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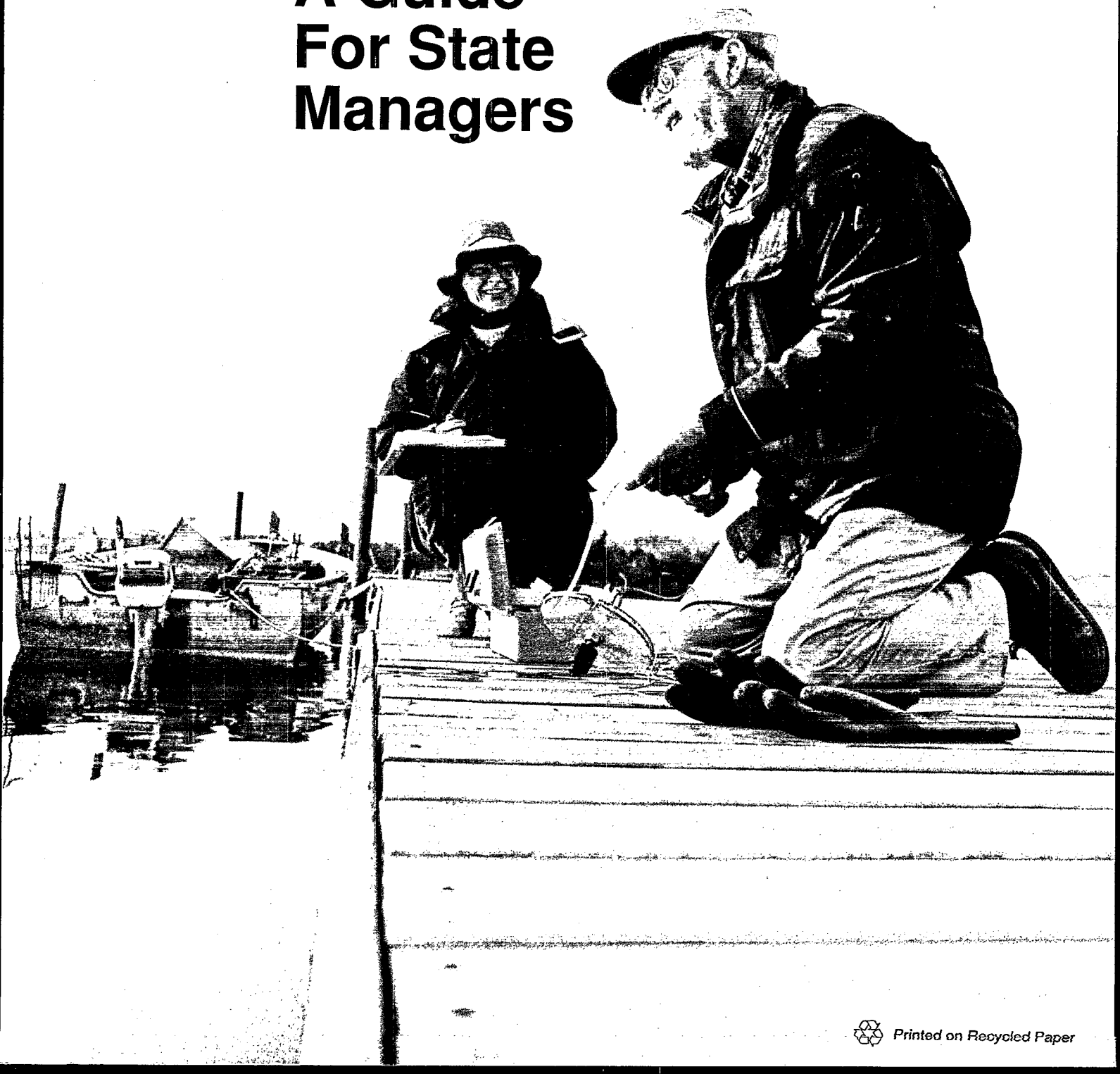
VOLUNTEER WATER MONITORING:

A Guide For State Managers



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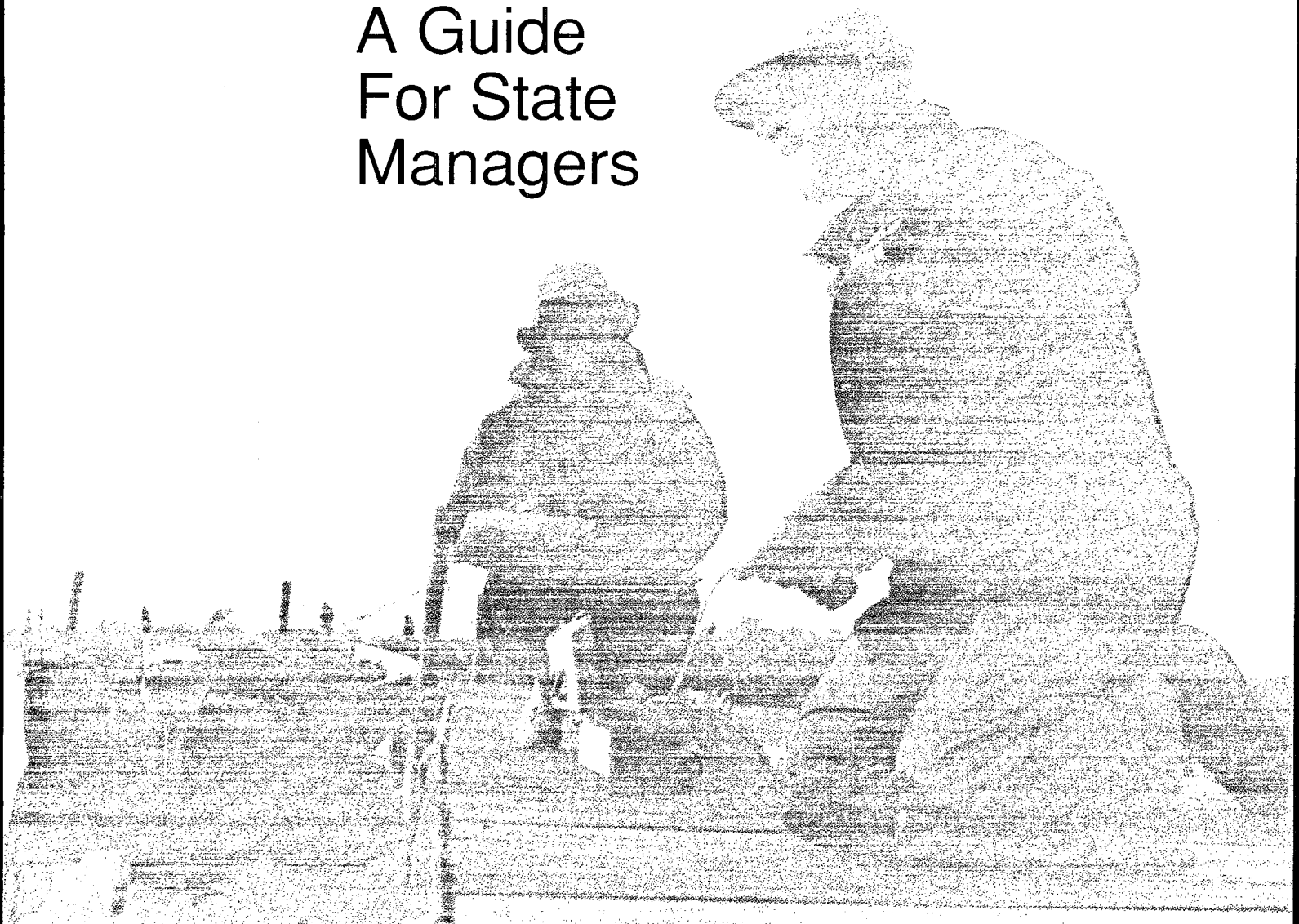

U.S. Environmental Protection Agency
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FOREWORD

Citizen volunteer monitoring is a relatively new development in the water quality assessment and management field. In a growing number of cases, States have recognized the value of volunteers and have begun to sponsor them in the collection of high quality baseline and screening data.

We at EPA encourage this partnership between State agencies and citizen volunteers. EPA has prepared this guide for State managers because of the benefits of volunteer monitoring both as a source of credible data and as a public education tool that encourages a sense of stewardship for our water resources.

This document cannot claim to be more than a guide. Specific approaches will vary depending on the type of waters to be assessed, the parameters to be monitored, and the amount of resources the State is able to commit to the program. Nevertheless, this guide should help new programs build on the experiences of successful, established programs and avoid any pitfalls they may have encountered. We also hope that this guide will help improve existing volunteer programs and spark interest in States that have not yet made plans to work with citizen volunteers.

Martha G. Prothro
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Cover Photo: Virginia Lee and Richard Wood take water samples as part of Rhode Island Sea Grant's successful Pond Watchers project.
Photo by Richard Turgeon.

All photographs are courtesy of individual or organization listed.

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Citizen volunteers are becoming increasingly involved in monitoring the quality of our Nation's waters. Volunteer monitoring programs-both State-sponsored and private—are being formed at a rapid rate throughout the country. Many States that were once skeptical about using volunteer information are becoming increasingly aware of the value of volunteer programs, both in collecting usable water quality information and in developing an educated and involved constituency committed to protecting water resources. Two national EPA-sponsored volunteer monitoring conferences, held in 1988 and 1989, have further spurred these developments; their success is testimony to the growing interest in this field.

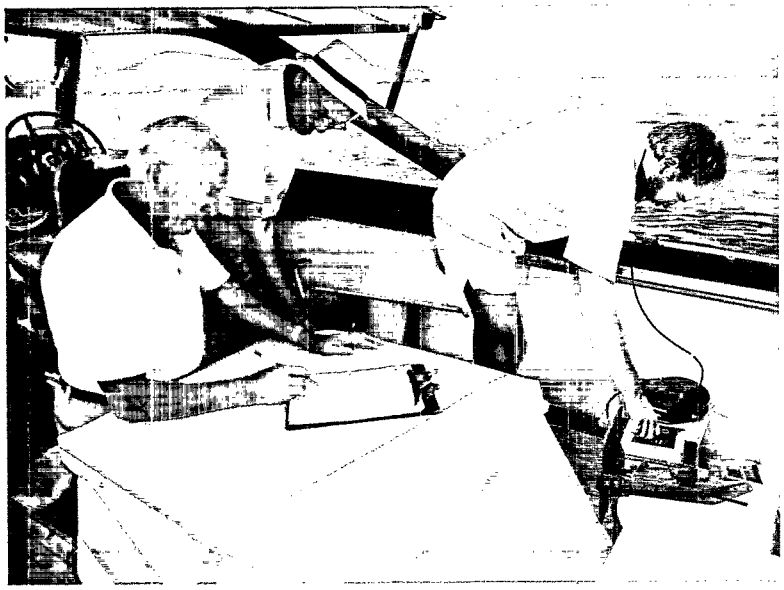


Photo courtesy of the New Hampshire Lakes Lay Monitoring Program.

Clifton Chandler (sitting) and William Hollenbeck, two volunteer monitors, record results while Jeffrey Schloss, coordinator of the New Hampshire Lakes Lay Monitoring Program, takes oxygen readings from different depths of Lake Winnipesaukee.

EPA's involvement in volunteer monitoring was sparked by two major developments. One was the passage of the Water Quality Act of 1987, which provided new impetus and funding for clean lakes and nonpoint source assessment and management programs, and which recognized the National Estuary Program (NEP). The NEP, in particular, encouraged public education and public participation in the identification and management of pollution problems. Volunteer monitoring was recognized by EPA as an excellent way to help implement these programs.

Second was an EPA study of the Agency's surface water monitoring activities (USEPA 1987). One of the study's recommendations was to enhance State and EPA capabilities to identify problems, conduct trend assessments, and characterize waters by investigating the usefulness of incorporating volunteers into State ambient monitoring activities.

As a result, EPA began a survey of existing volunteer monitoring programs, assessing their strengths and drawbacks. It soon became clear that the experience of several well-managed, State-sponsored programs could be of value to State water program managers who might be considering whether or not to develop their own volunteer efforts (for detailed information on five such programs, see Appendix). The recommendations of the two national volunteer monitoring conferences confirmed this need.

This guide for State managers was developed to meet this need. It provides an overview of the use of citizen volunteers in environmental monitoring. Its basic premise is that a well organized, properly maintained volunteer monitoring program can yield credible water quality data that will be useful to the State. To help State program managers launch and manage such a program, this document discusses how to plan and organize projects, how to involve the media, and how to prepare quality assurance plans that will ensure that data of known quality are produced. In addition, data management considerations and approaches to data analysis are discussed, as well as costs and funding issues. Examples drawn from successful existing programs are provided throughout this document.

The material in this document can be summarized in seven "basic ingredients for success."

I. Develop and articulate a clear purpose for the use of the data.

Data should be collected to meet a specific need or in response to a stated hypothesis. Clear Data Quality Objectives (DQO's) must be identified as the first step in planning.

The planning process should be carried out by a committee of data users, which involves potential as well as identified users, and includes members of the scientific research community, local and regional officials who will play a part in policy making based on the results, and citizen leaders who are potential volunteer monitors or represent groups from which volunteers will be recruited.

II. Produce "data of known quality" that meet the stated Data Quality Objectives.

The perception that good quality data cannot

be collected by amateurs is the most common reason given by professional monitoring managers declining to take advantage of this resource. Prepare a Quality Assurance Project Plan (QAPjP) for the project and make sure you adhere to its elements.

III. Be aware that volunteer monitoring is cost-effective but is not free.
A well-coordinated and quality-controlled project requires dedicated professional staff support. One person should be identified whose priority responsibility is the oversight and management of the volunteer program. Office administration, data management, and analytical support must be allocated up-front and carried through to demonstrable use of the data.

IV. Thoroughly train and re-train volunteers.
Make sure that they have the opportunity to gain an understanding of the ecology of their area. Volunteers should have a realistic understanding of the program's objectives and limits. Keep them informed and answer their questions promptly.

V. Give the volunteers praise and feedback—it's the psychological equivalent of a salary!
Keep a direct line of communication open at all times using the telephone, personal memos, and/or some form of newsletter. Ask their advice on general administrative issues, bring them into the proofreading process, and help them develop a sense of shared ownership of the program. Recognize their accomplishments through awards, letters of appreciation, publicity, and certificates. If at all possible, encourage experienced volunteers to shoulder increased responsibilities such as becoming team leaders or coordinators, carrying out more advanced tests, or helping with data analyses.

VI. Use the data your volunteers collect.
Nothing discourages participating volunteers more than seeing that their data are not being used. Simple analyses and attractive displays of high quality volunteer data should be presented to volunteers as well as to State staff. This will foster continued interest in the program and serve to educate and inform the public about local water quality issues.

VII. Finally, be flexible, open, and realistic with your volunteers and yourself.
Start with a small program you can easily handle. Synchronize the monitoring period to coincide with the period you can commit to supporting the volunteers. When starting a program, be frank about the chances for continued support and inform the group if resources disappear. Work with the strengths and interests of your volunteers and search for ways to make the most of your available resources. Talk with coordinators of similar programs in other States to learn of new ways to handle obstacles.

Planning, implementing, and maintaining a volunteer monitoring program requires organization, time, resources, and dedication. However, the payoffs can be very great. By designing this document to discuss both the responsibilities and the payoffs of a well run volunteer monitoring program, EPA is encouraging State water quality managers to consider how such a program might meet their needs. Once managers make a decision to proceed, this document can provide them with a framework for setting up their own programs.

This document cannot say all there is to be said; there are too many variables at work, too many ways a State might design its volunteer monitoring program, depending on its resources and needs. We hope, however, that its message is clear: that States should draw on the enthusiasm, expertise, and commitment of their citizens to monitor and protect the water resources that are so precious to us all.

Photo by John Bildahl

This document provides State, regional, and Federal program managers with a practical reference for developing, implementing, and maintaining a surface water volunteer monitoring program. A number of states have successfully expanded ongoing monitoring and assessment activities with the assistance of competent, trained volunteers (for examples, see the Appendix). These programs have demonstrated that volunteers can successfully deliver high quality data that can be used for surface water assessment and problem identification. Drawing on the collective experience of these programs, this document provides information on how to plan, fund, and maintain a volunteer monitoring effort that can provide credible, useful water quality data.

Photo by Larry LeBeouf

Save Our Streams Coordinator Karen Firehock gives Virginians a hands-on lesson in biological monitoring using a "kick-seine."

This guide begins by providing an overview of existing volunteer monitoring efforts and outlines how to plan a program that will produce high quality data. It then discusses steps in implementing a program, from launching a pilot to maintaining volunteer interest. Considerable focus is directed to providing credible, quality-controlled information and analyzing and presenting data provided by volunteers. This guide goes on to discuss costs and funding issues. The appendix describes five successful State-managed or sponsored programs. For further information on additional volunteer monitoring programs refer to the *National Directory of Citizen Volunteer Environmental Monitoring Programs* (USEPA 1990).

This document does not provide detailed information on specific monitoring methods that might apply to a volunteer effort. EPA plans to address methods in separate, companion handbooks for lakes and rivers.

1.1 VOLUNTEERS MONITOR A VARIETY OF PARAMETERS

The experience of citizen monitoring programs throughout the country proves that volunteers can be trained to carry out a wide variety of environmental monitoring tasks, provided they are given the appropriate equipment and instruction. Figure 1.1 provides examples of the range of monitoring activities in which volunteers have proven to be successful partners. Volunteer monitoring activities can be placed into three general categories: visual observation, physical and chemical measurements, and assessments of living resources.

Visual Observation

Volunteers often live near the sites they monitor, and so may have ready access to waters inaccessible to State personnel. Their familiarity with nearby waters also makes volunteers uniquely qualified to make visual observations of changes in water color following storm events; effects of erosion and sediment control measures; general impacts of earth disturbances during land development for agricultural or construction purposes; weather; land uses; impacts of recreational uses; and animal behavior and abundance.

Physical and Chemical Measurements

Volunteers also often measure a wide variety of chemical and physical parameters. Samples are collected using standardized, State-approved methods and equipment, and may be analyzed in the field using specially designed kits or sent to a laboratory for analysis. Among the parameters currently being measured by volunteer groups are: water and air temperature; water transparency; turbidity; suspended solids; salinity; river height and flow; rain and snow amounts; and chemical constituents such as pH, alkalinity, dissolved oxygen, nitrates, phosphates, chlorophyll, sulfates, pesticides, metals, and hardness.

Assessments of Living Resources

Recognizing the connection between the quality of waters and the condition of plants and animals in and around them, some volunteer programs recruit and train citizens to survey living resources. These surveys most often involve evaluation of benthic macroinvertebrates, fish, birds, and plants. Volunteers may also report on the condition of fish (noting tumors, growth abnormalities, and lesions, for example); the incidence of fish

kills and algae blooms; habitat condition and availability; and the presence and concentration of fecal coliform bacteria.

1.2 VOLUNTEERS MONITOR ALL TYPES OF WATERS

Lake Sampling

Lakes are often intensively used for recreation, and in many cases are managed by homeowner associations. Therefore, they often have a built-in constituency eager to participate in volunteer monitoring activities. In fact, most successful State-managed volunteer monitoring programs were initially developed to enhance State lake monitoring networks. States hoped to use volunteer-collected data to extend their monitoring coverage, establish baseline lake trophic conditions, and identify lakes experiencing water quality problems. A secondary objective was often to educate the public about lake ecology and lake management and protection.

The basic volunteer lake monitoring program asks monitors to collect Secchi depth data at one or two stations on their lake, two to four times a month during the summer season. Volunteers also record observations on the week's weather, the current uses of the lake (number of fishermen, swimmers, boaters, etc.) and the apparent condition of the lake. Data sheets are provided to list information on water color, turbidity, odor, suspended algae, other aquatic vegetation in the lake basin and along the shore, and current activities that could be affecting lake water quality.

FIGURE 1.1

Volunteers monitor a variety of parameters in all types of waters. (The programs listed in this matrix are provided as examples. For a more comprehensive list of existing programs, refer to USEPA 1990.)

FIGURE 1.1 Volunteers Monitor a Variety of Parameters in All Types of Waters

OBSERVATIONS	LAKES	STREAMS/RIVERS	ESTUARIES	NEAR COASTAL WATERS	WETLANDS
Physical/Chemical Measurements in Water Column	IL Volunteer Lake Monitoring ME Volunteer Lake Monitoring VT Lay Monitoring NH Lakes Lay Monitoring NY Citizens Statewide Lake Assessment FL Lake Watch	DE Stream Watch KY Water Watch MA Acid Rain Monitoring MI Friends of the Rouge River	Chesapeake Bay Citizen Montitoring RI Salt Pond Watchers NC Albemarle-Pamlico Citizen Monitoring MD Anne Arundel Co. Watershed Management FL Tampa Bay SWIM Team MA Falmouth Pond Watchers FL-AL Friends of Perdido Bay	MA Audubon Boston Harbor Monitoring WA Adopt-A-Beach	Hudson River National Estuary Research Reserve MD Jug Bay Wetlands Sanctuary
Microbiological Measurements in Water Column		MI Friends of the Rouge River	RI Salt Pond Watchers		
Visual Ecological Surveys	IL Volunteer Lake Monitoring WI Self-Help Lake Monitoring VT Lay Monitoring FL Lake Watch	Save Our Streams NJ Water Watch NC Stream Watch	Chesapeake Bay Citizen Monitoring RI Salt Pond Watchers FL Tampa Bay SWIM Team	Beach Debris Cleanups	MD Jug Bay Wetlands Sanctuary WI Wetlands Watch MN Wetlands Watch
Fish and Shellfish Surveys	ME Volunteer Anglers NH Lakes Lay Monitoring	ME Volunteer Anglers		NJ Sea Grant American Littoral Society	
Benthic Macro-invertebrate Surveys		Save Our Streams OH Scenic River Stream Quality Monitoring			
Primary Producer Surveys	VT Lay Monitoring NY Citizens Statewide Lake Assessment NH Lakes Lay Monitoring MT Clark Fork Coalition		Cheasapeake Bay Citizens Monitoring RI Salt Pond Watchers	NJ Sea Grant	MD Jug Bay Wetlands Sanctuary

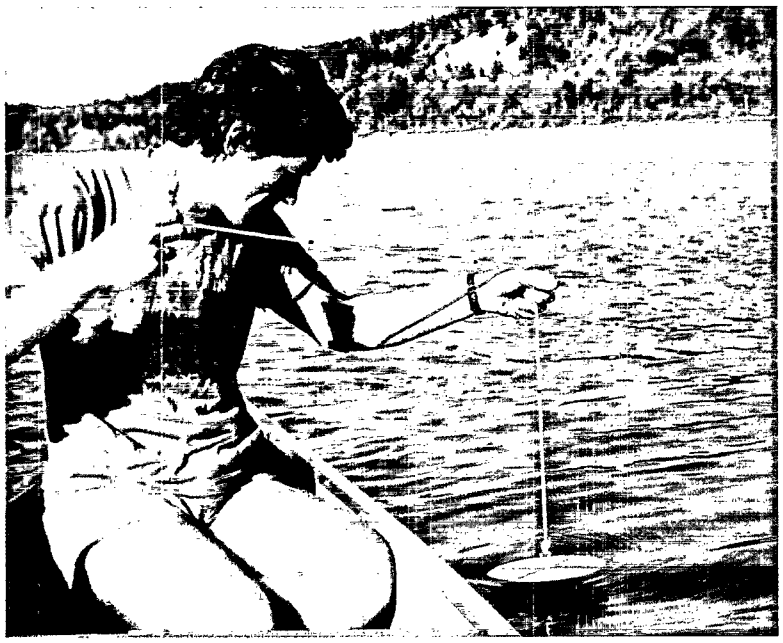


Photo by Carolyn Rumery Betz

Richard Betz prepares to take a Secchi disk reading at Devil's Lake in Sauk County, Wisconsin.

Some States use volunteers to collect additional water quality parameters that indicate lake trophic status. Volunteers collect and filter samples for chlorophyll and nutrient analyses. Analytical work is usually performed at State or private laboratories, although some States provide volunteers with field test kits, allowing them to do the analyses onsite.

A few States have used their volunteers during fishery and shoreline vegetation surveys. They have found that the citizens' intimate knowledge of the lake and its watershed provided useful information not generally available during a routine assessment.

Stream and River Sampling

Most States maintain a fixed network of stream and river stations, sampled regularly for chemical, physical, and biological parameters. Special intensive surveys are also performed periodically to comprehensively assess the water quality of a specific stretch of river. Most States with citizen monitoring programs prefer to use State staff for these baseline monitoring activities; volunteers collect data at secondary water quality stations to complement the State network and may sample regularly for parameters such as dissolved oxygen, temperature, pH, and nutrients. Some States have also relied on volunteers for comprehensive synoptic sampling efforts and to provide spot checks of specific problems in localized areas.

Approximately 20 years ago, the Izaak Walton League of America developed a simplified benthic macroinvertebrate sampling methodology to be used by volunteers to assess stream water quality (Save Our Streams). Volunteers are trained to collect benthic macroinvertebrates and sort them into gross taxonomic categories. The density and diversity of the organisms can then be used to make general statements about the overall water quality of the stream. Variations on this method have been used by several States for initial screening of water quality. If problems are indicated, the State then follows up with more comprehensive biological surveys.

Estuarine Sampling

In 1987, Congress created the National Estuary Program (NEP) to protect and restore water quality in the Nation's estuaries.The NEP focuses on the development and implementation of comprehensive management plans for individual estuaries, establishing a working partnership with Federal, State, and local governments; academic and scientific communities; industries and businesses; public action groups; and private citizens. The NEP recognizes that public education and involvement are essential to the successful restoration of estuarine waters, and strongly encourages States to incorporate citizen monitoring programs into their overall control effort. Successful citizen monitoring programs have been found to enhance estuarine monitoring activities, increase public understanding of the ecosystem, and build local support for necessary corrective actions.

Estuarine monitoring programs such as Chesapeake Bay Citizen Monitoring Program, Rhode Island Salt Pond Watchers, and Albemarle-Pamlico Citizen Monitoring Program, use volunteers to collect physical and chemical measurements in estuaries and in tributary streams and inlets. Since estuarine drainage systems are large and complex, volunteers can be especially helpful in upstream areas not normally covered by the State's monitoring network. Basic water quality measurements such as pH, transparency, salinity, dissolved oxygen, and temperature can provide useful information to a comprehensive monitoring program. Trained volunteers can also be used to assess aquatic vegetation in the estuary, and can provide information on acute problems such as spills, fish kills, and algae blooms.

Near Coastal Water Assessments

Historically, most States have focused their assessment and pollution control activities on fresh inland waters, in part because these are the most stressed and polluted of their waters, but also because inland waters are the easiest to monitor and manage. Many States are only now beginning to incorporate near coastal waters into their assessment activities and to draw on the assistance of volunteers in these activities. This new emphasis has been spurred to some extent by EPA's Near Coastal Waters Program, part of a long-range initiative by the Agency to restore and protect the water quality and natural resources of the nation's coastal areas.

At this time, volunteer activity in near coastal waters focuses on beach cleanups. In cleanup activities sponsored by the Center for Marine Conservation (in 25 States), volunteers maintain records on types and amounts of debris collected. Volunteers keep track of 23 different kinds of plastic debris, as well as certain varieties of metal, glass, paper, and any stranded or entangled wildlife. This unique monitoring information has been used to obtain ratification by 42 countries of a treaty that prohibits the dumping of plastics at sea by cruise ships, fishing vessels, and merchant and military craft.

Wetlands

State monitoring and assessment of wetlands resources is extremely limited. Little, if any, water quality monitoring is conducted; most assessment activities are limited to evaluations of changes in wetland area and rates of loss.

Volunteer monitoring activities in wetland areas are in their infancy as well. In Anne Arundel County, Maryland, the South County Creeks Commission, with technical assistance from U.S. Fish and Wildlife Service, has helped community groups learn to recognize and identify inaccuracies and incompleteness in the U.S. Department of the Interior's National Wetland Inventory maps and to make recommendations for corrections (Mary McHenry 1990). Volunteers have also been involved in marsh plant and animal inventories at National Estuarine Research Reserve sites (Gault, et. al. 1988).

Volunteers can carry out qualitative assessments and descriptions of physical changes in wetlands related to the impacts of point and nonpoint source discharges. Volunteers might also be helpful in monitoring the effectiveness of wetlands mitigation projects.

1.3 VOLUNTEERS CAN COLLECT USEFUL DATA

The experience of a number of State-managed volunteer monitoring programs proves that volunteer-collected water quality data can be used in many ways by States. However, it is also evident that volunteer data are underutilized in many States. The reason State program managers most often cite for not using volunteer data is lack of confidence in data quality.

The most common use of volunteer data may be for screening: potential water quality problems identified by volunteers are relayed to the State or other authority, which may follow up with its own assessment or control action. Volunteer data are also commonly used to provide baseline and trend information on waters or parameters otherwise unmonitored by the State. Of all the data collected by volunteers, lake water quality data appear to be the most widely used today. This is most likely because lake volunteer monitoring programs are often the best established; a few important measures of lake

RHODE ISLAND SALT POND WATCHERS

Several beautiful and productive shallow lagoons, locally known as salt ponds, lie along Rhode Island's southern shore. Since September 1985, over 30 volunteers have been monitoring water quality parameters every other week, from May through October, in seven of these ponds. Data collected by the Pond Watchers program have been used:

- as part of the State's water quality assessment report to USEPA;
- by the Department of Environmental Management (DEM) in deciding on seasonal closure of some of the salt ponds to shellfishing;
- by local municipal governments in zoning and planning board decisions;
- by the State and by municipalities in a cooperative effort to develop local harbor management plans and ordinances;
- by the State to revise regional septic systems construction standards and to pass legislation to develop waste water management districts for non-sewered areas.

These applications of Salt Pond Watchers data have spurred the State DEM to agree to establish a position of State Volunteer Monitoring Coordinator. This coordinator would work with all citizen monitoring groups to ensure that information is useful for State environmental decisionmaking (Lee and Kullberg 1986).

Photo by John Strawbridge

Volunteer checks a rain gage on the bank of Letter Kenny Lake, an impoundment on Conodoguinet Creek, Pennsylvania.

qualtiy (e.g., transparency) can be easily monitored by volunteers; and lakeside homeowners are likely to have a strong interest in seeing that the data are used.

Examples of how various State-managed volunteer programs use their data are presented below. Some of these examples are drawn directly from this document's Appendix, "Descriptions of Five Successful Programs."

Screening for Problems

Since it was established in 1978, the **New Hampshire Lakes Lay Monitoring Program** (LLMP) has been of value in helping protect the State's water quality. Data collected by volunteers were instrumental in limiting development that would have impaired Beaver Lake in Derry, and supported a successful effort to install a sewer line around the lake. On Lake Winnipesaukee, volunteer data demonstrated the adverse impact of nutrient loading due to fertilizers used at a condominium development and changes were made that reduced the runoff to the lake. Data collected by the volunteer monitoring program at Baboosic Lake in Amherst helped reroute a road expansion project that would have run too close to the lake. Volunteers provided information on septic sludge buildup around Merrimack's Naticook Lake, which resulted in the removal of the material (Schloss 1988).

