The Volunteer Monitor

The National Newsletter of Volunteer Water Quality Monitoring
Vol. 6, No. 1, Spring 1994

Note: This information is provided for reference purposes only. Although the information provided here was accurate and current when first created, it is now outdated.

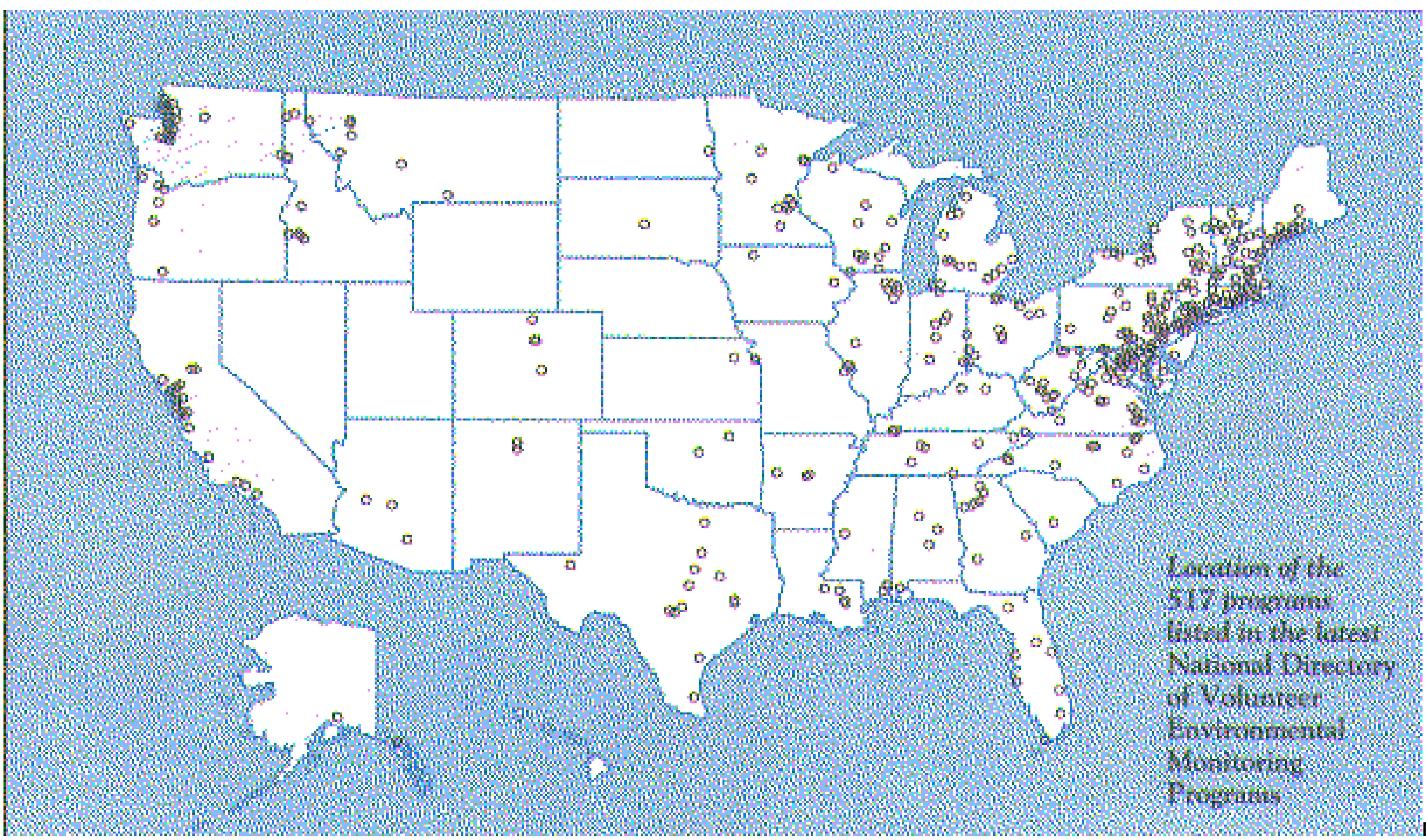
Special Topic: Volunteer Monitoring: Past, Present, & Future

Taking Our Own Pulse

Volunteer monitors often describe their work as "taking the pulse" of a waterbody. In this issue, we take the pulse of the volunteer monitoring movement itself. Where have we been, where are we now, and where do we want to go from here?

Twenty years ago, volunteer mointoring was in its infancy. In 1974, the map below would have contained no more than a handful of little circles. Today, with hundreds of thousands of volunteers participating in hundreds of programs nationwide, and with their data increasingly accepted and used, volunteer monitoring has truly come of age.

How and why has volunteer monitoring come so far? And with ever-increasing numbers of volunteers taking up the challenge of monitoring, how can we ensure that their energy, hard work, and dedication are translated into the greatest possible benefit to the environment?



Map created by River Watch Network

J. Tyler Campbell

Kris Ollock and Ken Didier learn monitoring techniques at Chester River Association training program.

Co-Editors: River Watch Network

The previous issue of The Volunteer Monitor announced that the Tip of the Mitt Watershed Council would be co-editing this issue. In fact, the schedule was rearranged slightly: River Watch Network was the co-editing group for this issue, and the Tip of the Mitt Watershed Council will (fittingly) co-edit the upcoming issue on the theme of "monitoring a watershed."

The following articles appear in this edition of *The Volunteer Monitor*:

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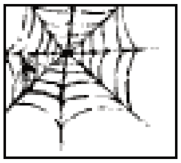

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How Citizen Monitoring Data Became a Part of Community Life

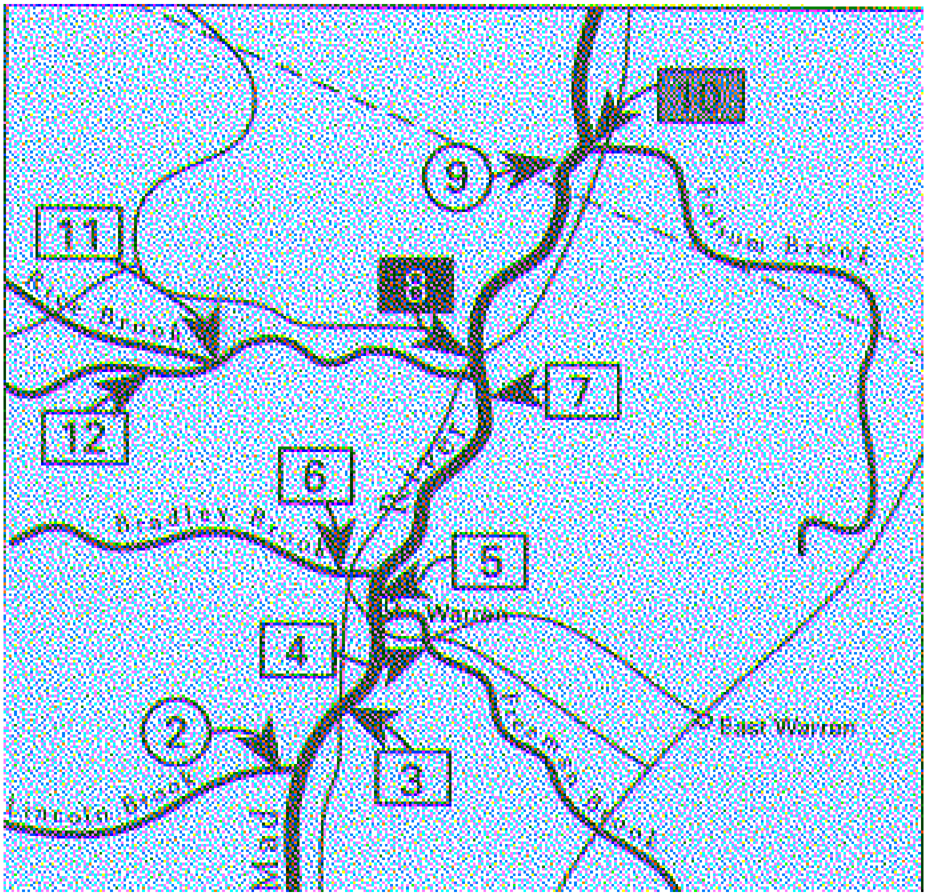
by Jack Byrne

During the summer, data from the Mad River Watch Program is as important as the daily weather forecast to people who live in the Mad River watershed. People check the local newspaper for the program's latest report on bacterial levels at their favorite swimming holes, then use that information to decide where it is safest to swim. In fact, it is now possible to predict which swim holes will be crowded and which will be sparsely used based on the data reported in the paper.

The Mad River runs 32 miles through north-central Vermont before joining the Winooski River in Middlesex. It is a river full of swimming opportunity, with 19 heavily used swim holes, most of them on private land and shared by their owners with a well-behaved public. A recent state Department of Environmental Conservation study of Vermont swim holes called the Mad River "an outstanding swimming resource and unquestionably one of the state's best."

The Mad River Watch Program began in 1985 with the help of River Watch Network, the Winooski Natural Resources Conservation District, and Harwood Union High School. In 1992, Friends of the Mad River took over sponsorship of the program. Thirty-eight sites have been regularly monitored during the summer by students and citizen volunteers for fecal coliform bacteria (recently, the program switched to monitoring *E. coli* bacteria). Since its inception, the program has been supported entirely by donations from local businesses and residents of the valley.

People in the area served by the Mad River Watch are now "coliform-literate." They know about state water quality standards and the health risks of exposure to fecal matter in their swimming waters. They know about the Mad River Watch Program, too: when Friends of the Mad River recently surveyed all the households in the watershed (about 3,000), they found that 80% of the 314 respondents were familiar with the program. The program's data have also been invaluable in helping local planning commissions and health boards identify village areas where there are sewage problems and agricultural areas where runoff is having an impact.



Portion of watershed map displaying Mad River Watch fecal coliform data for one year. Sites colored black (e.g. site #8) represent violation sites; those in gray are near-violation sites; and those in white are no-violation sites. Circles indicate sites that are popular swimming holes.

How has this broad awareness been accomplished? How did monitoring data become an expected and valued part of summertime community life? The process was a gradual one, based on education of the public through annual reports, the local newspaper, newsletters, and community meetings.

Each spring, just as local people are starting to use the river for fishing and boating and beginning to look forward to those warm summer days when they can swim, the Mad River Watch Program releases its annual report, highlighting the bacteria results. The report summarizes the previous year's findings, using both tables and a watershed map to show how many times each site was in violation of the state's standards for safe swimming. It also explains the basics of coliform monitoring, fecal contamination, and water quality standards. The report is mailed to residents and supporters and displayed at general stores, post offices, and other public places.

