CHAPTER 1

CENTRAL COAST REGIONAL CITIZEN MONITORING GUIDE

The Central Coast Regional Citizen Monitoring Guide is intended to provide concise, accurate information to community groups and nonprofits interested in monitoring their local watersheds or ocean waters. The manual is organized to provide a framework for a volunteer monitoring program that is scientifically valid and provides sound data.

Chapter 2 provides a brief description of the Monterey Bay National Marine Sanctuary and the Sanctuary's Water Quality Protection Program.

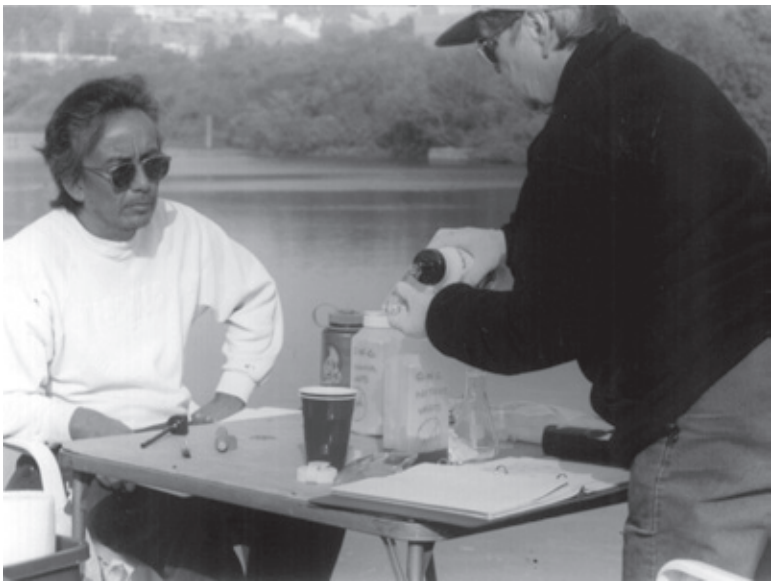
Chapter 3 provides an overview of pertinent state and federal legislation that maintains and protects the water quality of our streams and oceans. It is important for every citizen volunteer group to understand the context in which their data may be used according to state and federal environmental laws.

Chapter 4 provides an overview of citizen monitoring in the Central Coast and its role in water quality and watershed protection. Two case studies from the Central Coast are used to illustrate the usefulness of citizen monitoring programs in protecting water quality and assisting agencies by providing data for areas which otherwise may not be monitored.

Chapter 5 is an overview of how to design and implement your monitoring program and includes information on design process and types of monitoring, equipment, quality assurance/quality control, volunteer management, safety and adaptive monitoring.

Chapter 6 is a collection of monitoring protocols for various types of monitoring that may be conducted by volunteers. These protocols can be broadly defined as physical, chemical and biological monitoring. A discussion of each of these types of monitoring parameters is provided as an introduction to designing your monitoring program. For each of the

Training volunteers, Antonelli Pond



recommended monitoring parameters a description and protocol are provided for implementation by volunteer groups.

Chapter 7 provides information on how to interpret your data and how to provide analysis of your findings. The chapter also provides suggestions on how your data can be presented.

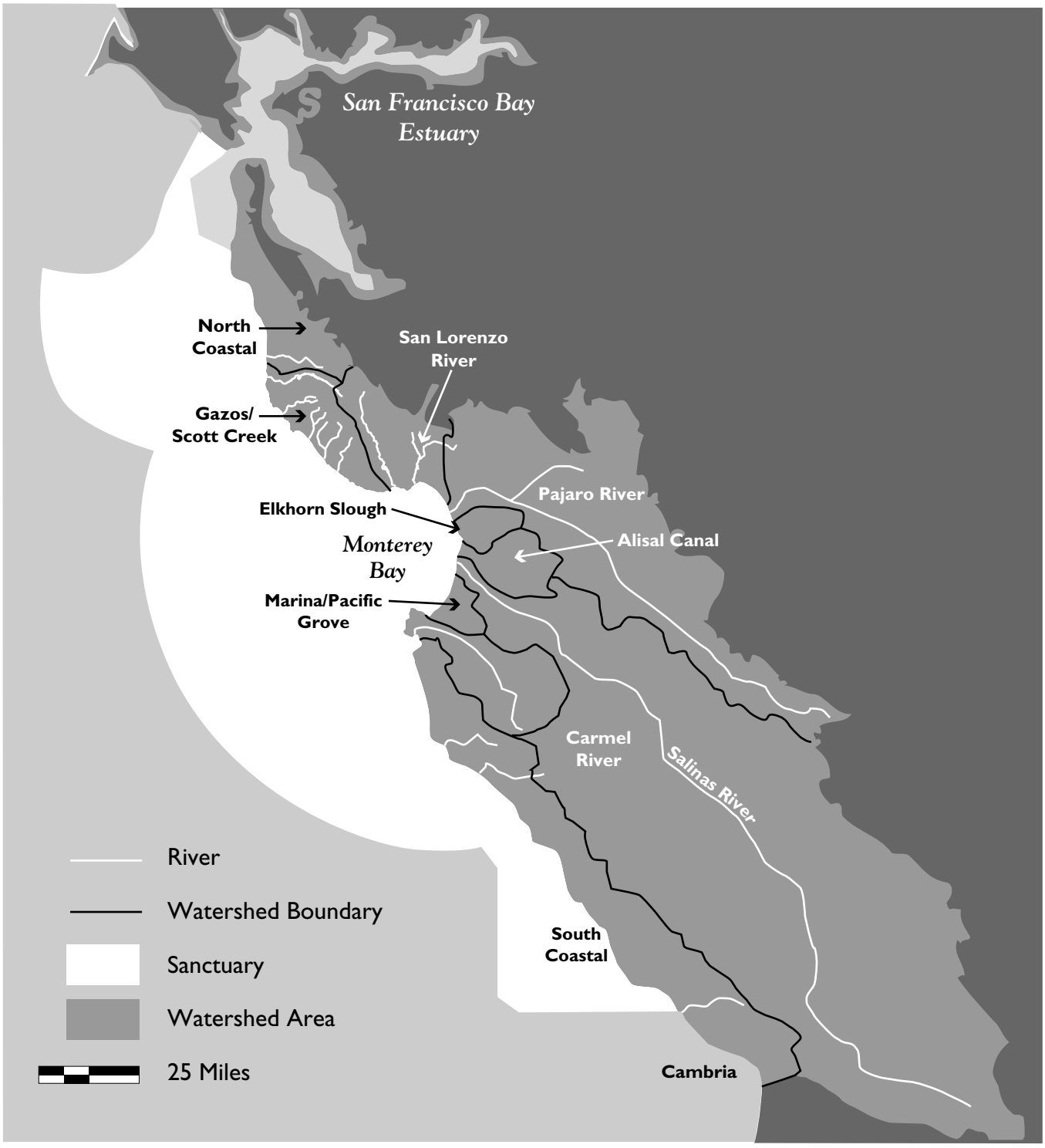
CHAPTER 2

THE MONTEREY BAY NATIONAL MARINE SANCTUARY AND ITS WATERSHEDS

The Monterey Bay National Marine Sanctuary is the largest marine protected area in the United States, and includes over 5000 square miles of water off the central California coast. It spans over 350 miles of coastline from Cambria in San Luis Obispo County to the Marin Headlands, extending as much as 53 miles offshore. The area was given sanctuary protection by Congress and the National Oceanic and Atmospheric Administration (NOAA) in 1992, in recognition of its dramatic underwater topography, the diversity of its unique plants and animals, the presence of threatened/endangered species and abundant commercial fisheries, and its standing as an important research site. Within the Sanctuary and its shores are more than 50 species on government special status lists, perhaps the most prominent being the Southern sea otter.