The Lake Lucille Property Owners Association has used three years of the New York Citizens Statewide Lake Assessment Program's (CSLAP) data to document the degradation of water quality in Lake Lucille, a 12-acre lake in southeastern New York. The analysis of high algae, macrophyte, and nutrient levels, decreasing water depth, and effects of stormwater runoff on water quality has led the association to propose sediment controls at upstream construction sites and a large-scale sediment removal (dredging) project throughout most of the lake floor. The local town board has passed the lay monitoring results to a consulting firm hired to review these restoration efforts. The collected data are thought to be the most up-to-date technical information available on the water quality of the lake (Survey 1989, Kishbaugh).

The Minnesota Pollution Control Agency staff has used data from its Citizen Lake Monitoring Program, in conjunction with State-collected chemical data, in a special study resulting in a successful finding against the J.L. Kraft Co. Phosphorus loads to the Sauk River and the downstream chain of lakes were reduced as a result of the finding (Bostrum 1988).

Kentucky's Division of Water used the volunteer data to identify two noncomplying dischargers and five stream sites where standards were exceeded. Although the State does not use volunteer data alone to implement enforcement actions, the citizen monitors have demonstrated that they can reliably locate water quality problems for further investigation by State enforcement personnel (Appendix, Kentucky).

Providing Baseline Data

The Anne Arundel County, Maryland, Office of Planning and Zoning sponsors a Volunteer Citizen Monitoring Program as part of its Watershed Management Program (WMP).

The data collected by the volunteers are used in conjunction with data from two professional monitoring programs within the WMP to provide a more complete picture of overall water quality. These data are also valuable to the residents of the county, since frequently the only documented water quality information available for the creeks in these watersheds comes from volunteers. Volunteer data have also been used to complement data from State and Federal monitoring programs. These data have also been used to demonstrate siltation of a creek resulting from a highway construction project and to evaluate a stormwater management waiver request. (Survey 1989, Haddon).

The Minnesota Citizen Lake Monitoring Program (CLMP) was initiated to detect and evaluate changes in lake water quality. The data are used for trend analysis of water quality in lakes where 10+ years of data are available. The State staff has also used data to help develop water quality standards for lakes and in preparing trophic status reports (Bostrum 1988).

New York's Citizens Statewide Lake Assessment Program (CSLAP) collects baseline data for preparation of lake-specific management plans, while educating lake residents and users about lake ecology, management practices, and data collection. The data are used to document trends on individual lakes, identify specific water quality problems, and calculate trophic status to support the DEC's lake management recommendations to individual lake associations (Appendix, New York).

In Illinois' Volunteer Lake Monitoring Program, volunteers collect baseline data (primarily Secchi disk depth) for 150 lakes, most of which are not monitored by State personnel. Federal, State, and local agencies refer to the data to document water quality impacts; select priority watersheds for Clean Lakes funding under Section 314(a) of the Clean Water Act, as well as for cost-share funding for soil-erosion control from the U.S. and Illinois Departments of Agriculture; evaluate the effectiveness of lake protection and management projects; and determine waterbody assessments for the Section 305(b)

FIGURE 1.2 A-B

Comparison of chlorophyll values (a) and Secchi Disk readings (b) between data collected by the New Hampshire Lakes Lay Monitoring Program and the Freshwater Biology Group (FBG) field team at the University of New Hampshire.
SOURCE: Schloss 1988.

FIGURE 1.2
New Hampshire Lakes Lay Monitoring Program
Volunteer vs. Professional Results

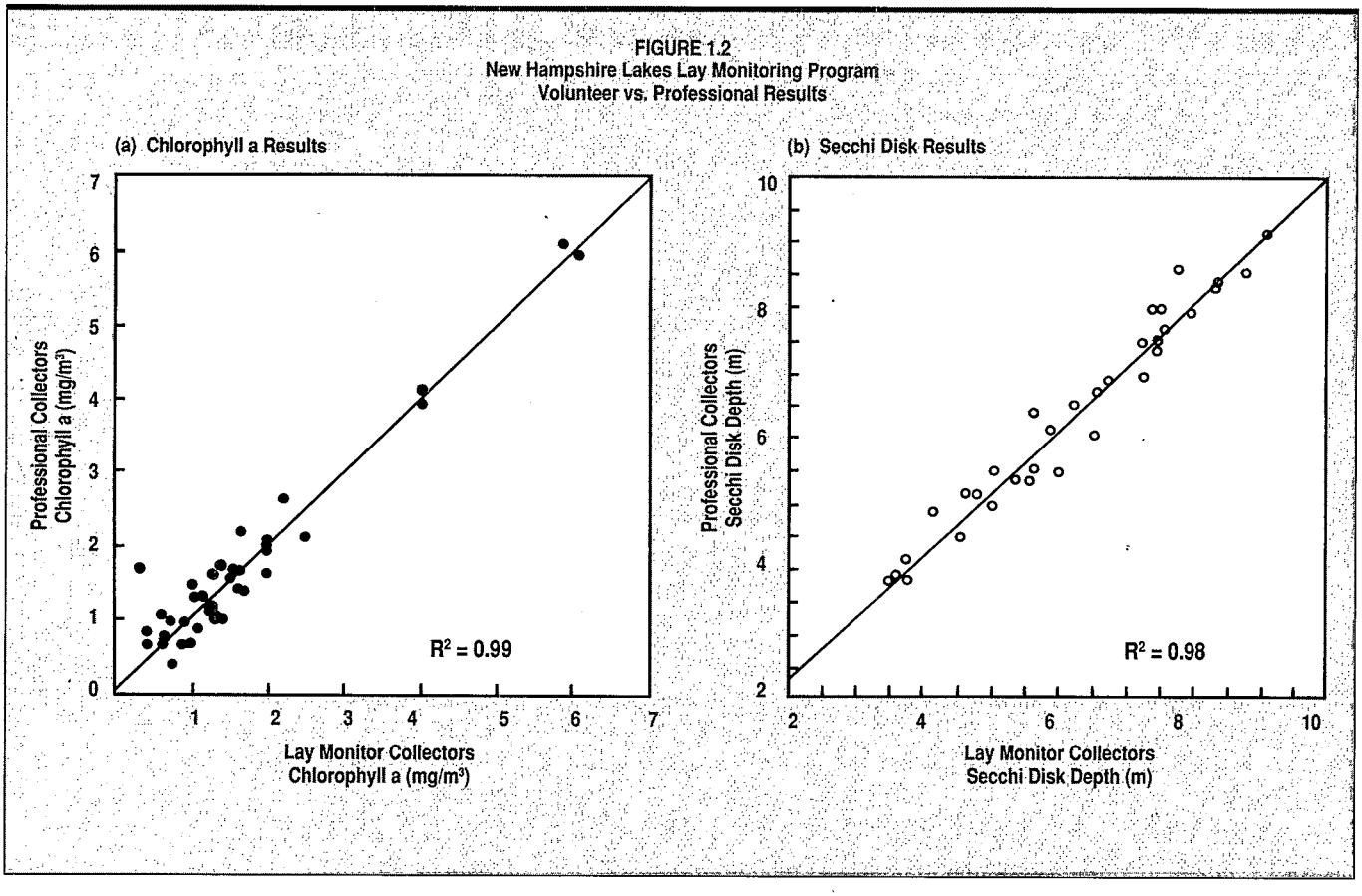
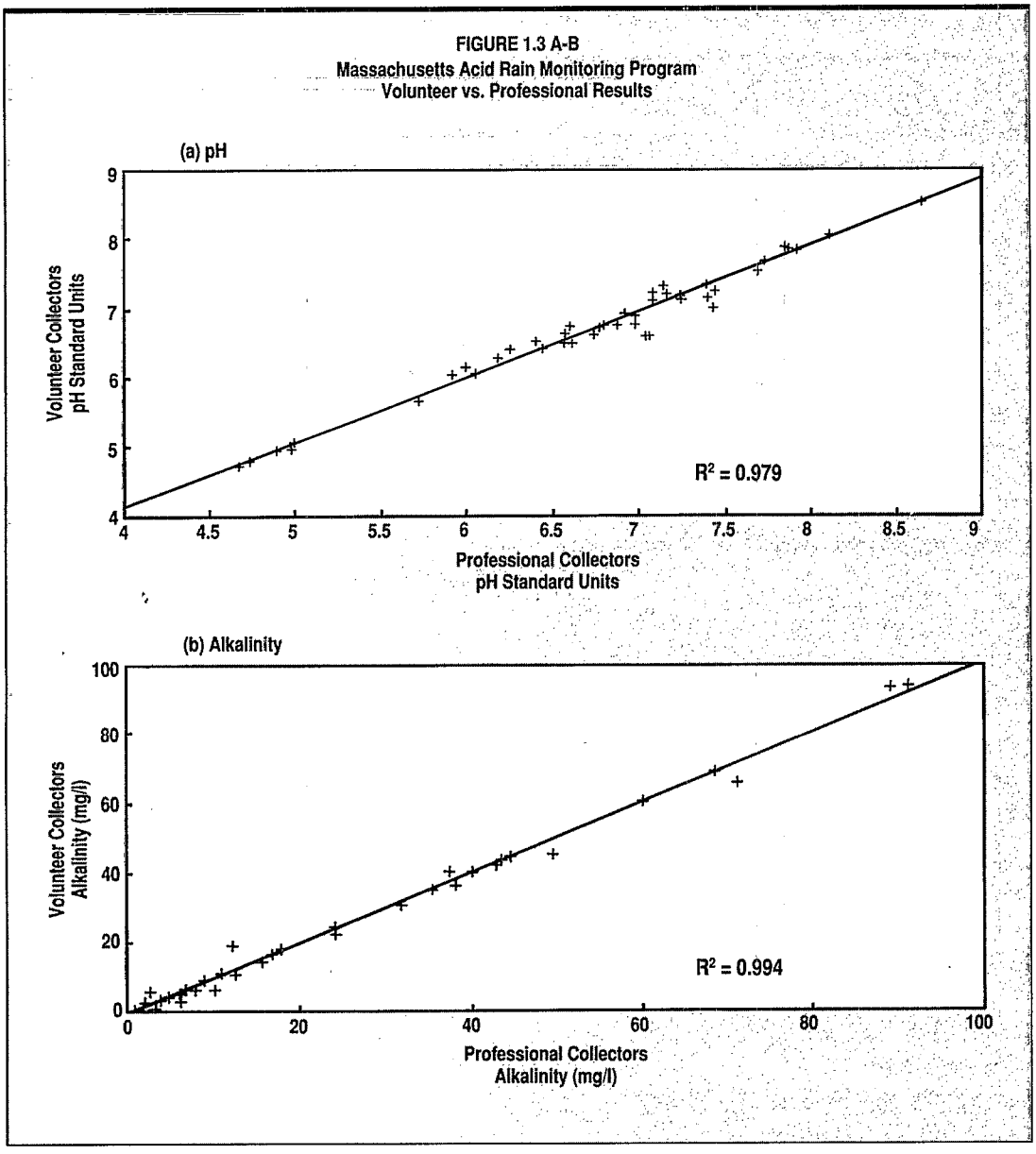


FIGURE 1.3 A-B

Comparison of results for samples collected by Massachusetts Acid Rain Monitoring (ARM) program volunteers vs. ARM staff for pH (a) and alkalinity (b).
SOURCE: Godfrey 1988.



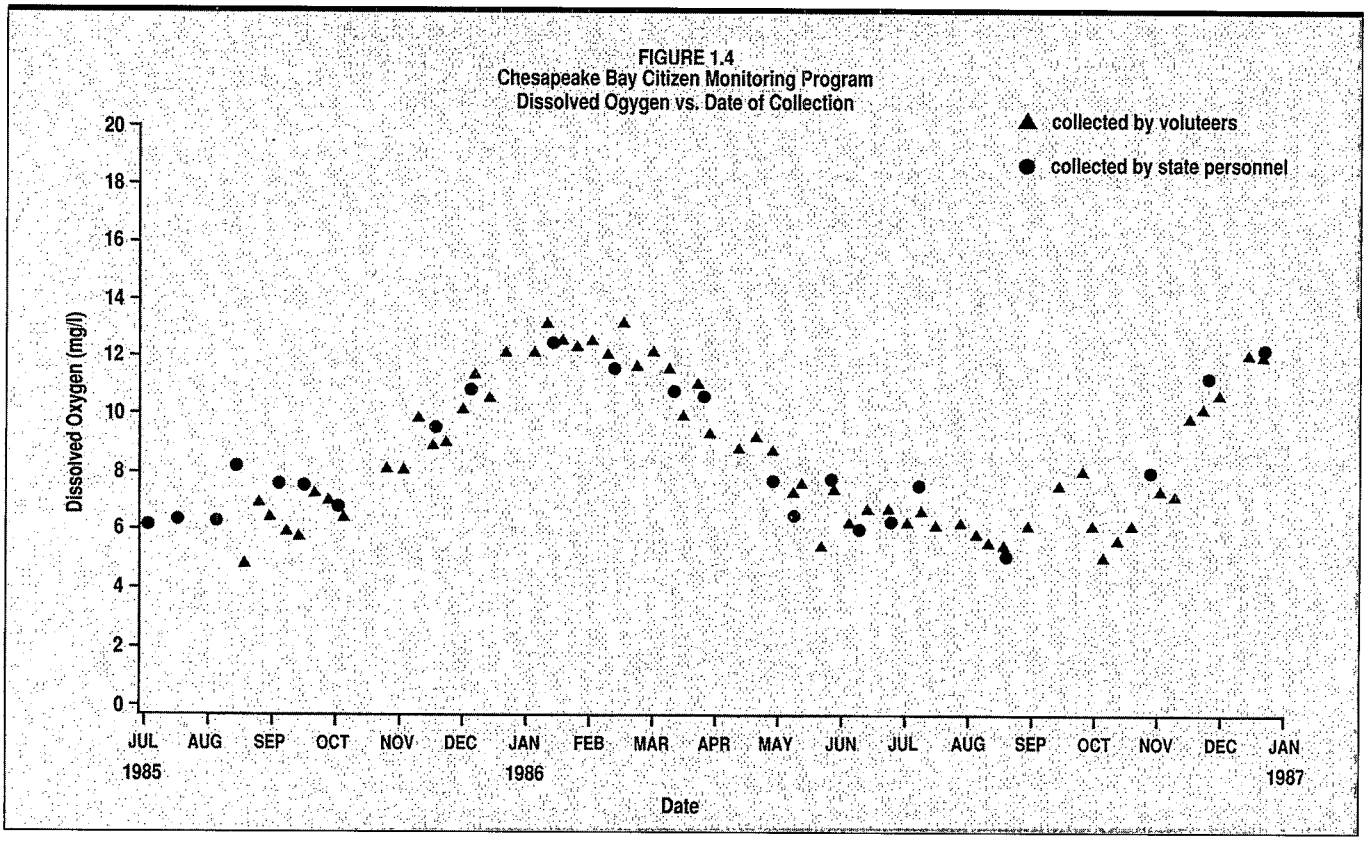
water quality report. Lakes monitored by volunteers are considered to be "evaluated" in 305(b) assessments. Only lakes sampled for physical, chemical, or biological data by State agency personnel are considered to be "monitored."

In addition to supplementing data collection, the VLMP has acted as a catalyst for local lake protection and restoration efforts; virtually all VLMP lakes have had lake protection and management measures implemented following participation in the program (Appendix, Illinois).

Providing High Quality Data

As mentioned above, concern about data quality is a major reason why volunteer data are not more widely used. However, many programs have demonstrated that volunteers *can* collect high quality, credible data. Three examples comparing volunteer and professional data are provided.

Figures 1.2A and B show Secchi disk readings and chlorophyll values collected by the New Hampshire Lakes Lay Monitoring Program and the Freshwater Biology Group field team at the University of New Hamp-



shire. While the samples were taken on the same day for the same site, they were usually done on different vessels at slightly different times in the day. Each point represents the comparison of results from a single measurement at a single lake site (Schloss 1988).

Another comparison between volunteer and professional monitoring data is shown in Figures 1.3A and B. The two graphs give results for samples collected by Massachusetts Acid Rain Monitoring (ARM) program volunteers vs. ARM staff for pH (a) and alkalinity (b) (Godfrey 1988).

Lastly, Figure 1.4 depicts dissolved oxygen data collected by volunteers in the Chesapeake Bay Citizen Monitoring Program plotted against data from a Virginia Water Control Board monitoring station about a mile away. These plots indicate that both data sets represent similar water quality conditions (Wastler 1987).

These and many other examples from other programs document the fact that high quality data can be expected from well-trained volunteers.

FIGURE 1.4

Plot of dissolved oxygen concentrations in the James River over time as collected by State and citizen volunteers.
SOURCE: Wastler 1987.

Photo by John Riddahl

Successful use of volunteers depends on understanding that citizens can be a valuable resource for many types of monitoring when they are well-trained and managed. Citizens should not, however, be viewed as an adjunct voluntary service of an agency; rather, they are partners who share in environmental protection. What keeps the volunteers together is not a single monitoring task, but their expanded role as the guardians and stewards of their local natural resources. This requires cooperation among regulators, resource trustees, and citizens at the local level. Making this partnership successful is a central challenge of all volunteer monitoring programs.

This chapter provides details on planning a volunteer monitoring program to augment data gathered by other State and regional surface water monitoring efforts. Planning a State-managed volunteer monitoring program is a multi-step process. To begin, State monitoring directors are urged to take a careful look at their existing programs, identify gaps in the data base, and consider where data collected by volunteers can be used to fill these gaps. This approach will help establish general goals for the program and identify uses and potential users of the data (i.e., State, local, or Federal agencies, lake associations, etc.). Next steps include developing a Quality Assurance Project Plan (QAPjP) to establish effective quality assurance and control procedures and assigning qualified State staff to implement the program. These steps are discussed below.

Volunteer monitoring program coordinators from around the country exchange ideas in a group discussion at the First National Workshop on Citizen Volunteers in Environmental Monitoring, Narragansett, Rhode Island. May 1988.

Photo by Steven Silvia

2.1 ESTABLISH GENERAL GOALS

Citizen monitoring programs are generally developed for three reasons:

1. To supplement water quality data collected by professional staff in water quality agencies and scientific institutions.

2. To educate the public about water quality issues.

3. To build a constituency of citizens to practice sound water quality management at a local level and build public support for water quality protection.

All three goals will be achieved with a well-organized program, but priorities should be set so that the program can be designed to meet a clearly stated primary goal. It is important to specify whether gathering data of known quality takes priority over public participation and education. This handbook is directed to those States that will, in fact, stress the collection of credible data as the chief goal of their volunteer monitoring program.

2.2 IDENTIFY DATA USES AND USERS

Another initial step in planning a successful volunteer monitoring project that will provide credible information is to clearly identify the use to be made of the data. Environmental data are commonly used:

- to establish baseline conditions (where no prior data exist);
- to determine water quality trends; and
- to identify current and emerging problems.

All prospective data users and their data needs should be identified during the planning stages of the program. Within a State agency, individuals potentially interested in the citizen data can include water quality analysts, planners, environmental engineers, fisheries biologists and game wardens, and/or parks and recreation staff. Outside the State agency, the data may be used by university researchers, local government planning and zoning agencies, Soil and Water Conservation Districts, lake associations, or Federal agencies, such as the US Geological Survey, US Fish and Wildlife Service, US Environmental Protection Agency, and the US Department of Agriculture's Soil Conservation Service.

A committee made up of representatives from the identified user groups—including

volunteers—should be convened early in the planning stage to refine the program objectives and determine if volunteers can provide the level of expertise required. This early involvement of all potential user groups is key to ensuring the success of the volunteer program. If State personnel have helped plan a volunteer monitoring program, they will support it more enthusiastically, and if volunteers are represented in the planning process, their needs and those of the State agency will be better integrated.

In addition, to ensure continued and careful data collection, it is important that participants see the end use of the data:

> "An agency is better served by volunteers who have a direct stake in what is being monitored, when they see themselves as stewards of their particular area and when they benefit from their monitoring efforts. One of the more successful monitoring projects in Puget Sound is the collection of shellfish (which are then examined) for red tide contamination. The monitors are recreational clam diggers who are anxious to hear the results of their monitoring—for obvious reasons!" (Pritchard 1988)

2.3 ESTABLISH QUALITY ASSURANCE AND CONTROL

Data users and water quality analysts must have confidence in the representativeness, consistency, and accuracy of data collected by volunteers. Effective quality assurance and quality control (QA/QC) procedures and a clear delineation of QA/QC responsibilities are therefore essential to ensure the utility of environmental monitoring data.

The USEPA QA/QC program requires that all EPA national program offices, EPA regional offices, and EPA laboratories participate in a centrally planned, directed, and coordinated Agencywide QA/QC program. This requirement also applies to efforts carried out by the States and interstate agencies that are supported by EPA through grants, contracts, or other formalized agreements. The EPA QA program is based upon EPA order 5360.1, "Policy and Program Requirements to Implement the Quality Assurance Program" (USEPA 1984a), which describes the policy, objectives, and responsibilities of all EPA program and regional offices.

Each office or laboratory which generates data under EPA's QA/QC program must implement the prescribed procedures to ensure that precision, accuracy, completeness, comparability, and representativeness are known and documented.

Determine the Data Quality Objectives

A full assessment of the data quality needed to meet the intended use should be made before QA/QC controls are specified. This can be done through the development of data quality objectives (DQO's). DQO's are qualitative and quantitative statements developed by data users that establish the variability that can be tolerated by the user and still meet the needs of the program. Establishment of DQO's involves interaction of program managers and their technical staff in deciding what information is needed,

DEFINITIONS

Although the terms quality assurance (QA) and quality control (QC) are frequently used interchangeably or together, in fact, they have different meanings.

QUALITY ASSURANCE is the whole system of activities that is carried out to provide users with data that meet defined standards of quality with a stated level of confidence. The QA system includes the coordinated activities of quality control and assessment. It is management's review and oversight at the planning, implementation, and completion stages of an environmental data collection activity that assures that data provided to data users are of the quality needed and claimed.

QUALITY CONTROL refers to those activities performed during environmental data collection to produce data of desired quality to document that quality. It includes activities designed to ensure that no systematic bias develops in the analysis system (beyond what is normally present) that would exceed the accepted accuracy and precision limits of the analysis. Therefore, this process involves determining the "precision and accuracy" of the numbers. It also involves planning control procedures to ensure that the analysis stays "in control" and that data of known quality are produced.

A third term, **QUALITY ASSESSMENT,** involves a continuing evaluation of the performance of the people collecting and analyzing the data. Technicians and laboratory chemists undergo periodic inspections and "audits" to check their performance. They exchange samples as well as analyze split samples to make sure no errors are developing.

DEFINITIONS

ACCURACY—Degree of agreement with true value, a measure of bias in a system (refers to equipment or procedure).

PRECISION —Measure of mutual agreement among individual measurements, reproducibility (refers to person using the equipment).

REPRESENTATIVENESS—Degree to which data accurately and precisely represent an environmental condition.

COMPARABILITY—A measure of confidence with which one data set can be compared to another.

COMPLETENESS—A measure of amount of valid data obtained compared to the amount expected to be obtained.

why it is needed, how it will be used, how it will be collected, and any time/resource constraints affecting data collection. It is especially important to get the formal involvement and support of your Quality Assurance Officer during the development of DQO's. By involving everyone who plans to use the data, as well as the groups assigned to collect it, one can increase the likelihood that it will meet the needs of the user(s). USEPA (1984b) describes the process for developing DQO's in more detail.

Develop a Quality Assurance Plan

USEPA order 5360.1 also requires State monitoring programs supported by EPA grants to prepare Quality Assurance Project Plans (QAPjP). A QAPjP documents the reliability of monitoring data by formally stating the program objectives, organization, monitoring procedures, and specific QA and QC activities designed to achieve the data quality goals of the program. The QAPjP must describe the procedures that document precision, accuracy, and completeness of environmental measurements and specify the resulting level of confidence.

Information on preparing a QAPjP is included in Chapter 4.1. In addition, three EPA guidance documents are available to assist in preparation of the Quality Assurance Project Plan: a general guidance document (USEPA 1980), a guidance document that combines a work plan with the QAPjP (USEPA 1984c), and a guide for preparing plans for the National Estuary Program (USEPA 1988).

2.4 ASSIGN STAFF RESPONSIBILITIES

It is essential to the success of a volunteer monitoring program that a qualified staff person be chosen to coordinate it. That person should, ideally, have a technical background and experience in recruiting, training, and managing volunteers. The State coordinator should also enjoy working with the public and have a strong commitment to the program. Without a coordinator with these qualifications, the program may encounter problems.

The Maine Volunteer Lake Monitoring Program, for example, began its efforts using staff from different State agencies to coordinate monitors; lack of central coordination proved to be a serious obstacle to the program. An attempt was made to give the program's coordination activities to a contractor. This also failed because of insufficient commitment by the contracting organization. The Maine Volunteer Lake Monitoring Program concluded that one central coordinator with technical expertise and personal commitment was necessary to maintain the program.

Planning and implementing a successful volunteer monitoring program is a full time job and it should be the coordinator's top priority at all times (see sample job description on p. 25). Although exact duties may vary between programs, in general the coordinator will:

- serve as administrator of the project;
- recruit and train volunteer monitors;
- receive, store, and analyze data;
- produce reports that summarize the data; and
- carry out quality control activities.

The coordinator must maintain close contact with the volunteers to ensure that the stated QC standards of the data are met and to be available to answer questions promptly. After all, a large part of the volunteers' reward for services rendered is access to the knowledge of experts in the field, as well as the perception that their concerns are being heard by people with the ability and authority to respond to these concerns.

Some States have enlisted the support and cooperation of regional and local governments to help with training volunteers and in the coordination of the program. Illinois uses its Regional Planning Commissions for this purpose. Anne Arundel County, Maryland recruits a volunteer team leader for each wa-

SAMPLE JOB DESCRIPTION
VOLUNTEER MONITORING COORDINATOR

The Volunteer Monitoring Coordinator has the following responsibilities:

In consultation with state agency personnel and other interested parties, determine which watersheds and which parameters in these watersheds will be monitored.

Recruit volunteers for each project. This will involve contacting interested groups, elected officials, and possibly businesses and industries in the area.

Make arrangements for a place to conduct a training session and arrange a time to suit a majority of volunteer monitors. Train any volunteers who are unable to attend the training session.

Keep in close touch with individuals at beginning of project. Answer any questions volunteers may have. Read over each data sheet as it comes in and contact any monitors who seem to be having trouble. Send refill reagents and replacement equipment upon request.

If required, enter all data in a suitable computer filing system. Carry out documentation and verification on the data. Provide plots of data to monitors and to data users. Carry out preliminary data interpretation. (These data management activities may be carried out by other State staff or volunteers. If so, the volunteer monitoring coordinator will assume an advisory role.)

Provide feedback to participants and data to users. This will involve writing progress reports and articles for publication in the program newsletter.

Plan for and carry out quality control sessions. There should be one about three months after start-up of any new project and at six month intervals thereafter.

Prepare quarterly reports for the sponsoring agency.

tershed. This volunteer is responsible for the collection and initial proofreading of data forms and for dispensing replacement reagents and equipment as needed. In New York, some county planning offices and regional soil and water conservation districts coordinate with local lake associations.

In summary, it is clear that many people from a variety of agencies and backgrounds should be involved during the planning phase of a State-coordinated volunteer monitoring program. The most important planning task they face is to ensure that all interested parties—from the State agency program manager to the volunteer in the field—understand and agree on the goals, limits, and needs of the program they are launching. Only when the basic planning groundwork is laid should the State move on to implement its volunteer monitoring program.

Photo by Cynthia Dunn

The experience of several State-managed volunteer monitoring programs has shown that implementation should begin with a pilot project. A pilot project allows the State to test its chosen approach—its recruitment and training procedures, its equipment and parameters for testing, and its data management and analysis procedures—on a limited scale before moving on to an expanded program.

This chapter will focus on setting up a pilot project that can serve as the starting point for the State's volunteer monitoring program. Procedures outlined in this section apply as well to the implementation of the post-pilot program. This chapter will go on to discuss how to expand the pilot project, and provides advice on maintaining the interest of participating volunteer monitors.

3.1 ESTABLISHING A PILOT PROGRAM

The pilot project provides an opportunity for the coordinator and supporting personnel to encounter on a small scale the types of problems they will face in setting up a statewide program. The average pilot project will probably be limited in scope to one large watershed or several smaller ones.

Pick a Location

The pilot project should begin in an area that can be successfully monitored by volunteers. Factors to consider include: 1) a real need for water quality information from this area, thereby ensuring the immediate use of the data collected; 2) a need for the type of data that can be obtained with methods known to be successfully tested by volunteers; 3) an available pool of people willing to participate; 4) physical and legal access to the water.

Select Sampling Equipment

The first step in selecting the best equipment for the pilot project is to test existing kits and equipment, picking those which appear to meet program needs. These kits and equipment should then be tested on water samples of known quality to determine accuracy, precision, and ease of use. Considerations in selecting a piece of equipment or kit include the level of skill required to use it; the cost of the kit; and any limitations the kit may place on the data that are collected. A partial list of chemical and equipment companies that currently supply volunteer programs is presented in Table 3-1.

Once volunteers have been recruited, extra equipment and reagents should be ordered to allow for breakage in transit and addition of sites or monitors during the recruitment process. Extra equipment may also be needed to train assistants and to allow for possible loss or breakage by the volunteers. Establish a policy to identify who will be responsible for paying for lost or broken equipment (free replacements are preferable in most circumstances).

When the sampling equipment has been selected and the sampling protocol has been established, an instruction manual should be prepared. Manuals that have been published by other volunteer monitoring programs may be suitable. However, it is helpful

Table 3.1
Scientific Supply Houses. A partial list of chemical and scientific equipment companies that currently supply volunteer programs.

TABLE 3-1
SCIENTIFIC SUPPLY HOUSES

PRODUCT NAME	ADDRESS/PHONE NO.	DESCRIPTION
LaMotte Chemical Products, Inc.	PO Box 329, Chestertown, MD 21620, 1-800-344-3100.	Chemical test kits for field and lab.
VWR Scientific.	PO Box 2643, Irving TX 75061, 1-800-527-1576.	Scientific instruments and chemicals.
Thomas Scientific	Main Office, 609-467-2000.	Scientific instruments and chemicals.
Millipore Corporation	Technical Services, 1-800-225-1380.	Specializing in bacterial testing.
HACH Company	PO Box 389, Loveland, CO 80539, 1-800-525-5940.	Chemical test kits for field and lab.
Fisher Scientific	711 Forbes Ave., Pittsburgh, PA 15219,1-800-225-4040	Scientific instruments and chemicals.