In 1987, the program began sending the results of its biweekly bacteria testing, plus background information, to the local newspaper. At first this prompted only an occasional news story. Then, in 1990, one reporter became so interested in the results that she began to incorporate them in a regular column which she has continued to this day.

Friends of the Mad River also features the Mad River Watch Program in its member newsletter, providing yet another opportunity for publicizing the program's data and activities.

Finally, the nine-year record of bacteria data (and other data) collected by the program is a central part of a recent effort by the Friends of the Mad River to develop a watershed conservation plan. Through a series of forums, the public has been involved in learning about water quality issues and identifying priorities for conservation action.

The most important reason that Mad River Watch data have become so well used is that the program has communicated the data both *persistently* and *consistently*. The program has focused its communication efforts on the bacterial results, since these are of the greatest interest to the public. These data have been continually placed before the public eye, and always in a format that can be readily understood even by those who may never have heard about fecal coliform testing before.

Jack Byrne *is the Executive Director of River Watch Network, 153 State St., Montpelier, VT 05602; 802/223-3840*.

River Watch Program *is a national, nonprofit organization that helps community groups and schools set up and implement river monitoring and protection programs. RWN now has a corps of 7,000 volunteers nationwide*.

Putting Data to Use

The "Top Three" Uses

According to the recent national survey of volunteer monitoring groups (see article titled "A Profile of Volunteer Monitoring"), the top three uses of volunteer data are **education** (checked by 85 percent of respondents) **problem identification** or "watch-dogging" (checked by 64 percent) and **local decisions** (checked by 56 percent). But what kinds of real-world activities do these rather broad terms translate to? To answer this question, let's look at some of the stories behind the statistics - starting with one that illustrates all the "top three" uses.

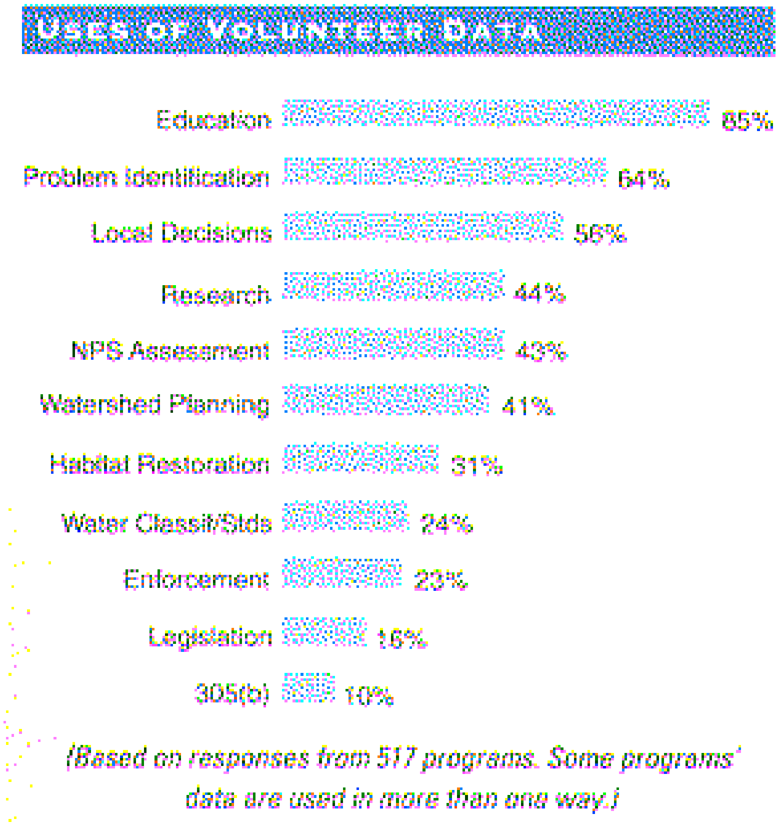
In October 1992, a group of residents in the Herring Run watershed in Baltimore worked with Maryland Save Our Streams to organize a survey of Herring Run. One hundred volunteers surveyed the entire 25-mile length of the stream and its tributaries for problems such as exposed sections of sewer lines, sewage overflow points, pipe outfalls, stream bank erosion, unshaded areas, fish migration barriers, heavy trash-dumping areas, and channelized stream sections. Almost by definition, surveys such as this constitute an example of *problem identification*. Collecting the survey data was also extremely *educational* for the participants. Volunteer Lynn Kramer, a leader in organizing the survey, points out that "walking a stream section and collecting data is a huge eye-opening and motivational experience."

The educational benefits of monitoring tend to spread out in circles to a wider and wider community, beginning with the volunteers themselves and then extending to friends, neighbors, businesses, elected officials, and so on. The Herring Run citizens used their survey data to educate the broader community by reporting their findings to city and county water quality agencies; to state agencies (Maryland Department of the Environment; Maryland Department of Natural Resources); at a community meeting; and, most dramatically, at a locally televised Baltimore City Council hearing. Kramer notes that the city council actually was educated about two topics: first, the conditions in the stream, and second, the strength of community interest in the stream.

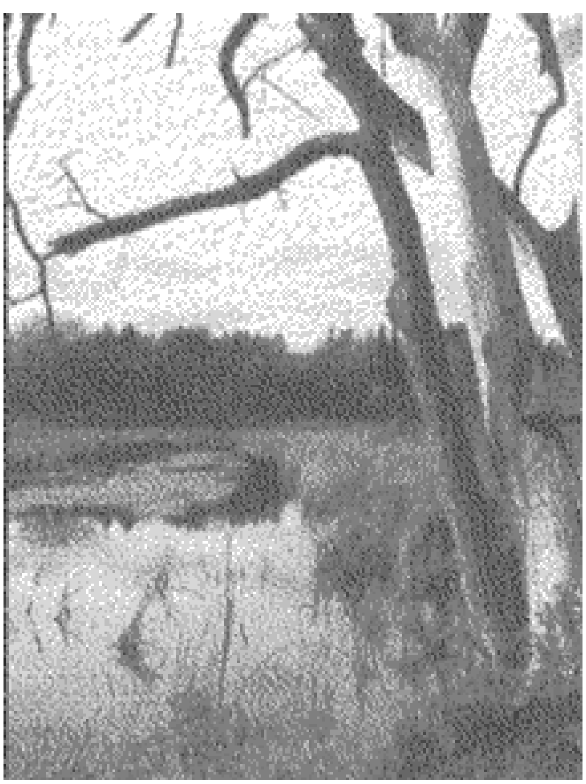
Of course the ultimate goal of identifying problems and educating the community about them is to get the problems resolved, often by making some *local decisions*. In the case of Herring Run, the citizens' presentation helped convince the city council to allocate funding for restoration activities, such as tree planting and wetland regeneration (exemplifying another of the data uses listed on the graph: *habitat restoration*). In addition, the Baltimore City Department of Public Works looked at every problem identified by the survey and gave the volunteers a detailed written report of all actions taken. Finally, the citizens themselves undertook improvement projects such as cleanups and storm drain painting.

Like the Herring Run survey, many citizen monitoring activities open the door for a whole variety of ways to put the information to use. These include not only uses by the monitoring group itself but also uses of the volunteers' data by government agencies, university researchers, and others.

Multiple Data Uses By A Local Agency



The Mississippi Headwaters Board, based in Walker, Minnesota, is an eight-county agency mandated to protect the natural values of the first 400 miles of the Mississippi River by limiting development, managing wastes and runoff, and maintaining setback zones from the water. To help carry out its mission, the MHB worked with River Watch Network to establish a citizen volunteer water monitoring program.



Mississippi Headwaters Board

The Mississippi River near its source at Lake Itasca in Minnesota.

Because the Mississippi headwaters run through glacial till, the river is vulnerable to sedimentation and erosion problems. In one agricultural county, volunteer monitors noted frequent instances of bank erosion and also found that the benthic macroinvertebrate community lacked diversity. Based on this *nonpoint source assessment*, the MHB decided to work toward keeping animals away from the banks to reduce sedimentation (an example of a *local decision*, as well as *watershed planning*). To accomplish this goal, the MHB has been encouraging and assisting farmers to enroll in federal cost-share programs that will help them build fences and plant appropriate shoreline vegetation (*habitat restoration*).

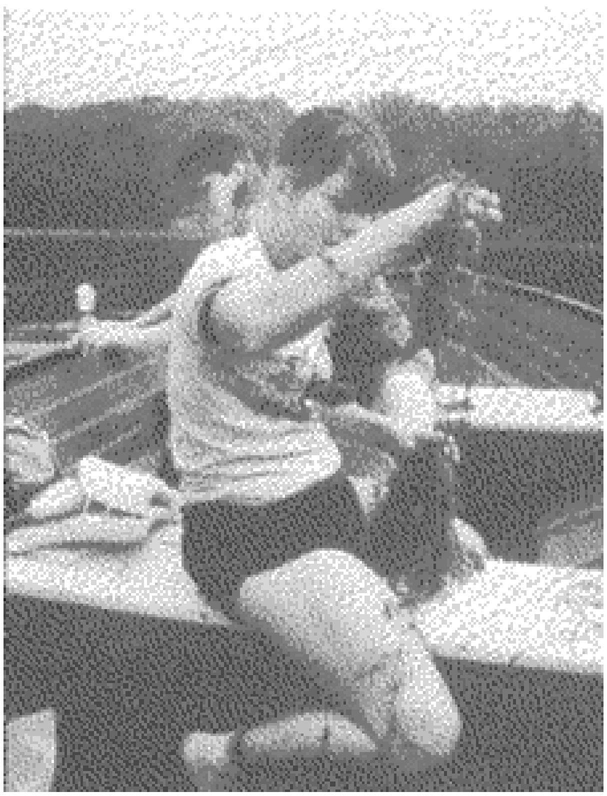
In another case, high school students monitoring a small tributary stream discovered high levels of phosphorus and nitrogen as well as high bacterial counts (*problem identification*). The phosphorus and nitrogen levels far exceeded state regulations for this area of the Mississippi, which is classed as an "Outstanding Resource Value Water." When county officials saw these results, they undertook a land use assessment, starting with a review of aerial photos. Groundtruthing, from the river, will follow in the spring. The county's assessment data will be used along with the students' monitoring results in developing a *watershed plan*. Meanwhile, the same students have been hired by the county to continue their monitoring efforts next summer.

Local, Cooperative Actions

Examples like the above two stories abound. Across the country, volunteers monitors' efforts are making a difference. But because their stories usually aren't major headline-grabbing material, sometimes their importance may be underestimated. In fact, some monitoring groups who were contacted for this article seemed almost apologetic at first that they couldn't report something "dramatic" - they hadn't nabbed any big polluters or won any million-dollar lawsuits. But solving community problems through local cooperative action rather than confrontation is really volunteer monitoring's goal, and a true mark of success. The following brief sampling shows some more examples of how volunteer monitors are putting their information to use.

