Watershed Management and Enhancement for the Morro Bay National Estuary: A Geographic Appraisal

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Introduction

Watershed management and water quality are central concerns in the area of natural resource management. Geographers' concern with regions and complex human and environmental interactions means that the profession has much to contribute to the study of watershed function, management, and change. This paper discusses the geographic implications of watershed management for water quality within the context of the Morro Bay National Estuary on the central coast of California. A discussion of the geographic and organizational issues related to watersheds leads to a regional overview of Morro Bay and its watershed, followed by a description of the locally led effort to organize a watershed management initiative and identify the problems affecting water quality. Enhancement projects implemented so far are outlined before an examination of the challenges that must be overcome in the watershed management process, based on experience in the Morro Bay area.

Regions and Watersheds

We have all heard the popular expression–*think globally, act locally*. Forman (1995, p.488) suggests that the optimum scale for planning is the region. A region is a geographic unit of the earth's surface that contains distinctive patterns of physical geography (e.g., climate, geology, vegetation) or human development (e.g., land use, policy, culture). A region encompasses a common sphere of human activity that links the physical environment with the human dimensions of resource utilization and landscape change.

A watershed is a geographic region. A watershed is all of the land area that drains to a common end point, such as a river, lake, or estuary. Sommarstrom (1994) accurately predicted that watershed management would be the hot topic in natural resource management for the decade of the 1990s. National policies often impose blanket rules that fail to consider the uniqueness of local resources and problems. Meanwhile, local policy and planning efforts can be piecemeal and unable to

transcend and link the complexity of larger issues and institutions. Watershed management provides an integrated regional approach to managing natural resources, at a scale that makes sense for planning.

Richard Wilson (1994), former director of California Department of Forestry and Fire Protection, stated that the watershed is a fundamental building block of landscape. Whereas political and administrative boundaries are artificial and typically drawn to exclude, watershed boundaries are inherently inclusive of many natural and social processes. People can relate to watersheds as both natural resource and community units. Wilson adds that watersheds are an important part of their sense of place, especially for rural dwellers. Individuals often identify strongly with a region or regional culture. This regionalism can act as a cohesive force and a catalyst for action. Furthermore, watersheds often transcend county and even state boundaries, thus emphasizing the need for coordinated management with a spatial component.

The analytical framework of geography has much to contribute to the understanding of watersheds and their management. Geography is a field of study that focuses on the interrelationships between the physical environment and human activities on the earth. It is a holistic discipline that links people and the land. As geographers, we must cultivate this human connection to the land, especially among urban dwellers, and provide a means through which people can learn how watersheds function, understand the human impacts on watershed health, and participate in the management of a watershed's resources. Geographers also study regions. A comprehensive regional approach that links natural resources and land use planning issues can aid in understanding and solving problems.

The 1990s saw the proliferation of over 1,500 locally led watershed management initiatives in the United States (Lant 1999). Griffen (1999) uses the term *watershed council* to describe an emerging form of public participation in natural resource management that includes local stakeholders in the resource management process. These efforts represent a trend toward private-public partnerships that bring together governmental institutions, non-governmental organizations, and individuals to manage local resources and land uses within a complex political and legal environment. The watershed council is a pragmatic action-oriented vehicle for resource managers and stakeholders to address common concerns at a scale the makes sense socially, ecologically, and spatially.

The policy impetus behind the watershed management movement is the enhancement of water quality. Water is an essential resource and serves vital functions for municipal water supply, agriculture,

recreation, and wildlife. Land management practices and other human impacts have the potential to affect the quality of water, and either enhance or degrade the activities that rely on it. Kenney (1999) notes that water links a host of otherwise distinct interests and activities, demanding coordinated planning and action at physically relevant regional scales.

Current water pollution law traces its roots to The Federal Clean Water Act, passed in 1972 (Gallagher and Miller 1996). The Clean Water Act addressed "point source" pollution, such as discharges from a factory or wastewater pipe. The Act was amended in 1987 to address "nonpoint" source pollution, which is the result of run-off over large or diffuse areas. Common non-point sources of pollution are fertilizer and pesticide runoff from agricultural lands, fecal contamination from rangelands, soil erosion, and a multitude of pollutants in urban storm runoff. Nonpoint source pollution often has no single identifiable source, meaning it is more difficult to locate, address, or regulate than point source pollution. Therefore, the organizational and geographic characteristics of watershed management provide an appropriate and effective mechanism for addressing problems related to water quality and nonpoint source pollution.