This is only a partial list of potential suppliers and does not imply endorsement by USEPA.

to provide specific written information about the particular project. The manual should include background information on what parameters are being measured and how the data to be obtained relate to local water quality problems. It can also include step-by-step instructions, with illustrations, on the use of the sampling equipment.

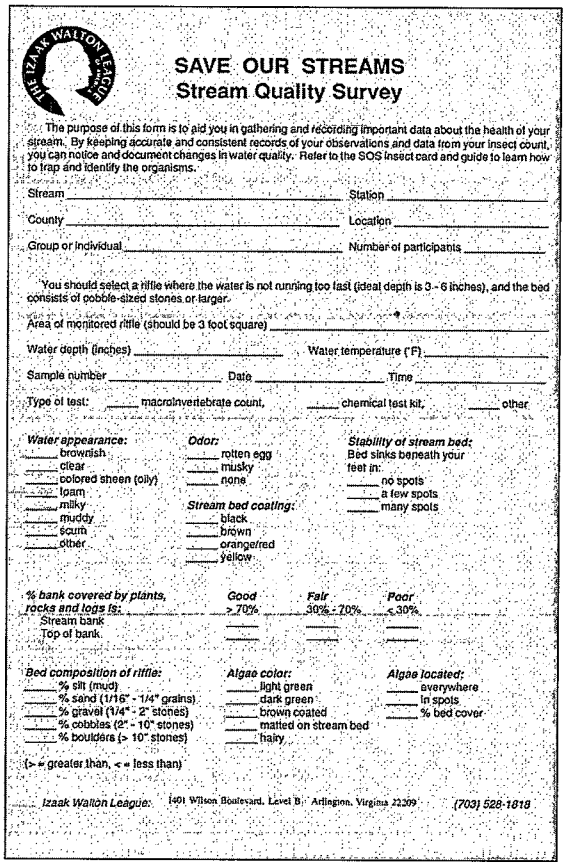
Design a Data Collection Form

Most monitoring data, including data collected by volunteer programs, are stored and managed by computer. Data users and the data base manager should be involved in the development of the Data Collection Form to be sure that its information can be easily and accurately computerized. Consideration should also be given to the ease with which the form can be filled out and understood by the volunteers. Examples of Data Collection Forms used by existing programs are shown in Figures 3.1, 3.2, 3.3 and 3.4.(See Appendix for more examples.) Duplicate forms, such as carbonless copies, make it possible for volunteers to maintain their own records.

Recording the "raw" numbers actually measured by the monitor minimizes later questions and confusion about the observed value reported. Any arithmetic should be carried out by the coordinator, preferably using a computer. As an example, see Figure 3.3, the Severn River Data Collection Form. The monitor records the observed hydrometer reading and the temperature of the water in the jar at time of measurement. The correction for temperature and the subsequent conversion from density to salinity are carried out using look-up tables or by computer. Potential errors made in the correction and conversion process are minimized.

Recruit Volunteers

As soon as the State coordinator has decided where the pilot project will be launched and what equipment will be used, volunteers can be recruited. The first step is to identify all organizations and individuals in the area who might want to participate in the project. Likely groups include civic associations, watershed associations, environmental advocacy groups, commercial and recreational users of the waterbody, government officials and agencies, waterfront property owners, and public schools, community colleges, and universities. State employees and advisors may know people who would like to be involved or may wish to volunteer if they live in the chosen watershed.



THE IZAAK WALTON LEAGUE OF AMERICA

SAVE OUR STREAMS
Stream Quality Survey

The purpose of this form is to aid you in gathering and recording important data about the health of your stream. By keeping accurate and consistent records of your observations and data from your insect count, you can notice and document changes in water quality. Refer to the SOS Insect card and guide to learn how to trap and identify the organisms.

Stream _____ Station _____

County _____ Location _____

Group or Individual _____ Number of participants _____

You should select a riffle where the water is not running too fast (ideal depth is 3 - 6 inches), and the bed consists of cobble-sized stones or larger.

Area of monitored riffle (should be 3 foot square) _____

Water depth (inches) _____ Water temperature (°F) _____

Sample number _____ Date _____ Time _____

Type of test: _____ macroinvertebrate count, _____ chemical test kit, _____ other

Water appearance:
_____ brownish
_____ clear
_____ colored sheen (oily)
_____ foam
_____ milky
_____ muddy
_____ scum
_____ other

Odor:
_____ rotten egg
_____ musky
_____ none

Stream bed coating:
_____ black
_____ brown
_____ orange/red
_____ yellow

Stability of stream bed:
Bed sinks beneath your feet in:
_____ no spots
_____ a few spots
_____ many spots

% bank covered by plants, rocks and logs is:	*Good* > 70%	*Fair* 30% - 70%	*Poor* < 30%
Stream bank			
Top of bank			

Bed composition of riffle:
_____ % silt (mud)
_____ % sand (1/16" - 1/4" grains)
_____ % gravel (1/4" - 2" stones)
_____ % cobbles (2" - 10" stones)
_____ % boulders (> 10" stones)

Algae color:
_____ light green
_____ dark green
_____ brown coated
_____ matted on stream bed
_____ hairy

Algae located:
_____ everywhere
_____ in spots
_____ % bed cover

(> = greater than, < = less than)

Izaak Walton League: 1401 Wilson Boulevard, Level B Arlington, Virginia 22209 *(703) 528-1818*

MACROINVERTEBRATE COUNT

Use letter codes (A = 1 - 9, B = 10 - 99, C = 100 or more) to record the numbers of organisms found in a 3 foot by 3 foot area. Then add up the number of letters in each column and multiply by the indicated index value.

GOOD	FAIR	POOR
☐ caddisfly larvae	☐ beetle larvae	☐ aquatic worms
☐ dobsonfly larvae	☐ clams	☐ blackfly larvae
☐ mayfly nymphs	☐ crane fly larvae	☐ leeches
☐ other snails	☐ crayfish	☐ midge larvae
☐ riffle beetle adult	☐ damselfly nymphs	☐ pouch snails
☐ stonefly nymphs	☐ dragonfly nymphs	
☐ water penny larvae	☐ scuds	
	☐ sowbugs	
	☐ alderfly	
_____ # of letters	_____ # of letters	_____ # of letters
☐ times 3 =	☐ times 2 =	☐ times 1 =
Index value +	Index value +	Index value

Now add together the three index values = _____ total index value.

Compare this total index value to the following numbers to determine the water quality of your stream. Good water quality is indicated by a variety of different kinds of organisms, with no one kind making up the majority of the sample.

☐ *Excellent (> 22)* ☐ *Good (17 - 22)*
☐ *Fair (11 - 16)* ☐ *Poor (< 11)*

Note: You should test at least 3 different riffles within a 24-foot area to ensure that you have a truly representative sample which includes all key organisms. You may also want to sample some of the rocks in slower-moving water, nearer the banks, because mayflies and stoneflies are sometimes found there instead.

Fish water quality indicators:
_____ scattered individuals
_____ scattered schools
_____ trout (good)
_____ bass (good)
_____ catfish (poor to fair)
_____ carp (poor)

Barriers to fish movement:
_____ beaver dams
_____ dams
_____ waterfalls
_____ other
_____ none

Land uses in watershed:
_____ factories _____ farming _____ fields _____ homes _____ stores _____ woods

Are there any discharging pipes? _____ no _____ yes If so, how many? _____

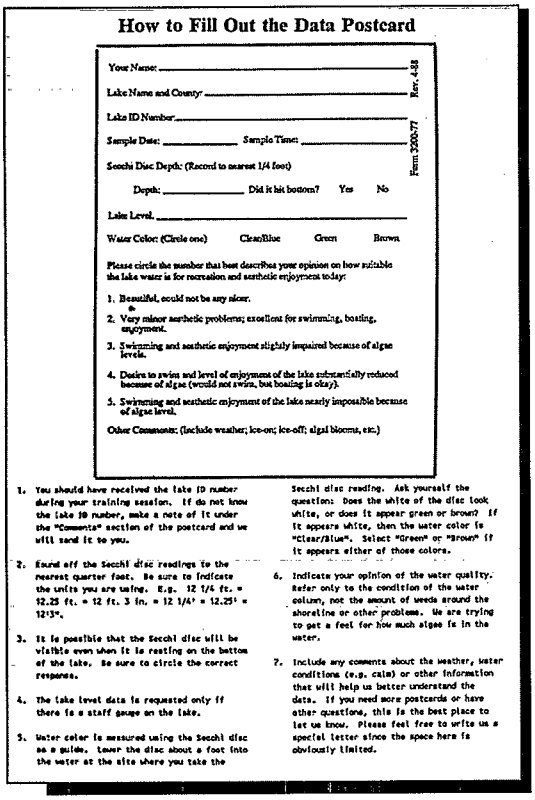
Did you test above and below the pipes to determine any change in water quality and were changes noticed?

Describe % and type of litter in and around the stream: _____

Figure 3.1
Save Our Streams Stream Quality Survey Form, The Izaak Walton League of America.

Figure 3.2

(Top left) Data Postcard used by the Wisconsin Self-Help Lake Monitoring Program.



How to Fill Out the Data Postcard

Your Name: _____ Rev. 4-88

Lake Name and County: _____

Lake ID Number: _____

Sample Date: _____ Sample Time: _____ Form 3200-77

Secchi Disc Depth: (Record to nearest 1/4 foot)

Depth: _____ Did it hit bottom? Yes No

Lake Level: _____

Water Color: (Circle one) Clear/Blue Green Brown

Please circle the number that best describes your opinion on how suitable the lake water is for recreation and aesthetic enjoyment today:

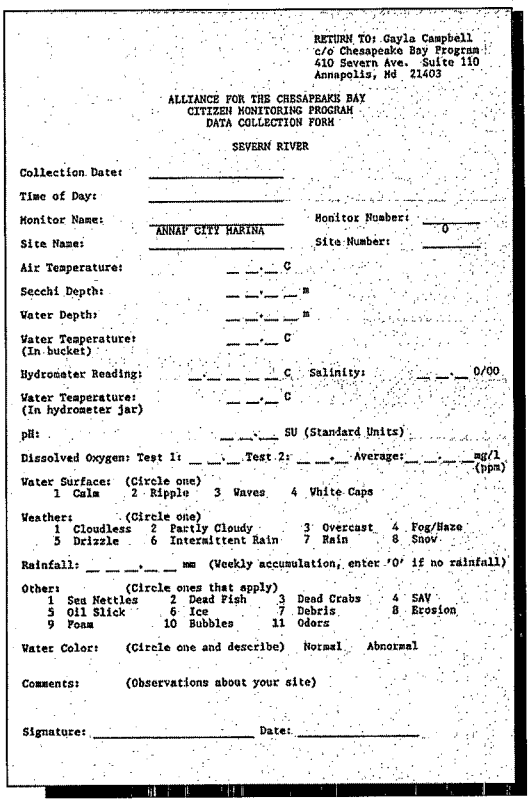
1. Beautiful, could not be any nicer.
2. Very minor aesthetic problems; excellent for swimming, boating, enjoyment.
3. Swimming and aesthetic enjoyment slightly impaired because of algae levels.
4. Desire to swim and level of enjoyment of the lake substantially reduced because of algae (would not swim, but boating is okay).
5. Swimming and aesthetic enjoyment of the lake nearly impossible because of algae level.

Other Comments: (include weather; ice-on; ice-off; algal blooms, etc.)

1. You should have received the lake ID number during your training session. If do not know the lake ID number, make a note of it under the "Comments" section of the postcard and we will send it to you.
2. Round off the Secchi disc readings to the nearest quarter foot. Be sure to indicate the units you are using. E.g. 12 1/4 ft. = 12.25 ft. = 12 ft. 3 in. = 12 1/4' = 12.25' = 12'3".
3. It is possible that the Secchi disc will be visible even when it is resting on the bottom of the lake. Be sure to circle the correct response.
4. The lake level data is requested only if there is a staff gauge on the lake.
5. Water color is measured using the Secchi disc as a guide. Lower the disc about a foot into the water at the site where you take the Secchi disc reading. Ask yourself the question: Does the white of the disc look white, or does it appear green or brown? If it appears white, then the water color is "Clear/Blue". Select "Green" or "Brown" if it appears either of those colors.
6. Indicate your opinion of the water quality. Refer only to the condition of the water column, not the amount of weeds around the shoreline or other problems. We are trying to get a feel for how much algae is in the water.
7. Include any comments about the weather, water conditions (e.g. calm) or other information that will help us better understand the data. If you need more postcards or have other questions, this is the best place to let us know. Please feel free to write us a special letter since the space here is obviously limited.

Figure 3.3

(Top right) Alliance for the Chesapeake Bay Citizen Monitoring Program Data Collection Form.



RETURN TO: Gayla Campbell
c/o Chesapeake Bay Program
410 Severn Ave. Suite 110
Annapolis, Md 21403

ALLIANCE FOR THE CHESAPEAKE BAY
CITIZEN MONITORING PROGRAM
DATA COLLECTION FORM

SEVERN RIVER

Collection Date: _____

Time of Day: _____

Monitor Name: _____ Monitor Number: _____

Site Name: ANNAP CITY MARINA Site Number: 0

Air Temperature: __ __.__ C

Secchi Depth: __ __.__ __ m

Water Depth: __ __.__ __ m

Water Temperature: (In bucket) __ __.__ C

Hydrometer Reading: __.__ __ __ __ C Salinity: __ __.__ 0/00

Water Temperature: (In hydrometer jar) __ __.__ C

pH: __ __.__ SU (Standard Units)

Dissolved Oxygen: Test 1: __ __.__ Test 2: __ __.__ Average: __ __.__ __ mg/l (ppm)

Water Surface: (Circle one)
1 Calm 2 Ripple 3 Waves 4 White Caps

Weather: (Circle one)
1 Cloudless 2 Partly Cloudy 3 Overcast 4 Fog/Haze
5 Drizzle 6 Intermittent Rain 7 Rain 8 Snow

Rainfall: __ __ __.__ __ mm (Weekly accumulation, enter '0' if no rainfall)

Other: (Circle ones that apply)
1 Sea Nettles 2 Dead Fish 3 Dead Crabs 4 SAV
5 Oil Slick 6 Ice 7 Debris 8 Erosion
9 Foam 10 Bubbles 11 Odors

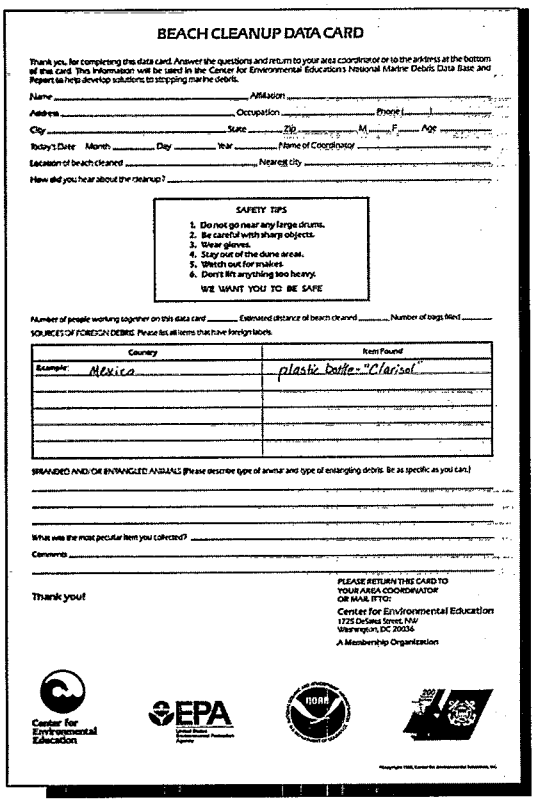
Water Color: (Circle one and describe) Normal Abnormal

Comments: (Observations about your site)

Signature: _____ Date: _____

Figure 3.4

(Bottom right and left) Beach Cleanup Data Card, Center for Environmental Education.



BEACH CLEANUP DATA CARD

Thank you for completing this data card. Answer the questions and return to your area coordinator or to the address at the bottom of this card. This information will be used in the Center for Environmental Education's National Marine Debris Data Base and Report to help develop solutions to stopping marine debris.

Name _____ Affiliation _____

Address _____ Occupation _____ Phone (__) _____

City _____ State _____ Zip _____ M ____ F ____ Age _____

Today's Date: Month _____ Day _____ Year _____ Name of Coordinator _____

Location of beach cleaned _____ Nearest city _____

How did you hear about the cleanup? _____

SAFETY TIPS
1. Do not go near any large drums.
2. Be careful with sharp objects.
3. Wear gloves.
4. Stay out of the dune areas.
5. Watch out for snakes.
6. Don't lift anything too heavy.

WE WANT YOU TO BE SAFE

Number of people working together on this data card _____ Estimated distance of beach cleaned _____ Number of bags filled _____

SOURCES OF FOREIGN DEBRIS Please list all items that have foreign labels.

Country	Item Found
Example: Mexico	plastic bottle-"Clarisol"

STRANDED AND/OR ENTANGLED ANIMALS (Please describe type of animal and type of entangling debris. Be as specific as you can.)

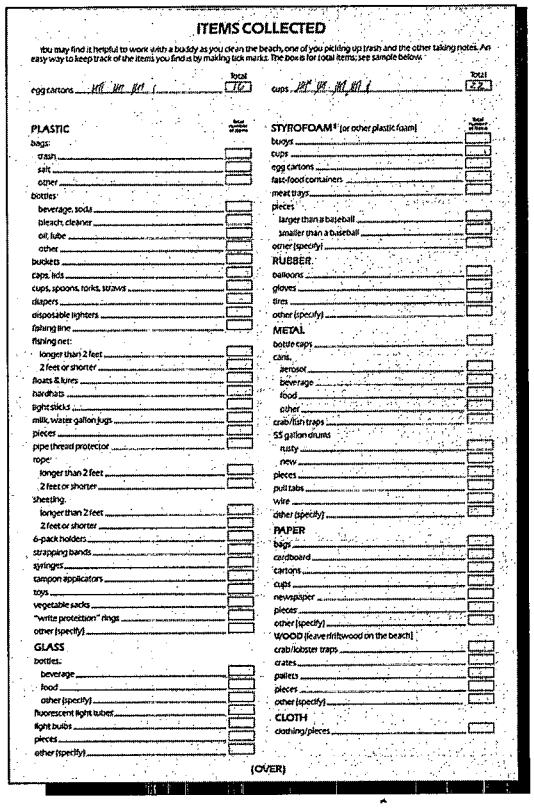
What was the most peculiar item you collected? _____

Comments _____

Thank you!

PLEASE RETURN THIS CARD TO YOUR AREA COORDINATOR OR MAIL IT TO:
Center for Environmental Education
1725 DeSales Street, NW
Washington, DC 20036
A Membership Organization

Center for Environmental Education · EPA · NOAA



ITEMS COLLECTED

You may find it helpful to work with a buddy as you clean the beach, one of you picking up trash and the other taking notes. An easy way to keep track of the items you find is by making tick marks. The box is for total items; see sample below.

egg cartons ||| |||| | Total 16

cups |||| |||| |||| || Total 22

PLASTIC
bags: trash, salt, other
bottles: beverage, soda; bleach, cleaner; oil, lube; other
buckets
caps, lids
cups, spoons, forks, straws
diapers
disposable lighters
fishing line
fishing net: longer than 2 feet; 2 feet or shorter
floats & lures
hardhats
light sticks
milk, water gallon jugs
pieces
pipe thread protector
rope: longer than 2 feet; 2 feet or shorter
sheeting: longer than 2 feet; 2 feet or shorter
6-pack holders
strapping bands
syringes
tampon applicators
toys
vegetable sacks
"wrist protection" rings
other (specify)

GLASS
bottles: beverage; food; other (specify)
fluorescent light tubes
light bulbs
pieces
other (specify)

STYROFOAM® (or other plastic foam)
buoys
cups
egg cartons
fast-food containers
meat trays
pieces: larger than a baseball; smaller than a baseball
other (specify)

RUBBER
balloons
gloves
tires
other (specify)

METAL
bottle caps
cans: aerosol; beverage; food; other
crab/fish traps
55 gallon drums: rusty; new
pieces
pull tabs
wire
other (specify)

PAPER
bags
cardboard
cartons
cups
newspaper
pieces
other (specify)

WOOD (leave driftwood on the beach)
crab/lobster traps
crates
pallets
pieces
other (specify)

CLOTH
clothing/pieces

(OVER)

Strive to recruit volunteers from a wide range of backgrounds. This helps establish the program's credibility and ensures cooperation within the community. Participant diversity provides the bonus of educating a greater variety of citizens in the community.

Certain types of individuals or groups may be more suitable than others for your particular project. Both the Chesapeake Bay Citizen Monitoring Program and the New Hampshire Lakes Lay Monitoring Program report failure in integrating students and youth groups into long-term monitoring programs because of the commitment required and the need for summertime sampling.

An attractive brochure or flier describing the overall volunteer monitoring program can be an effective recruitment tool. This brochure should include information on the objectives of the program—describing the benefit to the volunteer and to the resource—and should explain what will be expected of recruits.

A letter giving more details about the pilot project should also be developed and include information on:

- proposed monitoring site locations;
- project duration and length of commitment required of volunteers;
- sampling frequency;
- required equipment for volunteers (car or boat);
- volunteer qualifications, if any (background in laboratory techniques or knowledge of aquatic biology are ideal. However, it should be kept in mind that setting specific volunteer qualifications will limit participation in the program, possibly below an effective minimum level).

The letter and brochure should be sent to all identified interest groups. A short time later, the State volunteer coordinator should call the leaders of those groups and offer to attend a group meeting and answer questions about the project. If possible, the coordinator should develop a short slide presentation that describes the program and shows some of the sampling equipment and techniques. This will make it easier for potential volunteers to determine whether or not they would be interested in volunteering and are capable of carrying out the tests.

Followup calls to the organizations that have been visited are essential in enlisting volunteers. During the call, personal questions can be answered, the degree of volunteer interest can be gauged, and arrangements can be made for training.

The State may wish to develop a one year, performance-based "contract" as one way to ensure that those who agree to participate in the program are fully committed.

Train Volunteers

The initial training of the volunteers is crucial. Without such training, usable, high quality data cannot be obtained, and volunteers will soon grow frustrated. A few practical considerations should be noted here:

1. The coordinator should be sure to schedule the training session for a time when most volunteers can attend—most often an evening or a weekend.

2. Potential monitors should be told beforehand how long the training will

Figure 3.5

Sample Language for Liability Waiver.

FIGURE 3.5

SAMPLE LANGUAGE FOR LIABILITY WAIVER

WAIVER

In consideration of the foregoing, I, myself, my heirs, and executors do hereby release and discharge all Boston Harbor Monitoring Program supporting organizations for all claims, damages demands, actions, and whatsoever in any manner arising or growing out of my participation in said monitoring program.

Signature:

Date:

If a volunteer is under 18 years of age, a parent or guardian must sign the waiver

SOURCE: Massachusetts Audubon Society 1986.

IMPORTANT NOTE-LIABILITY

The Idaho Department of Health and Welfare (Water Quality Bureau of the Division of Environmental Quality) intends that citizen volunteers participating in this program are not acting on behalf of the Department of Health and Welfare in any official capacity. As such, it is the Department's intent that citizen volunteers are not authorized to be considered agents, employees, or authorized representatives of the Department for any purpose, and that citizen volunteers are not entitled to the same benefits enjoyed by Department employees.

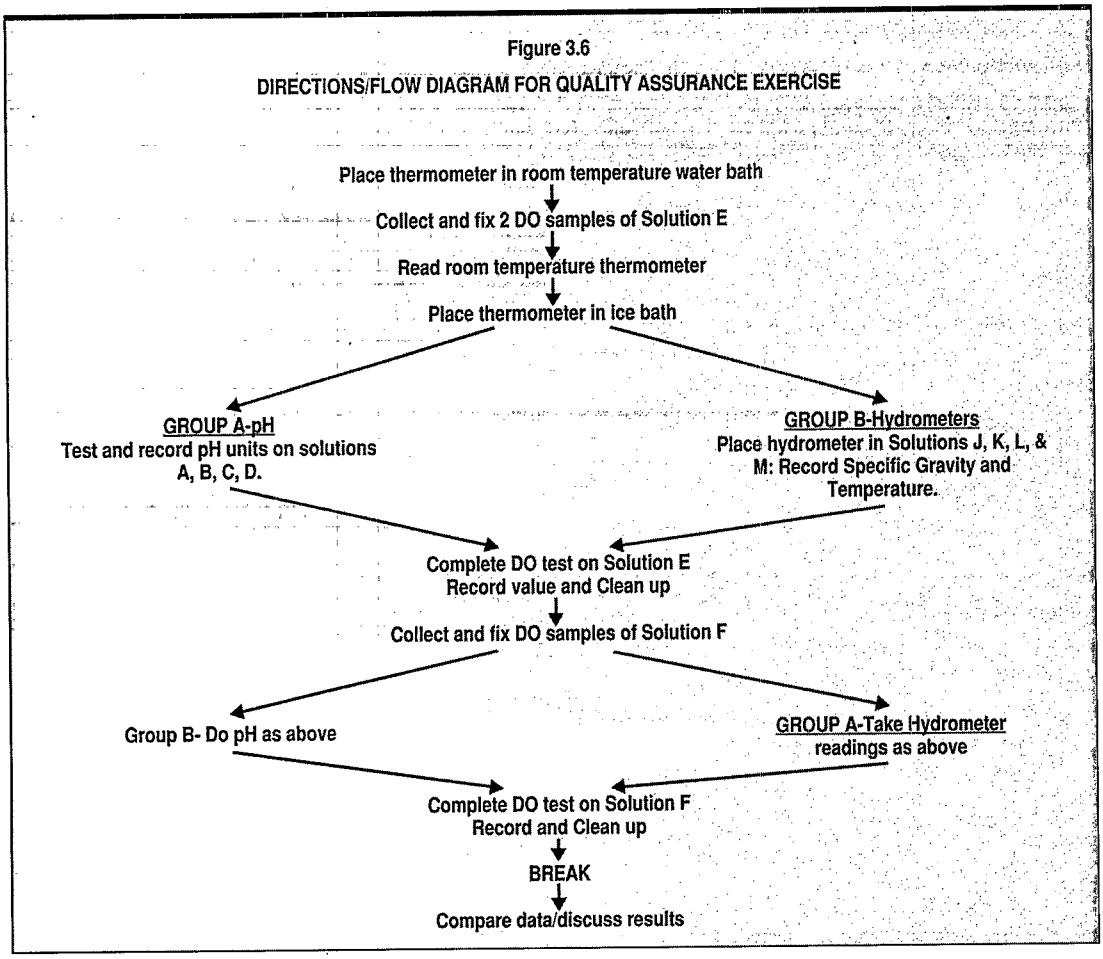
Citizen volunteers must recognize the potential for injury to themselves and their real and personal property, and to other persons and their real and personal property, which may result from citizen volunteer activities conducted under the Citizen's Volunteer Monitoring Program. The Department intends that citizen volunteers expressly assume all risks and liability for any injuries to, or caused by, citizen volunteers under this Program.

Citizen volunteers will be instructed in proper sampling techniques and handling of sample preservative acids. They will also be cautioned that if there is ever any doubt, they sould give safety priority over sampling. Every participant will also recive a copy of this study plan and sampling procedures.

SOURCE: Bellatty 1989.

Figure 3.6

Example Quality Control Exercise. The volunteers were divided into two groups to avoid congestion at any one station. Test solutions were: A - Bay water, B - vinegar and water with pH of 4.0, C - pH 7.0 buffer solution, D-ammonia and water with pH of 10. E - container of Bay water for testing dissolved oxygen (DO). F - container of water having no dissolved oxygen. G - cooler with room temperature water and H - ice bath. J, K, L, M - hydrometer jars containing water of different salinity values.
SOURCE: Chesapeake Bay Citizen Monitoring Program.



last and that they must plan to stay for the entire session. The training session should last no longer than four hours.

3. The program coordinator must have adequate assistance. Nothing will discourage volunteers more than a poorly-run initial training session. Generally, a 1:5 trainer to volunteer ratio is needed to ensure that volunteers can be closely observed and corrected as they begin learning sampling techniques. Groups of more than 20 people are difficult to manage.

4. Any onsite (water's edge) activities should be carried out at a location similar to that which the monitors will encounter at their assigned sites.

A training session agenda should include the following activities:

1. Presentation on the goals and objectives of the project, preferably by a representative of the user agency or group. This presentation can include why people monitor, historical information on the watershed, the problems that led to the decision to undertake this project, what the data will be used for, and how the project will benefit the volunteers, the community and the State. More detailed background information can be included in the instruction manual or other written materials.

2. A restatement of what will be expected of the participants—how long the training session will last and how long the project is expected to continue.

3. Distribution of all equipment and an explanation, in general terms, of its use; what would constitute abuse; what items are particularly fragile; replacement policy and cost; and policy on returning the equipment at the end of the project.

4. An overview of all necessary safety requirements. Safety measures should be carefully explained in the written materials and should be brought to the attention of volunteers at this point, emphasizing chemical emergency information. If boats are being

used for sampling, volunteers should be reminded about basic safety practices. If it is necessary to collect liability waivers (see Figure 3.5), pass these out and discuss the approach the sponsoring group or agency is taking.

5. An overview of the actual monitoring procedures. A slide show of step-by-step procedures is very helpful.

6. A trial run-through of the procedures. Trainers should first demonstrate proper methods, then circulate among the volunteers as they practice what they have learned.

7. Question and answer session.

The Ohio Scenic River Volunteer Monitoring Program Coordinator recommends that participants be given a week or so to consider their level of commitment after the initial workshop. This will screen out those who may simply be "caught up in the moment," and not actually willing to make a long-term, serious commitment to the program (Kopec 1990).

Conduct Ongoing Quality Control

Quality control (QC) is extremely important in all monitoring programs and can be a source of criticism in programs that use volunteers in monitoring. The challenge for volunteer program managers is to carry out QC exercises that assess the precision of the data being collected but are also fun and interesting for the volunteers. Experienced volunteer coordinators recommend turning these quality control sessions into educational and social opportunities for the volunteers, while making sure that volunteers understand why QC is important. Quality control sessions can be held anywhere there is sufficient space, light, and access to a sink (for cleanup) and facility for safe waste disposal.

The first QC session should be held about 3-4 months after sampling begins to make sure that all monitors are sampling and analyzing in a consistent fashion, and to answer any questions. Thereafter, two QC sessions should be held each year if sampling goes on throughout the year. If sampling is carried out on a seasonal basis, retraining and training sessions for new monitors can be held at the beginning of the sampling period and a QC check session can be scheduled for the middle of the season.