Detecting milfoil invasions

Milfoil Watchers are volunteers trained by the Vermont Department of Environmental Conservation to watch for "pioneer" (i.e., new) infestations of the non-native aquatic plant Eurasian watermilfoil. Early detection is critical since a new invasion is much easier to control. To date, sharp-eyed volunteers have spotted pioneer infestations in at least three Vermont lakes. When milfoil is found, Milfoil Watchers move quickly to inform lake residents of the problem and educate them about how they can help keep the infestation from spreading. Lake residents then work with DEC to implement control activities.



VT Dept of Environmental Conservation

Milfoil Watcher Rose O'Connell checks aquatic vegetation on a Vermont lake.

"Friendly watchdog" finds failed septic system

Phil Alden, a volunteer with Vermont's Lake Monitoring Program and a board member of the Lake St. Catherine Association, keeps a lookout for bacterial contamination in Lake St. Catherine. Two or three times each summer, Alden collects samples from potential problem areas such as stream mouths, areas of dense development, and areas of past problems. "It's friendly watch-dogging," stresses Alden. "We're not looking to get anyone in trouble. Our job is to help people keep the lake clean." So far, only one "alarming" bacterial count has been found. The cause proved to be a failed septic system, which the owners corrected immediately.

Long-term data used for lake management

The Minnesota Pollution Control Agency recently published a 100-page report entitled *Lake Water Quality Trends in Minnesota*. "Secchi disk data from our Citizens Lake Monitoring Program is the heart of that report,"says Steve Heiskary, a research scientist at the MPCA. For some lakes, the report includes a continuous data set dating from 1973, the year Minnesota's Citizens Lake Monitoring Program was founded. The report was sent to volunteers, lake associations, county water planners, state agencies, and libraries. Jennifer Lindbloom, Statewide Coordinator for the CLMP, says lake associations and government agencies use the report to help make decisions about such lake management issues as septic system upgrades, algicide treatments, dredging, and construction.

Monitoring impacts of highway construction

This year, Maryland Save Our Streams and the Maryland State Highway Administration entered into a new partnership whereby volunteers will conduct stream monitoring at SHA road construction sites before, during, and after construction. Parameters to be monitored include benthic macroinvertebrates, habitat assessment, and several physical and chemical measurements. SHA will use the data to determine existing stream conditions prior to construction, to assess the potential impact of road projects on streams, to determine whether contractors are adhering to sediment control regulations, and to implement enforcement measures and restoration and mitigation activities in cases where a construction-related impact is demonstrated.

Investigating use of macroalgae as indicators

Whereas stream monitors can use a stream's benthic macroinvertebrate community as an overall indicator of stream health, to date estuary monitors have had no group of organisms that can do the job equally well for estuaries. But researchers are working on the problem - and volunteers with Delaware's Inland Bays Citizen Monitoring Program are assisting in one such study, which is assessing the potential of macroalgae (seaweeds) to serve as indicators of estuarine health. In a year-long study conducted in 1992-3, researcher Kent Price at the University of Delaware Graduate College of Marine Studies measured the abundance of macroalgae at various locations, then used the citizen program's nitrogen and phosphorus data from the same sites to look for a relationship. He found that dissolved phosphorus levels showed a statistically significant correlation with macroalgae volume. Since Price's study ended, the volunteers are continuing the project themselves, measuring macroalgae volumes with the help of beach seines. Several years' worth of data will be needed to confirm the original findings.

Hotline for surfers

Surfers in Santa Cruz, California, who are members of the Surfrider Foundation regularly test the waters at popular surfing spots for fecal contamination. The results are available to other surfers, as well as the general public, through the organization's water quality hotline number.

Baseline data help lake management district

Roger Griffiths, District Manager for the Lake Region Lakes Management District in Florida's Polk County, says that the LRLMD has used baseline data collected by Florida Lakewatch volunteers on several occasions. For example, the volunteers' data helped LRLMD identify which lake in the District has the most severe water quality problems (i.e., is most eutrophic). That lake is slated to receive a trial alum treatment; if the treatment is successful, it may be applied to other lakes as well. In another recent case, when the Management District wanted to demonstrate to the Florida Department of Environmental Protection that runoff from a fertilizer company represented a threat to lake water quality, the District used Lakewatch volunteer data to document the baseline water quality in the lake. Griffiths says, "It was awfully nice to be able to say to DEP, 'This is what the background for the lake is.'" (The DEP agreed that the runoff was indeed a threat. The fertilizer company paid a fine and made changes in their loading and storage practices to prevent future discharges.)

Students discover sewage leak

During a routine sampling run, high school students participating in the Mill River Watch Program in Massachusetts discovered high bacterial levels coming from a storm drain. The students contacted the superintendent of the Department of Public Works and presented their findings, then worked with the superintendent to pinpoint the source - a broken sewer line. The break was promptly repaired. To publicize this success, the students organized a press conference featuring themselves, the superintendent, the city council, and the mayor. The students' efforts were particularly appreciated by the community because the leaking sewage had been getting into a downstream pond in which people often fished and waded.

Setting phosphorus standards

Volunteer data were used in both Vermont and Minnesota to set phosphorus criteria for lakes; see article on page 18 for the story.

Researchers use volunteer data to define ecoregion boundaries

Dan Canfield, a professor in the Department of Fisheries and Aquatic Sciences at the University of Florida, reports that data collected by Florida Lakewatch volunteers are used extensively by researchers at the university. In one project, the volunteers' data are helping researchers define the boundaries of specific ecoregions within the state of Florida. Given the large number of lakes in Florida, Canfield says, "the only way to identify these ecoregions is to use the volunteer data."

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The Wide World of Monitoring: Beyond Water Quality Testing

What picture do the words "volunteer environmental monitoring" bring to mind? Perhaps an image of a volunteer using a field kit to measure dissolved oxygen in a water sample, or lowering a Secchi disk from the side of a boat, or collecting stream macroinvertebrates in a kick-seine net.

All these are time-honored activities that have long been the mainstay of many volunteer monitoring programs, and certainly none of them shows any signs of becoming obsolete or diminishing in importance. But more and more programs are also recognizing the value of collecting other kinds of information - for example, information about local land uses, or shoreline vegetation, or recreational uses of a water body, or populations of birds or amphibians. Some of these kinds of data can be collected without ever touching the water. Some require little equipment beyond a trained pair of eyes, a data sheet, a pencil, and perhaps a measuring tape or some kind of identification key.

Here's a brief survey of some volunteer monitors whose activities go beyond the boundaries of traditional water quality testing.

Riparian Habitat Inventory

Citizens participating in Community Creek Watch are conducting an extensive inventory of riparian habitat at nine creeks in Santa Clara County (at the southern end of San Francisco Bay). Crews of volunteers are surveying riparian vegetation, birds, amphibians, reptiles, and fisheries habitat, as well as mapping the watershed and performing water quality tests. The project is coordinated by the Coyote Creek Riparian Station, with the goal of providing local decision makers with the information needed to protect remaining riparian habitat.

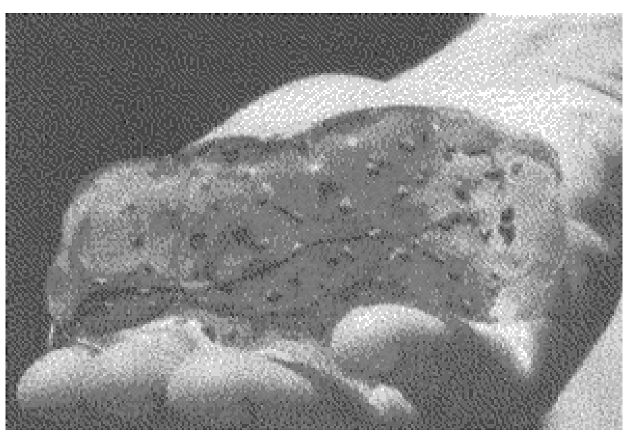
Eleanor Ely

Above, vegetation survey crew member Bert Manriquez determines the extent of different types of streamside vegetation along a transect line. Manriquez and the other crew members established the transect line by stretching a 100-meter measuring tape from the outside edge of the riparian vegetation on one bank, across the creek, and up to the outside edge of the riparian vegetation on the opposite bank. Now they are walking the transect, identifying the dominant types of vegetation and measuring the extent of each. The crew will eventually survey the entire creek (13.4 miles) at 500-meter intervals.

Amphibian Survey

Volunteers with the King County Amphibian Atlas Program in Washington State are helping the county Department of Development and Environmental Services determine which wetlands are used by which amphibians for spawning. The program was conceived two years ago by Klaus Richter, an ecologist at DDES, and developed in conjunction with the county's Surface Water Management Division.

Richter says he started the program because DDES, the agency charged with reviewing permits for the county, needed better data on wildlife uses of wetlands. "Wildlife information is the 'last frontier' in terms of environmental review, because it's expensive to collect that kind of data," says Richter. Lack of adequate wildlife data hampers both developers and DDES in their attempts to assess the impacts of proposed development and identify appropriate mitigation activities.



Klaus O. Richter

The volunteers are trained to identify spawn (egg masses) of three species of frogs, three species of salamanders, and one toad. During breeding season (March and April), volunteers make two visits to their adopted wetland to identify and count egg masses, map the eggs' location, and record their condition (dead eggs can be identified by their white, "moldy" appearance). "This program will provide us with ongoing, up-to-date information on existing conditions in individual wetlands," says Richter. "We won't have to ask permit applicants to start by collecting a year or two of baseline information."

Atmospheric Deposition Study

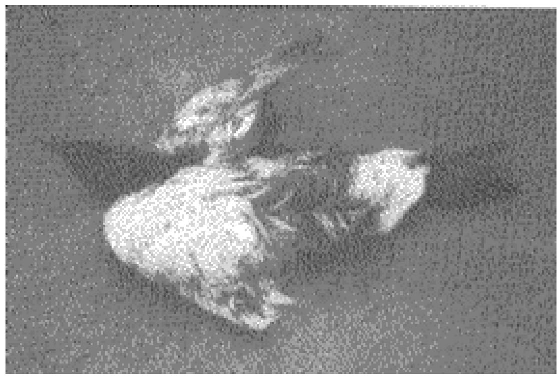
The peculiar-looking apparatus below is a bulk rain sampler of the type used by 11 volunteers with the Chesapeake Bay Citizen Monitoring Program participating in an atmospheric deposition study. The samplers are placed in several different types of locations, such as urban areas, forest areas, or next to manure pits on farms. Volunteers keep the collection bottle and funnel inside their homes when the weather is dry, then place them in the sampler when heavy rain is expected. The collected rainwater is analyzed at a laboratory for nitrogen, phosphorus, and herbicides.