The Sanctuary boasts the greatest biodiversity in temperate regions of the world. It is home to 28 species of marine mammals, 94 species of seabirds, 345 species of fish, 4 species of turtles, more than 450 species of marine algae and 31 phyla of invertebrates. Within a dozen steps on the rocky shore, one may walk over 90 species of invertebrates associated with intertidal red algae and over 300 invertebrate species associated with a mussel bed. This diversity encompasses a wide range of environments, including estuaries, rocky coastlines, sandy beaches, subtidal reefs and soft bottoms, open ocean waters, and the deep waters of the Monterey Bay canyon.

The Sanctuary also includes the waters of Elkhorn Slough, one of the largest remaining wetlands in California and a key nursery ground for fishes. Dramatic migrations of shorebirds visit the Elkhorn Slough estuary, a key stop for feeding and weight gain before the birds continue along the "Pacific flyway." Congress designated the Sanctuary as a marine environment of special national significance, to be protected for the generations to come.



The sanctuary and its eleven major watersheds

WATER QUALITY PROTECTION PROGRAM

The Water Quality Protection Program (WQPP) of the Monterey Bay National Marine Sanctuary is a partnership effort to enhance and protect the physical, chemical and biological conditions in the Sanctuary and its adjacent watersheds. The following map shows the WQPP's broad geographic range, including 5000 square miles of marine waters and 11 major watershed areas with over 7000 square miles of land. The watersheds include Drakes Bay, Gazos/Scott Creeks, Elkhorn Slough, Alisal Canal, Marina/Pacific Grove, North and South Coastal, and the San Lorenzo, Pajaro, Salinas, Carmel, and Big Sur Rivers.

Land use in this diverse region includes urban and suburban development, extensive areas of irrigated croplands, managed timber lands, grazing lands and other agricultural activities. Extensive public lands with diverse multiple uses are also present, including lands under the management of the federal, state and local governments. As water passes over any of the land uses in the watershed, it can pick up a variety of potential pollutants such as sediments, oils and grease, nutrients, pesticides, and pathogens which can be transported to the region's rivers, wetlands, harbors and nearshore waters.

In addition to diverse land uses, the region also encompasses parts of eight counties, 20 incorporated municipalities, various special districts, portions of two Regional Water Quality Control Boards, and the overlapping jurisdictions of at least 10 state and federal agencies which deal with water quality issues. This mix of land uses and agency responsibilities requires an approach that cuts across jurisdictional and political boundaries and focuses on watersheds.

The WQPP has developed three detailed action plans consisting of strategies to address urban runoff, regional monitoring and data sharing, and marinas and boating activities. A fourth action plan was completed in 1999 and addresses agricultural nonpoint source issues. The Sanctuary Citizen Watershed Monitoring Network implements one of the action plan objectives, to develop a coordinated regional monitoring program and data access system.

CHAPTER 3

PROTECTING WATER QUALITY AND WATERSHED HEALTH

One of the primary goals identified by many monitoring groups is the desire to improve the health of the watershed they are monitoring. Most groups are interested in improving water quality conditions within their watershed or improving habitat conditions for particular species within their watershed. A comprehensive understanding of key state and federal environmental legislation is necessary for monitoring groups to evaluate their data results. State and federal legislation applicable to the work of volunteer monitors include the federal Clean Water Act, the federal Endangered Species Act, the California Water Code, and the California Endangered Species Act.

CLEAN WATER ACT

The stated goal of the Clean Water Act (CWA), enacted in 1972, is to "restore and maintain the chemical, physical and biological integrity of the Nation's waters." The Act set two national water pollution control goals: a) to eliminate discharges of pollutants in harmful concentrations into the navigable waters of the United States; and b) to attain an interim goal of water quality that provides for the protection and propagation of fish, shellfish, and wildlife and provides for water contact recreation. The programs developed to meet these goals are complex, and implementation is carried out by a mix of federal agencies, designated state agencies and local governments.

Watershed monitoring groups and the Clean Water Act have a similar objective to restore and maintain healthy waters. Watershed-monitoring groups can play a crucial role in meeting the objective. A basic understanding of the mechanisms of the CWA will help monitoring groups identify how they can compile water quality data that can be used to advocate to improve conditions within local watersheds or report impairment of watersheds to the appropriate agencies. Monitoring groups can also use their data to ensure individuals, industries and government agencies remain in compliance with environmental legislation.

The San Lorenzo River, Santa Cruz

The central regulatory tool of CWA is the National Pollutant Discharge Elimination System (NPDES). All industrial and municipal point sources discharging directly into navigable waters of the United States are required to obtain a NPDES permit. Discharges from nonpoint sources are excluded from this requirement. The Environmental Protection Agency (EPA), the agency responsible for administering the CWA, is charged with creating technology-based and water-quality effluent limitations for point source pollution. The goal of effluent limitations is to restore water quality to fishable-swimmable status (i.e., to the point where it is safe for recreation and protect other beneficial uses of the waters). Technology-based effluent limitations compel point sources of pollution, such as sewage treatment plants and factories, to use the "best available technology" to treat their effluent before discharging into a body of water. In cases where even these limitations are unable to improve water quality, more strict water quality-based standards must be established.

Algal Bloom in Antonelli Pond

These limitations are enforced by the NPDES, a permit program administered by individual States. NPDES permits document the pollutants, or combination of pollutants to be discharged, and require that the party receiving the permit comply with all applicable sections of the CWA. Permits may be granted only after the opportunity has been given for public comment at a special hearing. Hearings are announced at least thirty days in advance in the Federal Register. Monitoring groups should watch the Federal Register in order to stay involved in the permitting process in their watershed. Copies of the permit application and the permit itself are made available to the public. Monitoring groups can juxtapose their water quality data and NPDES permits to identify potential violations of CWA effluent limitations.