Volunteers should be expected to attend all scheduled sessions. If a volunteer cannot attend at least one session a year, the coordinator (or a trained assistant) should make a site visit and evaluate the monitor's sampling procedures.

Quality control exercises should be as interesting as possible. There are two basic approaches:

1. All attendees carry out the tests on the same water sample with their own equipment the way they do it at their site. They fill out and submit a data collection form with their results; or

2. All attendees read and record results from previously set up laboratory equipment and kits similar to a classroom laboratory practical exam.

Data collection forms with the results recorded are submitted independently. The results can than be compared to determine bias. (See Figures 3.6 and 3.7 for examples of protocol and instruction sheets for QC exercises.)

The results from these sessions provide a measure of how well the members of the group perform and how precisely they meas-

Figure 3.7

Example Quality Control Exercise. The volunteers took readings from samples that were set up around the room. The temperature, pH, and hydrometer samples had a range of values. The dissolved oxygen sample was taken from a bucket of water collected from a nearby tidal river. SOURCE: Chesapeake Bay Citizen Monitoring Program.

Figure 3.7

QUALITY CONTROL AUDIT FORM

DIRECTIONS: You may take readings of the various samples in any order. This should minimize waiting.

TEMPERATURE: Keep the bulb of the thermometer in the water at all times so that the readings will be consistent from one person to the next. Record temperature to the nearest 0.5° C.

HYDROMETER: Record four (4) decimal places on the hydrometer readings and the temperature to the nearest 0.5°C.

pH: Record pH to the nearest 0.5 unit.

DISSOLVED OXYGEN: Do one titration using your own kit. When you rinse the sample bottle, pour the rinse water into the jar beside the bucket and be very gentle when filling the sample bottle to avoid aerating the water in the bucket.

SECCHI DEPTH: (Weather Permitting) Go to the place marked on pier and take reading with your disk.

RESULTS

Temperature:	Reading_____	°C	Thermometer #_____	
	Reading_____	°C	Thermometer #_____	
	Reading_____	°C	Thermometer #_____	
Hydrometer:	Jar #1: Hydrometer reading_____		Temperature_____	°C
	Jar #2: Hydrometer reading_____		Temperature_____	°C
	Jar #3: Hydrometer reading_____		Temperature_____	°C
pH:	Comparator #1_____		Standard Units (SU)	
	Comparator #2_____		Standard Units (SU)	
	Comparator #3_____		Standard Units (SU)	

Dissolved Oxygen Titration:_____ mg/l or ppm

Secchi depth:_____ m

ure the characteristics and constituents required.

Volunteers should be expected to sample on a schedule agreed to when they committed to participate in the program. Sampling schedules are usually missed for very basic reasons—sampling equipment breaks or the monitor runs out of reagent, for example. The coordinator should therefore keep replacement equipment and reagents on hand at all times and send requested replacements by return mail. The amount of reagent needed for most tests can be anticipated and replacements can be sent before the current supplies are depleted. The amount of a given reagent supplied at one time and the frequency of its replacement will depend on the reagent's shelf life.

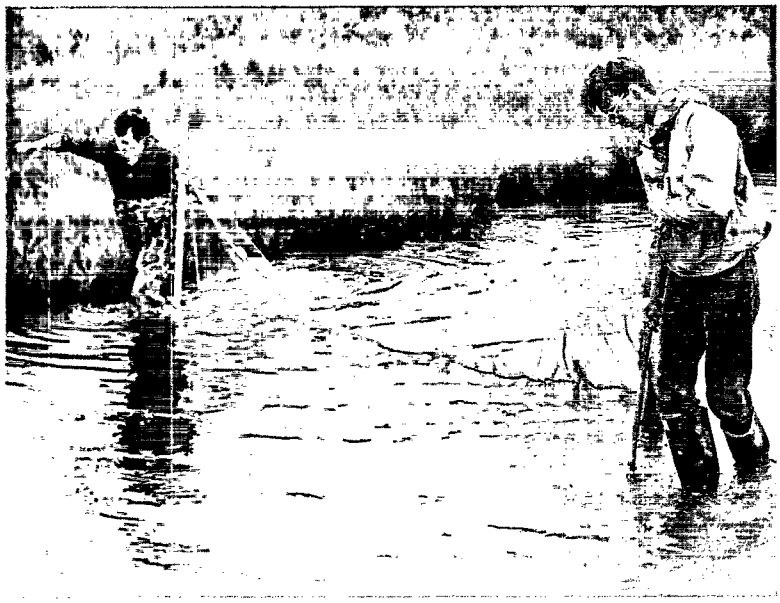


Photo by Cynthia Dunn.

Volunteers will count the fish caught in a seine net in a marsh creek on Port Isobel Island, Virginia.

Inclement weather, vacations, and other personal considerations may also cause volunteers to occasionally miss sampling schedules during the year. If the project's data quality objectives require absolute adherence to the sampling schedule, reliable substitutes should be recruited. Neighbors can plan to share a site, for instance. These substitutes should receive the same rigorous training as the regular volunteers and should carry out the sampling procedures every 4-6 weeks.

Refine Program Materials

Volunteers can provide invaluable feedback on the effectiveness of the training, equipment, and other materials used in the pilot project. To get such feedback, coordinators should prepare questionnaires to be distributed at the initial training session and at the end of the pilot phase.

At the end of the pilot phase, participants can be asked to critique the entire program. Questions that may be included are:

- Did you find the instruction manual adequate? Any suggestions for improvement?
- Did you have any trouble carrying out the tests? If yes, which ones and in what way?
- What have you enjoyed most about your involvement in this project?
- What have you enjoyed least? Suggestions for improvement?
- Would you be willing to continue and for how long?
- Did you receive enough information about the program to allow you to get maximum benefit from your participation? What would you like to see added?
- General suggestions for improving the program?

A complete report should be prepared for the data users and the advisory committee. This should include the results of the program evaluation questionnaires, a complete listing of the data collected, time-series plots or graphs of the data, and recommendations for program continuance and improvement.

3.2 EXPAND THE PROGRAM

An effective strategy for program expansion will rest on the foundation laid at the beginning of the program. Assuming the pilot project has been successful, the expansion will consist of branching out to more sites, other watersheds or additional analyses. Any problems that have been encountered during the pilot project can be corrected before and during program expansion.

Planning for expansion should be based on the results of the evaluation of the pilot project and in consultation with the advisory committee and data users.

It will be necessary to identify sources of funding and to make certain that volunteers are available in the new locations. Essentially, all the initial planning steps need to be repeated to ensure an orderly and timely expansion.

Remember that program expansion will increase the need for coordination, data management, and analysis at the project's

central office. It may require additional staff or more of the principal staff person's time. Experienced volunteers may be recruited to assume tasks connected with the coordination of the ongoing project (including recruitment of new volunteers) and summer interns may be helpful, particularly for projects that sample only in the summer months. It is important to bear in mind that program expansion brings with it the responsibility to maintain program continuation at the increased level. Volunteers are just that— volunteers. They can't always be relied upon to carry the burden of program expansion. Contingency plans must be developed to provide personnel backups.

3.3 MAKE THE MOST OF THE MEDIA

There's "news" in citizen monitoring. These volunteer programs may not generate stories that play on page one or lead off the evening news broadcast, but sponsoring organizations can still put the media to practical use in furthering project goals.

Publicity may be helpful in recruiting volunteers needed to start or expand a monitoring program. News or feature stories about citizen monitoring also draw public attention to water quality issues and help get across the idea that environmental protection is everybody's job.

It is not necessary to be a polished public relations professional to be successful in working with the media, but it is necessary to take the initiative. Reporters are not likely to come looking for a story; a program spokesperson probably will have to make the first move. That spokesperson may be either the State coordinator or a dedicated volunteer.

Before making the first move, it is important to take a look at the media serving the community. News outlets will probably include a large metropolitan daily newspaper, smaller dailies, television stations, rural or suburban weeklies and newsletters distributed by companies or community groups. These news organizations differ in their needs and interests, but have many similarities.

No matter which news organization you are approaching, be prepared before you call or visit. Be able to provide concrete details about what citizen monitors do and where they are doing it. Be able to supply volunteers' names (be sure about the spelling) and addresses. Ages and occupations can be of interest, too. Have phone numbers handy in case a reporter wants to follow up with other participants.

Here are some hints on getting media coverage:

Metropolitan newspapers. Mass-circulation dailies are not strong on community news but they are always interested in good feature stories. If you know a member of the newsroom staff, that's a good place to start. If you don't have a personal contact, ask for the "news desk." Present the monitoring program as a do-it-yourself environmental project or offer another element of interest that may be the "hook" for a feature story. Large papers use their own staff to write features and take pictures, but they will need basic background information, other contacts, and promising locations for photos.

Television news. The "news desk" is an appropriate contact at television stations,

Gasper River Water Watch Group after stream cleanup, Bowling Green, Kentucky.

Photo courtesy of Kentucky Water Watch Project

too. Stress the visual side of the story as the basis for a news feature: scenic locations, actual monitoring operations, articulate volunteers to explain what they are doing. Be willing to make arrangements that fit the schedule of a camera crew.

Smaller daily or weekly newspapers. Smaller papers, with fewer reporters, are more receptive to articles submitted by community groups. Remember that local papers want local news. Include as many names as reasonable. Stress the "grass roots" elements of the monitoring project. Provide photographs if available.

Newsletters. Organizational or corporate newsletters can be the channel of choice when you want to reach a specific audience with a specific message, i.e., to entice additional volunteers into a monitoring program. Tell the newsletter editor why his or her help is needed, and pro-

vide the item you'd like printed. Keep it short unless the editor invites a longer submission. Include a name and phone number where readers can call for more information.

3.4 MAINTAIN VOLUNTEER INTEREST AND MOTIVATION

Once good volunteers are recruited and trained, the program manager must work hard to keep the volunteers interested and enthusiastic about their sampling efforts. An example provided by the Kentucky Water Watch illustrates this point.

In a 1986 pilot study, the Kentucky program compared the performance of two groups, one which had actively requested monitoring duties and one which had been asked to participate. The groups were provided with varying levels of support based on their initial interest in monitoring. The group that had requested monitoring duties received little contact following training, lost interest rapidly, and did not submit data. In contrast, the group that had been recruited was telephoned at least once each month to acknowledge receipt of sampling results and to discuss the data; this goup submitted data for ten of the twelve sampling periods.

Successful monitoring programs devote significant resources to activities designed to motivate their volunteers. For example:

1. Send volunteers regular data reports. Data received from volunteers should be reviewed and entered into a data base as quickly as possible. At least twice a year, volunteers should be sent data summaries and time series plots showing their data and data collected by nearby volunteers. The data should be checked for errors and volunteers should provide the manager with information on missing data points or misrepresented data.

2. Keep volunteers informed about all uses of their data. Volunteers should know ahead of time how their data will be used. If they are contributing to a long-term data base, prepare annual data summaries showing the current condition of the waterbody compared to its previous condition. If the data are used for acute problem identification, send the volunteers information on areas where problems have been found. Explain how the volunteer data helped identify the water quality issue. If the data are being used to supplement the State 305(b) report (as, for example, in Rhode Island, Minnesota and Illinois), send volunteers copies of the report, or sections pertinent to their waterbody.

3. Prepare a regular newsletter. Volunteers need to be contacted regularly, so it is better to prepare an informal newsletter that can be sent out often, rather than a more time consuming, slick publication. The newsletter should contain information on new or changed sampling techniques, articles on the ecology of the study area, and particularly interesting interim results. The volunteers should be encouraged to submit articles, and can be recruited for editing and layout.

4. Be easily accessible for questions and requests. Give volunteers a phone number where they can always leave a message (use the State "Hot-line" if one exists, or install an answering machine on a local line). Respond to calls promptly; provide volunteers with the information they request. Do not give the volunteers the bureaucratic run-around ("Who you really need to talk to is .....").

5. Provide volunteers with educational opportunities. Be available to speak at civic organizations when requested. Provide volunteers with meetings and regular workshops where guest speakers can explain environmental sampling techniques or provide information on environmental policies pertinent to the sampling effort. Potluck dinners and picnics are nice ways to get volunteers to meet and interact with each other.

6. Keep the local media informed of the goals and findings of the monitoring effort. Prepare news releases covering major program activities such as annual meetings, annual training retreats, or the expansion of the program to a new watershed. Encourage media coverage of all activities but be sure to keep the tone of the articles upbeat and positive. The media provide visibility for recruiting new volunteers and lobbying for increased funding. Volunteers also like to see their efforts appreciated by the local community.

7. Recognize the volunteers' efforts. Define the most appropriate recognition techniques for your volunteers and your program. Some programs provide volunteers with awards for continued dedication to the sampling effort, while other programs find that awards and souvenirs are not appropriate to their participants.

8. Provide volunteers opportunities to "grow" with the program through additional training, learning opportunities, and changing responsibilities.

Despite the performance of many successful volunteer monitoring programs, there is still some skepticism in the scientific and technical community that volunteers can make positive contributions to environmental data bases. An important element in overcoming this skepticism is to demonstrate that volunteer monitors can provide credible information.

To ensure that credible data are collected and used, it is necessary that data be quality assured and adequately documented. This chapter provides "how-to" information for preparing a Quality Assurance Project Plan (QAPjP) and for providing data documentation. A QAPjP states the program objectives, organization, monitoring procedures, and specific quality assurance and quality control activities designed to achieve the data quality goals of the program.

A Data Documentation Form should be filed with the data base. This form provides details about why, where, how and under what circumstances the data were collected. Elements that should be included in such a form are discussed in Section 4.2.

This chapter also includes a discussion of data analysis and presentation methods that have been successfully used by existing volunteer monitoring programs.

4.1 PREPARE A QUALITY ASSURANCE PROJECT PLAN

Careful thought given to preparing and implementing a thorough Quality Assurance Project Plan (QAPjP) will ensure that quality data are provided by the volunteer monitoring program. The QAPjP format includes 16 elements, discussed below. If a particular element is not relevant to the project, a brief explanation of why it is not relevant should be included. (For detailed guidance on QAPjP preparation, refer to USEPA 1980b and USEPA 1988.)

1. Title Page. The title page should include names of the project officer, the immediate supervisor, the funding organization and anyone else who has major responsibility for the project.

2. Table of Contents is a listing of the included elements and appendices.

3. Project Description. The purpose of the project should be clearly stated. This identified purpose, which sets the pace for all that follows, should address questions such as: "Will these data be used and, if so, by whom? Have the data users evaluated the proposed sampling schemes, study designs, and analytical schemes to establish their relevance to the quality required by these users? How have the needs of the data users been translated into the study design in the broadest sense?"

A general description of the project should be provided in this section, including the experimental design. Describe exactly what will be sampled with an explanation of how the decision was made. Site locations should be identified by latitude and longitude. It may be difficult to predetermine site locations until all volunteers are recruited. In that case, state any site selection criteria that will be used and explain the general type of site that will be sought.

4. Project Organization and Responsibility . State the identified structure or organization responsible for the implementation of the program. A flow chart may be helpful here. Identify individuals responsible for the following as appropriate to the project's stated objectives:

- Overall QA/QC
- Sampling and sampling QC
- Analytical work and analytical QC
- Data processing and data processing QC
- Data review
- Program reviews

Determine what qualifications are required for participants, if any, and what provisions will be made for initial and routine training.

5. QA Objectives. For each major measurement parameter, list the QA objectives (derived from the Data Quality Objectives) for precision, accuracy, representativeness, completeness, and comparability. The program should be set up to produce data that are "in control" and "of known quality," i.e. data for which the accuracy, bias and precision have been determined.

The QA objectives can be summarized in a table as shown in Table 4-1.

6. Sampling Procedures. Decide which parameters can be monitored by volunteers. Existing programs have demonstrated that most parameters, including those requiring complicated sampling procedures, can be accurately monitored by volunteers if the recruitment process targets citizens with the appropriate level of expertise (see New York program profile in the Appendix). The overall program goal will determine whether

TABLE 4.1

PRECISION AND ACCURACY OBJECTIVES

PARAMETER	METHOD/RANGE	UNITS	SENSITIVITY*	PRECISION	ACCURACY	CALIBRATION
Temperature	Thermometer -5.0° to +45°	°C	0.5°C	±1.0	±0.5	with NBS Certified Thermometers
pH	Color Comparator Wide-Range Narrow-Range	Standard pH units	0.5 units 0.1	±0.6 ?**	±0.4 ±0.2	Orion Field pH Meter Beckman pH Meter
Salinity	Hydrometer	parts per thousand 0/00	0.1 0/00	±1.0	±0.82	Certified Salinity Hydrometer Set
Dissolved Oxygen	Micro Winkler Titration	mg/l	0.1 mg/l	±0.9	±0.3***	Standard Winkler & Y.S.I. DO Meter
Limit of Visibility	Secchi Disk Depth	meters	0.05m	NA	NA	NA

Note: The criteria used to judge completeness of data are addressed in Section 5.

*Determined by the increments measurable with the stated method reflecting estimation where allowed.

**Lack of sufficient data at present.

***Paired t analysis (α=0.05, 3 d.f.) of the standard deviation of the mean difference between 4 paired determinations.

Source: Chesapeake Bay Citizen Monitoring Program

parameters that can be measured accurately and precisely are favored over less sophisticated parameters that can be monitored by a larger constituency of volunteers. Consider the level of expertise needed to perform sampling, the time requirements, cost of sampling equipment, and the level of public interest associated with a parameter. In general, it is better to start with parameters that require simple monitoring procedures. After successful completion of a sampling season, experienced volunteers can be trained to carry out more complex tests. This also helps maintain volunteer interest.

7. Sample Custody. Sample custody is a critical part of any good laboratory or field operation. Where samples may be needed for legal purposes, "chain-of-custody" procedures must be used. As a minimum, the following sample custody procedures should be addressed in QA planning:

A. Field Sampling Operations including:

a. Documentation of procedures for preparation of reagents or supplies that become an integral part of the sample (i.e., filters and absorbing reagents).

b. Procedures and forms for recording the exact location and specific considerations associated with sample acquisition.

c. Documentation of specific sample preservation methods.

d. Pre-prepared sample labels containing all information necessary for effective sample tracking.

e. Standardized field tracking reporting forms to establish sample custody in the field prior to shipment or delivery.

B. Laboratory Operations including:

a. Identification of who will be sample custodian at the laboratory facility and will be authorized to sign for incoming field samples.

b. Provision for a laboratory sample custody log consisting of serially numbered standard lab-tracking report sheets.

c. Specification of laboratory sample custody procedures for sample handling, storage, and dispersal for analysis.

8. Calibration Procedures and Frequency Test all proposed procedures and sampling protocols in the field. Determine the accuracy

TABLE 4.1

Precision and Accuracy Objectives. A volunteer monitoring program should be set up to produce data that are of known quality and for which the accuracy, bias, and precision have been determined. This table shows an example of the quality assurance objectives determined for an estuarine volunteer monitoring program.

and precision of monitoring equipment and protocol by comparing the results obtained with volunteer equipment to the data generated by standard laboratory equipment. Determine what calibration needs to be done on the lab and field equipment. Maintain log books or data sheets of calibration activities. Keep a good record of equipment maintenance and repairs. State what standards or reference materials will be used in the project's quality control program.

9. Analytical Procedures. Be sure to document any analytical procedures. Describe the chemistry of non-standard methods used and reference the method number and book for accepted standard methods used.

If samples are sent to a State laboratory for analysis, a processing protocol must be designed to avoid contamination and delays which could alter laboratory results. The protocol should specify how samples will be preserved and packaged for transport to the lab; which days of the week to sample (to enable the samples to arrive at the lab before ice packs lose their effectiveness); and laboratory procedures for labeling and storing samples, and for recording data. Existing programs (New York and Illinois) provide volunteers with pre-labeled sample vials containing preservatives and rely upon ice packs to refrigerate samples in the mail during transport to the lab. Laboratory analysis procedures should follow standard, EPA-approved methodologies such as *Standard Methods for Water and Wastewater Treatment* (APHA, AWWA & WPCF 1985) or *Handbook for Analytical Quality Control in Water and Wastewater Laboratories* (USEPA 1979).

10. Data Reduction, Validation, and Reporting. This element addresses the activities involved in an overall data management plan.

Prepare standard data sheets that can be folded into thirds and mailed without an envelope, or on self-addressed post cards. Include the mailing address of the program coordinator on the data sheet, and decide if the data should be mailed into the central office as soon as it is collected, or all together at the end of the sampling season. Procedures for logging-in the data as it arrives at the central office must also be developed, so that delinquent volunteers can be identified and contacted to improve performance.

Data management software must be installed and tested prior to program implementation to avoid the time-consuming process of switching from a manual to a computerized data management system. The software should be capable of performing the selected statistical analyses, and of producing graphs, charts, and tables to ease report writing and reduce staff workloads. Most State-managed volunteer programs use some type of spreadsheet (e.g.Lotus) or a data base manager (e.g. dBASE) to store and manipulate their data.

When the coordinator (or other person responsible for data management) receives a data report from the volunteer monitor, the data should be processed using procedures developed and agreed upon during the planning stages of the project. Critical steps include the following:

a. As soon as possible after receipt, screen the data sheet thoroughly, checking for errors in identification numbers, decimal placement, dates, time, units reported, illegible handwriting in comment section, etc. The

The following data management recommendations were made by Illinois Volunteer Lake Monitoring Program staff based on seven years of experience refining their data management system:

- Organize data by waterbody identification numbers assigned for 305(b) assessments rather than by inconsistent lake names.

- Avoid the use of separate data coding procedures by developing PC software with data entry screens similar to the data forms submitted by volunteers.

- Enter the data into a PC system with editing capabilities to facilitate corrections.

- Develop a program to upload the data from the PC file into STORET. Within STORET, statistical analysis can be performed with packages such as SAS (Statistical Analysis System).

- Store the data under a unique STORET agency code to distinguish the data collected by volunteers from the data collected by STATE personnel.

- Two phases to data verification are recommended. First, the entered data must be checked against the volunteer data sheets. Then the data should be plotted to detect outliers, which often indicate recording errors such as reporting measurements in incorrect units, or assigning a measurement to the wrong sampling site. Volunteers should keep separate log sheets for reference to resolve questions about data.

(Survey 1989, Burns)

volunteer monitor should be contacted by phone or letter to straighten out any problems noted at this point while the information is still fresh in his or her mind. The volunteer monitor should be contacted if there are data gaps or if scheduled sampling times appear to have been missed. Every attempt should be made to screen out inaccurate data before they are entered into the computer data base. This step will also help the coordinator keep track of volunteer participation.

b. Submit the edited forms for data entry.

c. Carry out data verification on the computerized data. Data should be printed out in list form and in plots. The list should be checked against the original data sheets; plots should be examined for outliers so that simple recording mistakes (such as assigning data to the incorrect sampling site, reporting incorrect units, or improperly placing decimals) can be identified.

d. Submit corrections to data entry staff. After corrections are entered, a second examination should be made to verify that corrections were completed.

e. Declare the data to be "clean" or verified and transmit to the data user, EPA's water quality information system (STORET), or other designated data base. Large computer data sets can be run through range checks to help identify inaccuracies and anomalies that should be checked against the original data sheets. Data entry errors should be corrected. Inaccurate data should be expunged from the data base. Inaccurate data are values that are simply not believable, such as a salinity recording of 322.0 parts per thousand or a water temperature of 209.0 degrees C.

Anomalies, on the other hand, are true data which depart from the "typical" and therefore fall outside acceptable limits of defined range checks. In some cases, the anomaly may be understood in combination with data recorded in another data set. Examples of anomalous data are an extremely high concentration of dissolved oxygen in warm water during an algal bloom or an atypical Secchi measurement due to floods or heavy rains (USEPA 1989).

11. Internal Quality Control Checks. The approach to quality control will depend on the type of project and parameters being tested. A variety of QC activities can be carried out at retraining and QC sessions. (Refer to Chapter 3, "Conduct Ongoing Quality Control.")

Photo by John Bildahl

Quality Control is an important part of all monitoring programs. Volunteer monitors on the Patuxent River in Maryland get together twice a year to compare techniques and results.

Ways to assure the quality of the data set include running duplicate samples, sending samples with parameter values unknown to the monitors and/or the laboratory, and using two methods to test the same parameter.

12. Performance and System Audits. A systems audit consists of an evaluation of all components of the measurement system—the equipment, personnel, and procedures—to determine their proper selection and use. Such an audit includes a careful evaluation of both field and laboratory quality control procedures. An audit should be performed prior to or shortly after the project begins and periodically thereafter during the lifetime of the project. This should include a review of the program as a whole and the work of the individuals performing the sample collection and analysis.

These activities are basically the same as the internal QC checks detailed in the previous section. It is a good idea to bring in an outside auditor (this might be the EPA Regional Quality Assurance Officer (QAO) or State QAO) at least once a year to take a fresh look at your QC protocol and performance.

13. Preventive Maintenance. The following types of preventive maintenance items should be addressed in a QA plan:

a. a schedule of important preventive maintenance tasks that must be carried out to minimize gaps in the data. This might include backup monitors when people are ill or on vacation.

b. the supply of equipment and reagents to be kept on hand with a schedule for issuing fresh chemicals periodically.

c. assignment of an assistant (who can be a volunteer) to contact monitors who do not submit data sheets on time.

Trustom Pond is one of several ecologically fragile salt ponds found along Rhode Island's southern coast. Citizen monitoring of bacteria in these Ponds helped the State close the pond to shellfishing.

Photo by Jon Boothroyd

14. Specific Routine Procedures Used To Assess Data Precision, Accuracy, and Completeness. The routine procedures used should be included in the QA Plan. These procedures should include the equations to calculate precision and accuracy and the methods used to carry out any calibration and comparability studies.

15. Corrective Action. Corrective action procedures include the following elements:

a. the predetermined limits for data acceptability beyond which corrective action is required.

b. procedures for corrective action (i.e., decision to throw out data, definition of outliers).

c. identity of the individual responsible for initiating the corrective action and then approving it.

16. Quality Assurance Reports. The QAPjP should provide a mechanism for periodic reporting to the data user, and the individual(s) responsible for preparing these reports should be identified. As a minimum, these reports should include:

a. periodic assessment of data accuracy, precision, and completeness.

b. results of any QC sessions and audits.

c. significant QA problems and recommended solutions.

In summary, quality assurance and quality control should be a continuous process implemented throughout the entire monitoring program. As with any scientific endeavor, quality must be assured before the results can be accepted. Quality assurance is accomplished through establishment of thorough participant training, protocol guidelines, comprehensive field and lab data documentation and management, verification of data reproducibility, and instrument calibration.

4.2 PREPARE A DATA DOCUMENTATION FILE

Careful and thorough documentation of the data base ensures that it can be used with confidence and is especially critical for volunteer monitoring programs. Any water quality data collected by volunteers may be used by a State in its surface water assessment reports to USEPA. Therefore, the codes used in data entry and storage should be compatible with those used in STORET or in other relevant data sets. Data that will be entered into a State (or other formal) data base should be accompanied by appropriate documentation.

Elements that should be included in a data documentation file include:

a. Data set name, project title, name(s) of the individual(s) responsible for the data collection, name of collecting organization, and program sponsor.

b. A statement of the purpose of the data collection and, when available, the results and conclusions. This element can be designed to capture all other documentation that cannot be placed in other fields, such as key equations used to generate reported values.

c. A description of the type of observation stations (buoy, pier, shore, boat) including the number of stations or sites and number of observations.

d. Period of record (year/month/day) and hour (if applicable) of first and last observation. Length of record showing any breaks in the records of data collected over a period of time. If significant, specify when variables were added or dropped.

e. A list of geographic place names, geographic codes (Eco-Region codes, USGS, Hydrologic unit codes, STORET codes, State codes). Include the latitude/longitude coordinates of the study and the station names, identification number, and description of location and grid locators of individual sites/stations.

f. The sampling schedule for data collected with regular periodicity.

g. A list of the water quality indicators/parameters, the methods used to measure them and their USEPA method identification codes. This should be followed by a description of the method. Be sure to include units of measurement and detection limits. Include information on precision, accuracy, and replicate sampling, if available.

h. Any special quality assurance and quality control procedures used during data collection, analysis, and/or keypunching (USEPA 1989).

4.3 ANALYZE AND PRESENT DATA

It is essential that volunteer monitoring program managers include provision for data analysis and reporting in their initial project planning. Enough staff time must be committed in advance to carry out these important elements of the overall program, avoiding the "let's just get the data now and figure out how to analyze it later" attitude. It is also important to ensure that any information released to the public is absolutely accurate, especially where a State-administered program is involved. Misinformation and invalid data interpretation can be very damaging to the program.

Data analysis and reporting need not be overly sophisticated. In fact, selecting a level of interpretation appropriate to the problem at hand is a sign of good management. The ideas below are presented at increasing levels of sophistication and are intended to give an overview of the ways data collected by volunteers have been and are being analyzed.

The monitoring objectives established at the outset of a volunteer program will determine the types of data analysis that should be performed. Thorough analysis of the collected data requires staff time and resources, and should always be included in the initial program planning. Remember that volunteers need to see their data being used. A volunteer program will only succeed if the data are evaluated, interpreted, and relayed back to the citizen volunteers.

Since many volunteer programs are designed to collect long-term, baseline water quality information, in-depth interpretation of the data must wait until the program has been active for several years. However, each year's data should be plotted, reviewed, and discussed for the benefit of the volunteers.

State volunteer program managers must be prepared to present data to both in-house technical staff and non-technical volunteers. The two audiences require very different presentation styles.

The purpose of this section is to introduce new volunteer program managers to effective data presentation techniques directed at the lay volunteers. Examples of these techniques, drawn from existing volunteer programs, are discussed below.