Alliance for the Chesapeake Bay

The information will be used for a research study of atmospheric deposition (the "washing" of compounds out of the air by rain). Specifically, the study will investigate whether concentrations of nutrients and herbicides in rainfall are higher in areas near the sources of these substances.

Beached Birds and Netted Birds

Experienced birders volunteer with Adopt a Beach in Seattle, Washington, to monitor sea bird mortality by counting and identifying beached bird carcasses along selected portions of beaches in Puget Sound and along the outer coast. When a carcass is found, volunteers record information on the location, species, and ostensible cause of death. One of the project's goals is to establish baseline data so that when a catastrophic event (such as an oil spill) occurs, its impact can be evaluated in comparison to chronic or natural levels of sea bird mortality. Data on numbers of dead marbled murrelets (a threatened species) are provided to the U.S. Fish and Wildlife Service to help establish a mortality baseline.



Adopt A Beach

Carcass of a common murre on a Washington outer coast beach.

In another Adopt a Beach project, volunteer observers travel aboard fishing vessels to tabulate the incidental catch of seabirds in gillnets and purse seine nets. The information will help regulatory agencies and fishers determine and mitigate the impact of nets on birds, especially the marbled murrelet.

Monitoring the Underwater Environment

Five years ago, while visiting a relative who lived on a lake, scuba diver John Hicks-Courant made a dive that ultimately launched an international organization. "The lake looked perfect from shore," Hicks-Courant recalls, "but when I dived into it I could see immediately that something was very wrong. The bottom was absolutely lifeless." This experience led him to reflect that "if divers could tell people what they saw under water, maybe we could really help lakes and rivers." So, in 1991, Hicks-Courant founded the Divers Environmental Survey, a nonprofit network of environmentally conscious divers. Lake associations, towns, or state agencies contact DES to request various kinds of help. Some simply want a general survey, in which case the divers look for a healthy, diverse community of aquatic organisms. Others have a more specific request, such as asking divers to monitor the effects of a treatment for Eurasian watermilfoil.

Divers Environmental Survey

Divers prepare to submerge for a survey of the Concord River in Massachusetts.

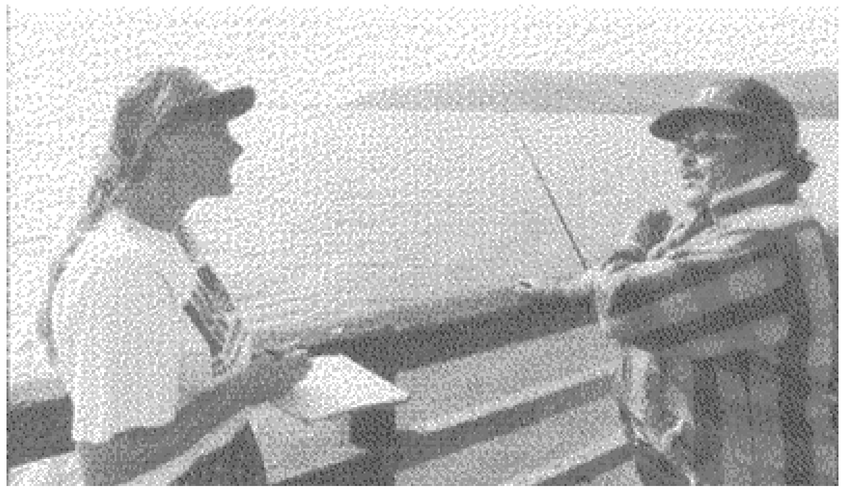
Fish Seining

Chum salmon are unusual: Whereas other salmon species spend a year living in fresh water before migrating to the sea, chum salmon hatch in December and move to the sea the following April, when they are only 1 to 2 inches long. But because of their lack of commercial value, chum salmon have long been overlooked. Now students at Seaside High School in Oregon are helping the Oregon Department of Fish and Wildlife (DFW) gather more information on this little-studied species. Every April for the past six years, the students have performed twice-weekly seining in the Necanicum estuary, using a fine-mesh 100-foot beach seine net. The students count all fish species caught in the net, record the counts on a DFW-approved data sheet, then return the fish to the water. The data sheets are sent to the DFW.

Eleanor Ely

Angler Survey

Below, Cortney Cassidy interviews a fisherman as part of a San Francisco BayKeeper survey to determine whether fish caught near sediment-contaminated areas of San Francisco Bay are being eaten more often than state guidelines advise. BayKeeper is especially concerned about consumption of such fish by children and pregnant women. Fifteen volunteers surveyed fishers at a variety of piers around the bay, asking them about where and how often they fish, numbers and species of fish caught, fish conditions they have observed (such as finrot, ulcers, or deformities), whether the fish are consumed, and who is eating the fish.



Richard Averitt

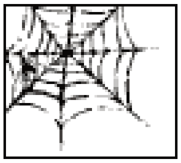
Well Testing

In 1993, college student interns working with Friends of the North Fork Shenandoah River, in Virginia, offered free testing of private wells to low-income families who requested this service. The students sampled 107 private wells and 5 springs. Testing at a university lab revealed that 10.8 percent of the sites exceeded the U.S. EPA drinking water standard for nitrate-nitrogen, 9.9 percent exceeded the standard for fecal coliforms, and 9.4 exceeded the standard for lead.

According to Friends president Dayton L. Cook, the wells that exceeded nitrate standards represent the greatest health threat. When water with high nitrate levels is used in making baby formula, it can cause "blue baby" syndrome. Friends is working to raise money to help low-income families install water treatment systems (at a cost of approximately $1,000) to remediate nitrate problems.

Friends has also established a long-term well monitoring program whereby 24 selected private wells will be tested annually to build a comprehensive database on groundwater quality in Shenandoah County.

The Volunteer Monitor, Vol. 6, No. 1, Spring 1994



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About *The Volunteer Monitor*

The Volunteer Monitor newsletter facilitates the exchange of ideas, monitoring methods, and practical advice among volunteer environmental monitoring groups across the nation.

Subscribing

The Volunteer Monitor is published twice yearly. Subscriptions are free. To be added to the mailing list, write to the address below. Your subscription will start with the next issue.

Reprinting articles

Reprinting of material from *The Volunteer Monitor* is encouraged. Please notify the editor of your intentions, and send a copy of your final publication to the address below.

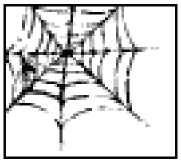
Participating

Let us know what topics you would like to learn more about, and what information you have to share.

Rotating co-editors

The Volunteer Monitor has a permanent editor and volunteer editorial board. In addition, a different monitoring group serves as co-editor for each issue. This unique structure ensures stability while allowing a variety of viewpoints to be represented.

Address all correspondence to: Eleanor Ely, editor, 1318 Masonic Avenue, San Francisco, CA 94117; telephone 415/255-8049.



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Back Issues

The following back issues are available:

- Fall 1991 - Biological Monitoring (photocopies only)
- Spring 1992 - Monitoring for Advocacy
- Fall 1992 - Building Credibility
- Spring 1993 - School-Based Monitoring
- Fall 1993 - Staying Afloat Financially

To obtain back issues, or additional copies of this issue, send a self-addressed stamped envelope, 9 x 12 or larger, to *The Volunteer Monitor*, 1318 Masonic Ave., San Francisco, CA 94117. First-class postage is 75¢ for one issue, $1.21 for two, and $1.44 for three. For $2.90, you can get up to 15 copies. For larger orders, please call for shipping charges.

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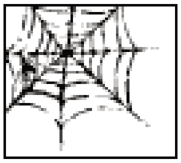

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To the Editor, from Amy Picotte

Just before the start of the 1994 summer field season, I would like to share with newsletter readers what the Vermont Lay Monitoring Program has found as a reliable solution for common problems with the "hose-crimp" sampling method.

The Vermont Lay Monitoring Program is designed to evaluate the nutrient enrichment of lakes. Monitors measure Secchi disk depth and collect samples for chlorophyll a and total phosphorus. As in many lake monitoring programs, the water samples are collected with a weighted garden hose marked off in meter intervals along its entire length. The hose is lowered straight down into the water to a depth twice the Secchi disk reading to obtain a composite sample (from the water's surface to the depth of the hose).

The tricky part of this procedure comes when the volunteer attempts to lift the hose from the water without losing any of the sample. The monitor must crimp the hose at the water's surface (by folding it back and forth several times), then keep the crimp tightly gripped in one hand while simultaneously reeling in a rope attached to the hose's lower (weighted) end. When the weighted end is brought into the boat, the crimp is released and the water is emptied into a bucket.

VT Dept. of Environmental Conservation

Vermont Lay Monitor Joe Southwick uses hose to collect composite sample for chlorophyll and total phosphorus analysis.

Two Vermont Lay Monitors, Roy Hill and Paul Steffen, both independently came up with the idea of attaching a hose shut-off valve to the unweighted end of the hose to eliminate the need for crimping. (The valve, available for under $2 at hardware stores, was designed to make it possible to shut off a garden hose at the hose end and not just from the tap.)

Last summer we tested the shut-off valve on about a dozen lakes. Both program staff and volunteers sampled at depths from 5 to 25 meters and found that we never lost any water volume during our sampling. The volunteers are highly pleased with how much easier this method is, especially when they sample alone.

Amy Picotte
Vermont Lay Monitoring Coordinator
Vermont Department of Environmental Conservation
Waterbury, VT 05671

To the Editor, from Mary Gilroy

The Spring 1993 issue of *The Volunteer Monitor* contained an article describing the low-cost water bath incubators, constructed from non-styrofoam coolers, that Colorado River Watch Network uses for fecal coliform testing. I would like to update readers on a design change that we have made since that article appeared.

In the model described in the newsletter, an aquarium heater was inserted vertically through a hole drilled in the cooler lid. However, we discovered that this placement of the heater could lead to problems because the main body of the heater is designed to be immersed in water when the heater is on. When monitors lifted the lid to put petri dishes into the incubator, the heater was raised out of the water, which sometimes resulted in heater malfunction.

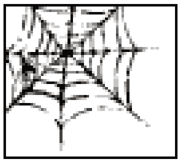
To prevent this problem, the design has been changed to allow the heater to be placed horizontally at the bottom of the incubator. Because the top portion of the heater is not designed to be immersed, this horizontal placement requires that the heater guard be removed and reglued for a tight seal. Also, care must be taken to ensure that the heater is completely level. Incorrect installment can result in leaking. For complete instructions for the new design, readers may contact me at the address below or call 512/473-3333, ext. 7634.