Congress has also amended the CWA to include Section 319, which mandates the creation of management programs to deal with nonpoint source pollution. Nonpoint sources are also addressed by Section 208, which authorizes a process for states to establish comprehensive planning for point and nonpoint source pollution, and in Section 303(e), which requires states to establish water quality management plans for watershed basins, and to provide for adequate implementation of water quality standards to control nonpoint source pollution.

A watershed-monitoring group's most powerful tool for protecting water quality is an accurate and consistent database. The following is a list of parame-

ters that may serve as a guide for data collection with regards to point and nonpoint sources of water pollution.

Bacteria and Pathogens Bacteria and pathogens can cause health problems in humans. Treated sewage, storm-water drainage, septic systems, and sewage dumping increase bacteria levels in a water column. The state uses "indicator species," such as fecal-coliform, to determine whether a body of water may be contaminated with untreated sewage. Many water quality monitoring groups perform fecal-coliform and related tests.

Sedimentation Sedimentation refers to erosion or the suspension and deposition of small particles in water bodies. Sediment is harmful to fish populations because high sediment loads suffocate salmon and amphibian eggs and limit food supply. Most citizen groups do not have the equipment to test for the amount of suspended sediment in a water column. However, they can monitor dredging and other sources of input such as runoff from agricultural, urban, logging, and strip mine lands.

Nutrients Nutrients such as nitrogen and phosphorus are essential to ecosystem health but are dangerous at high levels. Nitrates (compounds containing nitrogen) and phosphates (compounds containing phosphorus) stimulate the growth of algae and aquatic grasses. Through their aerobic activity (both respiration and photosynthesis), these organisms deplete oxygen in the water column. Fertilizers, sewage, manure, and detergents are common household items that increase nitrate and phosphate levels. Testing for nitrogen and phosphorus can be difficult and require substantial QA/QC procedures.

Low Dissolved Oxygen Biodegradable matter found in sewage, manure, shellfish processing waste, milk solids, and other food processing waste feed algae and aquatic weeds which in turn deplete the amount of oxygen available in the water column. Dissolved oxygen is also easy to for volunteers to test for.

Toxic Organic Chemicals, and Metals Toxic organic chemicals are synthetic compounds such as dioxin and DDT. They are dangerous because they do not biodegrade quickly in the environment, and have a tendency to accumulate in species at the top of the food chain. These compounds are very expensive for volunteer groups to test for.

Alkalinity/Acidity (pH) pH is a measure of the percent of hydrogen ions in a water column. Water with a pH value of 7 is neutral, above 9 is alkaline and below 5 is acidic. Most ecosystems cannot function in either acidic or alkaline waters. Toxins often attach to sediment. Acidic

Hydrologic modification,

Arana Creek

waters cause toxins to release from the sediment and be re-suspended in a water column.

Habitat/Hydrologic Modification Habitat modifications are actions that modify the physical structure of an ecosystem. For example, removal of streambank vegetation leads to increased water velocity. Hydrologic modifications alter natural waterflow. Many monitoring groups determine water velocity in a river or stream in order to calculate the volume of water flowing in a stream at a particular site. Stream volume is particularly important because many species, including federally listed endangered species such as coho salmon and steelhead and the California red-legged frog, require colder waters to spawn. Decreased water volume leads to higher water temperatures.

A monitoring group that collects data in these categories will be able to provide useful information concerning the health of their watershed. This data can help the EPA and local water agencies (such as the California State Water Resources Control Board and the California Regional Water Quality Control Boards) determine whether their watershed is an "impaired waterbody," requiring listing on the State's 303(d) list.

IMPAIRED WATERSHEDS: TOTAL MAXIMUM DAILY LOADS (TMDLS)

Many of the waterbodies in the Central Coast do not meet water quality objectives or support beneficial uses. Section 303(d) of the Clean Water Act requires states to develop a list of water bodies that do not meet water quality standards without application of additional pollutant controls. States are then required to develop a strategy for bringing those water bodies back into compliance through a process called a Total Maximum Daily Load (TMDL).

A TMDL is a process of assessing pollution problems, identifying input sources, proposing implementation measures and timelines, and developing a monitoring strategy. TMDLs for various categories of nonpoint pollution such as sediments, nutrients, pathogens, and pesticides are scheduled for development in several Central Coast watersheds over the coming years, including Salinas, Pajaro, San Lorenzo and Pescadero.

PORTER-COLOGNE WATER QUALITY CONTROL ACT

The Porter-Cologne Act, enacted in 1969, is California's primary water law, providing a complete regulatory framework for maintaining water quality for all surface and ground waters in the state. The Act directs each of the Regional Water Quality Control Boards (RWQCBs) to develop a regional water quality control plan, or "Basin Plan." Basin Plans describe the "beneficial uses" of each of the region's water bodies. Beneficial uses are simply uses that require good-to-excellent water quality. Beneficial uses include human uses such as recreation, shellfish harvesting, and municipal water supply, as well as "aquatic life" uses such as warm and cold water habitat, and fish spawning. The Basin

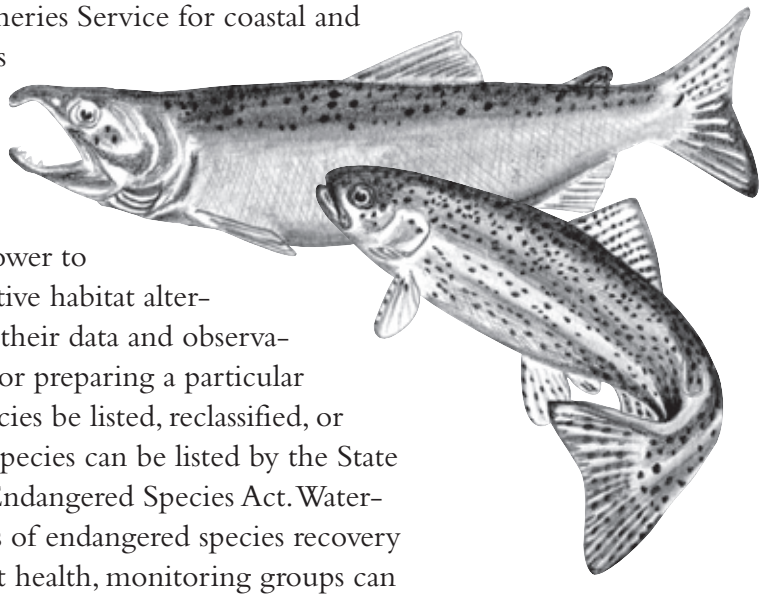
Plans describe the water quality criteria which must be maintained in order to protect each designated use. These criteria and beneficial uses are the key components for volunteer groups to focus on.

Each of the State's nine RWQCBs are responsible for administering regulations established by the Federal Clean Water Act and the California Water Code (Porter-Cologne Water Quality Control Act). The State Water Resources Control Board (SWRCB) oversees administration of the Code.