Morro Bay and Its Watershed

Morro Bay is the most important wetland system in central California between Monterey and Point Conception. The bay's 2,300 acres serve as habitat for migratory birds, as a nursery for numerous fish species, and as home to a diverse collection of wildlife, many of which are endemic to the region (MBNEP 2000b). The Bay and surrounding area are one of the last relatively undeveloped and unspoiled places along California's coast. Morro Rock, a 587-foot volcanic plug at the entrance of the bay, is symbolic of the scenic beauty of the region that attracts visitors from all over the globe.

The Morro Bay watershed is all of the land area that drains into the bay (Figure 1). The watershed covers approximately 48,450 acres or 75 square miles. The highest elevation within it is 2,763 feet above sea level, and the furthest point extends 10 miles from the bay. The watershed is comprised of two major sub-watersheds. Chorro Creek drains approximately 60% of the watershed and Los Osos Creek drains 40% of the watershed. The climate and vegetation of the area are quintessentially Mediterranean. Winter storms deliver up to 22 inches of annual rainfall, while summer is characterized by a near absence of rainfall that accounts for the region's golden brown hills. The primary vegetation types are annual grasslands, oak woodland, and chaparral.

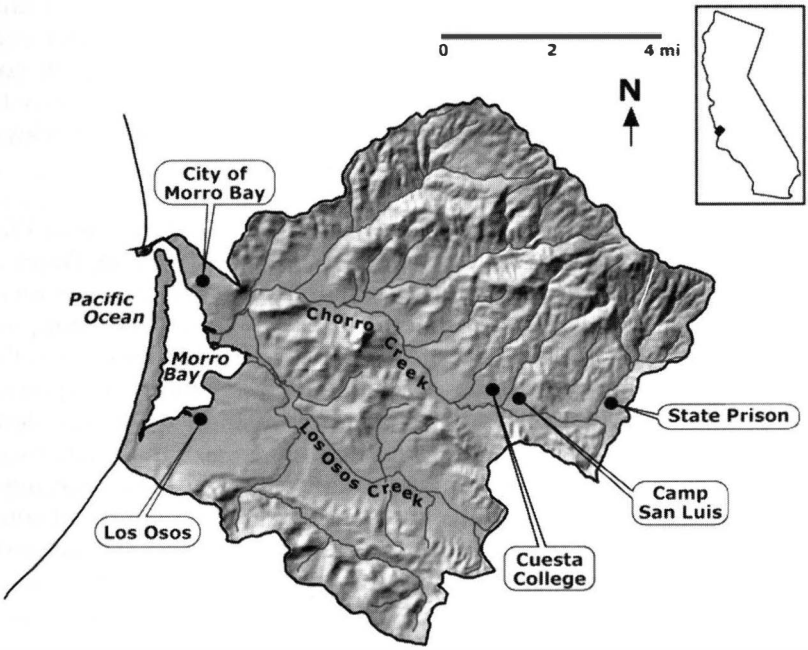

Figure 1: Morro Bay Watershed

The population of the Morro Bay watershed has doubled to approximately 40,000 over the last thirty years, with proportional impacts on the natural resources. The two principal urban centers are the city of Morro Bay, with a population of 9,845, and the unincorporated area of Los Osos/Baywood Park, encompassing a population of 18,000. In 1970, the Los Osos area had only 3,450 residents. Despite this rapid growth, Los Osos residents still rely on septic tanks. The other major population center is the state prison (California Men's Colony) that contains an inmate population of 9,000. The prison relies on a wastewater treatment plant that was installed in 1943, and suffers frequently from technical problems. Cuesta Community College, with an enrollment of nearly 8,000 students, also affects the watershed, as does the National Guard Camp San Luis Obispo, with 1,000 members.