Another issue confronted by many volunteer groups that test for bacteria is how to sterilize the equipment if they do not have access to an autoclave. The sterilization procedure used by CRWN volunteers has been to allow the membrane filtration equipment to dry completely between sampling dates (usually one or more weeks), then clean the apparatus with rubbing alcohol and rinse well with deionized water. However, during the bacteria-testing workshop at the recent national volunteer monitoring conference some attenders raised concerns over the possible toxicity of the alcohol to the indicator bacteria. To test this possibility, we plan to run side-by-side tests using boiling water as an alternative sterilization technique to alcohol. We are also looking into the feasibility of outfitting monitors with UV lamp boxes for sterilization. We welcome any ideas or suggestions that newsletter readers may have.

CRWN monitors use the fecal coliform test to identify trouble spots, which are then verified by Lower Colorado River Authority professionals. Our fecal coliform method has worked well for our purposes, providing our monitors with an accessible and affordable but still reasonably accurate screening test. The volunteers' fecal coliform counts have been used to identify leaking sewage lines and to help determine the swimming status of a creek in a state park.

Mary Gilroy
Environmental Coordinator
Colorado River Watch Network
P.O. Box 220
Austin, TX 78767

The Volunteer Monitor, Vol. 6, No. 1, Spring 1994



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From the Editor

In discussions about this issue, the editorial board, co-editing group (River Watch Network), and I found ourselves trying to define exactly what it is that's so special about volunteer monitoring. Why is it growing so fast, attracting so many new people?

One key seems to be that volunteer monitoring is almost unique in being value-neutral: Government, schools, different segments of a community can all engage with it. A monitoring project has the potential to cut across not only barriers of age, race, and class but also differences in opinion and political leaning.

What's more, monitoring engages all these different groups in an active, constructive, immediately satisfying way - they aren't just being asked to send in a check, write a letter, or sign a petition.

By drawing a wide variety of people into active participation, increasing their knowledge about the environment, and giving citizens a meaningful voice in government processes, volunteer monitoring ultimately works to democratize environmental decision making.

Change in Co-Editors

The previous issue of *The Volunteer Monitor* announced that the Tip of the Mitt Watershed Council would be co-editing this issue. In fact, the schedule was rearranged slightly: River Watch Network was the co-editing group for this issue, and the Tip of the Mitt Watershed Council will (fittingly) co-edit the upcoming issue on the theme of "monitoring a watershed."

Staff at *The Volunteer Monitor*

Editor: Eleanor Ely

Co-editing group for this issue: River Watch Network, Montpelier, VT

Graphic Designer: Brien Brennan

Printer: Alonzo Printing Co., Inc., Hayward, CA

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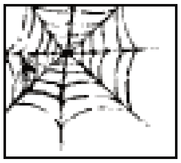
The Volunteer Monitor, Vol. 6, No. 1, Spring 1994



Just Published: New, Expanded Directory

The fourth edition of the *National Directory of Volunteer Environmental Monitoring Programs*, including 517 volunteer monitoring programs, is now available. The new directory devotes a full page to each program, providing information on environments monitored, parameters tested, number of volunteers, data uses, and program funding.

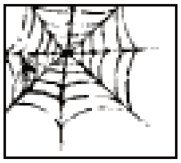
Information for the directory was gathered by mailing a detailed survey questionnaire to everyone on the mailing list for *The Volunteer Monitor* newsletter (about 8,000 names). Survey responses were entered into an electronic database, making it possible for the first time to obtain comprehensive statistics on volunteer monitoring activities nationwide. These statistics are presented and discussed in detail in the directory's introduction.

Who can use this directory? Just about everyone interested in volunteer monitoring: The group just getting started, who wants to find out if anyone else is monitoring in their area. The established program thinking about testing a new parameter, who could benefit from another group's experience. The group struggling to have its data accepted by a state agency, who needs to find good examples of programs whose data are already being used by government agencies.

The new directory was a joint project of the U.S. Environmental Protection Agency Office of Water and Rhode Island Sea Grant. The directory is available free of charge from Alice Mayio, U.S . EPA, Office of Wetlands, Oceans, and Watersheds, 4503F, 401 M St. SW, Washington, DC 20460; 202/260-7018. (Note: Each program listed in the directory will automatically be mailed one copy.)

The directory's compilers invite your help in making the next edition even more useful. What kinds of information would you like to see in future directories? What monitoring groups do you know of that were left out? Please send any suggestions for improvements to Meg Kerr, University of Rhode Island, Coastal Resources Center, S. Ferry Rd., Narragansett, RI 02882 (Internet mkerr@gsosunl.gso.uri.edu).

The Volunteer Monitor, Vol. 6, No. 1, Spring 1994



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Next Steps for Volunteer Monitoring

One conference goal was to define some "next steps" for volunteer monitoring. On the second morning, participants were divided into discussion groups according to EPA region and charged with generating goals and directions for monitoring in their region. The outcomes of those sessions, along with additional suggestions from other sessions and workshops, are summarized below:

1. Increase regionwide coordination and communication

- Form regional steering committees composed of federal, state, and local representatives
- Establish regionwide standard protocols for sampling and for QA/QC
- Produce regional directories and newsletters; maintain regional databases; hold regional conferences
- EPA regional coordinators should spend at least 30% of their time coordinating volunteer monitoring

2. Increase teamwork among volunteer monitoring groups

- Share data, pool resources, hold joint training sessions, work together on joint tasks
- Establish volunteer monitoring associations in each state
- Be collaborative, not territorial

3. Increase cooperation between volunteer monitoring groups and:

- environmental organizations
- other community groups
- businesses and universities

4. Work to achieve diversity - age, class, cultural, and racial

- Use watersheds as a way to link diverse communities
- Commit to diversity in organizational structure, literature, events
- Work with students as a useful "in" to communities
- Develop diverse niches for the diversity of individuals we want to attract
- LISTEN - i.e., don't assume we know others - needs and concerns

5. Adopt a watershed approach to monitoring

- Collect, analyze and apply information on the basis of the whole watershed

6. Communicate our successes

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Report from National Conference

In April, about 325 people attended the fourth National Volunteer Monitoring Conference, held in Portland, Oregon - the first time the national conference has been held on the West Coast. The U.S. EPA was the principal sponsor (as it has been for the previous three national conferences).

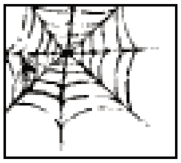
The conference steering committee had worked to make the meeting interactive and "hands-on." The agenda featured lab sessions, training workshops, and breakout discussion groups. In nearly every meeting room, walls became covered with sheet upon sheet of chart paper bearing the fruits of collective brainstorming.

Eleanor Ely

Marie Levesque Caduto, Connecticut River Watch Program Coordinator, demonstrates fecal coliform procedures during a workshop at the national conference.

The conference proceedings will be available in the fall from EPA. Audiotapes of individual sessions are available for $7 each ($35 for 6), plus postage and handling, from: T-MAR Tapes, P.O. Box 14944, Portland, OR 97214; (800)657-8218.

The Volunteer Monitor, Vol. 6, No. 1, Spring 1994



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Volunteer Data in the 305(b) Report

by Alice Mayio

Section 305(b) of the Clean Water Act mandates that states assess their water quality every two years and submit those assessments to EPA. EPA, in turn, summarizes the state assessments into a national report to Congress. These state and national assessments - both commonly referred to as "305(b) reports" - are among the very few sources of information we have on water quality conditions across the country.

How does volunteer monitoring fit into the 305(b) picture? More and more states are finding that the information collected by their water quality professionals is simply not enough - many waters are going unmonitored because state budgets are strapped and because the task of monitoring all of a state's waters is simply enormous. To help with this problem, since 1989 EPA has encouraged states to use all available data in their 305(b) water quality assessments.

In the guidelines issued in 1989, EPA explicitly identified volunteer monitoring data as a potential source of "evaluated" information states could use for their 305(b) reports - "evaluated" being the category that includes less-rigorous types of information such as land use patterns, predictive models, surveys, and historical information. Another category, "monitored" data, was reserved for recent, professionally collected data deemed to be generally of greater credibility.

Since 1991, EPA has told states they can consider quality-assured data produced by trained volunteers as "monitored," on par with professional data. This marks just one of the ways in which we are seeing volunteer data come of age in the 305(b) process. According to the survey conducted for the latest edition of the national directory, information from volunteer monitoring groups in 27 states is being used in 305(b) reports. In many cases these data are for lakes; most states have very small professional lake monitoring programs, and much of the lake data they have comes from volunteer programs funded through Section 314 of the Clean Water Act (the Clean Lakes Program). However, volunteer stream and estuary data are also beginning to be used in 305(b) reports. In the Rhode Island report, for example, data from the Salt Pond Watchers program are used to help assess the condition of shellfish-growing waters; in Virginia, data contributed by the Chesapeake Bay Citizens Monitoring Program and Izaak Walton League Save Our Streams volunteers are used to help assess coastal and inland streams.

The use of volunteer data in 305(b) reports is not high profile. It is not something that immediately affects the local community. But state decision makers - the ones who need to know which waters to target for cleanup, or which programs need more funding - use the 305(b) reports to help them make these decisions. And EPA and Congress rely on the national 305(b) report to tell them where we as a nation need to focus our pollution control resources. The current emphasis on nonpoint source pollution control is a case in point. As early as 1984, the national 305(b) report was revealing that nonpoint pollution sources such as agricultural and urban runoff had outstripped municipal and industrial "point source" pollution as the most widespread problems in the nation's waters.

If you are interested in knowing more about the 305(b) process and the potential use of your data in the state's report, you should begin by becoming familiar with the national 305(b) report. The most recent edition, *National Water Quality Inventory: 1992 Report to Congress* (EPA841-R-94-001), was just released on April 20, 1994. It is over 500 pages long and includes national statistics along with tables that present water quality information by state. Also released was the report's 44-page, easier-to-digest summary, *The Quality of Our Nation's Water: 1992* (EPA841-S-94-002), and 8-page *Fact Sheet - National Water Quality Inventory: 1992 Report to Congress* (EPA841-F-94-002). All three are free of charge and can be ordered from NCEPI, 11029 Kenwood Road, Building 5, Cincinnati,OH 45242; fax 513/891-6685. Be sure to include the EPA number when ordering your copy.

The next step is to become familiar with your state report. Both the summary document and the *Report to Congress* contain lists of the state 305(b) coordinators, the people who develop the reports and decide what to include in them. Write or call for a copy of the state report and begin a friendly dialogue with the coordinator; don't just send along your data and expect it to be used. The state coordinators have very specific quality control and format requirements for 305(b) data. Also, they may not be able to use your data if they already have enough information for the waters you monitor. But if the information you're collecting now isn't acceptable to the coordinator, maybe together you can work toward a solution for the future.

Alice Mayio is Volunteer Monitoring Coordinator for U.S. EPA. She may be contacted at U.S. EPA, Office of Wetlands, Oceans, and Watersheds, 4503F, 401 M Street, Washington, DC 20460.