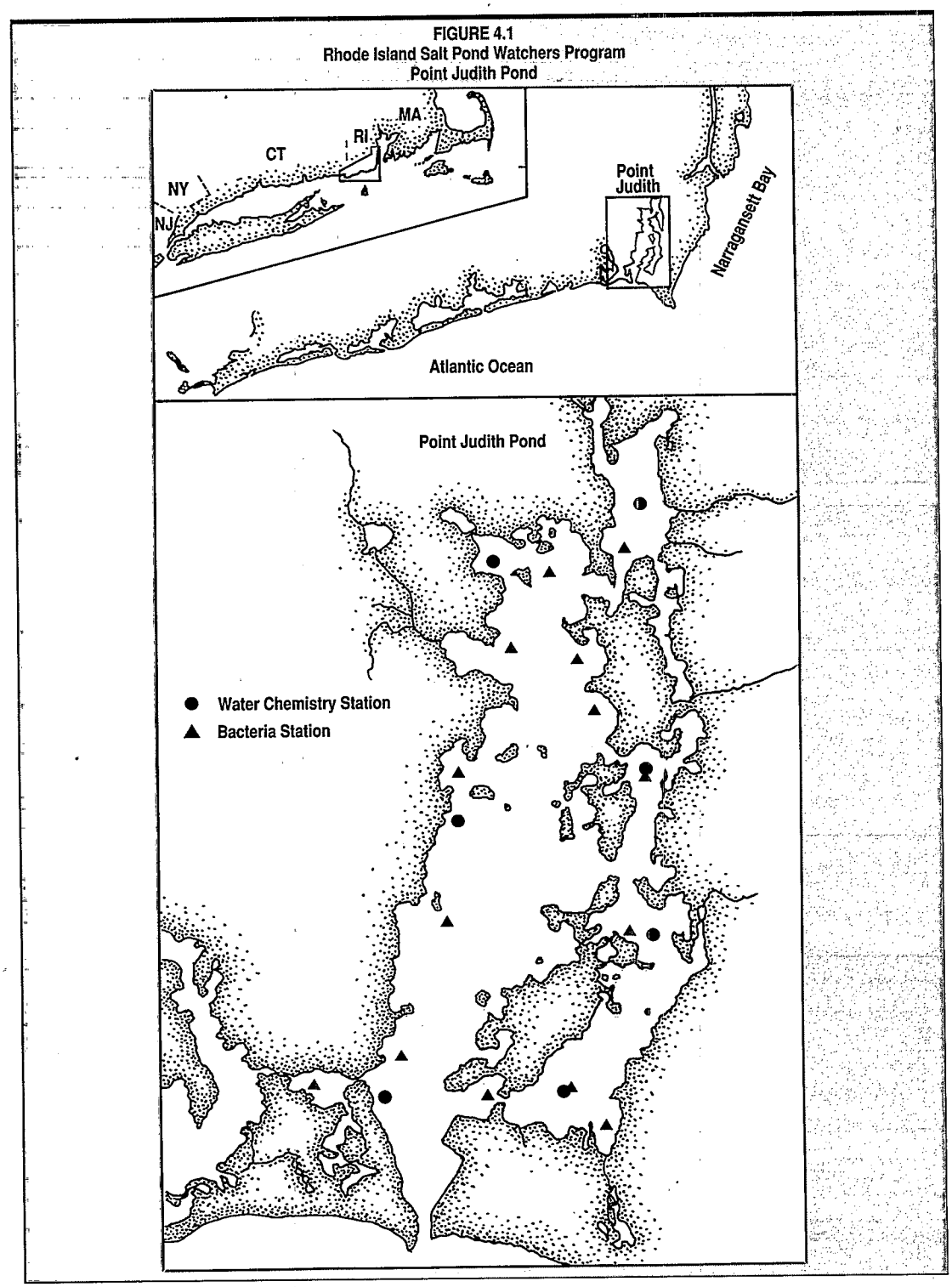
Maps

It is always useful to develop maps of the watersheds and waterbodies included in your sampling program. The maps can be copies of USGS, State, or county maps, or can be drawn by hand. The maps should display the physical characteristics of the waterbody (and watershed, in some cases) and should be kept up to date with the location of sampling stations. Include stations sampled by other groups and agencies as well as the stations managed by the volunteer program. Stations should be numbered and clearly defined on the map or in a separate index.

These maps will be used throughout the monitoring effort. They will help the coordinator locate new sampling sites, and can be used in publications summarizing the results of the sampling program. Maps also aid the person responsible for analyzing the col-

Figure 4.1

Maps showing the location of water chemistry and bacteria collection stations on Point Judith Pond, Rhode Island Salt Pond Watchers Volunteer Monitoring Program. SOURCE: Lee and Kullberg 1986.



lected data, providing information on station characteristics that may influence water quality.

In 1985, the University of Rhode Island Sea Grant program began a volunteer monitoring project on several of its shallow lagoons, known as salt ponds, which lie along the State's southern shore. (Further details of this program are in Chapter 1.) Figure 4.1 displays a series of maps graphically depict-

ing sampling stations for chemistry and bacteria in one of these ponds, Point Judith.

Ohio's Department of Natural Resources, Division of Natural Areas and Preserves, sponsors a stream monitoring program (see Appendix) using volunteers to collect and analyze macroinvertebrate populations collected with a simplified "kick seine" technique. Maps are effectively used (see Figure 4.2) in the program's annual reports to display the location of sites sampled by both volunteers and the State.

Graphs

Most successful volunteer programs find that simple graphs showing the variation of measured water quality parameters over time and space are informative and easy for the citizen volunteers to interpret. Graphs also help the volunteer program manager verify the incoming data, and often suggest methods for a more thorough analysis.

Volunteer lake monitoring program reports often summarize Secchi depth data in plots using a graphic disk as illustrated in Figure 4.3. Plots provide a quick view of the variation of Secchi depth over the sampling period and are easily understood by technical as well as non-technical audiences.

River monitoring data can be visually interpreted using graphs showing water

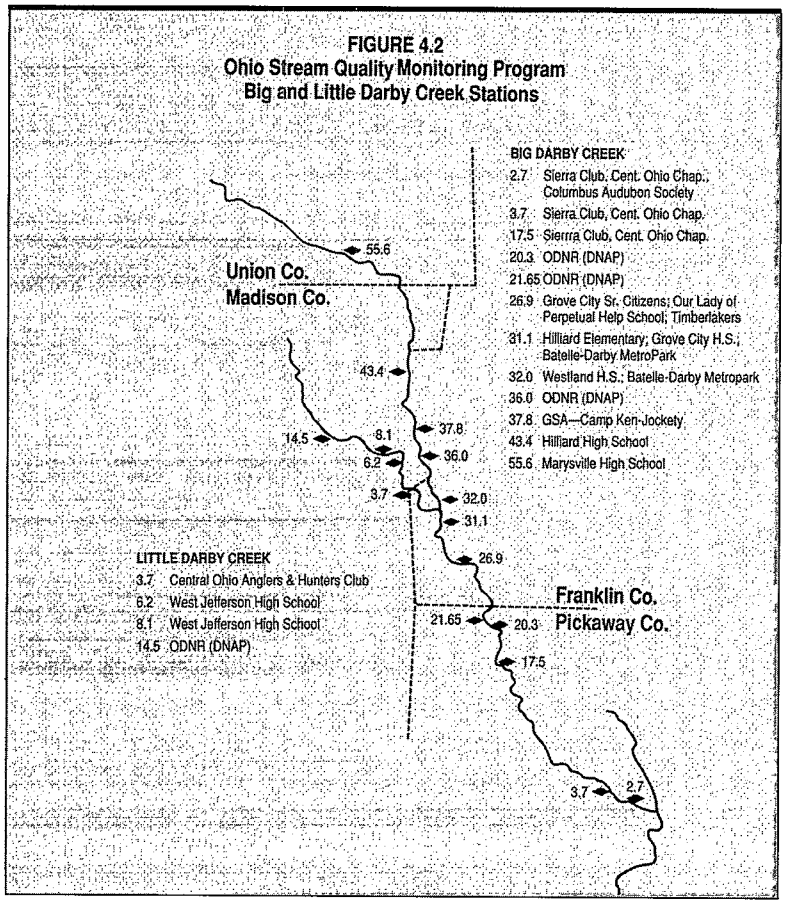


FIGURE 4.2
Ohio Stream Quality Monitoring Stations on Big Darby Creek and Little Darby Creek. Location of stations sampled by volunteers and State employees are shown.
SOURCE: Lewis and Kopec 1986.

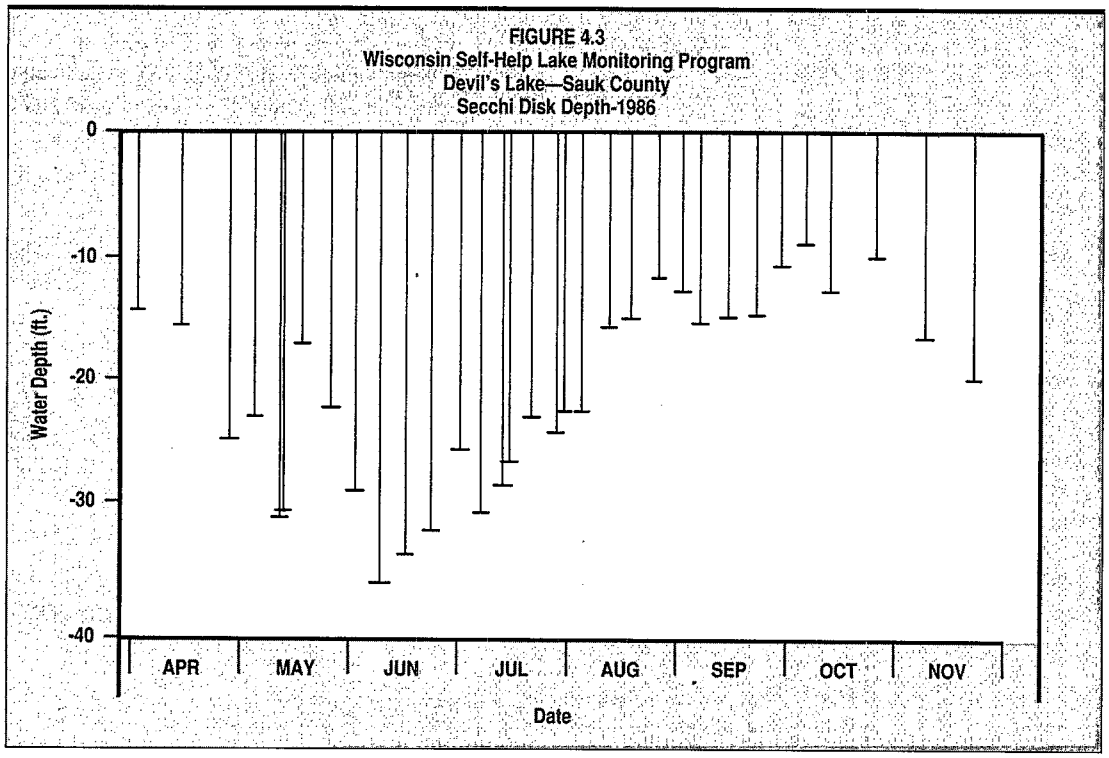
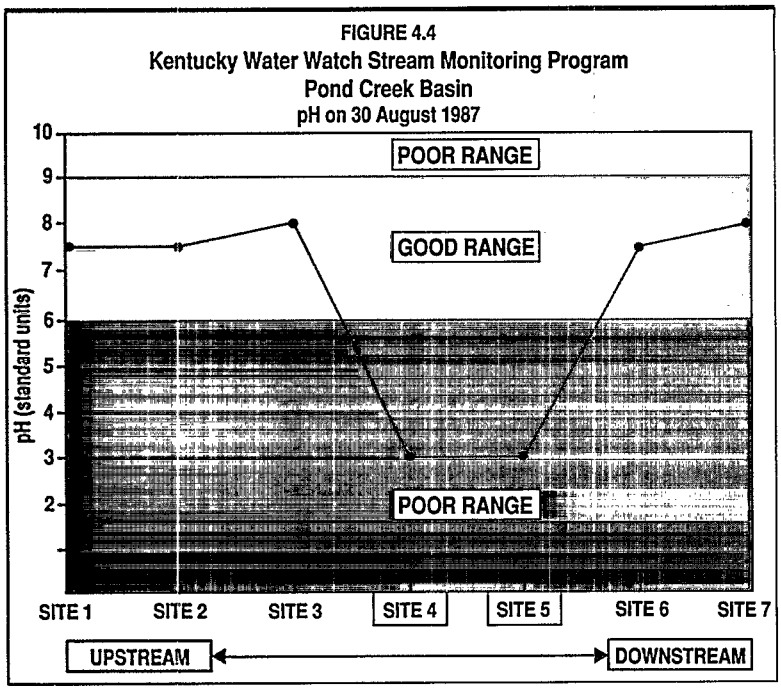


FIGURE 4.3
Plot of Secchi disk data for Devil's Lake, Sauk County, Wisconsin. Wisconsin Self-Help Lake Monitoring Program. Graphic presentation of the Secchi disk data depicts a disk being lowered into the water column.
SOURCE: Rumery 1987.



quality on the y-axis and river miles on the x-axis. If the river is affected by pollution, these plots often suggest where the impact is occurring and show whether the river is recovering. The plots also allow volunteers to examine how their data relate to other data collected by the program. Figure 4.4 shows pH data collected by Kentucky's Water Watch volunteers in the Pond Creek Basin (Cooke 1988). The graph effectively displays the variation of pH along the creek, clearly displaying the zone of degradation.

Charts

Bar charts can be used to display the spatial or temporal changes in data. Volunteers for Michigan's Tip of the Mitt Watershed Council Volunteer Lake Monitoring program measure Secchi disk depth and take samples for chlorophyll analysis throughout the summer. These data are used to calculate an average trophic state number for each lake. A bar chart is used in the program's 1986 Water Quality Report to summarize the vari-

FIGURE 4.4

pH of water at seven sites in the Pond Creek Basin sampled on 30 August 1987 by volunteers in the Kentucky Water Watch Stream Monitoring Program.
SOURCE: Cooke 1988.

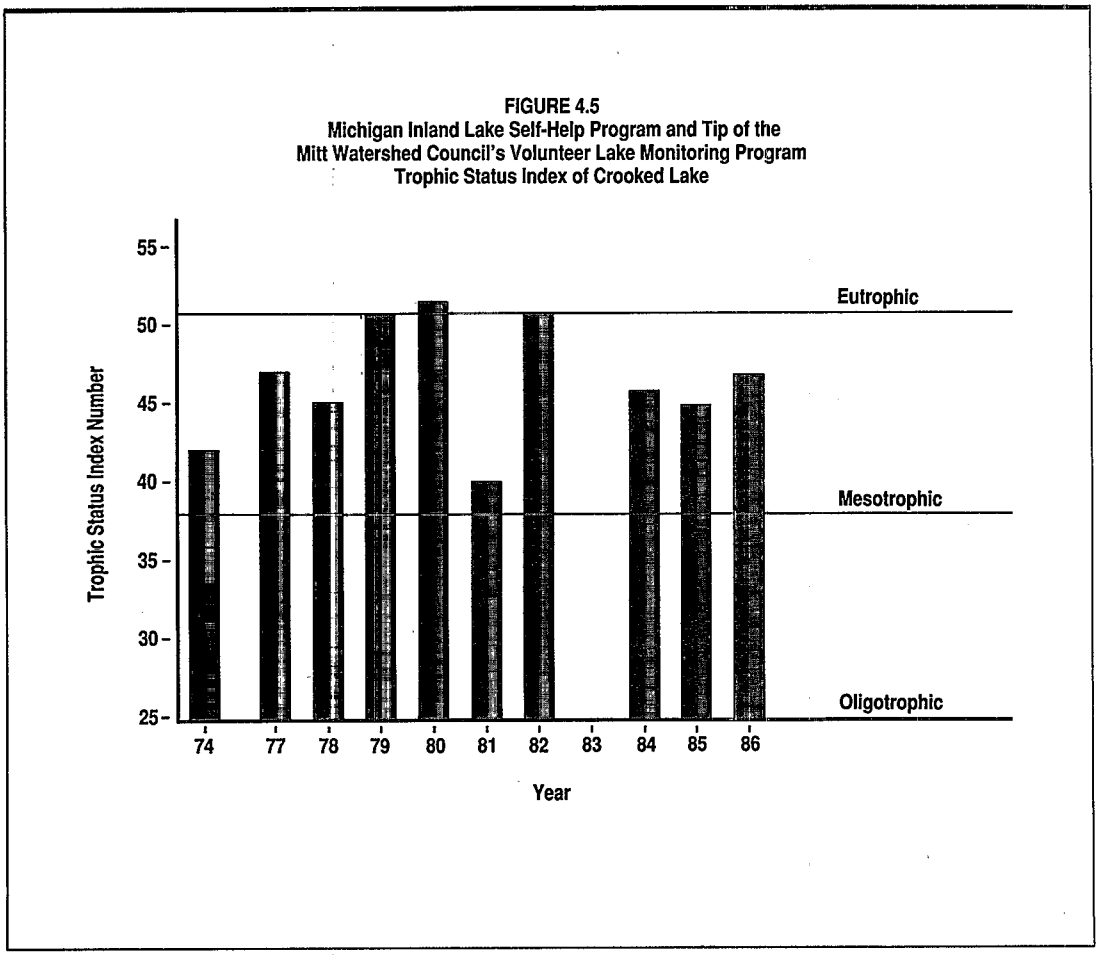


FIGURE 4.5

Trophic Status Index of Crooked Lake in northern Michigan from 1974 to 1986. Data was collected by volunteers participating in the Inland Lake Self-Help Program, Michigan Department of Natural Resources and the Tip of the Mitt Watershed Council's Volunteer Lake Monitoring Program.
SOURCE: McLennon 1986.

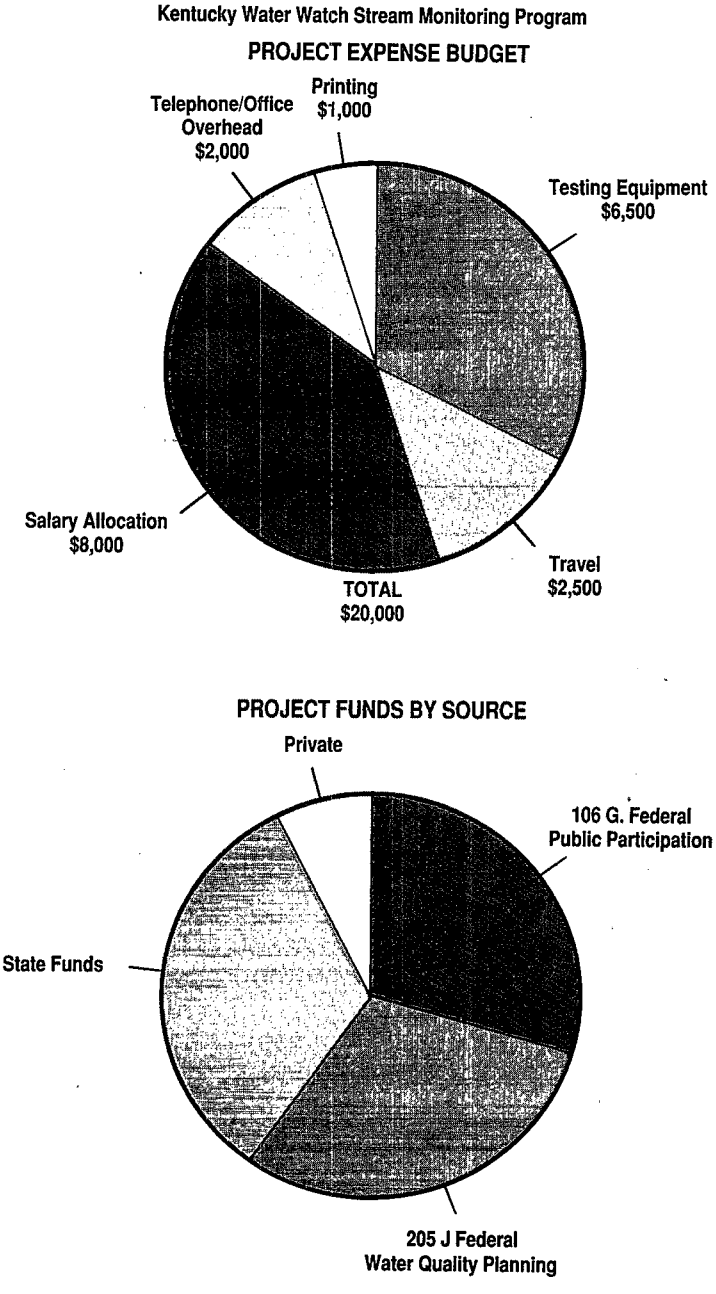


FIGURE 4.6

Charts show the expenses by category and the funding sources for the Kentucky Water Watch Stream Monitoring Program.
SOURCE: Cooke 1988.

ation in trophic state over time (Figure 4.5).

Pie charts are easy to construct, and effectively summarize information about the volunteer monitoring program. Pie charts have been used by Kentucky's Water Watch program to summarize funding sources and project expenditures (Figure 4.6). The charts are simple and easy to interpret and are suitable for both technical and lay audiences. The Illinois Lakes Lay Monitoring program manager uses volunteer-collected Secchi depth data to calculate Trophic State Indices (TSI), and has effectively summarized that data using a pie chart (Figure 4.7).

Box Plots

Although not currently used by any volunteer programs that were reviewed for this

FIGURE 4.7
Illinois Lakes Lay Monitoring Program
Trophic State Indices of Illinois Lakes in 1986

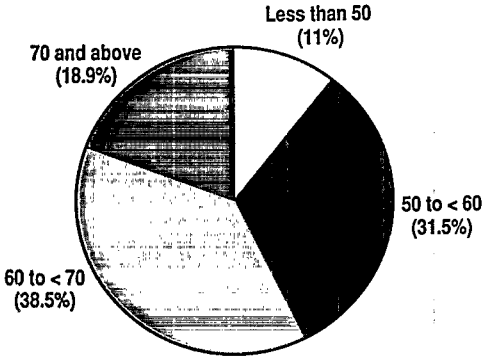


FIGURE 4.7

Trophic State Indices for Illinois lakes in 1986. Summary of trophic state indices was based on Secchi depth data collected by volunteers participating in the Illinois Volunteer Lake Monitoring Program. SOURCE: Hawes 1987.

document, the box plot can summarize a large amount of information about a set of data and is becoming a professional standard for describing data. The box plot can be useful for technical audiences interested in interpreting the data but can also be readily explained to a lay person [Tukey (1977) and McGill, et al. (1978)]. The box plot (see Fig. 4.8) is constructed from the order statistics, and visually displays the data's median, variability, and skew. It also provides information on the size of the data set and the statistical significance of differences between medians. The box plot is an informative method for graphical presentation and comparison of one or more sets of data on the same variable.

Figure 4.8

The steps below, described in Reckhow and Chapia (1983), may be followed to construct a box plot for a set of data on a single variable:

1. Order the data from the lowest to highest.
2. Plot the lowest and highest values on the graph as short horizontal lines. These are the extreme values of the data set and represent the data range.
3. Determine the 75 percent value (upper quartile) and 25 percent value (lower quartile) of the data set. These values define the interquartile range and represent the location of the top and bottom lines of the box. Using vertical lines, connect the highest value with the upper quartile and the lowest value with the lower quartile.
4. Plot the median as a dashed horizontal line within the box.
5. Select a scale so the width of the box represents the sample size, or the size of the data set used to construct each box. For example, the box width that describes a data set of 20 values can be displayed twice as wide as a data set of 10 values. Alternatively, the width may be set as proportional to the square root of the sample size. (Any proportional scheme can be used as long as it is consistently applied.
6. Determine the height of the notch (in the box at the median) based on the statistical significance of the median:

$$\text{median} \pm 1.7(1.25I/1.35\,n)$$

where I=upper quartile-lower quartile
n=number of values in the data set

With this mathematical definition of the notch heights, the notch in the box provides an approximate 95% confidence interval for comparison of box medians. Therefore, when the notches for any two boxes overlap in a vertical sense, these medians are not significantly different at about the 95% level.

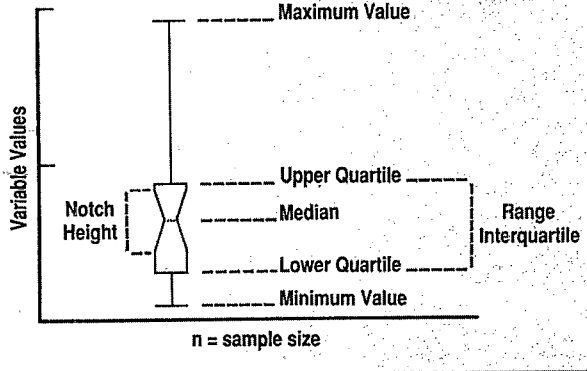


FIGURE 4.8

Box Plot Construction. These steps may be followed to construct a box plot for a set of data on a single variable. Adapted from Reckhow and Chapia 1983.

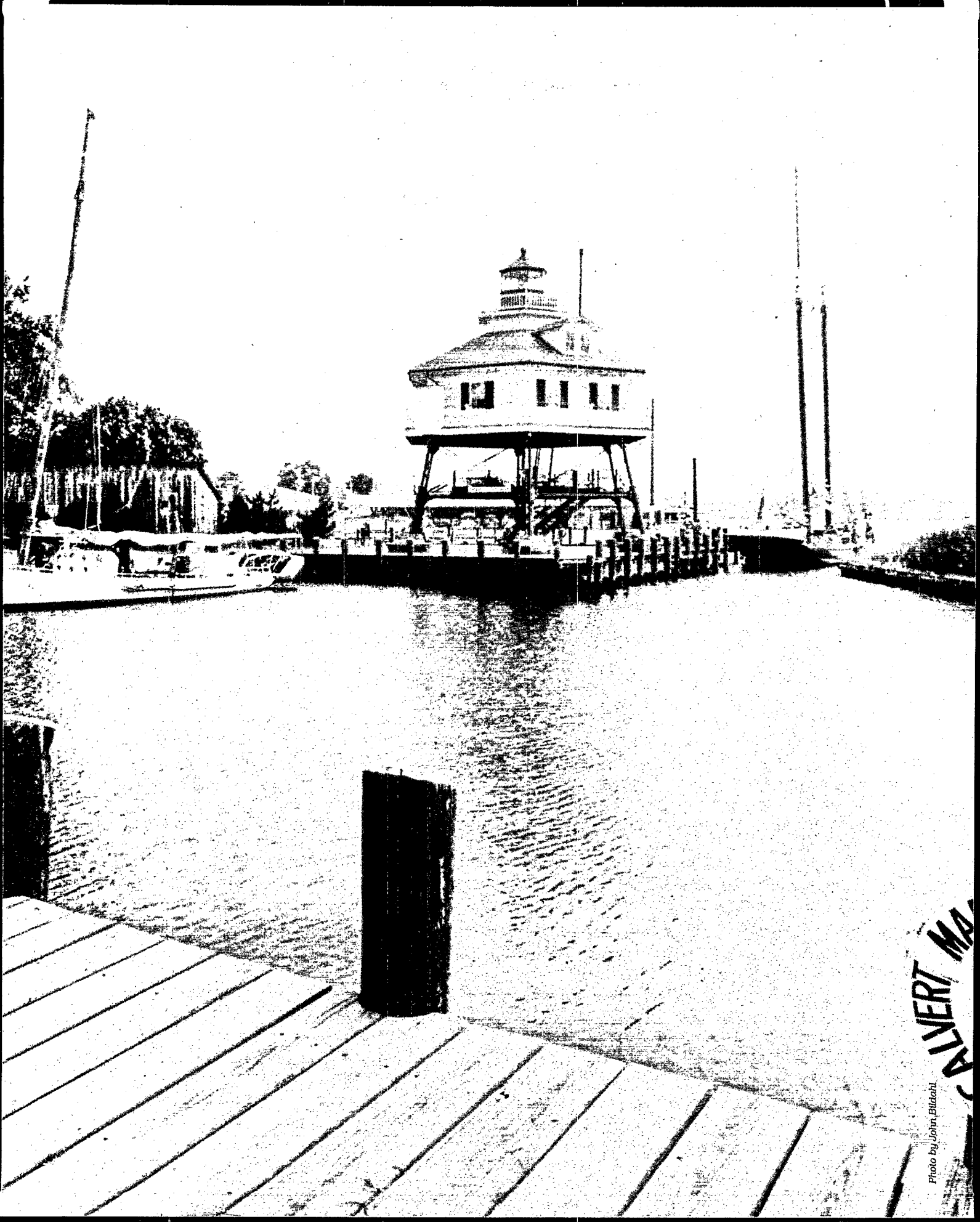


Photo by John Bildahl

The experience of many State-managed volunteer monitoring programs has shown that citizen monitoring is cost-effective but not free. It is a common misconception that citizen monitoring programs only require start-up funding and then become self-sufficient. In fact, the withdrawal of funding after one or two years is the most commonly reported reason for failure of volunteer projects.

Successful programs require staff dedicated to ongoing efforts to motivate volunteers and ensure that data quality goals are met year in and year out. Prior to implementing any volunteer monitoring program, States should review and adjust program objectives so they can be achieved with the available resources.

Carroll Curtis and Peyton Robertson measure the pH of the Mattaponi River in Virginia.

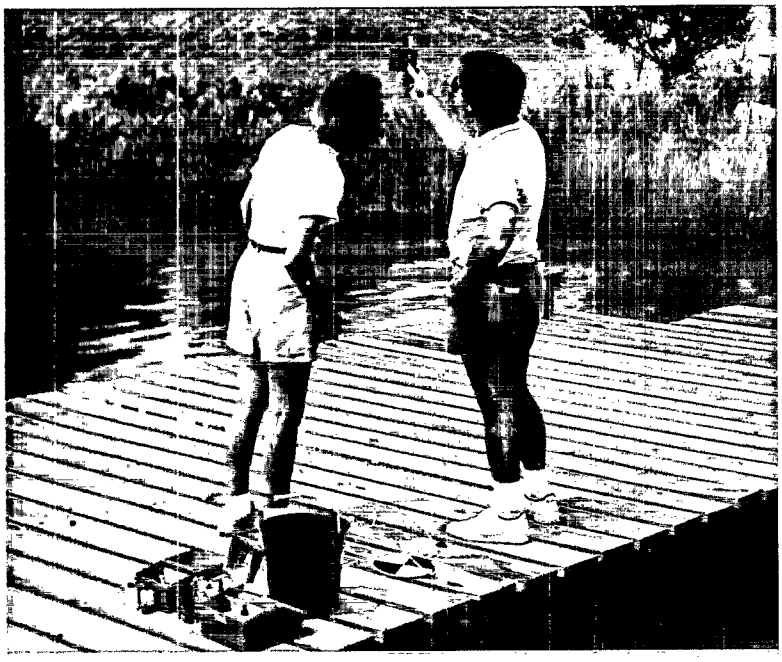


Photo by Cynthia Dunn

This chapter outlines various categories of expenses and the range of costs associated with different types of volunteer programs. The chapter concludes with a discussion of options for funding a citizen monitoring program and techniques for reducing program costs.

5.1 PROGRAM EXPENSES

A recent compilation of costs associated with citizen monitoring programs has been developed by the Chesapeake Bay Citizens Monitoring Program (Ellett 1988). This complete list of costs includes the following categories, many of which are "hidden" in other program areas in State sponsored programs:

- Staff salaries and fringe benefits
- Office overhead, including phone usage, postage, and duplicating
- Travel expenses to train volunteers, perform quality assurance checks, and promote the program
- Equipment, including replacing lost or broken equipment, and refilling chemical supplies
- Laboratory analysis
- Data management, including data entry, storage, and retrieval
- Data analysis, including costs of statistical packages such as SAS
- Printing costs for annual reports and newsletters
- Other activities, such as conferences

Nine States with volunteer monitoring programs were surveyed to assess the real costs of these programs. The results are summarized in Table 5-1. Total program budgets range from $15,000 to $127,000 with the majority of volunteer programs having annual budgets between $20,000 and $50,000. The broad range of budget estimates reflects differences in program scope, parameter selection, and administrative needs. Since it is often difficult to separate expenses associated with a volunteer monitoring program from other State program expenses, the figures in Table 5-1 are "best guess" estimates. Each State surveyed also had a unique methodology for estimating costs. For example, Illinois explicitly includes overhead costs of 62% on staff salaries, while many programs do not include overhead costs and thus appear less expensive to operate. Keeping these limitations in mind, the budget estimates provide a range of potential program costs.