THE ENDANGERED SPECIES ACT

The Endangered Species Act (ESA) prohibits any person from "taking" endangered or threatened species. California's Endangered Species Act mirrors the legislative intent of the federal law. The federal law includes harming in its interpretation of "taking", in which "harm" includes modifying or degrading a species habitat in a way that would significantly impair the area's breeding, feeding, or sheltering capacity and result in injury to the species. The federal ESA is administered by U.S. Fish and Wildlife Service for terrestrial habitats and inland waters, and by the National Marine Fisheries Service for coastal and marine habitats including those of anadromous fish. The state Endangered Species Act is administered by the California Department of Fish and Game.

Coho salmon and steelhead



The ESA is of particular importance to watershed monitoring groups because of its power to protect threatened species and prevent destructive habitat alterations. Watershed-monitoring groups may use their data and observations to illustrate the need for listing a species or preparing a particular recovery plan. Citizens may petition that a species be listed, reclassified, or removed from either the state or federal lists. Species can be listed by the State of California and not be listed by the federal Endangered Species Act. Watershed monitoring groups can also obtain copies of endangered species recovery plans. By monitoring water-quality and habitat health, monitoring groups can ascertain whether progress is being made towards removal of these species from the endangered species list.

The California red-legged frog (*Rana aurora draytonii*), coho salmon (*Oncorhynchus kitsuch*) and steelhead trout (*Oncorhychus mykiss*) have been listed as threatened under both the state and federal acts. These species, among a few others, are found in the watersheds draining into the Monterey Bay National Marine Sanctuary.

CHAPTER 4

CITIZEN MONITORING AND ITS ROLE IN WATER QUALITY & WATERSHED PROTECTION

STATUS OF CITIZEN MONITORING

The Monterey Bay National Marine Sanctuary and its watersheds have experienced a significant emergence of citizen monitoring activity over the last several years. A survey conducted by the Center for Marine Conservation and the Coastal Watershed Council identified over 20 volunteer or citizen organizations that were conducting some kind of monitoring in the Sanctuary and its watersheds. The survey, completed in March 1999, identified the extent of current monitoring activities, assessed the needs of existing programs, and highlighted potential gaps to be filled with new monitoring efforts.

Volunteer training at Gazos Creek, 1997

The results from the survey indicate that there are numerous groups working to monitor water quality; however, there are additional monitoring activities that can be done to help improve our understanding of the health of the Sanctuary and its watersheds. The groups represented in the survey include schools (K-12), universities, nonprofits and volunteers organized by government agencies. Virtually all of these groups conduct other stewardship activities in addition to monitoring, such as river cleanups, nature walks and stormdrain stenciling. Remarkably, many of the groups perform these activities on only minimal budgets. Funding sources include grants, fundraisers, membership dues, school science budgets, donations and barter trade.

Waterways that are monitored tend to be clustered in the Monterey-Santa Cruz area, although activity in San Mateo County was also represented. The number of sampling and testing locations per waterway range from 1 to 25. The Sanctuary would benefit from additional monitoring in the upper watersheds and along the southern end of the Sanctuary. Specifically, citizen monitoring activity would be beneficial in the Salinas River watershed, the Pajaro River watershed, the Big Sur coast and northern San Luis Obispo County.

The parameters that are tested vary from site to site. The most common identified parameters are temperature, pH, turbidity, dissolved oxygen, invertebrates, birds and wildlife, weather, photographic and visual surveys, sediment and habitat assessments, and data from restoration and cleanup activities. The frequency with which these parameters are collected varies widely, from daily to "irregularly."

The monitoring groups use the collected data in a variety of ways. "Education" is the use reported most often; other common uses for the data are "baseline information," "restoration," "research" and "decision-making." By far the most prevalent users of the citizen monitoring data are K-12 schools. After schools, monitoring groups reported that their data were used most often by non-profits, advocacy groups and local governments.

Computer hardware and software is in good supply to most groups, though some do not have the resources to store and/or share data electronically. Protocols for groups' sampling techniques and procedures for the training of volunteers also vary. About half of the programs reported some level of consistent volunteer training, while half reported none.

The survey results demonstrated that the Sanctuary benefits from the attention and stewardship provided by numerous citizens groups who are focusing on chemical, physical and biological monitoring of the Sanctuary and its watersheds. The survey also indicates that, in order to achieve the goal of comprehensive and coordinated monitoring, enhanced citizen monitoring activities are needed.

Citizen data will help agencies and the public to identify and address contamination of our waters. Moreover, long-term citizen efforts will show trends that will allow for better problem solving strategies. By maximizing the number and quality of government and citizen monitoring efforts that can be pulled together into one cohesive unit, we will improve the overall health of the Sanctuary and its watersheds and help them thrive to be one of the most productive and unique ecosystems on this planet. Citizen monitoring groups in the Monterey Bay area are already making a key difference by increasing public awareness and assisting resource agencies with important watershed data collection.

San Gregorio Creek citizen monitors

CASE STUDIES IN THE REGION:
Volunteer Programs Add to Knowledge about Water Quality

SURFRIDER FOUNDATION:
Blue Water Task Force Helps Keep Swimming and Surfing Areas Safe

In 1993 the Santa Cruz Chapter of the Surfrider Foundation created the "Blue Water Task Force" (BWTF), a volunteer based group which monitors water quality at a number of favorite beaches and surf spots along the coast. Through their fecal coliform testing program, the BWTF provides volunteer opportunities, raises public awareness, gathers and publishes data, and uses the data to enforce and influence legislation. Fecal coliform, found in contaminated water, is a health issue because it is an indicator of pathogens which may cause disease. The BWTF began compiling a database in 1994 on fecal coliform and total fecal coliform, a test which includes other bacterial species such as *Enterococcus*. State standards specify levels of fecal coliform bacteria should not exceed 200 per 100 ml [water] for body contact.

The recent passage of two water quality related bills in the California State Assembly and Senate, AB 411 and SB 65, is testament to the effectiveness of a solid volunteer-generated database. Surfrider chairperson Boots McGee believes in the effectiveness of the BWTF campaign. "We would like to think that our activism, in regards to water quality, has been one of the catalysts in the passing of AB 411 and SB 65."

The Surfrider Foundation believes that people who use public beaches have a right to know when bacteria have reached dangerous levels. Prior to SB 65, local jurisdictions had posted warnings on beaches. However, these signs were often posted in inconspicuous places. SB 65 mandates that beaches which violate health and safety standards more than twenty percent of the time must post warning signs at primary access points. Conspicuous beach posting compels local jurisdictions to work more actively to improve water quality.