The resources of Morro Bay and its watershed support numerous economic uses. The Bay is home to 75 commercial fishing boats, earning $4.6 million annually (CDFG 1999). Recreation and tourism draw an average of 4,000 tourists per day to the bay and surrounding area. The Morro Bay watershed has three state parks, a county park, three camp-

grounds, two 18-hole golf courses, two bird sanctuaries, and numerous designated nature trails. Other recreation activities include swimming, boating, kayaking, whale-watching excursions, and sightseeing. Tourism and visitor services dominate the economy of the City of Morro Bay, accounting for 37 percent of all jobs in the city and one-third of the city's general fund revenues (MBNEP 2000b). Morro Bay has 42 motels, and the scenic beauty of the area is a primary draw for the people who stay in them. A strong local economy is clearly linked to good environmental management.

The State Water Resources Control Board (referred to as the Regional Board) is the state agency that regulates water quality. The United States EPA and the Regional Board have identified 18 *beneficial uses* of the waters of the bay and watershed (Table 1). A beneficial use can be anything that relies on the water supply in a given watershed area. Table 1 reveals a complex pattern of land and water use in the Morro Bay watershed. The uses can be summarized into three general categories–economic, social, and environmental (or biological). It is also evident that some of these multiple uses are competing or mutually incompatible. Protecting for one use may degrade another. By law, however, all of the uses are protected, which means that a balance must be found that protects them all. Stakeholder groups must consider the needs of others in an effort to find a balance that protects and optimizes the most uses. Furthermore, Morro Bay and Chorro and Los Osos Creeks are listed as impaired by the state (SWRCB 1999), meaning that the activities in the watershed are subject to regulation in order to enhance water quality.

Table 1: Beneficial Uses of the Waters of the Morro Bay Watershed

Agricultural water supply
Commercial and sport fishing
Navigation
Aquaculture
Shellfish harvesting
Water contact and non-contact recreation
Industrial service supply: cooling water for electric power generation
Wildlife habitat
Rare and endangered species habitat
Municipal and domestic waters supply
Groundwater recharge
Cold freshwater habitat
Warm freshwater habitat
Migration of aquatic organisms
Spawning, reproduction, and/or early development of fish
Biological habitat of special significance
Estuarine habitat
Freshwater replenishment

(Source: MBNEP 2000b)

The Organizational Effort

In 1966, the California State Senate declared, "the preservation of Morro Bay's fish, wildlife, recreational, and aesthetic resources was of great importance to the people of California" (MBNEP 2000a). The resolution also recognized the need for a comprehensive approach to managing the resources of the estuary and watershed. In the early 1970s, the Morro Bay Task Force was formed and developed the first management plan. Lack of community involvement meant that this effort faded and resulted in no lasting action.

In 1986, the Task Force was reestablished. This time, the effort was supported by the creation of two non-governmental organizations. The Bay Foundation manages restoration funds, while The Friends of the Estuary promotes education and advocacy. Over time, the Task Force grew to more than 250 participants. In 1990, the California State Assembly affirmed the importance of the bay and supported the nomination of Morro Bay as a National Estuary. In that year, a "State of the Bay" conference was held. In 1994, the Governor established Morro Bay as California's first State Estuary, stating the bay was "one of the state's rare natural treasures" (MBNEP 2000a). In 1995, after nearly two decades of grassroots efforts, U.S. EPA named Morro Bay a National Estuary, one of only twenty-eight in the nation. The Morro Bay National Estuary Program (MBNEP) was formed, which receives $300,000 annually from EPA. However, MBNEP is a public-private partnership. The organization also receives financial and material support from the Regional Board (a state agency), and the Bay Foundation (a non-governmental organization) holds and disperses program funds.

The purpose of the Morro Bay National Estuary Program is the development and implementation of a Comprehensive Conservation Management Plan, or CCMP (MBNEP 2000a). The generation of the CCMP involved a coordinated local effort to bring together all of the stakeholder groups. The goals of the CCMP are to restore and maintain the health of the Bay and watershed, to address point and non-point sources of pollution, and to protect the beneficial uses of the waters and resources of the bay and watershed. In July of 2000, after four years of research and community meetings, the MBNEP staff completed the CCMP for Morro Bay and its watershed. To bolster the watershed management process, in 1997 the MBNEP was awarded $3.7 million from water quality mitigation funds levied on PG&E's Diablo Canyon nuclear power plant.

The guiding principles for implementing the CCMP include federal, state, and local coordination, private/public partnership, public involvement

in decision-making, and scientific credibility. A high level of governmental participation is essential because of the legal, regulatory, financial, and policy actions that are required to change the way natural resources are managed. Public involvement, especially among business and agricultural interests, is important in order to gain support for the policy changes and for the acceptance of new land management practices. Good scientific data add credibility to the call for change.