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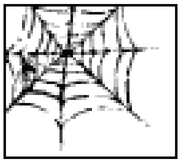
Working With Students

Wayne Baker/Texas Watch

Two-thirds of the programs surveyed work with middle and high school students, and 41 percent work with elementary students. A monitoring project provides a near-ideal educational opportunity, allowing students not only to practice hands-on science but also to learn about real-world environmental issues and help protect a local resource.



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A Profile of Volunteer Monitoring

Thanks to the survey conducted in 1993 to gather information for the fourth edition of the national volunteer monitoring directory, we have a much better picture than ever before of what the volunteer monitoring movement looks like - how extensive it is; who is monitoring what; which parameters they are measuring; and how volunteers' data are being used. (For information on how the survey was conducted, and how to order the directory, see article titled "Just Published: New, Expanded Directory".)

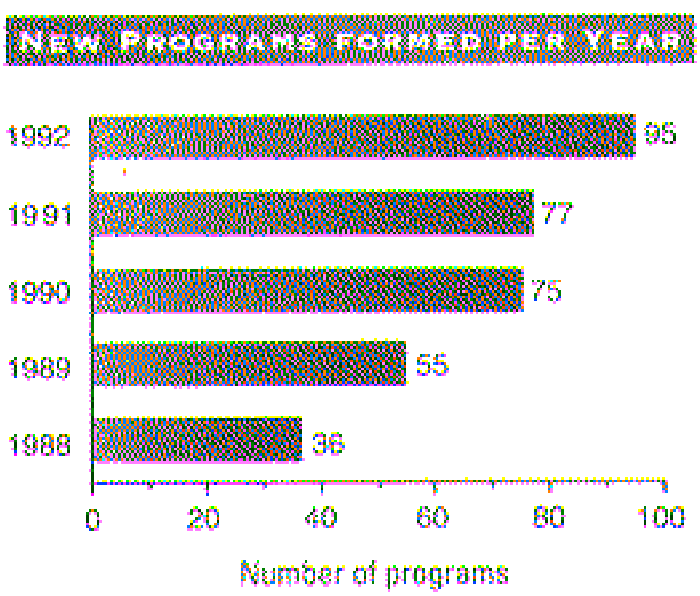
Most of the findings probably won't come as a major surprise to longtime observers of the volunteer monitoring movement. Instead, people familiar with volunteer monitoring are likely to discover that the results confirm a good deal of what they previously suspected or guessed.

The directory database contains information on 517 programs from 45 states. Bear in mind that the actual number of programs nationwide is undoubtedly larger than 517, both because new groups are constantly forming and because some groups were missed by the survey.

Big, and Growing

The map on the front cover graphically illustrates how widespread volunteer monitoring is. Four states have more than 30 programs each: Washington (39), Virginia (37), Pennsylvania (34), and New York (33).

Particularly impressive is the rapid growth of the movement: Over half the circles on the map represent groups founded in 1990 or later.



A Local and Grassroots Movement

Several of the survey findings underscore the strong local and grassroots nature of most volunteer monitoring. The majority of programs are small and low-budget - the median program size is 25 volunteers, and the median annual budget is $4,000. And even volunteers who participate in large-scale efforts such as a statewide lake monitoring program generally monitor a water body that they live on or near.

In addition, local communities are a key source of financial support for volunteer monitoring groups - a finding not fully anticipated when the survey questionnaire was designed. The questionnaire listed six choices of funding sources - state, federal, foundation, corporate, dues, and "other." As it turned out, the category "other" was selected most often, and when respondents wrote in specific sources under this category they were usually local sources: town and county government agencies, school districts, local businesses and groups, and community-based fundraising events.

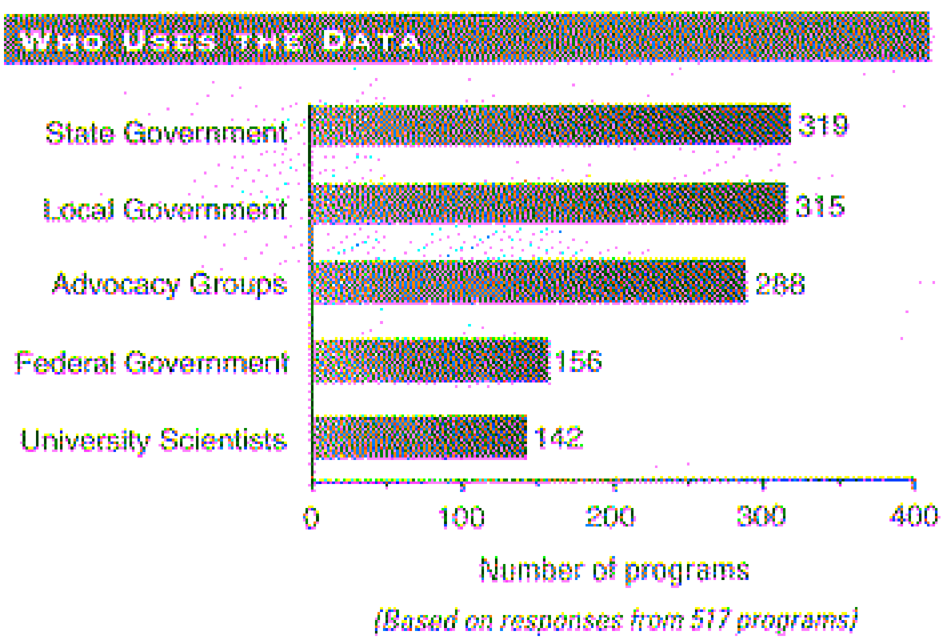
Most importantly, volunteer monitoring has its greatest impact at the local level. The top three uses of volunteer-collected data - education, problem identification, and local decisions - all reflect primarily local activities (see graph).

Bill Brinson/Rivers Curriculum Project

This local focus is exactly what should have been expected, for the heart of volunteer monitoring has always been the dedication of individuals to protecting water bodies that they live near and care about; about which they feel a sense of personal ownership. Ask volunteers why they got involved in monitoring and you'll often hear, "My grandchildren play in this creek," or "My family uses water from this lake as a drinking water supply," or "We don't want the place where we live to be ruined."

Increasing Government Use of Data

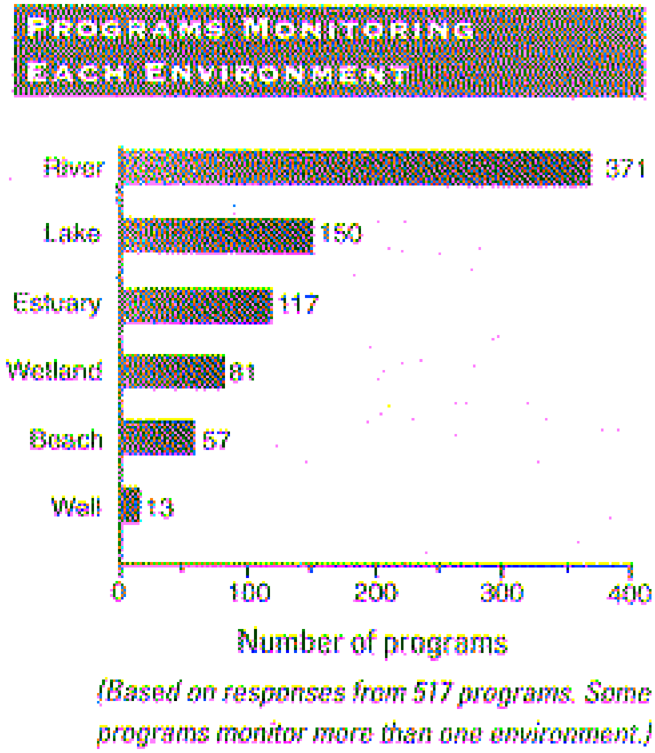
But even if volunteer monitoring's roots are firmly planted in the local community, its effects often reach far beyond the local level. Particularly encouraging is the growing use of volunteer data by government agencies - well over half the groups surveyed report that their data are used by state and local government agencies. The list of data uses (see graph) provides insight into what these government agencies are doing with the information. Water classification, enforcement, and legislation are typically state-level data uses, while watershed planning and nonpoint source assessment may indicate data use by either local or state government. And volunteer data included in a state's 305(b) report to EPA and Congress become part of the federal government's assessment of the state of the nation's waters.



Government is not only a significant user of volunteer data, it's also an important supporter of volunteer monitoring programs. About one third of the programs in the directory database receive funding from state government, and about one quarter receive federal funding. Clearly, government agencies are recognizing that volunteer monitoring is a worthwhile investment.

What Environments are Monitored

Historically, volunteer monitoring programs tended to monitor just one specific type of water body, most often streams or lakes. The survey found that this pattern is changing; 38 percent of programs reported that they monitor more than one water body type. This change reflects the trend toward a whole-watershed approach - for example, evaluating a lake in conjunction with its tributaries, outlet streams, and associated wetlands.



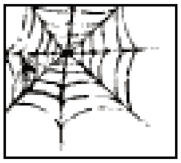
Rivers are monitored by the largest number of programs - nearly three-quarters of the groups surveyed include river monitoring. Lakes follow (monitored by 29 percent of programs), with estuaries close behind. While these figures might seem to imply that there's over twice as much volunteer monitoring activity on rivers as lakes, that assumption is not as safe as it seems. Another survey question asked for the number of stations sampled for each water body type, and surprisingly, the responses showed that the number of lake stations monitored is almost the same as the number of river stations. The explanation for this seemingly contradictory finding is the existence of some very large statewide lake monitoring programs, often run by state water quality agencies. Nine states have programs that monitor over 100 lakes each; three of these programs (in Florida, Minnesota, and Wisconsin) monitor 400 or more lakes each.

Future trends

This first national survey has established some baseline data on the status of volunteer monitoring and pointed to some trends. As additional data are gathered by means of future surveys, we will be able to confirm these trends. Healthy indicators to watch for would be continued growth in numbers of programs, numbers of volunteers, acceptance and use of volunteer data, funding for monitoring programs, regional coordination, and monitoring of whole watersheds. But as the movement increases in size, scope, and stature, we should also take care to protect and preserve its local, grassroots character.

(Note: Much of this article is based on information published in the new national directory's introductory section, written by Meg Kerr, Eleanor Ely, Virginia Lee, and Alice Mayio. Readers interested in a more detailed discussion of the survey results, including additional graphs and statistics not included here, are encouraged to refer to the directory.)