AB 411 requires California's coastal counties to sample water, at least once a week, on beaches which receive more than 50,000 visitors per year. They must then release these data to the public. Surfrider publishes data, as do local jurisdiction, but Surfrider publishes their results more visibly, in local magazines and newspapers and the internet. Concurrent water quality testing by a non-governmental entity provides a check on governmental data. Surfrider can encourage local jurisdiction to retest in places where the organizations achieved incongruous results. The BWTF's testing also expands the amount of data available to the public by testing at a higher number of beaches than local jurisdictions. In making data available to the public, Surfrider also provides valuable volunteer opportunities.

Checks and balances are important to ensure the accuracy of the county governments results. Both the public and the local government benefit from the Surfrider Foundation's continued participation in this process.

URBAN WATCH PROGRAM:

Helping to Identify Common Urban Runoff Pollutants

Another long running citizen monitoring program in the Sanctuary began in 1996. Named the "Urban Watch Program," the program is a cooperative project of the City of Monterey, the Monterey Bay National Marine Sanctuary and the Coastal Watershed Council. The Urban Watch Program helps identify common pollutants discharging into the Sanctuary from urban stormdrains. Stormdrains are not filtered through a sanitary sewer system, so any pollutants that are discharged into a stormdrain flow directly into the receiving water without any treatment.

The Urban Watch Program is designed to help smaller cities identify the types of pollutants that may be flowing through their stormdrains during the dry-season when the drains are not being used to carry stormwater runoff from rainstorms. The monitoring is done by citizen volunteers who collect water samples from designated stormdrains over a 24 hour period. The samples are tested for detergents, copper, phenols, chlorine, turbidity, ammonia, color and odor. All of these parameters can indicate illegal discharges from residential, commercial or industrial land uses.

Since 1996, the Urban Watch Program has helped document the types and concentrations of pollutants commonly discharging from stormdrains around Monterey Bay. Pollutants such as detergents, copper, phenols and chlorine have been identified through testing done by the volunteers. In response to these findings, the City of Monterey and the Monterey Bay National Marine Sanctuary have been able to develop targeted educational materials and training programs for residents, business owners and municipalities to help reduce urban runoff. Annual monitoring conducted through the Urban Watch Program has shown a decrease in certain pollutants corresponding to the educational materials and programs developed by the Sanctuary and City of Monterey.

The Urban Watch Program is yet another example of how citizen monitoring can provide valid data for targeting public education about keeping the waters of the Monterey Bay National Marine Sanctuary clean for all generations.

CHAPTER 5

DESIGNING AND IMPLEMENTING A MONITORING PROGRAM

The best way to ensure a quality citizen monitoring program is to spend adequate time and resources on the design and implementation of the program. This requires funding for equipment, training, quality assurance/quality control procedures and volunteer mentoring. The following information is provided to help with the design and implementation of your monitoring programs.

STARTING YOUR PROGRAM

If you want to start a program in your watershed, there are several steps you will want to think about before you begin. Spending a good deal of "up front" time preparing for a new monitoring program is well worth the effort. If you put the time in early, your program will not only run better, but you can also secure funding and troubleshoot the myriad of problems that inevitably arise with a new program.

Watershed problem identification, Gazos Creek,

Establish a need. Why do you want to conduct volunteer monitoring in your watershed? What problems have been identified within the watershed? Is your watershed listed as "impaired" by the State Water Resources Control Board under the Clean Water Act Section 303(d)? Have community members or local resource agency people expressed concern or interest in monitoring your watershed? Are special status species present within the watershed? These questions need to be answered before you begin deciding what kind of monitoring you will be doing.

During the planning process, **develop a relationship with local resource agencies** and find out what their needs are. Resource agencies can lend support, credibility, additional training, equipment and often need aid in collecting data. Forming an alliance with resource agency personnel can provide a crucial link to the validity of your data and can ensure that your data gets used. Make sure you check with the resources agencies to find out what their data collection standards are so you are not collecting useless data.

Before you begin, you will most likely need to **obtain funding** for planning, equipment, staffing and quality assurance. It is important to maintain a diverse funding base that will provide for the longevity of your program. Funding sources are varied and can include private foundation grants, state and federal grants, and contract service agreements with local agencies and jurisdictions or nonprofit organizations. Keep in mind that the grant process, whether private foundation or government, is often a slow one. You should anticipate a one to two year turnaround from application submittal to actually putting the check in the bank.

If one has not been done already, **perform a Watershed Assessment.** You should find out how much research has been done before you begin the assessment because, chances are, much of the footwork has already been done by another entity. Collect as much background information about your watershed as money and time allows. Here's a list of some of the resources you should investigate:

1 On the ground reconnaissance: Get to know the watershed by walking and driving around. You can learn a great deal just by familiarizing yourself with the area.

2 Aerial photos (historic and current): Track down aerial photos at a nearby university library, US Forest Service office, local Resource Conservation District office or other resource center. You can also search the Internet for aerial photos through sites such as the US Geological Survey. Examine historic and current aerial photos of the watershed so you can get a sense of how the watershed has changed over time and what historic and current problems might be present.

3 Environmental documents and watershed-related documents: Through the CEQA (California Environmental Quality Act) process or other environmental regulations, many resource agencies such as the California Department of Fish and Game, California Department of Forestry, city and county environmental services, planning and/or public works departments may have performed environmental surveys regarding an area within your watershed. Contact these agencies to find out what studies have been done.

Aerial photos

Investigate the internet. There are a lot of local, state and federal resources available online. Some useful websites are listed in the general references and resources section at the end of this manual.

You may also want to check with local environmental consulting firms. A good deal of environmental studies are done within the private and nonprofit sectors but the work often does not reach the public. Depending on the type of project, some firms may be able to share some of their findings with you.

4 Anecdotal information: Some of the best resources you can tap into are local residents. By talking to the people who have a long history with the watershed you will be amazed at the historical information you'll learn. Long-time residents often know more about historic conditions in a watershed than any scientific report can offer. Any anecdotal information you can find can lend a lot of insight to present watershed conditions.

Based on the results of your watershed assessment you are now ready to **design your monitoring program**. Again, the design stage is one of the more important, if not the most important stage of your program. Design questions that need to be reviewed include:

Why (identify the questions you want to answer)
Where (what sites are you going to monitor)
What (what parameters will you be monitoring)
When (sampling frequency and timing)
How (sampling methods, analysis, and quality assurance)

WHY—what questions will your monitoring answer? Are you interested in general watershed condition, the location of pollutant sources (point source pollution), impacts of potential pollutant sources, effects of restoration efforts, or long term trend detection?

Determining what parameters to monitor

Your answer to these questions will determine the next question in your monitoring design process of **WHERE** you will monitor. Examples of monitoring sites would include coastal confluences, main-stem sites, tributaries, paired studies of upstream and downstream sites, before and after monitoring on a single site tied to some event, or paired studies between two watersheds. When you are considering your monitoring site you will also need to consider access and safety issues with regards to getting to the site, also whether high stream flows or tides might influence the site, and whether or not the site can easily be located years after your monitoring program is completed.