The following paragraphs address each of the cost categories outlined in Table 5-1.

Staff Costs

Staff salaries are generally the single most expensive item in volunteer monitoring program budgets. At least one full-time coordinator is recommended to start a program, and additional part-time personnel may be required during the sampling. Additional staff costs, such as employee benefits and office overhead, are often overlooked but should be recognized. Staffing requirements vary depending on the program size and the number and complexity of monitoring parameters

TABLE 5.1
CITIZEN MONITORING PROGRAM BUDGETS

State	Number of Monitored Waterbodies[1]	Number of Sampling Sites	Sampling Frequency (Duration)	Parameters	Total Costs[2]	Staff[3]	Equipment[4]	Lab Analysis	Printing and Postage	Travel	Other Costs[5]
IL	150 L	450	2/month (May-Oct)	Secchi depth (Nutrients & solids in 50 lakes)	$127,000*	$63,000 (2.3 FTE)	$4,000*	$20,000 (100 sites)			$40,000
KY	57 R	57	1/month (All Year)	DO, pH, nutrients	20,000*	8,000 (0.33 FTE)	6,500		1,000	2,500	2,000
ME	215 L	215	2/month (May-Sept)	Secchi disk (chl-a in 5 lakes)	26,300	21,000 (1 FTE)	300	2,500 (5 sites)	2,500		
MI	175 L	175	4/month (May-Sept)	Secchi depth	15,000	8,000 (0.33 FTE)					7,000
MN	350 L	350	4/month (June-Sept)	Secchi depth	44,000*	25,000 (1 FTE)	3,000		7,000		9,000
NY	61 L	61	4/month (June-Oct)	Secchi depth DO, pH, Chl-a, nutrients, lake level, color, rainfall, conductivity, macroinverte-brates	125,000*	40,000 (1.5 FTE)	14,000	45,000	6,000		20,000
OH	10 R	150	2-5/year (Apr-Oct)	Benthic macroinverte-brates	55,000	49,000*	2,000			10,000	
VT	71 L	137	4/month (June-Aug)	Secchi depth Chl-a, phos-phorus	22,900	12,000	5,000	2,800		3,100	
WI	170 L	170	2/month (May-Sept)	Secchi depth	41,500	35,000 (1.5 FTE)	3,500		3,000		

[1] Lakes are abbreviated with an "L"; rivers are abbreviated with an "R".

[2] Total cost estimates that include overhead are indicated with an asterisk (*).

[3] Asterisk-includes % time of central office and field OH Scenic River Program personnel who administer and assist the Stream Quality Monitoring Program, along with seasonal and part-time personnel.

[4] One-time equipment costs are indicated with an asterisk (*), and not included in the total cost.

[5] Other costs include the balance of the total costs not accounted for in the various cost categories. Other costs include office overhead, staff benefits, conference costs, and cost categories, such as printing and travel expenditures, that could not be isolated from the overall annual budget.

that are selected. Obviously, small programs require less administration to coordinate volunteers, and less clerical staff to enter data and type reports. Parameter selection has a more subtle impact on staff needs. For example, programs that limit volunteer monitoring to Secchi disk measurements often do not require hands-on training by professional staff.

Equipment and Laboratory Expenses

Parameter selection determines equipment and laboratory costs. Some parameters do not require laboratory analysis and the equipment needed to measure them is inexpensive. For example, a Secchi disk can be purchased for approximately $20 or constructed by the volunteers. Providing standardized disks to the volunteers ensures quality control, saves time, and minimizes volunteer frustration. However, several low-budget programs do require the volunteers to construct their own disks or purchase the disks.

Biological parameters, such as benthic macroinvertebrates, can also be measured with a minimal equipment cost. The equipment required to monitor benthic macroinvertebrate communities in Ohio's Scenic Rivers volunteer monitoring program includes a four-by-four foot nylon mesh net, plastic containers, hand lens, thermometer, and identification sheet. Equipment costs are further reduced by constructing the seine nets with defective hoe handles donated by a local industry. Species identification is performed onsite, thereby eliminating laboratory expenses. Ohio's annual expenditures for equipment, used for replacing broken equipment and constructing new nets, is approximately $2,000.

In contrast, monitoring for chemical parameters requires either relatively expensive onsite test kits or laboratory analyses. Two test kits capable of sampling stream chemistry for one year have been priced at $165 and $295 (1988). The Kentucky citizen monitoring program solicited bids from chemical testing companies and selected a test kit that measures dissolved oxygen, nitrate-nitrogen, ortho-phosphate, pH, and chlorides monthly, at an annual cost of $165 per kit. The Delta Laboratories, Inc. offers a kit equipped to perform 50 repetitions of the above tests plus hardness, turbidity and screening for heavy metals for $295 (Delta Laboratories, Inc. 1987). If volunteers working with the Delta Laboratories kit suspect metal or pesticide pollution in their waterbody, samples can be preserved for analysis by the Laboratories at no additional cost.

In some programs, the cost of test kits is passed on to volunteers. One-third of the participants in Kentucky's program purchase their test kits, reducing the annual equipment costs from $9,405 to $6,500. In Ohio, beyond the initial free provision of one or two nets and kits, participants often purchase additional equipment at $25 per set.

Laboratory analysis of chemical parameters is also expensive and includes additional costs for postage and chemicals required to preserve samples. For example, the New York program spends approximately $40,000 annually for laboratory analyses of total phosphorus, nitrate nitrogen, chlorophyll, color, alkalinity, pH, and conductivity on 53 lakes. Mailing the samples to the labs costs an additional $100 per lake. The Illinois program adds $20,000 to their annual budget for chemical analyses at 100 sites on 50 lakes. Thus, laboratory analysis costs alone can exceed the total program budgets of many State citizen monitoring programs, and can only be undertaken by well-funded programs.

Data Management Costs

Computer facilities are often necessary to manage and analyze the data collected by the volunteers, compare volunteer data with other data bases such as STORET, and prepare reports. In addition to hardware and software costs, the budget should include staff time to enter, review, edit, and analyze data. These costs are difficult to assess because most existing programs rely on support services within the State agency to perform these tasks.

Printing and Postage Expenses

Several thousand dollars should be budgeted for printing and mailing newsletters and annual reports which inform the volunteers and other State personnel about the accomplishments of the program. Costs will depend upon the size and format of the publications and their frequency. Other costs associated with rewarding and educating volunteers may include organizing annual conventions for citizen monitors and providing rewards such as plaques, hats, T-shirts, lapel pins, and certificates.

Travel Expenses

Citizen monitoring personnel often travel

extensively during the sampling season to train volunteers and perform quality control checks. The geographical size of the State, the number of staff and volunteers, and the emphasis placed upon personal contact with volunteers influence travel expenses. Ohio spends about $4,000 annually on travel; each group is trained onsite, and the program coordinator travels frequently to promote the program. Other agencies report travel expenses between $2,000 and $3,000.

5.2 COMPARISON OF TWO STATE PROGRAMS

The Michigan Self-Help Lake Monitoring program is a low-cost monitoring program with an annual budget of $15,000. The program has generated fourteen years worth of Secchi disk data utilized by the Michigan Department of Natural Resources to document long-term lake quality trends and responses to lake management actions. Equipment costs, laboratory costs, and travel expenses are eliminated by limiting monitoring to Secchi disk depth and requiring the volunteers to construct their own disks. Staffing needs are reduced by restricting training to written instructions and telephone conversations. Costs are further minimized by hiring a college student intern during the summer to perform data entry, print computer-generated reports, and send out mailings. Of the staff time spent on the citizen monitoring program annually (approximately 1/3 full time equivalent), half of the hours are allocated to the student intern. The Michigan Department of Natural Resources estimates that duplicating volunteer monitoring efforts using State employees would increase the State's overall monitoring costs by about $85,000 annually.

In contrast, the Illinois Volunteer Lake Monitoring Program has an annual budget of $127,000 and employs a large staff (totalling 2.3 FTE at a cost of about $63,000) to enhance personal contact between State personnel and volunteers. Illinois personnel individually train volunteers, perform follow-up visits, organize an annual conference, write newsletters, prepare educational materials, provide technical assistance, and produce a seven-volume annual report that includes statistical analyses of volunteer data.

Overhead costs, which include employee benefits, travel expenses, office expenses, printing and postage, are estimated as a percentage of staff costs. Therefore, the larger Illinois staff generates a larger overhead expense estimate. The Illinois program also includes chemical monitoring at 100 sites on 50 lakes (at an annual cost of $20,000) and, unlike the Michigan program, provides Secchi disks to volunteers.

5.3 FUNDING OPTIONS

There are three principal sources of funding for State-managed volunteer monitoring programs: federal grants, State funds, and private in-kind contributions. These sources are also available to private groups. Each of these are discussed below.

Volunteers keep records on the types of debris found on the Texas coast.

Photo courtesy of the Center for Marine Conservation

Federal Grants

States may use grant monies awarded under Sections 104(b)(3) (Research Grants); 106 (Grants for Pollution Control Programs); 205(j) (Grants for Water Quality Management Planning); 314 (Clean Lakes Program); 319 (Nonpoint Source Management Programs); and 320(g) (National Estuary Program) of the Water Quality Act of 1987 to initiate citizen monitoring programs. Some of these funds may also be available to public or nonprofit private agencies and organizations.

Estuaries designated in the National Estuary Program (NEP) of the Water Quality

Act of 1987 are eligible for combined Federal and State funds to support research and public participation projects that can include volunteer monitoring. The Pamlico-Tar River Foundation has been funded to develop such a program under the Albemarle-Pamlico Estuarine Study in North Carolina.

Federal funding for volunteer monitoring programs on coastal waters can be routed to State universities from the National Oceanographic and Atmospheric Administration (NOAA) Sea Grant Program and the Coastal Zone Management Program (CZMP). The Rhode Island Salt Pond Watchers and the New Jersey Marine Recreational Program are examples of volunteer monitoring programs administered by State universities receiving Sea Grant Extension Funds. The Chesapeake Bay Citizen Monitoring Program is expanding its activities and exploring the feasibility of using volunteers to monitor nonpoint source pollution abatement efforts with funding from NOAA CZMP.

Unusual avenues to obtain Federal funds should not be overlooked, although they may be of only short-term value. For example, an Ohio Soil and Water Conservation District secured funds to use for young people to collect water quality information using volunteer monitoring program methods through the Federal Job Partnership Training Act.

State Funding Sources

General State revenues have been used to establish programs such as New York's Statewide Lake Assessment Program. Depending upon State laws, funding from general State revenues may require approval from the State Legislature. This can delay program implementation, as was the case in New York. However, the authorization of general revenues in 1987 provided a mandate to the New York Department of Environmental Conservation to set up a lay monitoring program and a position for a program coordinator. General revenues may be supplemented with innovative State funding sources such as Wisconsin's tax on motorboat fuels and Ohio's State tax return checkoff for natural resources programs.

State agencies or legislative bodies may distribute funds to local governments or agencies to implement volunteer monitoring programs. This approach has been used in Washington State where Public Involvement and Education (P.I.E.) grants have been used to fund the Puget Sound Water Quality Authority's volunteer monitoring program. State agencies may also provide funding to private organizations to administer citizen monitoring programs. Delaware, for example, supports the Delaware Stream Watch Program by providing funds to the Delaware Nature Society that originated from industrial fines.

Private Funding Sources

In some cases, individuals or organizations participating in a citizen monitoring program have successfully solicited funds, in-kind services, and equipment from private sources. Non-profit organizations can obtain funding through dues and contributions from corporate members. A group of Rhode Island Salt Pond Watchers obtained a grant from IBM to pay for the chemical analyses of water samples. Other private contributions include defective hoe handles donated from a local industry to the Ohio Scenic River Program to construct seine nets, and boat auction registration fees donated to the New Jersey program by a boating association. In addition to their donated time, most volunteers provide in-kind contributions of their boating equipment and fuel, and many also purchase monitoring equipment, thereby reducing program equipment costs.

No individual source of funding is guaranteed to persist and sustain a volunteer monitoring program. Therefore, long-term program stability depends upon a diversity of funding sources. Program planners should investigate all potential sources of funding and cost saving measures.

5.4 TECHNIQUES FOR REDUCING PROGRAM COSTS

Most cost saving techniques involve reducing staff costs, the largest single program expense. Staff costs can be minimized by hiring summer college interns to assist program directors in writing reports, training volunteers, and entering data. (Interns generally receive a lower salary and are exempt from benefits.)

Volunteers themselves can sometimes perform a variety of administrative tasks to supplement State personnel. For example, volunteers may be available to enter data, prepare statistical summaries, prepare graphics and articles for newsletters, or organize events. Identifying volunteer talents, and tapping into them, will both reduce the workload of the paid staff and help ensure that volunteers enjoy their duties.

Photo by John Bidaghl

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START-UP DATE
1981

SAMPLING SITES
150 Lakes, 450 sites (1988)

PARAMETERS
Secchi disk depth, total depth, and field observations on all lakes; suspended solids and nutrients are monitored on a subset of 30-50 (100 sites) lakes annually.

SAMPLING FREQUENCY
Twice a month between May and October (solids and nutrients sampled once a month on selected lakes).

NO. VOLUNTEERS
Approximately 200 annually (total participation between 1981 and 1987 was 750)

ADMINISTRATION
Administered by the Illinois Environmental Protection Agency's Lakes Program. The Statewide VLMP Coordinator is supported by Lakes Program staff, three Areawide Planning Commissions and three part-time employees from the IEPA's Office of Community Regulations. Funded with Federal grants and State matching funds.

STATE CONTACT
Amy Burns, Lakes Program, Division of Water and Pollution Control, Illinois Environmental Protection Agency, 2200 Churchill Road, Springfield, IL 62706 (217) 782-3362

PROGRAM OBJECTIVES

In 1981, the Illinois Environmental Protection Agency (IEPA) initiated one of the first comprehensive citizen monitoring programs. The Volunteer Lake Monitoring Program (VLMP) was designed to educate the public about local lake quality and management options, and supplement IEPA data collection on Illinois' lakes. The volunteers collect baseline data (primarily Secchi disk depth) for 150 lakes, most of which are not monitored by State personnel. Federal, State, and local agencies refer to the data to document water quality impacts; select priority watersheds for Clean lakes funding under Section 314(a) of the Clean Water Act, as well as for cost-share funding for soil-erosion control from the U.S. and Illinois Departments of Agriculture; evaluate the effectiveness of lake protection and management projects; and determine waterbody assessments for the Section 305(b) water quality report. Lakes monitored by volunteers are considered to be "evaluated" in 305(b) assessments; only lakes sampled for physical, chemical, or biological data by State agency personnel are considered to be "monitored."

In addition to supplementing data collection, the VLMP has acted as a catalyst for local lake protection and restoration efforts; virtually all VLMP lakes have had lake protection and management measures implemented following participation in the program.

VOLUNTEER RECRUITMENT AND TRAINING

Initially, 200 lake associations were targeted for volunteer recruitment in a 1979 pilot study. The thirty-one volunteers that responded received written instructions describing construction and use of a Secchi disk; only two lake clubs participated for the entire sampling season. In response to the pilot study results, the program was advertised to a broader audience through State agency newsletters and private newspapers, and the program protocol was modified to encourage volunteer involvement. The VLMP was structured to encourage personal contact between the staff and volunteers. The staff began training volunteers individually and distributed standardized Secchi disks; conferences, reports, and newsletters were developed to inform volunteers about their contribution to lake management, and to provide incentives for continued participation.

New volunteers are individually trained at their lake by a member of the VLMP staff. While visiting three sites on the lake, the volunteer is instructed in the proper procedure for using the Secchi disk, recording field observations, and completing the monitoring form. Secchi disks with calibrated nylon ropes, fact sheets, instructions, reporting forms, and postage-paid return envelopes are distributed at the training session. The volunteers are expected to have a boat, an anchor and the necessary safety equipment.

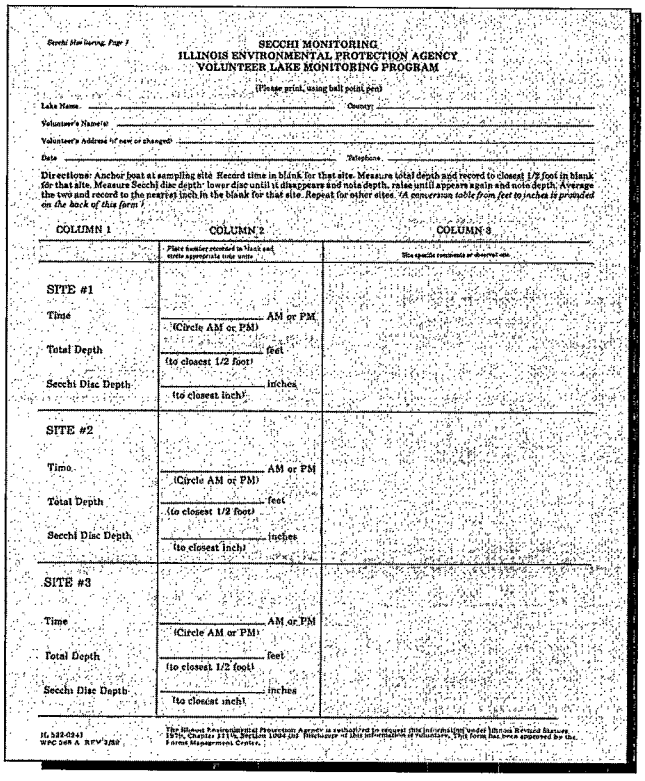
As a result of the program's emphasis on personal contact with volunteers, most participants reapply to the VLMP annually, thereby reducing the need to recruit new volunteers. Currently, the program operates at maximum capacity and recruitment is targeted for special lake studies identified by the IEPA. In 1987, public water supply operators, State park personnel, and Soil and Water Conservation District employees were enlisted, but the primary recruitment drive is aimed at former volunteers. Reapplication is encouraged by mailing letters and registration forms to all former volunteers in late winter or early spring.

Detailed monitoring instructions and data sheets are mailed to returning volunteers in the spring. It is a VLMP goal to carry out a quality control and retraining visit each year the volunteer returns to the program. In practice, follow-up visits have not been possible except in the three State regions administered by Areawide Planning Commissions. Limited retraining in the other three State regions occurred primarily in 1987, six years after program inception.

SAMPLING PROTOCOL

Three monitoring stations are usually established by IEPA on each lake: one over the deepest portion of the lake near the dam (most Illinois lakes are impoundments), one at mid-lake (medium depth), and one in the lake headwaters (shallow depth). The number of sampling sites will vary depending upon lake size and configuration. VLMP participants measure total depth and Secchi disk depth at each station twice a month between May and October, for a total of 12 sampling periods. In addition to the depth data, the participants record field observations of current weather conditions, the previous week's precipitation, as well as qualitative assessments of water color, amount of suspended sediment, suspended algae, and aquatic plants (see Figure 1). Volunteers return the forms to IEPA in addressed, post-

FIGURE 1
Illinois Volunteer Lake Monitoring Program Data Reporting Form



Secchi Monitoring, Page 1

SECCHI MONITORING
ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
VOLUNTEER LAKE MONITORING PROGRAM

(Please print, using ball point pen)

Lake Name: _____ County: _____

Volunteer's Name(s): _____

Volunteer's Address (if new or changed): _____

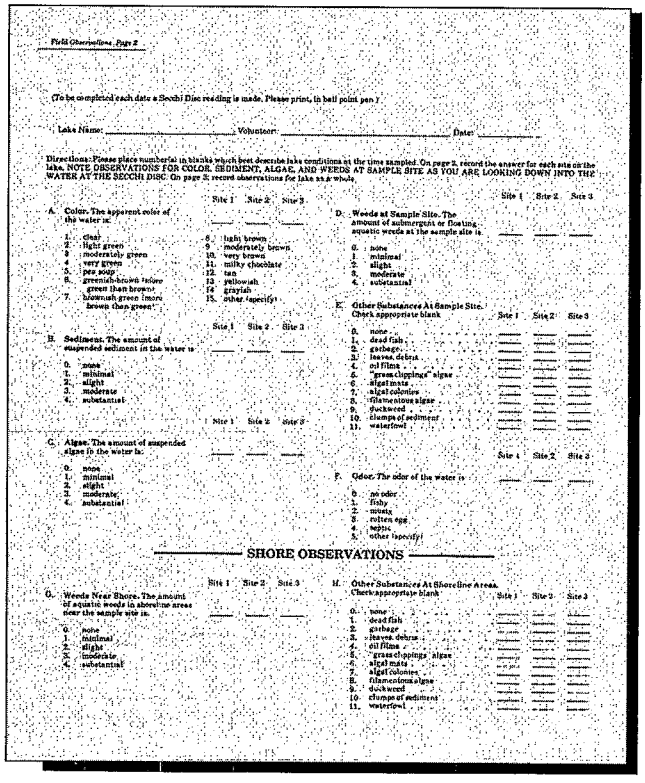
Date _____ Telephone _____

Directions: Anchor boat at sampling site. Record time in blank for that site. Measure total depth and record to closest 1/2 foot in blank for that site. Measure Secchi disc depth: lower disc until it disappears and note depth, raise until appears again and note depth. Average the two and record to the nearest inch in the blank for that site. Repeat for other sites. *(A conversion table from feet to inches is provided on the back of this form.)*

COLUMN 1	COLUMN 2 Place number recorded in blank and circle appropriate note units	COLUMN 3 Use specific comments or observed site.
SITE #1		
Time	_____ AM or PM (Circle AM or PM)	
Total Depth	_____ feet (to closest 1/2 foot)	
Secchi Disc Depth	_____ inches (to closest inch)	
SITE #2		
Time	_____ AM or PM (Circle AM or PM)	
Total Depth	_____ feet (to closest 1/2 foot)	
Secchi Disc Depth	_____ inches (to closest inch)	
SITE #3		
Time	_____ AM or PM (Circle AM or PM)	
Total Depth	_____ feet (to closest 1/2 foot)	
Secchi Disc Depth	_____ inches (to closest inch)	

IL 532-0241
WPC 568 A REV 3/89

The Illinois Environmental Protection Agency is authorized to request this information under Illinois Revised Statutes, 1979, Chapter 111½, Section 1065 and Disclosure of this information is voluntary. This form has been approved by the Forms Management Center.



Field Observations, Page 2

(To be completed each date a Secchi Disc reading is made. Please print, in ball point pen.)

Lake Name: _____ Volunteer: _____ Date: _____

Directions: Please place number(s) in blanks which best describe lake conditions at the time sampled. On page 1, record the answer for each site on the lake. NOTE OBSERVATIONS FOR COLOR, SEDIMENT, ALGAE, AND WEEDS AT SAMPLE SITE AS YOU ARE LOOKING DOWN INTO THE WATER AT THE SECCHI DISC. On page 2, record observations for lake as a whole.

A. Color. The apparent color of the water is:

	Site 1	Site 2	Site 3
	____	____	____

1. clear
2. light green
3. moderately green
4. very green
5. pea soup
6. greenish-brown future green (hen brown)
7. brownish green (more brown than green)
8. light brown
9. moderately brown
10. very brown
11. milky chocolate
12. tan
13. yellowish
14. grayish
15. other (specify)

B. Sediment. The amount of suspended sediment in the water is

	Site 1	Site 2	Site 3
	____	____	____

0. none
1. minimal
2. slight
3. moderate
4. substantial

C. Algae. The amount of suspended algae in the water is:

	Site 1	Site 2	Site 3
	____	____	____

0. none
1. minimal
2. slight
3. moderate
4. substantial

D. Weeds at Sample Site. The amount of submergent or floating aquatic weeds at the sample site is

	Site 1	Site 2	Site 3
	____	____	____

0. none
1. minimal
2. slight
3. moderate
4. substantial

E. Other Substances At Sample Site. Check appropriate blank

	Site 1	Site 2	Site 3
0. none	____	____	____
1. dead fish	____	____	____
2. garbage	____	____	____
3. leaves, debris	____	____	____
4. oil films	____	____	____
5. "grass clippings" algae	____	____	____
6. algal mats	____	____	____
7. algal colonies	____	____	____
8. filamentous algae	____	____	____
9. duckweed	____	____	____
10. clumps of sediment	____	____	____
11. waterfowl	____	____	____

F. Odor. The odor of the water is

	Site 1	Site 2	Site 3
	____	____	____

0. no odor
1. fishy
2. sewage
3. rotten egg
4. septic
5. other (specify)

SHORE OBSERVATIONS

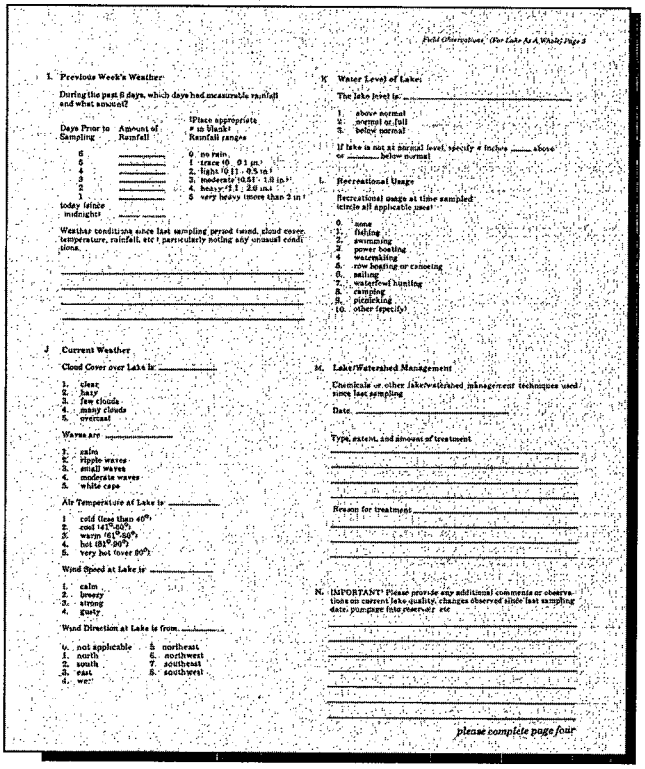
G. Weeds Near Shore. The amount of aquatic weeds in shoreline areas near the sample site is:

	Site 1	Site 2	Site 3
	____	____	____

0. none
1. minimal
2. slight
3. moderate
4. substantial

H. Other Substances At Shoreline Areas. Check appropriate blank

	Site 1	Site 2	Site 3
0. none	____	____	____
1. dead fish	____	____	____
2. garbage	____	____	____
3. leaves, debris	____	____	____
4. oil films	____	____	____
5. "grass clippings" algae	____	____	____
6. algal mats	____	____	____
7. algal colonies	____	____	____
8. filamentous algae	____	____	____
9. duckweed	____	____	____
10. clumps of sediment	____	____	____
11. waterfowl	____	____	____



Field Observations, (For Lake As A Whole) Page 3

I. Previous Week's Weather

During the past 8 days, which days had measurable rainfall and what amount?

Days Prior to Sampling	Amount of Rainfall
8	_____
7	_____
6	_____
5	_____
4	_____
3	_____
2	_____
1	_____
today (since midnight)	_____

(Place appropriate # in blanks' Rainfall ranges

0. no rain
1. trace (0 - 0.1 in.)
2. light (0.1 - 0.5 in.)
3. moderate (0.51 - 1.0 in.)
4. heavy (1.1 - 2.0 in.)
5. very heavy (more than 2 in.)

Weather conditions since last sampling period (wind, cloud cover, temperature, rainfall, etc.), particularly noting any unusual conditions.

_____
_____
_____
_____

J. Current Weather

Cloud Cover over Lake is: _____

1. clear
2. hazy
3. few clouds
4. many clouds
5. overcast

Waves are: _____

1. calm
2. ripple waves
3. small waves
4. moderate waves
5. white caps

Air Temperature at Lake is: _____

1. cold (less than 40°)
2. cool (41°-60°)
3. warm (61°-80°)
4. hot (81°-90°)
5. very hot (over 90°)

Wind Speed at Lake is: _____

1. calm
2. breezy
3. strong
4. gusty

Wind Direction at Lake is from: _____

0. not applicable
1. north
2. south
3. east
4. west
5. northeast
6. northwest
7. southeast
8. southwest

K. Water Level of Lake:

The lake level is: _____

1. above normal
2. normal or full
3. below normal

If lake is not at normal level, specify + inches _____ above or _____ below normal

L. Recreational Usage

Recreational usage at time sampled (circle all applicable uses):

0. none
1. fishing
2. swimming
3. power boating
4. waterskiing
5. row boating or canoeing
6. sailing
7. waterfowl hunting
8. camping
9. picnicking
10. other (specify)

M. Lake/Watershed Management

Chemicals or other lake/watershed management techniques used since last sampling

Date: _____

Type, extent, and amount of treatment

_____
_____
_____
_____
_____

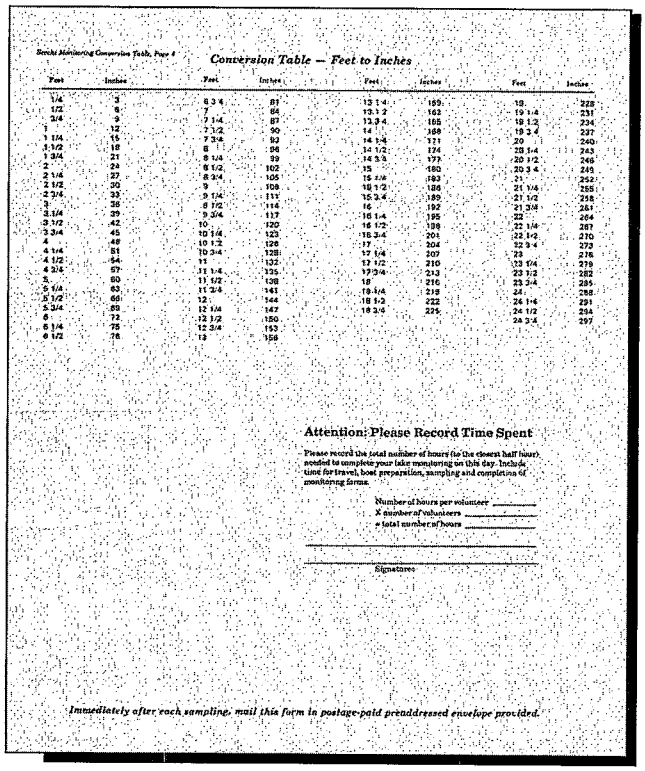
Reason for treatment

_____
_____
_____
_____
_____

N. (IMPORTANT) Please provide any additional comments or observations on current lake quality, changes observed since last sampling date, pumpage into reservoir, etc.