The Volunteer Monitor, Vol. 6, No. 1, Spring 1994



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Volunteer Monitoring: A Brief History

by Virginia Lee

Early Monitoring - Weather, Birds, Fish

Using volunteers to monitor the environment is not a new idea. For more than 100 years, the National Weather Service has trained volunteers to report daily measurements of rainfall and air temperature throughout the country. There are now 11,500 volunteer weather stations nationwide (compared to only 300 nonvolunteer stations). More than 500 of these stations have 100 years of continuous monitoring, and it is not unusual for individual volunteers to serve for 25-50 consecutive years. Much of our knowledge of our nation's climate is based on these long-term volunteer records.

Since the early 1900s, volunteers have also provided a national network of observations on bird populations through the National Audubon Society's Christmas Bird Count (started in 1900) and the U.S. Fish and Wildlife Service's Bird Banding Program (started in 1920). Initially the U.S. Fish and Wildlife Service organized bird watchers to provide information prior to the hunting season so that hunting limits could be set to conserve migratory waterfowl populations. This expanded over the years to a formal partnership between research scientists and volunteers, with the data stored in a national database. In 1965 a breeding bird census was included, in which bird watchers around the country do roadside counts of breeding birds every June and send in their results to the national database.

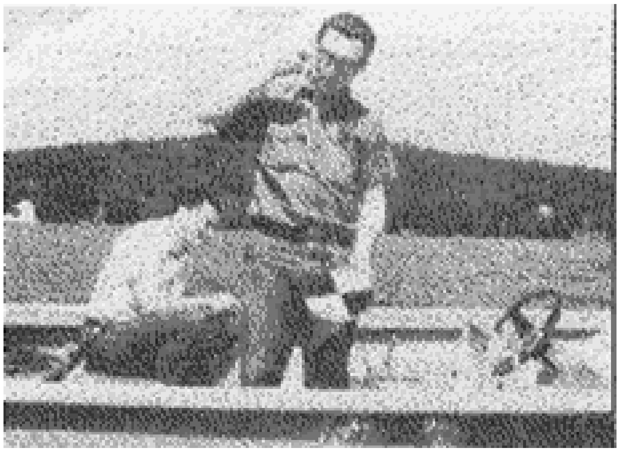
Volunteers have also been used by the National Marine Fisheries Service since 1954 to track fish populations. Volunteers tag and release fish and report tag information on captured fish, contributing to a database on fish population that would otherwise have been virtually impossible to obtain.

Water Monitoring - The Beginnings

Water quality monitoring by volunteers is a more recent undertaking, essentially starting in the late 1960s and the 1970s as grassroots efforts by lake associations and stream conservation groups. The 1972 passage of the Clean Water Act, which required states to assess the quality of their surface water, provided the impetus for several of the early state-supported volunteer monitoring programs.

In the early 1970s, Joseph Shapiro, a professor at the University of Minnesota's Limnology Research Center, was concerned about deteriorating water quality in the state's lakes. He wrote, "But how does one monitor 12,000 or even 2500 lakes? Is there a parameter that is diagnostic and at the same time easily enough measured so that it can be measured by those persons already at the lakes - the residents of the area? Fortunately, such a parameter does exist - Secchi disk testing." In 1973 Shapiro had 1,000 Secchi disks manufactured and began recruiting volunteers. By 1975 volunteers were monitoring 250 lakes and the Minnesota Pollution Control Agency was providing partial funding for the program.

Similarly, in Maine, researchers and state officials were grappling with the problem of how to monitor lakes statewide. In 1974 the Maine state legislature provided funding for the DEP to start the Maine Volunteer Lake Monitoring Program. Michigan's Self-Help Water Quality Monitoring program started that same year, and within a few years state-sponsored lake-monitoring programs were also established in Vermont, New Hampshire, New York, and Illinois. State agencies used the information to help classify lakes according to trophic status, as mandated by Section 314 of the Clean Water Act (Clean Lakes Program), and lake associations used it for local conservation activities.



ME Dept. of Environmental Protection

Volunteers for Maine Department of Environmental Protection's Volunteer Lake Monitoring Program take a Secchi reading in the mid-1970's.

Meanwhile, river and stream monitoring was evolving independently. In 1969, Malcolm King founded Save Our Streams in Maryland, and in 1970 he persuaded Maryland's Department of Natural Resources to include the SOS program as an item in the state budget. Initially MD SOS focused on raising public awareness of stream pollution through volunteer stream cleanups and construction site inspections. In 1974, the Izaak Walton League of America's national office adopted the SOS concept and promoted it through its state and local chapters. Between 1975 and 1977, the IWLA's "Water Wagon" - a motor home equipped with kick seines, basic field kits, and SOS literature - visited schools and community groups in every state in the contiguous United States. Program highlights included "critter hunts" (aquatic insect counts) and simple chemical testing (dissolved oxygen and pH).

Izaak Walton League of America

Kids learn about water quality testing at the Izaak Walton League's Water Wagon in 1975.

The 1980s: Growth in Credibility and Scope

At first, most government agencies did not accept that volunteers could gather credible data. In the words of Matthew Scott, a Maine Department of Environmental Protection biologist who helped found the Department's Volunteer Lake Monitoring Program in 1974, "The biggest stumbling block in the beginning was skepticism. At that time most people in the water quality business were chemists and engineers who believed testing needed to be done by professionals. It was like being a heretic to suggest volunteers could collect data."

Barbara Taylor, a volunteer with Maryland Save Our Streams in the early 1970s and now the organization's director, recalls, "I would call county inspectors, take them to a construction site, and point out violations. Their response was basically, 'You're just a housewife. Let me explain this to you. This isn't really sediment, it's just discoloration.' "

Taylor says that during the 1980s, agencies and volunteer programs "grew together." The volunteers got more sophisticated about quality assurance and achieved a "demonstrable record of success" in collecting credible data that could be used for management decisions, habitat restoration, and in some cases new legislation. At the same time, agencies were increasingly recognizing the value of the volunteers' data - especially as their own budgets got smaller and they had to cut back on data-collection activities.

One milestone for volunteer data credibility came in 1987 when the Chesapeake Bay Citizens Monitoring Program prepared the first EPA-approved Quality Assurance Project Plan for a volunteer monitoring project. A further boost to credibility was EPA's recog nition that volunteer monitoring data could be used in 305(b) reports (see Alice Mayio's article titled "Volunteer Data in the 305(b) Report"), along with the agency's publication (in 1990) of Volunteer Monitoring: A Guide for S tate Managers. Procedures manuals for volunteer lake and stream monitoring soon followed (see article titled "The Monitor's Basic Library" for more information on resources available from EPA).

The 1980s were also a time of enormous growth, in both numbers and scope. The fourth national directory includes 170 programs founded between 1980 and 1989, compared with just 31 founded in the previous decade.

At the same time volunteers were branching out to monitor other types of water bodies. Three estuary monitoring programs - Rhode Island Salt Pond Watchers, the Chesapeake Bay Citizens Monitoring Program, and Maine's Clean Water Program - were all founded in the second half of the decade. In 1986, the Center for Marine Conservation developed a data card that was used by volunteers to catalogue debris picked up during the Texas Coastal Cleanup. The next year, four states used the data card in statewide beach cleanups, and in 1988 CMC officially coordinated a National Beach Cleanup involving 25 U.S. states and territories. Information from the data cards was catalogued in CMC's national marine debris database and used to support the MARPOL legislation outlawing disposal of plastics at sea.

An increasing outreach effort to schools and students was also taking place. For example, Washington State's Adopt-A-Stream Foundation, founded in 1985 to promote environmental education and stream enhancement, by 1990 had 30 county groups and 40 schools adopting streams, building fish ladders, rearing and restocking salmon, and working to support protective legislation for streams and wetlands. Colorado River Watch Network began in Texas in 1988 and by 1990 involved 10 high schools and junior high schools, 351 educators, and 250 students monitoring nutrients, dissolved oxygen, bacteria, and other parameters. The Interactive Rouge River Water Quality Project (1986), in which high school and middle school students in the Detroit area monitor water quality as part of their school curriculum, is one of the earliest examples of urban river networking.

Increased national networking, greatly facilitated by the support of EPA's Office of Water, has been key to the growth of volunteer monitoring. Starting in 1988, EPA has sponsored four national conferences and several regional ones. Other networking tools supported by EPA are The Volunteer Monitor newsletter, ever- larger editions of the National Directory of Volunteer Environmental Monitoring Programs, and a volunteer monitoring electronic bulletin board. Kentucky Water Watch Program Coordinator Ken Cooke notes that, as a result of these efforts, "people get farther faster now than in the old days because more information is available."

Douglas Gamage

The first national volunteer monitoring conference - University of Rhode Island, May 1988.

The 1990s: A more holistic approach

During the 1990s, we are evolving toward a more integrated approach to monitoring. Now programs are evaluating streams, lakes, estuaries, wetlands, and in some cases groundwater, along with adjacent land uses, in whole-watershed assessments. This approach is linking communities along the watershed in a stronger sense of their connection to the environment and to each other. The Tennessee Valley Authority and the Chesapeake Bay Citizens Monitoring Program are two examples of programs that have effectively integrated volunteer monitoring on a whole-watershed scale. TVA combines results from school monitoring programs with results from other citizen monitoring programs for lakes, reservoirs, and streams in several large riverine watersheds of the Tennessee Valley. These data are used to evaluate conditions in the watersheds and to involve citizens in water resources education, decision making, and stewardship. The Chesapeake Bay Citizens Monitoring Program utilizes volunteers to monitor both in the major rivers in the Chesapeake Bay watershed and in the bay itself.

Another facet of the holistic approach is the trend to increasingly integrate monitoring with action. Jack Byrne, Executive Director of River Watch Network, reports that 1992 was a year when many of the groups RWN works with began to use their data to spur people into action. Byrne says, "This marks a significant transition for River Watch groups, moving from data collection and interpretation to community action and restoration of their rivers." Karen Firehock, Save Our Streams Director for IWLA, describes the evolution for SOS: "As we did in the early days, SOS still uses volunteer monitoring as a tool to increase public awareness about water quality issues. However, because the quality and reliability of the data have improved, those data can now be used by volunteers and managers alike to assess, manage, and restore their waters." A consequence of the increased emphasis on action is that many programs now spend time training volunteers in leadership skills as well as monitoring protocols.

Perhaps one of the most striking examples of linking action with assessment is the rise of the "keeper" programs in the 1990s. Starting with the Hudson River Keeper in the late 1980s, followed by the Long Island Sound Keeper, the San Francisco BayKeeper, and others, the bay and river keepers have from their inception used their data to spur enforcement actions to clean up our waterways.

Both the integration of monitoring with action and the whole-watershed approach are fundamental to the model pioneered by GREEN (Global Rivers Environmental Education Network), which evolved out of the Interactive Rouge River Water Quality Project. Through GREEN, students in 500 high schools in all 50 states, as well as students in other countries, are linking up by computer to share monitoring information and experiences in solving water quality problems. That model is now being modified and adopted throughout the country.