Once you have chosen your sites you need to determine **WHAT** you will monitor and **WHEN** you will monitor. Again, revisit your why questions in determining the parameters that you will measure for, as well as how often your sampling should take place. Here's an example: if you are interested in determining how stream flows may be affecting steelhead in your stream, you will want to figure out how to measure stream flow. You would also want to measure flow during the summer months, as this is when water is scarce and may adversely impact steelhead. Finally, in a highly controlled stream, you may want to measure stream flow throughout the day or only in the morning or only in the evening. Again, spending time on these questions should be done at the beginning of your program before you ever collect any data.

Finally, detail **HOW** you will be collecting the data. Documenting the protocols that you have used, as well as developing good data collection and review procedures are of the utmost importance in providing quality data from your program. These procedures are often referred to as Quality Assurance/ Quality Control (QA/QC) procedures and they are another important component of your program. QA/QC simply means documenting the way you have done your monitoring and data analysis and conducting your monitoring in a way that is consistent with this documentation. Important features for your QA/QC plan include the type of equipment you are using and the precision, accuracy and resolution of that equipment. Your QA/QC plan should also include the testing protocols that you are using and your methods for calibrating your equipment to assure that it is properly working. Finally, your QA/QC plan should include contact information about your program and the name of the person to contact concerning questions about your data. An excellent reference for developing a QA/QC plan is *The Volunteer Monitor's Guide to Quality Assurance Plans* developed by the US Environmental Protection Agency and available for free to volunteer monitoring groups.

After you have researched the watershed and have developed a monitoring design, you are ready to **recruit volunteers**. Some helpful recruitment methods include press releases through local newspapers and radio stations. Post announcements at community meetings and contact other local environmental organizations or volunteer programs. Allow 4-6 weeks of recruitment efforts to recruit enough volunteers.

Compile an information packet and application to send to your prospective volunteers. In these materials, clearly state the program goals and volunteer requirements. Request that prospective volunteers fill out an application and return it before the program begins. Although the application is generally very simple and brief, the act of filling it out and returning it lets you know the applicant is serious about volunteering.

Plan on recruiting enough volunteers to allow for 1-2 substitutes in case a volunteer has to leave the program. For instance, Coastal Watershed Council's weekly water quality monitoring programs have 2-4 volunteers per week with

a total of 8-16 volunteers per program. While most volunteers are scheduled on a regular basis, one or two substitutes are on-call in case one person can't volunteer on a certain date. It's important not to have more volunteers than you need. If you have too many volunteers, people will not have enough to do and may become disgruntled with the program.

Once you have your volunteers in place, provide them with a thorough Volunteer Training Program before they begin monitoring. Generally, a combination of hands-on training and local expert lectures provide a good training background for your volunteers. Provide your volunteers with a binder of pertinent reading material with both background watershed information and copies of the monitoring protocols they will be using on a regular basis. After the program begins, provide additional training in the field during the first monitoring sessions so your volunteers feel comfortable performing the monitoring tasks. This will also help with the QA/QC aspects of your program.

MAINTAINING THE PROGRAM

Establish Stewardship: "Take care of your volunteers and they will take care of the watershed." The most successful volunteer monitoring programs not only provide good, useable data but are fun and maintain the same volunteer base over time. To achieve this, your program coordinator must be available and accessible to volunteers. Make sure you get out in the field with the volunteers frequently. Volunteers often have a lot of questions about the watershed; return their phone calls promptly and if you don't know the answers to their questions, get the answers from someone who does. Providing additional training in the form of annual lectures with guest speakers, new protocols training and information about other related workshops also keeps volunteers interested.

Another key aspect of your program is to reward volunteers! Remember, these people are out there collecting hours of information for free! Even if you have a small budget, many local businesses are more than happy to donate products (especially food) to charitable causes- just be sure to allow 1-2 months from the time you request a donation to when they can fulfill the request. T-shirts and other products are also great for volunteers after they have donated a certain amount of time. Not only do they receive a gift for their time but they also have something they can wear in the field that identifies them as a volunteer with your organization.

Volunteer appreciation day

Data! Data! Data! Don't let your data collect dust. Before you begin your monitoring program, you should have a sense of who is going to use your data. For instance, the Santa Cruz Surfrider Chapter publishes their fecal coliform data in the local weekly papers. Surfers and beach goers can easily check and make sure the coliform level at their beach is safe for swimming. Be sure that your data meets the criteria of your user group before you collect the information: some monitoring equipment or protocols may or may not be suitable for use by some agencies. Once you've compiled your data into an easy-to-read format, report your data findings to interested parties. Likely user groups are resource agencies, local media, and most importantly, your volunteers.

Another outlet for your data is "CCAMP," the Central Coast Ambient Monitoring Program, a project of the Central Coast Regional Water Quality Control Board. CCAMP provides a data platform for volunteers to enter their data and conduct analysis through graphing and charting tools. CCAMP can also provide mapping resources for volunteer groups. By entering your data into the CCAMP database your data will become part of the larger data collection for central coast watersheds. You can access the CCAMP web page at www.ccamp.org.

Pursue Additional Funding Sources to Maintain Program. Don't forget to stay on top of the funding regimen. If you want to keep your program going, you've got to plan ahead. Try to plot out your grant proposals one to two years before your current funding runs out. This provides plenty of time to strategize where you might seek additional funding and also allows buffer time in case of unexpected changes in grant sources, guidelines, etc.

BUILDING YOUR PROGRAM- "ADAPTIVE MANAGEMENT"

Baseline Data Once you've collected an adequate amount of baseline data, you can start to see what problems need to be addressed or what monitoring holes have not been filled. Baseline water quality data should be collected for at least 2 years. After that baseline period, you can restructure the program to address specific problems and/or look into potential restoration options. Focused monitoring can also be used to address specific problems or problem areas within your watershed that require a closer look.

Once you have collected baseline data, you have a good foundation of data and knowledge to prioritize restoration needs within your watershed. So many watershed restoration projects are conducted without a lot of preliminary work. By conducting baseline information, you can clearly line out your restoration goals and assess the effectiveness of the project by comparing pre- and post-monitoring data.

Once you have a good data set, you may choose to get involved in advocacy. Advocating watershed causes and legislation with good science behind you is much more effective than without that information and credibility.

CHAPTER 7

MONITORING PROTOCOLS —DATA PRESENTATION & INTERPRETATION

PRESENTING AND INTERPRETING YOUR DATA

"No other tasks are more important to the success of your volunteer monitoring program." *EPA, Stream Monitoring Manual*

While many volunteer groups take the time to plan and design their programs to collect good quality data, they often have not identified an outlet for that data. Planning for how and when you will be presenting your data is another crucial component to putting together your monitoring program. The key to preparing good data reports is to revisit the questions that helped you design your monitoring program.