_____
_____
_____
_____
_____
_____
_____

please complete page four



Secchi Monitoring Conversion Tech, Page 4

Conversion Table — Feet to Inches

Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches
1/4	3	6 3/4	81	13 1/4	159	19	228
1/2	6	7	84	13 1/2	162	19 1/4	231
3/4	9	7 1/4	87	13 3/4	165	19 1/2	234
1	12	7 1/2	90	14	168	19 3/4	237
1 1/4	15	7 3/4	93	14 1/4	171	20	240
1 1/2	18	8	96	14 1/2	174	20 1/4	243
1 3/4	21	8 1/4	99	14 3/4	177	20 1/2	246
2	24	8 1/2	102	15	180	20 3/4	249
2 1/4	27	8 3/4	105	15 1/4	183	21	252
2 1/2	30	9	108	15 1/2	186	21 1/4	255
2 3/4	33	9 1/4	111	15 3/4	189	21 1/2	258
3	36	9 1/2	114	16	192	21 3/4	261
3 1/4	39	9 3/4	117	16 1/4	195	22	264
3 1/2	42	10	120	16 1/2	198	22 1/4	267
3 3/4	45	10 1/4	123	16 3/4	201	22 1/2	270
4	48	10 1/2	126	17	204	22 3/4	273
4 1/4	51	10 3/4	129	17 1/4	207	23	276
4 1/2	54	11	132	17 1/2	210	23 1/4	279
4 3/4	57	11 1/4	135	17 3/4	213	23 1/2	282
5	60	11 1/2	138	18	216	23 3/4	285
5 1/4	63	11 3/4	141	18 1/4	219	24	288
5 1/2	66	12	144	18 1/2	222	24 1/4	291
5 3/4	69	12 1/4	147	18 3/4	225	24 1/2	294
6	72	12 1/2	150			24 3/4	297
6 1/4	75	12 3/4	153				
6 1/2	78	13	156				

Attention: Please Record Time Spent

Please record the total number of hours (to the closest half hour) needed to complete your lake monitoring on this day. Include time for travel, boat preparation, sampling and completion of monitoring forms.

Number of hours per volunteer _____
X number of volunteers _____
= total number of hours _____

_____
Signature

Immediately after each sampling, mail this form in postage-paid preaddressed envelope provided.

age-paid envelopes immediately after sampling.

Some selected volunteers also collect water samples at selected stations on 30-50 lakes once per month from May to October. The criteria for selecting these lakes include: where IEPA needs data; public ownership or access; proven volunteer reliability at the lake; lake size; amount of lake use; and level of public concern. Sampling consists of immersing a one-quart bottle with nitric acid preservative for nutrient analysis, then filling the large bottle again to provide a suspended solids sample. The bottles are immediately placed in a cooler with a 48-hour ice pack and mailed to the IEPA laboratory. At the laboratory, samples are analyzed for total and volatile suspended solids, ammonia-nitrogen, nitrate+nitrite-nitrogen, and total phosphorus.

DATA MANAGEMENT

Information from the data forms submitted by volunteers is entered into a PC data management system as soon as possible following arrival at the IEPA. This procedure serves three purposes: 1) check-in of forms and tracking of volunteer participation; 2) entry of Secchi disk data and qualitative information into a data base for graphical and tabular outputs; and 3) preparation for data entry into STORET. Coding is not necessary because the data entry screen mimics the data sheet submitted by the volunteers.

Verification consists of two phases. First, the data are printed in tabular form and checked against the original data sheets. Second, the data are plotted and examined for outliers so that simple recording mistakes, such as assigning data to the incorrect sampling site or reporting Secchi depth in feet instead of inches, can be identified. Questionnaire data are discussed with the volunteers who keep a separate log sheet at home to further document procedures.

Following verification, the data are uploaded to STORET using a program written by State personnel. VLMP data are stored in a unique file to distinguish them from IEPA-collected data. Statistical analyses performed using STORET and SAS include calculation of the minimum, maximum, and mean Secchi disk depth; calculation of a Carlson Trophic State Index; and analysis of Tukey's Multiple Range Test to compare year-to-year changes in mean Secchi disk depth. The IEPA staff all examine within-lake variation in clarity by comparing Secchi depth data from the three sites on each lake. Observational data is used in the interpretation of clarity data.

PROGRAM ADMINISTRATION

Within the Illinois EPA, the VLMP is located in the Lakes Program Subunit of the Division of Water Pollution Control's Planning Section. A Statewide VLMP Coordinator administers all aspects of the VLMP, including the acquisition and distribution of equipment, preparation of the annual summary reports and newsletters, and the coordination of training, data management, and laboratory analysis. The Statewide VLMP Coordinator's responsibilities also include technical assistance regarding lake ecology, monitoring, and management; conference planning; and preparation of information/education materials.

Other Lakes Program personnel assist with various aspects of the program such as data review, report preparation, computer programming, technical assistance, and information/education.

Three of the six State VLMP regions have Areawide Planning Commissions (designated under Section 208 of the Clean Water Act); IEPA contracts with these Commissions to administer the VLMP and provide lake management technical assistance and information/education in their regions. The Areawide VLMP Coordinators are responsible for training volunteers, managing data, preparing regional reports and newsletters, and providing lake management technical assistance. In the remaining regions, the IEPA Office of Community Relations assists with volunteer training, follow-up visits, and report writing.

VOLUNTEER RECOGNITION

To recognize volunteer commitment, citizen monitors receive awards based upon the number of completed sampling periods and seasons. The awards include a thank you letter and a certificate of appreciation signed by the IEPA Director, cloth emblems, engraved wooden plaques, and lapel pins. The awards are presented during the VLMP session of the Illinois Lake Management Association (ILMA) Conference held annually in the spring.

The purpose of the VLMP session is to retrain returning volunteers and recognize outstanding volunteers. Participants exchange information among themselves, attend retraining sessions, and meet with VLMP

FIGURE 2
Annual Budget and Funding Sources for Illinois' VLMP

A. Illinois Environmental Protection Agency - funded with Clean Water Act (CWA) Section 106 funds and State matching funds.	
1. Lakes Program Staff (3 persons totalling 0.75 FTE). Responsible for Statewide program administration, coordination, and supervision; provide lake management technical conference, and information/education assistance; data management; preparation of annual State summary and three regional report volumes; and editing the newsletter.	$30,000*
2. Clerical and summer staff (3 persons totalling 0.5 FTE). Perform data management, mailings,and assist with report preparation.	$12,000*
3. Community Relations Coordinators (3 persons totalling 0.3 FTE). Make training and follow-up visits on 65 lakes; assist with report and newsletter writing.	$15,000*
4. Volunteer Water Quality Monitoring - chemical analysis. Lab analysis at $50 per sample for total phosphorus, nitrate+nitrite-nitrogen, ammonia-nitrogen, total and volatile suspended solids.	$20,000
5. Annual Illinois Lake Management Association and VLMP Conference.	$1,000
B. Areawide Planning Commissions - funded by CWA Section 205(j).	
1. Areawide Planning Commission personnel and overhead (3 persons totalling 0.75 FTE). Responsible for program administration, training and follow-up visits, and data management for 75 lakes; lake management technical assistance, conference planning, and information/education; and preparation of 3 regional reports.	$45,000*
ANNUAL BUDGET	$123,000
C. One-time Equipment Costs - purchased with CWA Section 205 (j) funds.	
1. Two hundred Secchi disks with calibrated ropes, at $20 each.	$4,000
TOTAL BUDGET (does not include equipment costs)	$127,000

* Includes 44.2% indirect costs which cover printing, telephone, copying, and office space; and 18% for fringe benefits, travel, and supplies.

Figure 2

The annual budget and funding sources for Illinois' Volunteer Lake Monitoring Program.

staff to discuss concerns. Volunteers may participate in a panel discussion describing how VLMP data have been used to promote local lake protection and management. Holding the VLMP conference in conjunction with the ILMA Conference allows the volunteers to discuss their concerns with lake management professionals, and increases their exposure to broader lake management issues.

The Illinois program places emphasis on writing reports which present the VLMP data in a professional format. A statewide summary report is published annually with six companion regional reports containing individual lake data analyses and lake management recommendations. The report is distributed to Federal, State and local agencies, libraries, and individual volunteers. Four newsletters are mailed to volunteers during the monitoring season, featuring important pointers regarding monitoring techniques and educational information on lake conditions and management. Volunteers who perform consistent sampling also receive a report analyzing the results of their sampling and suggesting applicable lake protection and restoration strategies. These reports inform the volunteers, as well as other State agencies and local lake management authorities, of the value of the VLMP data. A considerable amount of staff time is also

devoted to technical assistance and educational activities associated with the VLMP.

PROGRAM EXPENSE AND FUNDING

The Illinois Citizen monitoring program is funded through Clean Water Act Section 106 and 205(j) grants and State matching funds. The annual program budget (shown in Figure 2) accounts fully for all overhead expenses, such as travel costs, office expenses, staff benefits, printing, and supplies. The annual budget includes $30,000 for Lake's program staff and overhead; $45,000 distributed to three Areawide Planning Commissions; $15,000 for IEPA Community Relations Coordinators; $12,000 for clerical assistance with data entry, mailings, and report preparation; $20,000 for laboratory analyses; and $1,000 to host the VLMP conference. Two hundred Secchi disks were purchased for a one-time cost of $4,000.

SELECTED PROGRAM MATERIALS

Volunteer Lake Monitoring Program, 1987; Volume I: Statewide Summary Report. Illinois Environmental Protection Agency, Division of Water Pollution Control.

Summary of Illinois' Volunteer Lake Monitoring Program. Illinois Environmental Protection Agency, Division of Water Pollution Control. 6 pages.

Lakes Program Summary. Illinois Environmental Protection Agency, Division of Water Pollution Control. 4 pages.

PROGRAM OBJECTIVES

The Kentucky Water Watch Volunteer Stream Sampling Project (VSSP), one component of the State's Water Watch public participation program, is designed to achieve the following goals:

1. To generate data for the Kentucky Division of Water on stream segments not included in the existing Kentucky Ambient Water Quality Monitoring Network;

2. To enable community groups to acquire local water quality data;

3. To educate the public about the condition and importance of Kentucky's water resources.

The primary objective is to produce high quality data which can be used by both State personnel and local community groups. To meet this objective, the project has focused on recruiting volunteers with scientific or technical backgrounds, thereby enhancing data quality, but restricting public participation. To date, the State has found the data capable of detecting acute water quality problems in stream segments not included in the Ambient Monitoring Network. During the project's initial year (July 1987-July 1988), the Division of Water used the volunteer data to identify two noncomplying dischargers and five stream sites where standards were exceeded. Although the State does not use volunteer data alone to implement enforcement actions, the citizen monitors have demonstrated that they can reliably locate water quality problems for further investigation by State enforcement personnel.

The State enters the citizen data into a unique file on the State Prime Interagency Data Base with the intention of documenting baseline conditions and long-term water quality trends in the future. The data are not entered into STORET or incorporated into the State's 305(b) reporting process at this time.

Independently, the volunteer groups use their data to document and publicize local water quality conditions, under the condition that they specify the data origins and limitations. Currently, the VSSP is expanding public participation to school groups. The data submitted by the school groups are less accurate and consistent than data collected by other groups; therefore, these data are kept in a separate file to prevent deterioration of the existing data base quality. The primary objective continues to be the establishment of a reliable data base for State and public use.

THE PILOT STUDY

The VSSP is an offshoot of the Kentucky Water Watch Program, a public participation program initiated by the Division of Water in 1985. The principal objectives of this program are to promote community awareness of water quality issues and to encourage individual responsibility for the protection of water resources. Under the program, citizens form Water Watch groups to "adopt" a stream or lake (i.e. take responsibility for informing the State of water quality issues relevant to their waterbody and initiating protection efforts). Over the last three years, groups in this program have organized stream rehabilitation projects, developed educational presentations, and performed simple biological surveys to characterize water quality in some adopted waterbodies.

In 1986, several Water Watch groups expressed a desire to undertake systematic chemical monitoring of their adopted streams. The Division of Water (DOW) tested citizen monitoring as a means of acquiring additional data on a disputed stream, Rock Creek. The pilot study compared the performance of an existing Water Watch group and the McCreary County Hiking club, solicited specifically to sample Rock Creek. Each group received varying levels of support from the Water Watch coordinator based upon their initial interest in monitoring. The existing Water Watch groups received little contact following training because they had requested monitoring responsibilities; this group's motivation rapidly deteriorated and the group did not submit data. In contrast, the McCreary County Hiking Club was telephoned at least once each month to acknowledge receipt of sampling results and discuss the data. The phone conversations informed the volunteers that State personnel had examined the data, and provided the volunteers with an opportunity to resolve monitoring protocol problems. As a result of the interest expressed by the DOW, the hiking club submitted data for ten of the twelve sampling periods during the year-long pilot study. On the basis of the hiking club results, the pilot study was considered a conditional success, and additional groups were contacted to initiate the VSSP.

VOLUNTEER RECRUITMENT AND TRAINING

Scientifically trained volunteers from the existing Water Watch network were recruited to implement the full-scale VSSP. Sampling

START-UP DATE
1987

SAMPLING SITES
7 Rivers, 57 sites (1988)

PARAMETERS
Onsite chemical analysis of dissolved oxygen, pH, nitrate, phosphate, iron, chlorides, and temperature.

SAMPLING FREQ.
One survey per month, year round.

NO. VOLUNTEERS
Over 100 volunteers in 31 sampling groups.

ADMINISTRATION
Administered by the Kentucky Division of Water's Water Watch Program. The Water Watch Coordinator manages the monitoring project under the supervision of a commission of State agency directors. Federal Clean Water Act grants and general State revenues fund the program.

STATE CONTACT:
Ken Cooke, Kentucky Water Watch, Division of Water, Kentucky Natural Resources and Environmental Protection Cabinet, 18 Reilly Road, Frankfort, KY 40601 (502) 564-3410

applications were sent out to targeted groups on the Water Watch Newsletter mailing list, including university and community college science departments, environmental engineers at private industries, existing Water Watch groups, and high school teachers. Groups lacking technical expertise, such as school students, were not solicited. High standards for volunteer selection were set - one member of each group had to have at least a college degree minor in a science-related field. Respondents were evaluated with a point system favoring groups with technical and scientific experience, groups with previous volunteer service in the Water Watch Program, and groups in close proximity to priority streams. Priority streams were those not sampled in the State-staffed Ambient Water Quality Monitoring Network or the Stream Use Designation Study. The State selected a volunteer pool that includes professional biologists, chemists, engineers and lab technicians, as well as property owners along priority streams.

The selected volunteer groups signed a contract to collect monthly samples at a minimum of two sites between July 1987 and July 1988. Groups failing to submit data for 80% of the contracted sampling periods were considered for removal from the program. Each group appointed a group supervisor from its membership to organize sampling trips and act as group liaison with the program staff.

Prior to monitoring, volunteers received two hours of onsite training with the project coordinator. At this time, chemical test kits, written instructions describing procedures and data analysis, and reporting forms, were distributed. In addition to performing the chemical tests under the coordinator's supervision, the volunteers were required to attend a follow-up session on interpreting and publicizing sampling results.

In response to the pilot study results, monthly phone calls were made to all group supervisors to encourage volunteer commitment and enthusiasm for the program. Other motivational strategies included publicizing enforcement action initiated with volunteer data, acknowledging participation with certificates, and distributing caps with the project logo to volunteers. The personal contact between State staff and volunteers, in conjunction with the publicity from successful enforcement actions, are credited with sustaining public interest in the VSSP. Approximately 70% of the volunteer groups have applied to continue sampling for a second year, and a surplus of Water Watch groups are available to replace the three groups asked to leave the program because of inconsistent monitoring.

SAMPLING PROTOCOL

Monitoring parameters were selected by sending a questionnaire to water quality specialists within the State Division of Water (DOW), and several specialists at the U.S. Fish and Wildlife Service and the U.S. Geological Survey. Each professional was asked to rank the ten most important factors affecting Kentucky waters. The most important factor received ten points, the next factor was assigned nine points, and so on. Based on this point system, the three parameters ranked as most important were dissolved oxygen, pH, and conductivity. The DOW then determined the availability and cost of tests to monitor these parameters and requested bids from several chemical companies for appropriate monitoring equipment. Of the top three parameters, conductivity was eliminated from consideration by the high cost of conductivity meters.

Two versions of the test kit were approved for use by volunteer monitoring groups. In urban and agricultural areas, volunteers sampled for dissolved oxygen, pH, temperature, nitrate-nitrogen, orthophosphate, and chlorides. In mountain and coal-field locations, sulfate and iron were sampled instead of nutrients. Subsequently (after quality control checks revealed serious problems), the sulfate test was discouraged and the DOW disregarded the sulfate data. The test kits perform with an overall precision of $\pm$ 20% and, it should be noted, are not EPA approved. However, the dissolved oxygen test (the azide modification of the Winkler Method), performed with a variance of $\pm$0.2 ppm (within 5%) in five quality control checks comparing test kit results and dissolved oxygen meter results.

In 1988, 31 volunteer groups monitored 57 stream sites monthly with the chemical test kits. The test kits were distributed without charge to groups sampling priority waters designated by the DOW. Volunteer groups sampling non-priority streams, as well as school groups (approximately 30% of sampling groups) were required to purchase test kits from DOW for $165 per kit.

The reliability of the volunteer data is assured in a three-pronged quality control program. First, individual accountability is

assigned to the group's supervisor who must sign each reporting form. In the second phase, groups periodically receive blank samples of deionized water and standard solutions prepared at the State lab. The groups test the samples and report their results back to the DOW. These standard tests alerted the DOW to a problem with the sulfate test. Volunteers were reporting concentrations of 200 ppm in deionized blanks due to contamination from barium chloride buildup on the test kit test tubes. The sulfate test results were dropped based upon the quality control results. Although some groups continue to sample sulfates, the data is not accepted by the DOW. Field tests are the third component of the quality control program. Periodically, State personnel accompany volunteers and compare the results of volunteer test kits with State equipment results.

DATA MANAGEMENT

Each volunteer group supervisor sends one copy of the data forms to the DOW and maintains a separate copy for his or her own use. The program coordinator examines the data for unusual values and phones the volunteers to verify questionable results. The data, including verified outliers, are entered onto a Xerox 8010 Work Station with word processing and graphic capabilities to generate public reports. The Work Station data analysis capabilities are restricted to plotting simple graphs and sorting the data by high and low data values. To perform more sophisticated analysis, the data are entered onto the State Prime Interagency Data Base, a mainframe system with access to Statistical Analysis System (SAS), then downloaded to an IBM PC Symphony Software spread sheet. Outliers are excluded from the mainframe data base, and the volunteer data are stored in a unique mainframe file to distinguish them from data collected by State employees.

Currently, the data are insufficient to detect water quality trends, but correlations between high nutrient concentrations and low dissolved oxygen levels have been identified on individual streams. In the future, time series regression analysis will be employed to statistically document trends.

The citizen monitoring results are published in regular reports and distributed to interested groups as well as the State Biological Staff and DOW Field Offices. Volunteer groups are encouraged to share their information with the local community as long as the limitations of the data are clearly stated (i.e., not officially sanctioned by the State). Several monitoring groups independently plot and publicize their sampling results by printing the data in their club newsletters or posting the results in public locations including classrooms and a post office.

PROGRAM ADMINISTRATION AND BUDGET

The VSSP is managed by the Water Watch Program Coordinator under the supervision of the Quality Control Committee. The Committee is comprised of supervisors from the State agencies affected by the citizen monitoring project, including the monitoring and enforcement branches. The Committee set the project guidelines to ensure that the program would be integrated into the existing State agency workload and would produce reliable data. The coordinator's duties include selecting the monitoring groups, conducting training sessions, maintaining contact with the volunteers, setting up the quality control tests, writing reports, and managing interagency use of the volunteer data. The coordinator developed a network of college professors, called Expert Advisors, to field questions from the volunteers. Each monitoring group has a volunteer supervisor who maintains contact with the coordinator.

Costs of the VSSP are approximately 30% of the total Water Watch Program budget, or $20,000 annually. Of this, the largest expenditure is the coordinator's salary, $8,000, which amounts to at least 1/3 FTE. An allocation of $2,500 pays for the extensive travel required of the coordinator (about 750 miles per week). Supply costs have been limited because nearly a third of the volunteer groups purchase the test kits; during the first year, expenditures on supplies amounted to about $6,500. Printing and overhead costs are estimated to be $3,000.

The source of funding for the VSSP is approximately as follows: 30 percent from Section 106(g) grants and 25 percent from Section 205(j) Federal Water Quality Planning grants under the Clean Water Act; 30 percent from State funds; and 15 percent from private sources. The grants are combined into one public participation fund which is accessed for the VSSP.

BENEFITS FROM THE VOLUNTEER STREAM SAMPLING PROJECT

In addition to providing background data for future trend analysis, the VSSP has iden-

tified specific water quality problems at five sites during the first year. Remedial actions have already been implemented at two sites—a dairy farm and a factory manufacturing jeans. Volunteers also discovered two abandoned mines and sent the information to the State Division of Abandoned Lands for further action.

The remedial action at the jeans factory resulted almost entirely from volunteer efforts. The monitors, including a lab technician and a school teacher, detected phosphorus concentrations 30 times the State standard of 0.5 ppm. The VSSP coordinator felt the results were reliable based upon the volunteers' expertise and the consistency of the sampling results. The volunteers were encouraged to continue sampling upstream until they located a potential source of the phosphorus, which led them to a wastewater treatment plant. The volunteers visited the plant operator who admitted the problem came from a jeans factory not following pretreatment guidelines. Subsequently, the factory cooperated with State officials and installed equipment to improve its pretreatment of wastewater.

In the case of the dairy, citizen sampling indicated low dissolved oxygen concentration in a creek. The volunteer went upstream and witnessed a milky discharge from a dairy plant. The DPW enforcement branch was notified and inspected the plant but could not locate a discharge. The volunteer continued to casually monitor the plant and observed that the discharge only occurred in mid-afternoon. The enforcement branch was again notified, and with more specific information was able to inspect the plant at the appropriate time.

The results from the VSSP's first year generate a sense of power and participation for the volunteers and the public. The reapplication rate suggests that the project has been successful in maintaining public interest and support. While the public appears to perceive the VSSP as successful, the State Standards and Specifications Group within the DPW still perceives the project with skepticism, despite efforts to integrate the program into the existing agency structure and workload.

SELECTED PROGRAM MATERIALS

Kentucky Water Watch Stream Monitoring Project: Training Material for Volunteer Monitoring Teams. Kentucky Natural Resources and Environmental Protection Cabinet, Division of Water. 1988. 28 pages.

Kentucky Water Watch Stream Monitoring Project Report to Citizen's Monitoring Workshop, May 1988 - Volunteers Monitor Kentucky Water. Kentucky Natural Resources And Environmental Protection Cabinet, Division of Water. 1988. 38 pages.

Water Watch Adopt-a-Stream Program: Program Overview. Kentucky Natural Resources and Environmental Protection Cabinet, Division of Water. Undated. 12 pages.

A Field Guide to Kentucky Rivers and Streams. Kentucky Natural Resources and Environmental Protection Cabinet, Division of Water. 1985 (revised May 1986). 114 pages.

PROGRAM OBJECTIVES

The Citizen Statewide Lake Assessment Program (CSLAP) is a cooperative effort developed by the New York State Department of Environmental Conservation (DEC) and the New York Federation of Lake Associations, Inc. (FOLA), a coalition of lake researchers, landowners, and interested citizens committed to promoting lakes research and exchanging lake management information. The program is designed to collect baseline data for preparation of lake-specific management plans, while educating lake residents and users about lake ecology, management practices, and data collection. The data are used to document trends on individual lakes, identify specific water quality problems, and calculate trophic status to support the DEC's lake management recommendations to individual lake associations.

The CSLAP supplements DEC's Lake Classification and Inventory Survey (LCI), the State-staffed program that monitors New York's lakes. Generally, DEC staff sample less than 5% of the State's 7000 lakes each year, and regular monitoring is restricted to special study lakes. By employing the same equipment and procedures as DEC, the CSLAP volunteers can expand the number of lakes monitored and increase sampling frequency. To date, the DEC has not incorporated the CSLAP data into the State 305(b) Report because most of the lakes monitored by volunteers are not included in the "problem" waterbodies that are covered in the 305(b) Report. However, DEC has used CSLAP data to determine the effect of onsite wastewater systems at several lakes and to make preliminary assessments of lake water quality for the 1990 305(b) report.

In addition to generating baseline lake quality data, the CSLAP facilitates the exchange of information between lake residents and State personnel. In 1988, the DEC distributed a user survey to approximately 5,000 members of lake associations participating in the CSLAP. The questionnaire was designed to evaluate public perceptions of lake water quality, sources of degradation, and management strategies for maintaining or improving water quality. The survey should determine if lake users perceive the water quality problems detected by monitoring, and therefore are willing to cooperate with DEC management plans and provide financial assistance for implementing protection efforts. The questionnaire may also identify localized, episodic water quality problems not detected by regular sampling. The DEC intends to use the information to direct additional monitoring and research projects.

PARAMETER SELECTION

Parameters were selected for inclusion in the CSLAP from a list of nine standard water quality parameters monitored in State-staffed programs. The selection criteria included ease of data collection, cost of analysis and equipment, and value of the information obtained. Total-phosphorus, nitrate-nitrogen, chlorophyll, "true" color, conductivity, pH, temperature, and Secchi disk transparency were chosen for the first sampling season, 1986. Laboratory costs prohibited the inclusion of informative but less essential parameters, such as dissolved organic carbon (DOC) and the dissolved states of phosphorus. When possible, less expensive surrogate parameters were substituted; for example, "true" color analysis was selected to provide a rough measure of DOC.

In 1987 the program purchased two DO-meters and found that each meter could be shared by up to six lake associations. DO testing became an optional activity in 1988 for a subset of the CSLAP lakes. Other analyses, such as macrophyte identification and precipitation and water level monitoring, have been added to the monitoring regime to address specific public concerns and fill DEC information gaps.

VOLUNTEER TRAINING AND RECRUITMENT

All CSLAP participants must be members of a lake association that is affiliated with and recommended by the New York Federation of Lake Associations (FOLA). DEC and FOLA work together to choose new lakes. The selected lake associations confirm their interest in the program and commit a team of at least two primary and two secondary volunteers to attend training. Following the initial year of the program (1986), a surplus of lake associations have sought admission into the CSLAP, and active recruitment has not been necessary.

CSLAP personnel train each group entering the program onsite during a 3-4 hour session. The training session includes an introduction and explanation of the program, equipment distribution, instruction on sample collection and processing techniques, and a question-and-answer session. The volunteers also receive written instructions describing sampling and mailing procedures. The CSLAP

START-UP DATE
1986

SAMPLING SITES
75 Lakes (1990)

PARAMETERS
Secchi disk depth, lake level, precipitation, dissolved oxygen, macrophytes; volunteers also collect, process, and mail water samples to the State Department of Health laboratory for analysis of nutrients, chlorophyll, color, pH, and conductivity.

SAMPLING FREQ.
Weekly samples between June and October.

NO. VOLUNTEERS
Approximately 280

ADMINISTRATION
Jointly administered by the New York State Department of Environmental Conservation and the New York Federation of Lake Associations, Inc. Funded primarily with State general revenues.

STATE CONTACT
Scott Kishbaugh, New York Department of Environmental Conservation, Bureau of Technical Services and Research, Room 301, 50 Wolf Road, Albany, NY 12233-3502 (518) 457-7470

TABLE 1
CSLAP Quality Control Data from 1987

Lake Name	Date	Sample Type	Total P (mg/l)	NO3 (mg/l)	Sp Cond (μmho/cm)	pH	Color (ptu)	Chl a (μg/l)
Glen Lake	7/3	CSLAP	0.010	<.02	262	8.02	10	8.3
	7/6	LCI	0.012	<.02	250	7.90	16	NA
Loon Lake	8/10	CSLAP	0.009	<.02	81	7.43	21	2.1
	8/10	DEC	0.007	NA	81	7.19	17	5.9
Crooked Lake	8/2	CSLAP	0.011	<.02	148	8.32	12	7.3
	8/2	DEC	0.012	NA	136	8.49	10	NA
Lake Moraine	7/29	CSLAP	0.017	0.28	237	8.31	2	6.3
	7/29	DEC	0.012	0.27	236	8.02	7	5.5
Petonia Lake	8/4	CSLAP	0.008	<.02	63	6.83	6	3.0
	8/4	DEC	0.006	NA	63	7.02	5	3.3
Tuscarora Lake	8/2	CSLAP	0.013	NA	165	7.86	6	3.4
	8/2	DEC	0.011	<.02	165	7.41	12	2.1
Conesus Lake	8/1	CSLAP	0.010	<.02	336	8.17	5	3.9
	8/1	DEC	0.011	NA	336	8.07	6	2.1
Cuba Lake	8/1	CSLAP	0.019	<.02	119	7.14	9	24.4
	8/1	DEC	0.013	<.02	118	7.18	NA	17.0
Findley Lake	7/30	CSLAP	0.047	<.02	209	7.29	11	62.2
	7/30	DEC	0.056	NA	210	7.38	12	73.3
	10/1	CSLAP	0.049	0.04	215	7.76	11	73.2
	10/1	CSLAP	0.036	0.04	210	7.64	12	49.6
Silver Lake	8/1	CSLAP	0.056	<.02	278	7.44	11	151
	8/1	DEC	0.052	<.02	271	7.45	9	144
Wolf Lake	8/8	CSLAP	0.018	<.02	36	5.58	13	29.6
	8/8	DEC	0.017	<.02	36	6.57	17	31.8
Sacandaga Lake	7/11	CSLAP	0.006	0.03	43	6.97	15	13.7
	7/10	DEC	0.007	0.08	43	7.25	19	15.8
Brant Lake	7/5	CSLAP	0.008	<.02	73	7.42	16	4.4
	7/6	LCI	0.008	<.02	57	7.50	16	4.5
	8/10	CSLAP	0.006	<.02	77	7.25	11	4.4
	8/10	DEC	0.008	<.02	138	3.72	10	5.7
	9/14	CSLAP	0.004	NA	75	7.07	6	5.2
	9/15	LCI	0.007	<.02	55	7.25	4	3.5

TABLE 1

New York Citizen Statewide Lake Assessment Program (CSLAP) quality control data from 1987. Comparison of data collected by CSLAP volunteers and Department of Environmental Conservation (DEC) staff and by Lake Classification and Inventory (LCI) personnel during 1986 and 1987.

staff perform quality assurance follow-up visits at least once during the sampling season, during which any continuing sampling problems may be resolved.