The organizational structure for CCMP implementation is composed of the executive committee, the implementing committee, the task force, and the MBNEP staff. The eleven-member executive committee is the policy and decision-making body. The membership on the committee represents a balance of sectoral and regional interests. Government at all levels is represented and includes U.S. EPA, the Regional Board, San Luis Obispo County, City of Morro Bay, and Los Osos Community Services District. Non-governmental interests are represented by the Bay Foundation and stakeholder groups such as agriculture, commercial fishing, and environmental organizations.

The function of the implementing committee is to provide professional review of CCMP actions, including research, evaluation, and monitoring. Committee members are organized into technical, finance, and outreach education work groups. The task force is open to all interested participants and acts as a public forum for information sharing. The role of the MBNEP staff is the coordination and management of all activities that are carried out under the MBNEP umbrella. Staff are the day-to-day managers who administrate the program. The MBNEP staff includes a program director, a scientific coordinator, a public outreach coordinator, interns, and an office manager.

Priority Problems

Morro Bay National Estuary Program staff, through research and public outreach efforts, identified six *priority problems* affecting water quality in Morro Bay and the watershed (MBNEP 2000a). The most important problem is accelerated sedimentation of the bay. Tetra Tech's (1998a) bathymetric survey and Haltner's (1988) historic data (from 1884, 1919, 1935, and 1987) indicate that Morro Bay is filling in with sediment at ten times the rate that would be expected without human disturbances in the watershed. Between 1884 and 1998, the mean high water area of the bay decreased by about 15 percent, and the area at the lowest tides decreased by about 60 percent. Without mitigation, the bay will fill completely in 300 years and threaten many of the beneficial uses in the process. Sediment is a direct threat to estuarine and freshwater habitat and is detrimental to navigation and the fishing industry. The Army

Corps of Engineers dredges the main navigation channel in the bay every five years, at a cost of $4.56 per yard of sediment removed (MBNEP 2000b).

The Tetra Tech sediment loading study (1998b) surprisingly indicated that the most significant source of sediment in Morro Bay was erosion from chaparral-covered National Forest lands in the higher elevations of the watershed. These lands are periodically scorched by wildfires, and when followed by a high precipitation El Niño year, several feet of sediment can be deposited in the bay in a single year. This indicates that not all sources of erosion are human caused, and also emphasizes the need for cooperation among all levels of government in local watershed management efforts. Eroding streambanks are another important cause of erosion, especially when riparian vegetation has been deliberately removed or when the banks are trampled by cattle. Other sources of erosion include bare ground in farm fields, improperly installed or maintained unimproved roads and culverts, and urban run-off from construction sites and other non-vegetated areas.

The second priority problem is high bacteria levels. One of the main contributors is failing septic systems. This is especially true for Los Osos/Baywood Park, an urbanized area of 18,000 people without a public sewage treatment facility. In 1998, after years of disagreement, the state mandated the installation of a sewer, but problems related to cost, location, design, and permitting have delayed construction. Discharged effluent from the state prison (inmate population 9,000) is often contaminated because of treatment plant failures. Illegally moored boats and improper marine sewage disposal present additional problems. Others sources of bacteria include domestic animal waste and runoff from rangeland cattle operations. High bacteria levels threaten recreation, a commercial shellfish operation in the bay, and the drinking water supply in Los Osos/Baywood Park.

The third priority problem is nutrients, primarily in the form of nitrogen. Excess nutrients promote the growth of algae that reduces the level of dissolved oxygen in the water, resulting in degraded habitats and fish kills. The primary causes of nutrient pollution are leaking and failing septic systems, urban and agricultural fertilizer runoff, wastewater discharges, and animal waste.

The fourth priority problem is low levels of freshwater flow in the dry season. This problem affects habitat such as stream environments that support the endangered steelhead trout. Agricultural water supply and groundwater recharge are also threatened. Chorro and Los Osos Creeks are "fully appropriated" for much of the year, and extraction sometimes

exceeds flow when water is poorly managed. In addition, urban users continue to waste water as many people treat water as ubiquitous and basically a free good. They often do not understand where their fresh water originates and the impacts they have on the watershed.