There are many more resources available to help with data interpretation , especially through the State Water Resources Control Board and your local Regional Water Quality Control Board. Contacts and resources are listed at the end of this document. "CCAMP," Central Coast Ambient Monitoring Program, is a particularly useful program established by both the Central Coast Regional Water Quality Control Board and the Bay Foundation. Their mission is "to collect, assess, and disseminate water quality information" for the Central Coast. They have developed some extremely useful tools for data management and have been a key resource for citizen monitoring groups.

Presenting your data

A Few Suggestions for Presentation

Step 1: State your goals and describe your programs

What were the goals of your monitoring program? Were they to collect baseline data on a stream that had never been monitored before? Were they to collect information on possible degradation to a waterway from a known point source in your watershed? Were they to inform your community about waterways which may not be safe for swimming in?

Revisiting your monitoring goals is therefore the first step in preparing your data report. Your data report should state your goals and include a description of your program so that readers get a complete picture.

Step 2: Determine when your reports should be prepared and published

Another question which arises for volunteer groups is how often data reports should be prepared. Is once a year enough or should the reports be more frequent? Again, the answers lie in the design and goals for your program. Groups who are monitoring fecal coliform levels may want to publish their data weekly so that the public can have ready access to the data. Groups who are collecting baseline information for a stream which has never been monitored before may want to collect a year's worth of data before publishing a report. You may also have reporting requirements for your funders. Whatever schedule you decide to publish your data on, make it a consistent schedule so that your data users get used to receiving your report on that schedule.

Step 3: Provide context to your data report

Nothing is worse then receiving a data report that is only charts and numbers. When preparing your data report, think about the pertinent information that should be provided to the reader. Examples include watershed or waterway description, land use description, monitoring site descriptions (e.g., is it in a flood control channel or natural stream), unique geologic or hydrologic conditions (e.g., presence of springs), biologic conditions (e.g., is the stream a steelhead stream), etc. These qualitative descriptors provide the data users with a context to place the data in and are as important to providing a good data report as the numbers. Another key feature to providing context to your report is to provide a map of your monitoring sites. Software programs such as TOPO, provide USGS base maps which can be formatted to identify your monitoring sites. Pictures of your monitoring sites can also be provided in your data report.

Data report

Soquel Creek Watershed Rainfall Totals
Data Courtesy of Donna Bradford, Santa Cruz County Planning Dept.

		Bates Cr	Burell Fire Station	Schaffles Rd	Olive Springs Quarry	cumulative total	total by Jan
1997	July						
	Aug	0.2	0.67	0.95	0.47		
	Sept						
	Oct	0.97	1.8	1.08	0.95		
	Nov		2.52		1.5		
	Dec	6.34	3.68	4.35	4.15		
1998	Jan	4.1	10.42	15.31	13.04		83.76
	Feb	11.69	17.04	20.79	20.06		
	Mar	4.65	7.04	6.42	6.57		
	Apr			2.95	2.78		
	May	2.4		5.84	4.57		
	June	0.08		0.24	0.12		
total		32.83	53.12	57.83	63.15	206.77	

		Bates Cr	Dure Fire Station	Schaffles Rd	Olive Springs Quarry	cum ulative total	total by Jan
1998	July						
	Aug						
	Sept	0.05		0.19	0.2		
	Oct	1.89	0.91	0.75	0.83		
	Nov	7.24	6.36	7.13	7.98		
	Dec	1.61	2.01	0.35	1.69		
1999	Jan	13.56	12.05	9.07	11.3		75.82
	Feb	8.82	8.06	8.77	8.27		
	Mar	4.05	5.03	5.53	5		
	Apr	2.99	3.11	2.86	3.19		
	May	0.08	0.08	0.12	0.12		
	June	0.24	0.35	0.35	0.24		
totals		38.33	41.87	24.8	38.83	143.29	
						31% less than 97/98 water year	

		Bates Cr	Burell Fire Station	Schaffles Rd	Olive Springs Quarry	cumulative total	total by Jan
1999	July						
	Aug			0.39	0.08		
	Sept	0.12	0.04	0.88	0.08		
	Oct	0.47	0.55	0.35	0.35		
	Nov	4.53	5.63	3.82	5.12		
	Dec	0.43	0.39	0.47	0.39		
2000	Jan	14.8	13.74	9.78	15.17		77.22
	Feb						
	Mar						
	Apr						
	May						
	June						
	July						
						within 5% of 98/99 water year	
						18% less than 97/98 by end of Jan 99	

Step 4: Ask for a technical advisor to review your report prior to publication

After completing a draft of your report, request that one of your technical advisors review the report for clarity. Request that advisor to spend time reviewing your data analysis techniques and your conclusions. Ask your technical advisor if you can list them as a reviewer on the cover of the report to help with the validation of the results presented in the report.

Step 5: Identify who should receive your reports

With the myriad of government agencies involved with managing and maintaining water quality, it can be confusing to identify who should receive your reports. In developing your mailing list think about who would benefit from having the data accessible to them. Obvious recipients should include staff from the Environmental Protection Agency (EPA), Regional Water Quality Control Boards, California Coastal Commission, Department of Fish and Game, Monterey Bay National Marine Sanctuary, local city or county staff, resource conservation districts, and special districts (e.g., water districts). The report should also be made available to community nongovernmental organizations and groups who may be interested in or are assisting with your program. Most importantly be sure to send your data reports to your volunteers so that they can see first-hand the information they have helped to collect for their local waterway. The Web is obviously another outlet by which to distribute your data reports. Depending on your organization's accessibility to the Web you may which to publish your data reports via your web page, thus saving on copying and mailing costs and time.

Public information meeting, San Gregorio

A Few Suggestions for Data Analysis

Your data analysis should reflect your monitoring goals and questions you asked at the beginning of your program. The following steps are suggested for completing your data analysis for presentation in your data report.

Step 1: Review field data sheets and input information as soon as possible

Your field data sheets are obviously the key to your monitoring program and data collection. It is best to enter the data from your field data sheets as soon as possible after the volunteers have completed their monitoring. This is especially helpful if there are questions concerning the data sheets (e.g., data outliers, incorrect units of measurement, no data collected). A call to the volunteers to ask questions about the data sheet will yield better results if the monitoring day is fresh in their minds and not a few weeks or months old. The field data sheets should be kept in a safe place and in a manner that they are well organized and easily searchable.

In the review of the field data sheets be sure to look for accurate units of measurement, any corollary information that might explain a result (e.g., water

color or odors), and explanations for data results such as a heavy rain event or especially warm day. A good internal quality check on data is to look for consistency between parameters; did the DO go down as the temperature went up? This consistency check is most easily done with water quality parameters, but can also be done with biological and physical monitoring. Finally flag any data outliers on the field data sheets for later consideration in your analysis.