SAMPLING PROTOCOL

CSLAP participants measure Secchi disk transparency and collect water samples between June and October. During the initial sampling season on each CSLAP lake, one site is sampled weekly; if the data indicate little variation from week to week, sampling frequency is reduced in subsequent seasons to minimize laboratory costs. The sampling site is established over the deepest portion of the lake by constructing transects connecting permanent shoreline landmarks. Volunteers collect samples with a Kemmerer bottle lowered to a depth of 1.5 meters and transfer a sample into a collapsible (acclimated) polyethylene container. Air and water temperatures and weather conditions are recorded. On shore, the volunteers prepare the samples for shipment to the New York State Department of Health (DOH) laboratory: phosphorus samples are placed in bottles containing sulfuric acid preservative; a "true" color sample is filtered through a millipore membrane filter; a chlorophyll sample is acquired by passing 25 ml of lake water through a membrane filter coated with a magnesium carbonate suspension and placing the filter in a borosilicate vial filled with a solution of methanol and chloroform; and the unpreserved pH/specific conductivity and nitrogen samples are bottled.

The samples are placed in a styrofoam packing crate with two 72-hour ice packs and the sample identification forms, then mailed to the DOH laboratory with prepaid postage labels. DOH returns the crates to the volunteers with new vials prepared with the preservatives. Each volunteer rotates three packing crates and their ice packs with the lab to avoid problems arising from postal delays in returning the crates.

Following the completion of one sampling season, volunteers may expand monitoring activities by collecting hydrology data with rainfall and staff gages, determining dissolved oxygen profiles with a Nester permanent membrane DO meter, or collecting aquatic vegetation. For this last activity, DEC staff designed a macrophyte sampling protocol in response to frequent complaints about aquatic weeds. The protocol consists of dragging a weighted rake fitted with a steel collar and retrieval lines across the lake bottom for a fixed distance, at three depths related to water transparency. This protocol is followed at several sites throughout the littoral zone. Individual genera are tagged, placed in plastic bags, and mailed to the DEC for species identification and archiving. During the first year of macrophyte sampling (1987), the volunteers collected 25 plant species on 10 lakes, including most of the significant species identified by an independent comprehensive macrophyte survey of Babcock Lake. The protocol is not intended to identify every plant species present, but the preliminary results suggest that the macrophyte procedures can provide a reliable profile of the significant species present, their growth patterns, and relationship to lake clarity.

The program staff perform quality control checks during two follow-up visits to each lake during the sampling season. The coordinators observe the volunteers' technique to ensure consistency, then collect samples from the same location at roughly the same time. The samples collected by the volunteers and the staff are analyzed by the DOH laboratory and the results are compared. Concurrent sampling by volunteers and other DEC survey teams also serve as quality control checks. Comparison of data collected by CSLAP volunteers and staff, and Lake Classification and Inventory (LCI) personnel during 1986 and 1987 (Table 1), indicate only slight variation. Many of the observed differences can be inherently attributed to equipment and procedures. Discrepancies in the pH values are thought to be due to carbon dioxide contamination and biological activity in the sample during transport to the DOH laboratory.

FIGURE 1
Sampling Record

SECTION 1

LAKE NAME _____ DATE _____

SAMPLER(S) _____

SOUNDING DEPTH (See Reverse Side)

SECTION 2

SECCHI DISK
Reading (1) _____ (on bottom?) ☐
Reading (2) _____ ☐

SECTION 3

TIME ☐ AM ☐ PM AIR TEMPERATURE

WATER SAMPLE DEPTH WATER TEMPERATURE

SECTION 4

Check all conditions present two or more days in a week (you can check more than one box).

Today	Wind	Past Week
☐	Calm	☐
☐	Moderate	☐
☐	Windy	☐
	Sky	
☐	Clear	☐
☐	Pt. Cloudy	☐
☐	Overcast	☐
☐	Rainy	☐

Comments
Unusual weather conditions or pollution problems this past week, observations during today's sampling, deviations (distance and direction) from the primary sampling site, etc.

Initials _____

FIGURE 1
New York Citizen Statewide Lake Assessment Program Sampling Record Form.

The excellent quality control results have enabled the CSLAP program coordinator to promote the program as a reliable source of lake quality data to other State Agency personnel. As a result, annual funding from the State of New York has been increased and the program continues to expand; the number of monitored lakes has increased from 25 in 1986 to 61 in 1989. Aquatic weed sampling was added to the program in 1987, dissolved oxygen monitoring became optional during the 1988 sampling season, and acid rain monitoring began in 1989.

DATA MANAGEMENT

A Sampling Record (Figure 1) is completed for every sampling period, and mailed to the DEC either directly or via the DOH. The recorded information and data from DOH

sample analysis are entered into a dBASE-III management system on a personal computer at the DEC. Statistical analysis, tables, graphs, (using Microsoft Chart) and report texts (using Wordstar 2000) are prepared on the personal computer. Survey forms are entered on Excel. At this time the database is insufficient to detect trends; therefore, analysis is limited to descriptive statistics, including minimum, maximum, and mean values of nutrients, chlorophyll, and Secchi disk depth. A Carlson Trophic State is assigned to each lake based upon the mean values. Statewide correlation between chlorophyll, phosphorus, and Secchi disk depth are also assessed.

Program results are highlighted in an annual report that includes a summary of information collected at each monitoring site. Program results are also publicized in the FOLA newsletter, at FOLA conferences, and at lake association meetings.

PROGRAM ADMINISTRATION

The CSLAP is jointly administered by one full-time program coordinator designated by the DEC, and one part-time coordinator appointed by the FOLA. The DEC responsibilities include preparing the sampling protocol, contacting the participating lake associations, purchasing and distributing equipment, training volunteers, coordinating analytical services with the DOH, managing data, implementing the quality assurance plan, and compiling the annual report. The FOLA Coordinator assists in recruiting lake associations, volunteer training and maintaining contact with volunteers, and presenting program results in newsletter articles and at lake association meetings. The FOLA Scientific Advisory Board reviews the CSLAP annual report and provides technical assistance on program revisions. The DOH performs all analytical services; their responsibilities include sample receipt and in-house preservation, internal quality control of samples and processing paper work, returning mailers and supplies to the volunteers and compilation of laboratory reports.

The 1988 CSLAP budget of roughly $110,000 consists of $85,000 secured from the DEC operating budget, and $25-30,000 provided by the Finger Lakes Association to fund the addition of 19 lakes to the program. (The Finger Lakes Association is a coalition of counties that acquired Local Assistance funds from the State Budget to perform aquatic vegetation studies in the Finger Lakes District.) Program funds are allocated as follows: $45,000 to pay the salaries of the DEC Program Coordinator and the FOLA Coordinator; $6,100 for materials for returning volunteers; $41,000 for laboratory analysis; $5,500 to mail samples to the DOH laboratory; $2,500 to purchase dissolved oxygen meters; and approximately $10,000 for other expenses including printing reports and office overhead.

Lake monitoring costs decline sharply following the initial year; the equipment and most of the materials are reused and the sampling frequency may be reduced if the first year's data indicates little weekly variation. As a result, laboratory analysis costs for an individual lake may drop from $1100 during the first sampling season, to $500 in subsequent years. Similarly, equipment costs may decline from $450 to $75.

SELECTED PROGRAM MATERIALS

Annual Report 1987: New York State Citizens Statewide Lake Assessment Program. New York State Department of Environmental Conservation, Division of Water. 1988. 431 pages.

Citizens Statewide Lake Assessment Program Sampling Protocol. State of New York Department of Environmental Conservation, Division of Water, and the Federation of Lake Associations, Inc. 1988. 36 pages. This instruction manual describes basic water sampling procedures for CSLAP participants.

New York Citizens Statewide Lake Assessment Program (CSLAP) User Survey. New York State Department of Environmental Conservation, Division of Water, and the Federation of Lake Associations, Inc. 1988. 10 pages.

CSLAP Vegetation Survey Protocol. New York State Department of Environmental Conservation, Division of Water. Undated. 2 pages.

PROGRAM OBJECTIVES

Ohio's Scenic River Stream Quality Monitoring Program has two primary objectives. The first is to educate citizens about the importance of stream biology, particularly macroinvertebrates, as a measure of stream quality. The second is to develop and maintain a base of information to evaluate long term changes in river quality. The program centers around the hands-on involvement of citizens in the collection and identification of benthic macroinvertebrates as well as the calculation of a simple stream quality index value. The biomonitoring procedures, which can be quickly and easily performed, are within the understanding of individuals in nearly any age group, and, as such, are not designed to pinpoint subtle shifts in water quality.

Unlike many other programs, the Ohio citizen monitoring effort is administered by a State agency that does not regulate water quality. The program is managed by the Ohio Department of Natural Resources (ODNR), Division of Natural Areas and Preserves, as a component of Ohio's Scenic River Program. Monitoring results are shared periodically with the Ohio Environmental Protection Agency (OEPA), the agency empowered to regulate water quality, as well as local health departments. The Agency may investigate sites where severe degradation is indicated.

VOLUNTEER RECRUITMENT AND TRAINING

Ohio Scenic River staff maintain an aggressive volunteer recruitment effort that includes Statewide newspaper advertising, television spots, and direct mailings. Currently, close to 5,000 volunteers participate in 150 monitoring groups. Program personnel constantly work to expand the participant pool by working with numerous organizations, including garden clubs, Big Brothers and Sisters, Grange associations, conservation groups, wastewater treatment plant operators, and schools. Numerous organizations have incorporated environmental protection into their goals, and welcome the opportunity to participate in the stream monitoring program. At the present time, volunteer interest exceeds the capacity of the program, primarily because the program is restricted to the ten State-designated Scenic Rivers. Budgetary limitations on staff time and equipment acquisition also are a limiting factor regarding program expansion.

Ohio's citizen monitoring program began its sixth year in 1989 and includes 150 sites on the ten State-designated Scenic Rivers. Each monitoring group is assigned one or more sampling locations. A member of the Scenic River Program staff spends several hours training each group in the proper sampling technique and identification procedures.

Since the inception of the program in 1983, approximately 50% of the original volunteers are still involved in the program. A number of those seasonal volunteers are now beginning to request additional responsibilities. As a result, State staff are considering an expansion of the program to include some chemical monitoring. John Kopec, the program supervisor, believes that volunteer tasks must increase somewhat in complexity and number to maintain volunteer interest.

SAMPLING PROTOCOL

Ohio's volunteer monitoring program was adapted from procedures outlined in the national Izaak Walton League's Save Our Streams Program. Various techniques were tested and modified to develop an approach that is easy to learn and which may be implemented by a wide range of age groups.

Each volunteer group is supplied with a net, a manual that describes sampling methods, identification sheet of macroinvertebrate taxa, and a set of forms for recording observations and analyses. Using the information they have collected, volunteers develop a qualitative index of stream quality based on the overall diversity of indicator species collected. This index was cooperatively developed by the OEPA and the Ohio Scenic Rivers Program.

The volunteers perform the "kick seine" technique described in the program handbook. The seine net is stretched across the downstream edge of a riffle area measuring approximately 3 feet by 3 feet. The monitors pick up all stream bed materials two inches or larger in the sample area and brush aquatic insects and other organisms into the seine net. Then a volunteer thoroughly kicks up the bottom substrate to dislodge burrowing organisms. The captured organisms are identified and the volunteers calculate a cumulative index value based upon the variety of collected taxa indicating excellent, good, fair, or poor stream quality (Figure 1). Groups are encouraged to collect more than one sample at a site and consolidate the results. If poor water quality is indicated, the volunteers may work upstream in search of a source,

START-UP DATE
1983

SAMPLING SITES
10 Rivers, 150 sites (1989)

PARAMETERS
Biological monitoring (benthic macroinvertebrates)

SAMPLING FREQ.
2 to 5 surveys annually between April and October

NO. VOLUNTEERS
Approximately 5000

ADMINISTRATION
Administered by the State Scenic Rivers Program and funded through a State tax refund check-off and general revenues. Several State and regional staff devote part of their time to the program, along with part-time seasonal employees.

STATE CONTACT
John Kopec, Ohio Department of Natural Resources, Scenic Rivers Section, Fountain Square Columbus, OH 43224 (614) 265-6458

although time constraints usually prevent this procedure. All results are recorded on an assessment form and mailed either to the regional stream monitoring coordinator or the Scenic River Program Central Office.

Most groups sample between two and five times a year, primarily between April and October when river flow and temperature conditions are conducive to sampling. Although a standard monitoring schedule has not been implemented for the program as a whole, priority stations have been established which are sampled at least three times a year with one sample performed by the Scenic Rivers Program staff. Priority stations are selected to correspond with OEPA sites, to monitor upstream and downstream of point source discharges, to provide for easy access and accommodations, and to evenly distribute sampling stations along each Scenic River. Additional quality control measures have not been formalized, but ad hoc comparisons of volunteer and OEPA data are performed whenever possible. For example, citizen monitors and OEPA personnel sampled side by side downstream from an industrial operation that was permitted to release a large volume of waste (prior to closing) in 1987. The two data sets compared favorably.

To date, the citizen monitoring data has revealed only a few instances of poor stream quality (septic tank failures, sewage treatment plant overflows, and an industrial waste discharge were suspected sources). However, this is understandable as the program is limited to designated Scenic Rivers which by definition possess a high water quality rating. Nevertheless, the primary objective of the program is being fulfilled: to develop awareness, understanding and appreciation of stream ecology, while permitting the average citizen hands-on involvement with stream resource protection.

FIGURE 1

Ohio Scenic River Stream Quality Monitoring Program Stream Quality Assessment Form.

STREAM QUALITY ASSESSMENT FORM

STATION OR 16.3 STREAM Olentangy River SAMPLE # 1

LOCATION L K Riffle

COUNTY Delaware TOWNSHIP/CITY Delaware DATE 5-1-88 TIME 2:00 p.m.

GROUP OR INDIVIDUALS The Oliver Bailey Group NO. OF PARTICIPANTS 2

DESCRIBE WATER CONDITIONS (COLOR, ODOR, BEDGROWTHS, SURFACE SCUM, ETC.)

Slightly muddy; heavy bottom growth. No odor.

HACH KIT RESULTS (if used) AND OTHER OBSERVATIONS

USE BACK OF FORM IF NECESSARY

WIDTH OF RIFFLE 40'
WATER DEPTH 8" to 10"
WATER TEMP. (°F) 64

BED COMPOSITION OF RIFFLE (%)

SILT ☐ SAND ☐ GRAVEL (¼"- 2") ☐
COBBLES (2"- 10") [x] BOULDERS (> 10") [x]

MACROINVERTEBRATE TALLY

ESTIMATED COUNT LETTER CODE
A = 1 to 9
B = 10 to 99
C = 100 or more

GROUP 1 TAXA	LETTER CODE	GROUP 2 TAXA	LETTER CODE	GROUP 3 TAXA	LETTER CODE
WATER PENNY LARVAE	A	DAMSELFLY NYMPHS		BLACKFLY LARVAE	
MAYFLY NYMPHS	A	DRAGONFLY NYMPHS		AQUATIC WORMS	A
STONEFLY NYMPHS	A	CRANE FLY LARVAE		MIDGE LARVAE	
GOBSONFLY LARVAE	A	BEETLE LARVAE		POUCH SNAILS	
CADDISFLY LARVAE	C	CRAYFISH		LEECHES	
RIFFLE BEETLE ADULT	A	SCUDS			
OTHER SNAILS	A	CLAMS	A		
		SOWBUGS			
NUMBER OF TAXA (times) INDEX VALUE 3	7 / 21	NUMBER OF TAXA (times) INDEX VALUE 2	1 / 2	NUMBER OF TAXA (times) INDEX VALUE 1	1 / 1

CUMULATIVE INDEX VALUE: 24

STREAM QUALITY ASSESSMENT

EXCELLENT (> 22) [x] GOOD (17-22) ☐
FAIR (11-16) ☐ POOR (< 11) ☐

PLEASE SEND THIS FORM TO:

Mr. John S. Kopec, Planning Supervisor
Division of Natural Areas and Preserves
Ohio Scenic Rivers Program
1889 Fountain Square Court
Columbus, Ohio 43224 Phone: (614) 265-6458

DATA MANAGEMENT

The information from data sheets submitted to ODNR is entered into a computer data base for use in the preparation of reports and possibly trend analysis in the future. The stored data include the estimated count category for each species identified, the total number of taxa collected, the Cumulative Index Value, and the Stream Quality Rating for each sampling period at each site (Figure 1). Statistical analysis is not performed because the data lack the technical refinement necessary to analyze benthic macroinvertebrate population fluctuations. Trends may be revealed after a sufficient data base has been acquired. Raw data indicating unusual water quality conditions are shared with the OEPA, who determines if the conditions warrant further investigation.

PROGRAM ADMINISTRATION

The citizen monitoring program is run largely by ODNR personnel as a component of the State Scenic Rivers Program in the Division of Natural Areas and Preserves. The Scenic River Program Planning Supervisor coordinates the program and is responsible for interagency coordination and communication with the federal government, managing the program funds, setting program policies, and writing the annual reports. The planning supervisor oversees four seasonal employees who work approximately 20 hours a week between April and October, training and maintaining contact with the volunteers. Additional assistance is given by a staff of

four Scenic River regional coordinators.

An annual report describing the citizen monitoring results is mailed to key members of each participating organization, and letters of recognition are also sent to volunteers. While the Ohio program does not produce a regular volunteer newsletter, local media coverage of volunteer projects is actively pursued to provide additional recognition for the participants.

The Scenic River Program staff are investigating expansion of the volunteer monitoring program through assistance to Ohio Soil and Water Conservation Districts (SWCD's). Six SWCD's are currently involved with locally administering stream quality monitoring. The current program supervisor envisions the Scenic River Program maintaining its monitoring program on Scenic Rivers, but also training other agencies to expand citizen monitoring to streams outside of the Scenic River Program's jurisdiction.

The citizen monitoring program is primarily funded with general State revenues and a natural areas State income tax refund check-off program. The 1988 budget totalled approximately $55,000. Costs for the program are distributed as follows: the Scenic River planning supervisor allocates approximately 50% of his time to the volunteer monitoring program, at a cost of approximately $15,000. Four regional Scenic River Coordinators spend 10-15% of their time between April and October assisting the volunteer program at a cost of approximately $16,000. Four part-time seasonal stream monitoring coordinators are paid $18,000. Four thousand dollars are allocated for travel expenses. Overhead office and report printing costs are not included in the budget. Annual equipment costs average $2,000. The tax-refund monies support the salaries and travel expenses of the seasonal stream monitoring coordinators. All other expenses are funded by general State revenues, and occasional donations.

SELECTED PROGRAM MATERIALS

Stream Quality Monitoring: A Citizen Action Program. Ohio Department of Natural Resources, Division of Natural Areas and Preserves. Undated. 20 pages.This instruction manual covers basic sampling methods and provides a taxonomic key to stream-dwelling macroinvertebrates.

Ohio Scenic Rivers Stream Quality Monitoring Program: Annual Report 1989 Results. Ohio Department of Natural Resources, Division of Natural Areas and Preserves. 58 pages.

START-UP DATE
1985

SAMPLING SITES
10 Rivers, 60+ sites (1989)

PARAMETERS
TIDAL AREAS: Air and water temperature, Secchi disk depth and total depth, salinity, pH, dissolved oxygen, ammonia, precipitation, field observations of water conditions and color, weather, general condition of site. NONTIDAL AREAS: Air and water temperature, turbidity, river height, precipitation, nitrate, dissolved oxygen, field observations.

SAMPLING FREQUENCY
Weekly year round.

NO. VOLUNTEERS
60+—some sites are shared by 1-3 volunteers.

ADMINISTRATION
Administered by the Alliance for the Chesapeake Bay, Inc. (ACB) under the guidance of the Monitoring Subcommittee to the Implementation Committee of the Chesapeake Bay Program. Funded with grants from USEPA, Region III and NOAA, Coastal Zone Management Program grants to the states of Virginia and Maryland. Private donations have provided funds for dissolved oxygen kits.

PROGRAM CONTACTS
Kathleen Ellett, Citizen Monitoring Director and Gayla Campbell, Maryland Citizen Monitoring Coordinator, ACB, 410 Severn Avenue, Suite 110, Annapolis, MD 21403. (301) 266-6873. Billy Mills, Virginia Citizen Monitoring Coordinator, ACB, P.O. Box 1981 Richmond, VA 23216 804-775-0951.

PROGRAM OBJECTIVES

The Alliance for the Chesapeake Bay, Inc. (ACB) began a pilot water quality testing project for volunteers in July 1985 as one of the activities funded under its Chesapeake Bay Program public participation grant from USEPA. The project was designed to answer four questions which were addressed in the "Chesapeake Bay Citizen Monitoring Program Report, July 1985 - October 1988":

1. Can citizens collect water quality data that meet rigorous quality control standards?

2. Do data collected at nearshore locations reflect water quality in the river generally? Such shallow, nearshore waters are increasingly recognized for their importance as living resources habitats.

3. What are the most reliable sampling procedures, reporting formats, and data management systems for a volunteer program?

4. Is it feasible to include a permanent, Bay-wide citizen monitoring network among the long-term Bay management strategies of the State and Federal governments?

A major objective of this program was to demonstrate that citizen volunteers can collect water quality data that meet rigorous quality control standards. Data collected by volunteers were compared to data collected by State agency staff at nearby monitoring stations. Figure 1.4, Chapter 1, shows dissolved oxygen concentrations in surface water samples at a volunteer-monitored, nearshore site and at a Virginia Water Control Board monitoring station located in the mid-channel of the river about one mile apart. Inspection of the data plots indicated that both the volunteer-collected data and the State monitoring data represent similar water quality conditions (Wastler 1987).

Based on method comparisons and data results, the Implementation Committee of the Chesapeake Bay Program endorsed the incremental expansion of the Citizen Monitoring Program. The Committee has instructed its relevant subcommittees to report on ways citizen monitoring data can be used to provide a better understanding of the status of the quality of the nearshore habitat.

A preliminary comparison of data collected from all the volunteer monitored sites and by State agency staff indicated that patterns of differences between the citizen monitoring sites and state monitoring stations occurred frequently enough to suggest that they may reflect actual conditions (Ellett, et al. 1989). A more thorough analysis of nearshore water quality compared to mid-channel water quality in tidal tributaries is planned. The data will also be used in the verification of an interpolation model of water quality in major tributaries to the Bay.

The data can also be used to look at correlations between certain measured variables, such as low dissolved oxygen, and the frequency of observed events, such as fish kills and algae blooms. It should be possible to identify which sites provide for particular living resources habitats and attempt to link their character with water quality indicators. It would also be useful to evaluate the feasibility of using the citizen monitoring data set to determine the data collection frequency optimal for time series of water quality indicators.

VOLUNTEER RECRUITMENT AND TRAINING

Whenever possible, volunteers are sought who live on or near the water. Recruitment letters are sent to individuals and organizations that have an interest in water quality or in monitoring. This includes The Sierra Club, The Audubon Society, The League of Women Voters, Soil Conservation District Committees, river basin and civic associations, maritime businesses, etc. An effort is made to involve different user groups, such as commercial and recreational fisherman, marina owners, boating clubs, etc. Extensive follow-up by telephone is necessary to find people who are willing to participate.

The volunteers initially attend a 3-hour training session. These sessions include the viewing of an introductory slide show and explanation of the need for the data to be collected. This is followed by a demonstration of the test procedures.

Two quality control (QC) sessions per year are conducted by the monitoring coordinator. QC sessions follow two basic approaches: 1) volunteers test the same water with their equipment in the way they do it onsite; 2) volunteers read/record laboratory standards. Their results then provide a measure of how well they perform as a group and how precisely they measure the water quality indicators being tested.

SAMPLING PROTOCOL

Sites were not preselected for this voluntary program. However, State monitoring program coordinators in Maryland, Virginia, and Pennsylvania were consulted to determine suitable locations. The following crite-

ria were used to select sites:

1. stations should be equally divided in lower estuarine, riverine-estuarine transition and tidal fresh zones of tidal rivers;

2. stations should be located above and below the mouth of any significant tributary running into the river;

3. stations should be above and below major construction sites and wastewater treatment plants;

4. stations should be near a farm or animal holding facility that is instituting best management practices;

5. several stations should be nearshore opposite a State water quality monitoring station to allow for more direct comparison of data sets.

Data quality is a key aspect of the Chesapeake Bay Program. A Quality Assurance Project Plan (QAPjP) was prepared for the volunteer program and accepted by the Chesapeake Bay Program Quality Assurance Officer (QAO) (CBCMP 1987). Initial testing of volunteer methods was conducted at the EPA Central Regional Laboratory, Annapolis, MD under the supervision of the CBP QAO and various other chemists and technicians. The selected tests were written up in a "Citizen Monitoring Manual" specifically designed for this program (Ellett 1986).

Instruments and methods were chosen based on simplicity of use, cost, and accuracy. Every possible effort was made to use methods that were comparable to those employed by the CBP Monitoring Program. Where methods were necessarily different, methods comparison tests were performed and the degree of comparability was determined. The units reported are the same as those used in the CBP Monitoring Program.

Volunteer monitors collect data and samples once a week year round. Surface water samples are obtained in a bucket from the water's edge, a dock or pier and, in a few instances, from a boat.

In the standard tidal waters program, five water quality parameters are measured at each site: water and air temperature; pH using color comparator kits; Secchi disk depth and water depth; salinity using hydrometers; and dissolved oxygen (DO) using micro-Winkler titration kits (two samples are titrated at each sampling time). Color comparator kits are used to test for ammonia in the tidal fresh zone of the James River in Virginia. The water chemistry kits used in this program are manufactured by LaMotte Chemical Products, Inc.

Monitors report weekly accumulated rainfall if they can install a rain gage near the site. Rain gages are not installed at sites that are not on private property because they might be vandalized. In addition, information on weather and general observations about the site (live or dead organisms, debris, oil slicks, ice, odor, water color, anything unusual) are recorded on a Data Collection Form and sent to the project coordinator.

Monitors on the Conestoga River in Pennsylvania record air and water temperature, river height at most sites, water color and weather conditions and weekly accumulated rainfall. They test for dissolved oxygen and nitrate-nitrogen using a color comparator kit. They also record turbidity using a visual comparison method based on the Jackson candle turbidity column with results reported in Jackson turbidity units (JTU) which correspond to nephelometric turbidity units (NTU).

Volunteers on the Patuxent River began taking samples for laboratory analysis of nutrients in late 1989 and volunteers in selected locations in Virginia rivers will begin nutrient sample-taking in 1990. Virginia volunteers survey their sites for the presence of common wildlife for the State's Department of Game and Inland Fisheries as part of the U.S. Fish and Wildlife Service's Multi-State Fish and Wildlife Information Systems Project. Volunteers assist in groundtruthing of the submerged aquatic vegetation aerial photographic survey each year. They also estimate population density of jellyfish species during the summer months.

DATA MANAGEMENT AND ANALYSIS

Data are reported on a Data Collection Form supplied to the volunteer monitors. See Figure 3.3, Chapter 3 for an example form. The monitors are instructed to make a copy of the form and to send the original to the coordinator every two weeks in supplied envelopes. They keep a copy to guard against loss in the mail and to facilitate discussion of later questions about data reported. They may use carbon paper or photocopy the original for their own records. Data are keypunched by Chesapeake Bay Computer Center (CBPCC) personnel by running a Fortran data entry program. The raw data file is used as input to a Statistical Analysis System (SAS) program which creates a data listing by site and creates plots of the parameters. After the data listing has been checked for keypunch and coding errors and corrected by computer

center personnel and the coordinator, a printout is sent to each monitor. They are asked to look over the listing and report any errors to the coordinator. Verified data are available to the public upon request.

PROGRAM ADMINISTRATION AND BUDGET

The establishment of a volunteer monitoring program was suggested in the management plan that was developed following the research phase of the Chesapeake Bay Program (USEPA 1980). In response to a request from the CBP Monitoring Subcommittee, The Alliance for the Chesapeake Bay, Inc. established an ad hoc committee to analyze and report on the desirability and feasibility of citizen monitoring efforts and to provide specific recommendations. The committee's proposal was presented to and accepted by the CBP Implementation Committee which determines detailed policy for the CBP. This committee and its several subcommittees are made up of representatives from the States, the District of Columbia, and Federal agencies that are signatories to the CBP Agreement to restore and protect the Chesapeake Bay.

A committee of eight Bay managers and scientists worked with the Citizen Monitoring Coordinator in setting up the pilot program. This technical advisory committee reviewed the project plans and the protocol manual, provided technical guidance to the project coordinator as needed, and reviewed and evaluated results for inclusion in interim reports.

A Citizen Monitoring Workgroup of the Monitoring Subcommittee continues to provide direction to the program managers with input from relevant State agency personnel. The Chesapeake Bay Citizen Monitoring Program (CBCMP) began an extensive expansion in Virginia and Maryland in the spring of 1989. The program director provides oversight for the regional program; helps plan and conduct quality control sessions; and prepares and presents reports. The director also writes and edits the newsletter, *River Trends*, which is published four times a year and sent to volunteer monitors as well as other interested people.

The State citizen monitoring coordinators carry out day-to-day management of all projects in their respective states; recruit and train volunteer monitors; receive, store and manage data in cooperation with CBPCC personnel; plan and implement quality control activities; have direct contact with volunteers and carry out QC activities; order, calibrate and issue replacement equipment and dispense reagent refills.

The 1989 budget for direct costs to manage the CBCMP in three states is approximately $112,000. Funding is provided by the EPA public participation grant to ACB and NOAA Coastal Zone Management grants to Maryland and Virginia that then contract with ACB to implement projects in Maryland, Pennsylvania, and Virginia. Program funds are allocated as follows:

Personnel (2 and 1/2 people):	$80,000
Travel:	8,000
Equipment:	7,000
Supplies:	1,000
Training and Quality Control:	800
Informational materials:	1,300
Newsletter:	700

EPA provides data management support and office support for the director and the Maryland coordinator. The Virginia Council on the Environment provides office support for the Virginia coordinator.

REFERENCES AND SELECTED PROGRAM MATERIALS

Alliance for the Chesapeake Bay, Inc. 1986. *Citizen Monitoring Manual.* Baltimore, MD.

Ellett, Kathleen. *An Introduction to Water Quality Monitoring Using Volunteers: A Handbook for Coordinators.* 1988. Alliance for the Chesapeake Bay, Inc. Baltimore, MD.

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US Environmental Protection Agency, Region III, Chesapeake Bay Program, 1986. *Quality Assurance Project Plan (QAPjP) for the Chesapeake Bay Citizen Monitoring Program.* USEPA QAMS 1980 Document. Annapolis, MD.

US Environmental Protection Agency, Region III, Chesapeake Bay Program. *Chesapeake Bay: A Framework for Action.* Appendices. Philadelphia, PA. 554 pages.

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