The fifth priority problem is toxic pollutants. Urban runoff contains oil, gasoline, tire and brake-pad dust, household chemicals, and industrial contaminants. Pesticides are the primary agricultural pollutant. Other sources include runoff from inactive mine tailings, solid waste disposal areas, illegal chemical disposal, and boat paints and boat repair activities. Toxic pollutants affect fish spawning and other habitats, shellfish harvesting, and water recreation.

The final priority problem is habitat loss. This problem is integrally linked to the other problems mentioned above because development, agriculture, and recreation all can damage habitat. Some of the most threatened habitats are eelgrass beds, wetlands, coastal dune scrub, and riparian area vegetation.

The discussion of the priority problems indicates that there are a large number of causes of impaired water quality in Morro Bay and its watershed. However, identifying the problems is only the first step toward enhancement of the region's resources. The challenge lies in finding solutions that can effectively address multiple problems that have multiple contributors. An integrative regional approach that links human impacts and land processes is required for sustained progress. The comprehensive conservation management plan (CCMP) represents an effort at such an approach.

Enhancement Projects

Although the CCMP was only recently completed and the MBNEP is just entering the implementation phase, affiliated agencies have been working to address the problems identified above and to enhance resource management practices in the Morro Bay watershed. The Morro Bay Watershed Enhancement Project (MBWEP) funded projects from 1991 to 1999 (Robbins 1999)[1]. Approximately $1.2 million dollars were spent on more than 235 water quality enhancements (Figure 2).

The MBWEP installed a sediment trap at Chorro Flats near the mouth of Chorro Creek. In the late 1940s, Chorro Creek was channeled into a 15-foot high levee, the riparian vegetation on Chorro Flats was cleared, and the area was put into irrigated agriculture. The levying of Chorro Creek increased the depth and velocity of its flow, thereby increasing the sediment load carried directly into the bay. In 1993, 85 acres were

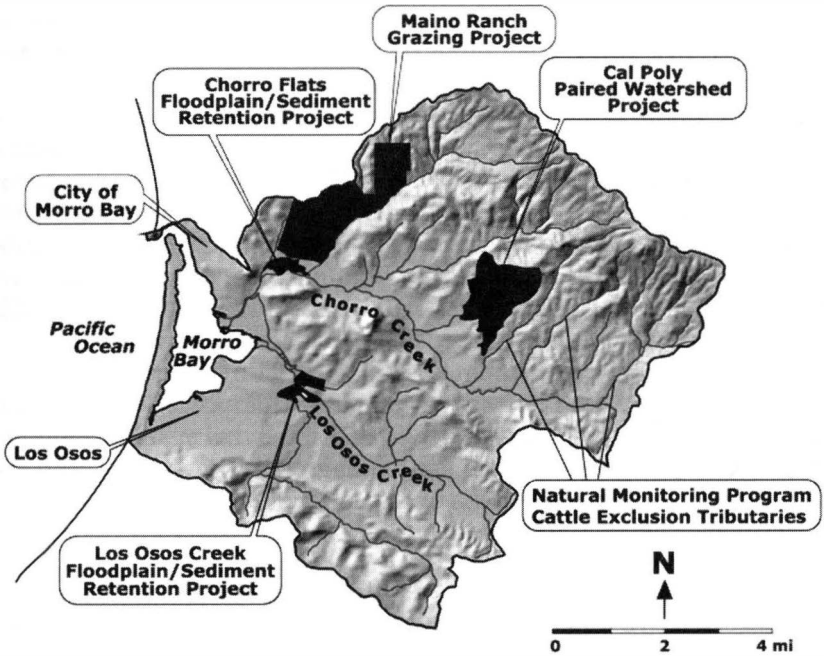

Figure 2: Enhancement Projects in the Morro Bay Watershed

purchased to create the Chorro Flats Sediment Trap and Habitat Restoration Project. A new levee was built to recreate a wetland area, and the floodplain was revegetated. The total project cost was $700,000. High flows during storms spread over Chorro Flats, allowing the water to slow and sediment to drop onto the floodplain before reaching the bay (Figure 3). A 1999 USDA Natural Resources Conservation Service (NRCS) topographic and sediment field survey concluded that 213,000 tons of sediment had been captured, and that 85% of the bed load and 17% of the fine material carried by Chorro Creek is being deposited in Chorro Flats. Approximately one-quarter of the sediment from the entire watershed is captured by this one enhancement project. The history of Chorro Flats also demonstrates how perceptions and use of natural resources change over time.