Most volunteer groups use either a spreadsheet or database program for storing their data electronically. The key to cutting down on data error when going from your field data forms to your computer records is to format your database or spreadsheet to accept the data as it is laid out on your field data forms.

Step 2: Select the appropriate analysis tools for conveying your data

Actual analysis of your data is really tailored to your program; however, general options include: 1) graphing, 2) descriptive statistics, and 3) statistical methods. Graphing is a visual portrayal of your data and can be especially helpful in comparing annual or seasonal data sets. Examples would include a line graph of two cross sections of a stream from an annual monitoring program to compare channel aggradation. Another example would be a bar graph comparing two water quality parameters (e.g., DO and water temperature). Most graphical techniques use bar charts, line charts or pie charts to convey data relations.

Descriptive statistics are very basic statistics that describe a data set and commonly include median, average, maximum, minimum and standard deviation. These types of statistics can be very helpful when looking at seasonal or annual data. It is helpful to have reference materials on basic statistical analysis available for staff who are preparing your data reports. Once these descriptive statistics have been calculated they can also be used with the graphing techniques discussed above.

Statistical methods are used to show what levels of confidence, or the amount of error, investigators have in the data (Oregon, 1999). Examples of these statistical methods include multiple and linear regression, multivariate analysis, and correlation analyses. It is recommended that volunteer groups consult with a technical advisor before using any of these types of statistical analysis, as each type is specific to certain types of data sets.

Step 3: Reviewing your results

Once you have completed your data entry and analysis, it is time to make sense of your data. Again, keeping in mind the goals for your monitoring program, what questions can you now answer with your data? Some of the most powerful data reports relate the data back to set objectives for a waterway. The most common objectives that data are compared against are the designated water quality objectives for the beneficial uses of a particular waterway. These objectives can be found in the Regional Water Quality Control Board's Basin

Plan which includes the waterway you are monitoring (see Regional Water Quality Control Board information in the General References section). You can access a copy of your region's Basin Plan at: www.swrcb.ca.gov.

Other sources of criteria which may be used for comparison are available through the EPA (e.g., phosphates) and through the Department of Fish and Game (e.g., stream flow, dissolved oxygen). Academic papers and life history criteria for particular species can also be used for interpreting data. Finally, the EPA and local environmental health departments have criteria which can be used to compare safe levels for water-contact recreation, fish harvesting, and water supply. Careful research of these standards should be conducted prior to preparing your data report. Technical advisors are especially helpful with this research and in assisting with data interpretation.

Important factors to consider when you are comparing your data against selected water quality standards include: reviewing your data for correct units of measurement; reviewing your data based on time of year collected; and reviewing past data sets to look for similar trends that may be found in your results. Correct units of measurement are critical, especially with parameters such as turbidity, conductivity, stream flow and physical measurements such as longitudinal profiles and cross-sections. Analyzing your data based on time of year collected is also important in avoiding incorrect conclusions with regards to parameters like temperature, conductivity, turbidity, and stream flow. The time of year that you collect your data greatly influences your results. Finally, take the time to review past data sets and reports before drawing conclusions. This trend analysis review is especially important for documenting baseline conditions within a watershed.

For more information about appropriate data tools, please visit the Central Coast Ambient Monitoring Program website: www.ccamp.org.

Volunteer trash cleanup, Soquel Creek

GENERAL REFERENCES

Citizen Monitoring Network Contacts

Coastal Watershed Council
903 Pacific Avenue, Suite 207A
Santa Cruz, CA 95060
(831) 426-9012
(831) 421-0170 FAX
cwc_office@yahoo.com
www.coastal-watershed.org

Center for Marine Conservation
55C Municipal Wharf
Santa Cruz, CA 95060
(831) 425-1363

Monterey Bay National Marine Sanctuary
Water Quality Protection Program
209 Foam Street
Monterey, CA 93940
(831) 647-4250

Other Contacts

California Regional Water Quality Control Board
Central Coast Region
81 Higuera Street, Suite 200
San Luis Obispo, CA 93401-5427
(805) 549-3147

California Regional Water Quality Control Board
San Francisco Bay Region
Revital Katznelson
1515 Clay Street, Suite 1400
Oakland, CA 94612
(510) 622-2470
rk@rb2swrcb.ca.gov

Dominic Roques, State Volunteer Monitoring Coordinator
Division of Water Quality
State Water Resources Control Board
901 P Street
Sacramento, CA 94244-2130
(916) 657-1020
ROQUD@dwq.swrcb.ca.gov

California Department of Fish and Game
20 Lower Ragsdale Drive
Monterey, CA
(831) 649-2870

Surfrider Foundation Santa Cruz Chapter
P.O. Box 3203
Santa Cruz, CA 95062
(831) 476-7667
blue@surfridersantacruz.org
www.surfridersantacruz.org

California Salmonid Stream Habitat Restoration Manual
State of California Resources Agency Dept. of Fish and Game
Inland Fisheries Department
ATTN: Salmonid Habitat Restoration Coordinator
1416 Ninth Street
Sacramento, CA 95814
Ph: 916.654.5997

Hands On Save Our Streams– The Save Our Streams Teacher's Manual
Save Our Streams Program
Izaak Walton League of America
707 Conservation Lane
Gaithersburg, MD 20878-2983
Ph: 1.800.BUG.IWLA

Central Coast Ambient Monitoring Program
Karen Worcester,
Senior Environmental Specialist
81 Higuera St., Suite 200
San Luis Obispo, CA 93401-5411
Ph: 805.549.3147
www.ccamp.org

Oregon Watershed Assessment Manual
Contact: Ken Bierly,
ken.bierly@state.or.us
Oregon Watershed Enhancement Board
255 CapitolSt. NE, 3rd floor
Salem, OR 97310-0203
Ph: (503) 378-3589 x831

Oregon Water Quality Monitoring Technical Guide Book
Department of Environmental Quality
Laboratory Division
1712 SW Eleventh
Portland, OR 97201
Ph: 1.800.452.4011

Streamkeeper's Field Guide-
Watershed Inventory and Stream Monitoring Methods
The Adopt-A-Stream Foundation
600-128th Street SE
Everett, WA 98208
Ph: 206.316.8592

Volunteer Monitoring Protocols **and** *Riparian Station How-to Manual.*
San Francisco Estuary Institute
180 Richmond Field Station
1325 South 46th Street
Richmond, CA 94804
Ph: 510.231.9539

Volunteer Stream Monitoring: A Methods Manual
U.S. EPA
Technical Document #: EPA 841-B-97-003
www.epa.gov

The Volunteer Monitor
www.epa.gov/owow/volunteer/vm_index.html