerns represent two of the most crucial problems of the Salinas Valley; the lack of ground water recharge and the need for access to historic wetland property for restoration. Both issues are being addressed by the Watershed Institute Working Group partnerships. Ground water recharge studies are being planned for several restoration sites and the Watershed Institute and Sustainable Conservation will continue efforts to develop positive incentive programs for land owners.

Second TAC Meeting

The Second meeting was held on November 14, 1996 and reviewed a draft version of the North Salinas Valley Restoration Plan including a discussion of land form changes suggested within the document. Concerns were voiced regarding channel modifications which could increase the water height in wetlands adjacent to farm land. Many local farms use tile drains which allow irrigation water to drain directly into the drainage channels and the increased water height would cause water to flow up into farm land. We agreed land form changes to drainage channels in areas which use tile drains would be directed at increasing drainage area but not height of the water table.

Third TAC Meeting

The Technical Advisory Committee completed the third meeting on January 8, 1997 regarding local wetland restoration activities. The AMBAG 205j *Northern Salinas Valley Watershed Restoration Plan* has been completed and accepted by the TAC to stand as the guiding document for the use of wetland restoration to improve surface water non-point source pollution within the Salinas Valley. Further, the TAC has reviewed water quality data from this 319h program and determined that the monitoring information collected from several of the restoration areas has successfully documented improvements to water quality. Suggestions given by TAC members were incorporated into the Watershed Institute water quality monitoring plan and are listed below.

- Long term water quality data should continue to be collected at a limited scale.
- Additional water measurements would be more cost effective than sediment analysis until tissue analysis data is received and reviewed.
- The development of a Water Quality Review Committee should be formed to better develop future monitoring goals.
- Additional money will be sought to continue monitoring and water pollution research within the restored demonstration projects.

The Next Step

Future Restoration Plans

Several additional properties are targeted for restoration along the Moro Cojo Slough (Fig. 18). One restoration project being planned is a joint project working with RON and the North County High School on property along the upper Moro Cojo, helping to fulfill mitigation requirements of the North County High School Coastal Development Plan. This and other proposed restoration activities directly follow actions identified within the Moro Cojo Restoration Plan (1997).

Other proposed restoration areas which are being negotiated with land owners include property within the lower Moro Cojo Slough and a parcel within the Castroville Slough drainage. Restoration activities will also be directed towards the upper part of the watershed including the Natividad Creek/Carr Lake district and the Salinas hill sides. A 319h grant has been awarded to the Watershed Institute to continue the restoration activities begun within this grant and to begin additional sites.

Planning Restoration Activities in the Salinas Valley

Additional parcels are being discussed for access or are in the first stages of restoration. Future sites of restoration include the National Wildlife Refuge Salinas River Restoration area, the Tottino property, and the North Monterey County High School/Moro Cojo site (Fig. 18). A preliminary restoration plan has been developed for the NMCHS/Moro Cojo project and is included in the appendix.

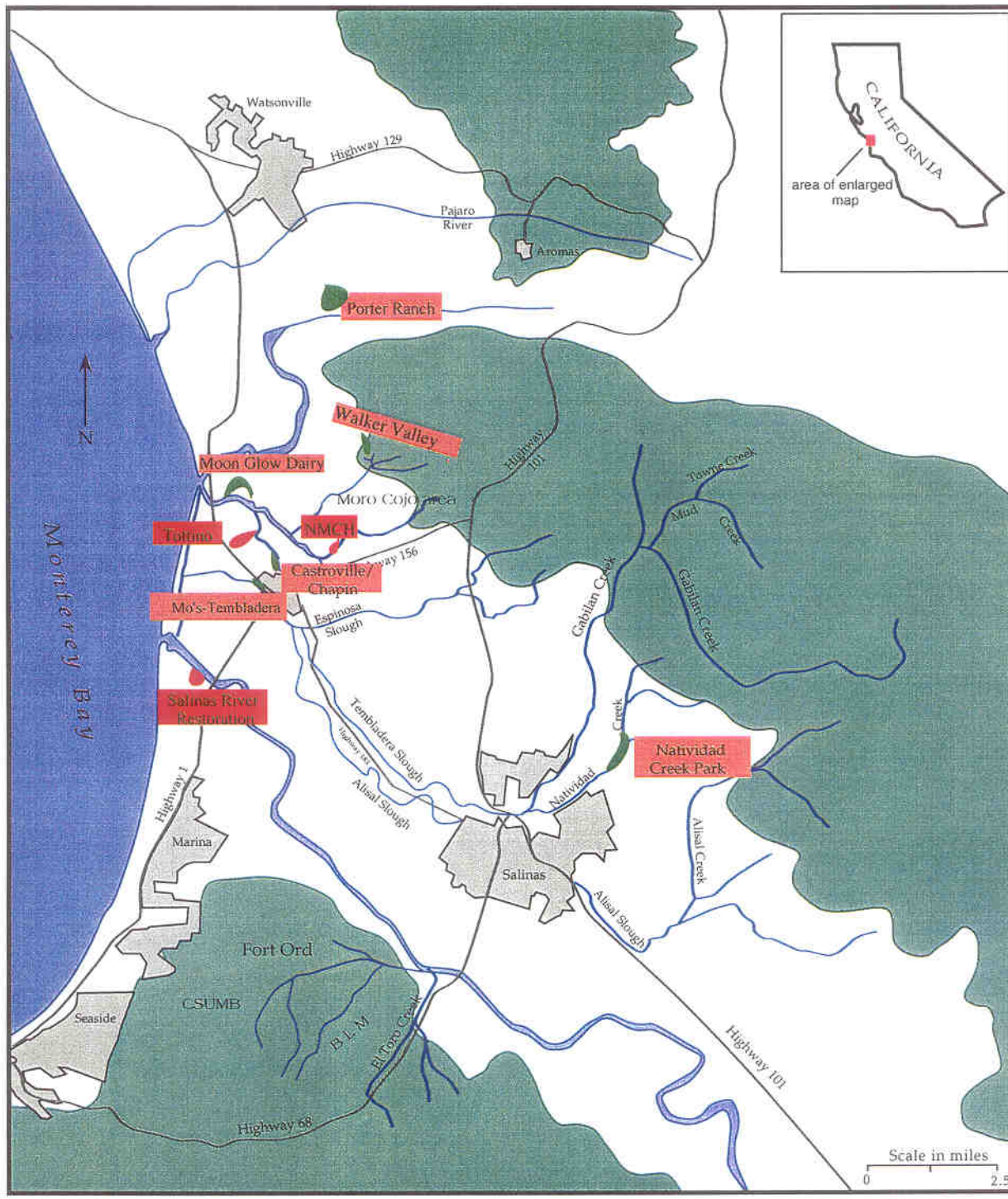


Figure 18. Proposed future restoration sites - (marked in dark red) and local restored wetlands sites (light brown).

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