In 1995, the MBWEP created a wetland reserve on Los Osos Creek, meaning that both major creek systems in the Morro Bay watershed now have sediment deposition areas. The project obtained a conservation easement on 144 acres of private land just upstream from the estuary. One hundred and eleven acres were allowed to flood and return to riparian habitat. Thirty-three acres were placed in an agricultural easement and permanently protected. Despite remaining in private hands,

the land cannot be cleared or developed. By 1999, the site had already trapped an estimated 135,000 tons of sediment.

The Watershed Enhancement Project also assisted landowners in stabilizing severely eroded streambanks. A stabilization project typically involves grading, bank stabilization (often with large boulders), and vegetation plantings. NRCS engineered the projects, obtained the permits, and provided cost share assistance. This experience illustrates that private landowners may not have the technical or financial means to implement many watershed enhancement activities, and emphasizes the need for a cooperative approach to watershed management.

Another important component of the MBWEP was to work with cattle ranchers to stop sediment at the source, especially given that rangeland accounts for approximately 60% of the land area in the watershed. NRCS and UC Cooperative Extension provided education, technical assistance, and cost share funds to help ranchers implement so-called best management practices to reduce non-point source pollution. The Maino Ranch demonstration project is the centerpiece of this effort. The ranch owner runs 210 commercial beef cows on 2,250 acres of annual rangeland. Between 1992 and 1994, the rancher implemented a time-controlled grazing management program. The ranch was divided into 30 pastures where cattle typically spend one to five days in any given pasture, thus allowing the land to rest 95% of the time. The project installed 40,800

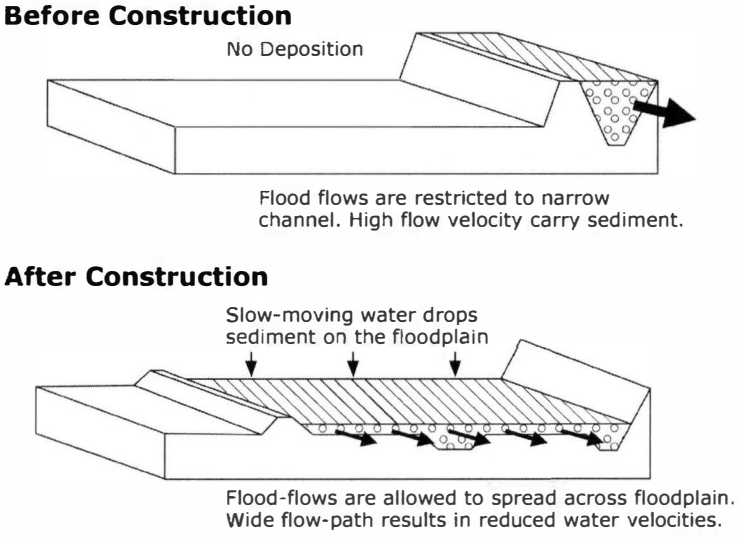

Figure 3: Chorro Flats Floodplain and Sediment Retention Project

feet of electric fence, 26,750 feet of plastic pipe, and two 18,000-gallon water tanks at a total cost was $110,000, 90 percent of which was provided in cost share assistance. Riparian pastures allow the rancher to control cattle access to creeks in order to protect riparian vegetation and streambanks, as well as minimize manure loading in streams.

The new grazing management system has led to better forage cover, more even forage utilization, more plant biodiversity, improved stream habitat for the endangered steelhead trout, and more observed wildlife. Cattle production and the quality of the natural resources are both improved. However, a properly functioning grazing program requires more than just the installation of new pipe, tanks, and fencing. What makes the system work is good management by the landowner, which requires experience and local knowledge. The Maino Ranch hosts field trips for ranchers, conference attendees, and other stakeholder groups in an effort to promote diffusion of the new practices.

UC Cooperative Extension organized three rangeland water quality short courses. Ranchers from the central coast area attended five-day courses with field trips where they learned about water quality issues, best management practices, and land use planning. Short courses are part of Cooperative Extension's statewide effort to promote voluntary compliance with State water quality standards. Future educational outreach efforts in the Morro Bay watershed need to focus on irrigated agriculture, which involves practices that can affect all of the priority problems. Cooperative Extension in San Luis Obispo County is currently developing short course material targeted for farmers.

UC Cooperative Extension's educational activities also included the 4-H watershed model, which is a topographically correct concrete scale model (10 X 15 feet) of the Morro Bay watershed. 4-H kids apply props and spray water on the model to simulate watershed concepts, erosion, buffer strips, fertilizer run-off, bacterial contamination, and urban run-off of detergent and oil. It is a simple but very powerful demonstration of watershed functions and spatial relationships between human activities upstream and their impact on the bay. The 4-H program also used the video series "From Ridges to Rivers: Watershed Explorations" and other curriculum materials in local schools.

The Morro Bay Watershed was selected by U.S. EPA to participate in the National Monitoring Program, a federal program that is administered by the state. Since 1995, 11 different water quality tests have been taken weekly and biweekly at 17 sites within the watershed. The monitoring program includes cattle exclusion fencing on three of the tributaries of Chorro Creek. An upstream-downstream model is combined with

varying cattle access and water testing. Volunteer monitors have also been used to take samples around the bay, especially during storm events to monitor urban runoff. The volunteer monitoring program has the added benefit of increasing community participation and awareness. National Monitoring Program data provide information about sources of pollution, environmental management strategies, and the evaluation of best management practices. Spatial analysis of water testing data can help to identify, link, and locate human impacts on water quality with specific land uses. The program also adds scientific credibility to the watershed management initiative.

The other major component of the National Monitoring Program is the paired watershed monitoring project. The project is a cooperative effort between Cal Poly State University in San Luis Obispo, the Regional Board, and NRCS. Two similar sub-watersheds were identified on Cal Poly's rangeland in the Chorro Valley. Four hundred acres on Chumash Creek were designated as the treatment area, and 480 acres on Walters Creek were designated as the control. Baseline data were collected starting in 1993, and in 1995 management practices (similar to those on the Maino Ranch) were installed on Chumash Creek. Data will be collected for ten years from both creeks on climate, streamflow, water quality, cross-sectional stream profiling, and vegetation. The data for the first five years of the study indicate a 50 percent reduction in sediment yield in the treatment area (Robbins 1999). The data are so convincing, that the Cal Poly faculty managers wish to end the study early, in order to implement similar management practices in the control area.

With the completion of the CCMP in July of 2000 and the organizational structure in place, the Morro Bay National Estuary Program moves into the implementation phase. MBNEP has assumed leadership in coordinating and initiating actions to enhance the water quality of Morro Bay and its watershed. Most of the enhancement work so far has taken place in rural areas. The MBNEP needs to build on that work, but also focus future actions in the urban areas, which is where most of the people live. The cumulative impact of urban runoff on water quality is substantial, yet landscape change is often least understood by urban residents. They interface less directly with the physical environment than agriculturalists, for example.

Conclusion

The case of the Morro Bay watershed illustrates several problems that must be confronted when managing the resources of a watershed. First, there is a problem of multiple and sometimes competing uses of an area's resources. It is paradoxical that some of the beneficial uses of the

water in the Morro Bay watershed are mutually incompatible (e.g., agricultural water supply and freshwater habitat), yet they are all protected by law. This necessitates compromise. A successful organizational effort must bring people together from diverse stakeholder groups who often have opposing views on natural resource management issues. However, with broad representation, there is a possibility of reaching consensus on action and facilitating long-term change.

Second, when managing the resources of a watershed, there are conflicting and overlapping jurisdictional and administrative authorities involving numerous federal, state, and local agencies. In order for a comprehensive management effort can proceed, government at all levels must be represented and involved. This problem is compounded by the fact that some stakeholder groups, notably farmers and ranchers, may not like the idea of government involvement in their affairs.

The Morro Bay National Estuary Program is a quasi-governmental agency. It is accountable to the U.S. EPA and the Regional Board for funding and policy oversight. However, partnership with local non-governmental organizations (i.e., The Bay Foundation and The Friends of the Estuary) and industry representation in the MBNEP organizational framework adds credibility to the management process, broadens public participation, and gives distance from government. This framework provides a vehicle for decision-making that is local and not subject to constant governmental approval. In order to gain widespread support of landholders in the watershed, they must perceive MBNEP actions as non-regulatory, as well as collaborative, inclusive, and transparent.

Finally, there is a general lack of understanding by the public of spatial relationships. Many people simply do not understand how watersheds function and how humans impact them. The MBNEP and participating interests identified what they consider to be the most important problems affecting the health of the bay and watershed, specifically sedimentation, chemicals, bacteria, habitat loss, etc. However, the priority problems as listed are physical in nature, representing immediate symptoms and not the causes of the problems affecting water quality in the Morro Bay watershed.

The challenge of addressing the priority problems and maintaining and restoring the bay lies in understanding the human dimensions of watershed and landscape change. It is not difficult for stakeholders to acknowledge the physical problems in the watershed, but few believe that they are contributing to these problems. Most rural landowners feel that they are the true stewards of the land. However, this is not always true. Furthermore, most urban dwellers are often disconnected

from the land. They are unaware of the waste they generate and where it goes. Very few people even know where their water comes from.

If watershed managers expect to achieve widespread participation among landowners and the public in the enhancement process, they must begin by focusing their efforts on two critical actions. First, outreach efforts need to educate people about watersheds and how they function. Second, various stakeholder groups have to learn how their actions impact the watershed and understand their role in contributing to the larger problems. Once they understand the processes that shape watersheds and the human-induced problems associated with them, then they become more open and willing to take action and participate in enhancement initiatives. Therefore, watershed education outreach efforts such as water quality short courses, the 4-H watershed curriculum, and volunteer monitors are essential steps in creating the understanding that is necessary for people to change. These endeavors provide the basis for the public participation that is required for sustained enhancement of a watershed.

Watersheds are geographic regions, and the management of the resources of these regions lends itself to the analytical framework of geography. Geographers are especially good at integrating the study of human activities and the natural environment. A regional approach provides a comprehensive framework for understanding the processes that link human land uses with environmental concerns in a specific place. The organizational dynamics of a watershed scale management initiative provide the appropriate local mechanism for managing resources and solving problems that require integrated regional solutions.

References

CDFG (California Department of Fish and Game). 1999. *California Commercial Landings.* Long Beach: CDFG.

Forman, Richard T. T. 1995. *Land Mosaics: The Ecology of Landscapes and Regions.* Cambridge: University Press.

Gallagher, Lynn M., and Leonard A. Miller. 1996. *Clean Water Handbook,* 2nd ed. Rockville, Maryland: Government Institutes Inc.

Griffin, C. B. 1999. Watershed Councils: *An Emerging Form of Public Participation in Natural Resource Management.* Journal of the American Water Resources Association 35(3): 505–518.

Haltiner, Jeff. 1988. *Sedimentation Processes in Morro Bay, California.* San Francisco: Philip Williams and Associates.

Kenney, Douglas S. 1999. *Historical and Sociopolitical Context of the Western Watersheds Movement.* Journal of the American Water Resources Association 35(3): 493–503.

Lant, Christopher L. 1999. *Human Dimensions of Watershed Management.* Journal of the American Water Resources Association 35(3): 483–486.

MBNEP (Morro Bay National Estuary Program). 2000a. *Comprehensive Conservation Management Plan for Morro Bay.*

_____. 2000b. *Understanding the Morro Bay Estuary and Watershed: A Characterization.*
Robbins, Scott. 1999. *USDA Water Quality Hydrologic Unit Area Final Report: Morro Bay Watershed.* Morro Bay: USDA Natural Resources Conservation Service.
Sommarstrom, Sari. 1994. *A Practical Guide to Some Practical Watershed Management Guides.* Watershed Management Council Newsletter 6(Spring).
SWRCB (State Water Resources Control Board). 1999. *California Water Quality Assessment Report.* Sacramento: SWRCB, Division of Water Quality.
Tetra Tech. 1998a. *Morro Bay Bathymetric Survey.* Prepared for the Morro Bay National Estuary Program, Los Osos, CA.
_____. 1998b. *Sediment Loading Study.* Prepared for the Morro Bay National Estuary Program, Los Osos, CA.
Wilson, Richard A. 1994. *California Watersheds: Natural Resource and Community Integrators.* Watershed Management Council Newsletter 6(Spring).
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Vendor display at Stockton Meeting