William Stapp

High school students participating in GREEN (Global Rivers Environmental Education Network) monitor the Rouge River in Detroit.

Increasingly, schools are getting excited about volunteer monitoring as a unique opportunity for interdisciplinary learning. Students can take on real water resource problems in their community; work through the science and math; use language skills, music, and art to communicate their results; and finally apply concepts from civics and social studies as they take action to solve the problems. The Rivers Curriculum Project, based in Illinois, is training teams of teachers to take this approach.

The Future

We are witnessing the growth of an exciting new dimension of environmental stewardship in this country as citizen and student volunteers get involved in monitoring our aquatic resources. We have learned some important lessons: that volunteer does not equal amateur; that volunteer does not equal free of charge; and that volunteer does not equal frivolous. With the nation's increased awareness of the importance of nonpoint source pollution, we expect to see an expansion of volunteer involvement in the next few years. An essential next step will be addressing environmental health and water quality as critical social issues, for everyone, in urban and rural communities alike.

Virginia Lee is the founder of Salt Pond Watchers and Program Manager for the Coastal Resources Center, University of Rhode Island, Bay Campus, Narragansett, RI 02882-1197; 401/792-6224.

The Volunteer Monitor, Vol. 6, No. 1, Spring 1994

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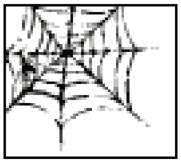
A Few Important Dates in Volunteer Monitoring

- 1890 - National Weather Service starts Cooperative Weather Observer Program
- 1900 - National Audubon Society begins Christmas Bird Count
- 1954 - beginning of Cooperative Game Fish Tagging Program (National Marine Fisheries Service)
- 1969 - Save Our Streams founded by Malcolm King; program subsequently adopted by Maryland Save Our Streams and Izaak Walton League
- 1970 - first Earth Day
- 1972 - passage of Clean Water Act; required states to monitor surface water
- 1973-74 - statewide lake monitoring programs started in Minnesota, Michigan, and Maine
- 1975 - Izaak Walton League's Water Wagon tours U.S.
- 1985 - two estuary monitoring programs launched: Rhode Island Salt Pond Watchers and Chesapeake Bay Citizen Monitoring Program
- 1987 - amendments to Clean Water Act
- 1987 - Interactive Rouge River Water Quality Project involves Detroit-area high school students
- 1987 - Chesapeake Bay Citizen Monitoring Program completes EPA-approved Quality Assurance Project Plan
- 1988 - first national volunteer monitoring conference held at the University of Rhode Island; 85 attendees
- 1988 - Center for Marine Conservation sponsors first International Coastal Cleanup
- 1988 - first edition of national volunteer monitoring directory
- 1989 - first issue of The Volunteer Monitor newsletter (8 pages; 3,000 copies)
- 1990 - first EPA guidance document (Volunteer Water Monitoring: A Guide for State Managers)
- 1992 - Maryland Volunteer Water Quality Monitoring Association formed (first statewide association)
- 1994 - fourth national volunteer monitoring conference held in Portland, Oregon; over 300 attendees
- 1994 - fourth edition of national volunteer monitoring directory
- 1994 - Vol. 7, no. 1 of The Volunteer Monitor newsletter (24 pages; ?19,000 copies)

Izaak Walton League of America

Kids learn about water quality testing at the Izaak Walton League's Water Wagon in 1975.



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What Parameters Volunteer Groups Test

One of the questions on the recent national survey asked volunteer monitoring groups what parameters they test. Not surprisingly, the answers showed that the most widely used parameters tend to be those that are relatively simple for volunteers to perform and that don't require expensive equipment: temperature, Secchi depth, stream macroinvertebrates, dissolved oxygen, pH (see table below). It also turns out that the water quality tests conducted by volunteer groups aren't all that different from those conducted by professionals monitoring the same type of water body. This makes sense, of course, since both volunteers and professionals base their choice of parameters on their concerns about the water body.

For example, the most common threat to lakes is eutrophication (nutrient over-enrichment). To assess a lake's trophic status,volunteers and professionals alike most often use Secchi depth, phosphorus, chlorophyll a, and dissolved oxygen. Of these, Secchi depth testing is the most popular for volunteer lake groups because its low cost, simplicity, and convenience allow groups to collect frequent measurements on a large number of lakes over a long period of time.

Rivers have historically been affected by, and regulated for, point sources of organic waste; and dissolved oxygen, temperature, flow, and nutrients have traditionally been used to monitor such problems. Macroinvertebrates (most importantly aquatic insect larvae) are also widely used as water quality indicators in rivers and streams because of their ability to integrate the effects of a variety of pollutants over time. And bacteria are an important parameter in any water body used for recreational sports (especially swimming) or shellfishing, because of the public health implications of fecal contamination.

River Watch Network

Macroinvertebrates are extremely useful indicators of stream health. What's more, these little "bugs" fascinate volunteers in a way that more mundane chemical parameters simply can't match.

How programs choose parameters

But sweeping generalizations about the problems faced by "lakes" or "rivers" can only begin to explain why volunteer groups choose the parameters they do, because in reality each water body is unique - and so is each monitoring group. Each group has its own particular concerns about a water body, and its own particular capabilities and resources. As Geoff Dates, New England Coordinator for River Watch Network, puts it, "You don't start by picking parameters - you start with 'What questions do we want to answer?' The parameters are in service to the questions."

For example, if you want to assure that the water you sample is safe for swimming or shellfishing, that leads you to test bacteria. If your question is whether the water body meets state water quality standards, you would start by finding out which parameters your state has established numerical standards for. (States differ, but parameters commonly included in standards include bacteria, dissolved oxygen, temperature, and pH.)

You may want to assess productivity, in which case you would probably select some or all of the trophic status indicators discussed above, and possibly other indicators such as aquatic vegetation surveys. Or perhaps your question concerns the impact of particular pollution sources, either point (e.g., a wastewater treatment plant) or nonpoint (e.g., a developed area or a farm). The parameters you pick will depend on the nature of the suspected pollution source, but might include nutrients (phosphorus and nitrogen), bacteria, temperature, dissolved oxygen, biological oxygen demand (BOD), and/or turbidity.

OK, so you've defined your question and you've come up with a list of potential indicators that would help you answer it. "This is your 'wish list,'" says Dates. "Now you have to get real." Getting real means relating the desired parameters to your group's resources - financial, technical, and human. It also means taking into account who your likely data users are and what they want.

To see how all these factors play out in real life, let's take a look at how one group - Rhode Island's Salt Pond Watchers - chose their parameters.

"Top Eight" Parameters for Specific Water Bodies

Rivers only (204 programs)	Lakes only (44 programs)	Estuaries only (36 programs)
Temperature (169)	Secchi depth (39)	Temperature (33)
Macroinvertebrates (151)	Temperature (26)	Dissolved oxygen (30)
pH (141)	Phosphorus (23)	Salinity (30)
Dissolved oxygen (118)	Chlorophyll *a* (23)	pH (23)
Debris cleanup (95)	Dissolved oxygen (17)	Secchi depth (22)
Flow (91)	pH (15)	Rainfall (14)
Habitat assessments (90)	Turbidity (13)	Nitrogen (13)
Nitrogen (89)	Coliform bacteria (12)	Coliform bacteria (13)

Parameters commonly tested in rivers, lakes, and estuaries by volunteer monitoring groups. *(Note that this table is based only on survey responses from programs that monitor one single water body type—rivers only, lakes only, or estuaries only.)*

Case study: Salt Pond Watchers

Rhode Island's salt pond region encompasses a series of shallow estuaries that lie behind barrier beaches along the state's scenic south ocean shore. The region supports a vital tourism economy and the ponds are popular for boating, swimming, and commercial and recreational fishing and shellfishing.

"We don't have problems with toxic discharges, as in the urban parts of the state," says Pond Watcher founder Virginia Lee. "And we no longer have a lot of agricultural land use. We're growing houses, not potatoes. Our concern was that rampant suburban development was threatening the health of the ponds."

Development is responsible for two threats: bacterial contamination and nutrient over-enrichment. Virtually all the houses in the area have on-site sewage disposal systems; when these fail, fecal bacteria can contaminate the salt ponds. Even properly functioning septic systems are a major source of nitrogen (via groundwater) to the ponds. Lawn fertilizer contributes additional nitrogen, as well as phosphorus, via runoff.

So when the Salt Pond Watcher program began in 1985, they looked for parameters that would help answer two basic questions: (1)

Are bacteria levels high enough that people could get sick from eating raw shellfish from the ponds? and (2) Are nutrient levels high enough to cause noxious algae blooms and anoxic conditions?

To assess fecal contamination the Pond Watchers obviously needed to monitor bacteria, but they had to choose from among several possible indicator species and methods. These choices were dictated by their commitment to having their data used by the state's Department of Environmental Management to determine whether the ponds were safe for shellfishing. In any salt waters where commercial shellfishing occurs, FDA regulations apply, and these are very specific: The indicator bacteria must be fecal coliform; the method, multiple tube dilution. Rhode Island DEM follows these FDA requirements, so the Pond Watchers did, too.

"We wanted DEM to feel confident in our bacteria data," says Lee, "so we worked with them to develop protocols and identify sampling sites. We had our samples analyzed in the same lab DEM uses (the state Department of Health lab), for the same indicator, and by the same method, so there would be no excuse to ignore the volunteers' data.

Robert Wiatrolik

Bob Eisenhart, a volunteer with Illinois' Volunteer Lake Monitoring Program, lowers a Secchi disk into Lake Petersburg. Secchi depth is the number one parameter tested by volunteer lake monitoring groups.

"For the first two years, DEM was skeptical of our data. But by the third year they were finding the data so useful that they asked us to expand our program and sample at all DEM's stations - which we did."

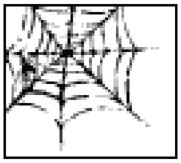
The teamwork has paid off: DEM does use Pond Watchers' data to assess bacterial contamination of the ponds, identify and fix failed septic systems, and close areas to shellfishing where necessary.

For monitoring potential nutrient over-enrichment, the group decided to test for salinity, temperature, phosphorus and nitrates (both important nutrients in estuaries), chlorophyll a (as an indicator of algal growth), and dissolved oxygen.

The volunteers themselves could easily measure temperature, dissolved oxygen (using field kits), and salinity. What they couldn't measure were the nutrients and chlorophyll. Based on previous research by University of Rhode Island scientists, they knew that nutrient levels would be too low to be accurately measured by field kits. Fortunately, the Pond Watchers were able to have nitrate, phosphorus, and chlorophyll a analyses performed in university research labs as an in-kind service.

The Pond Watchers are a textbook example in study design. They framed their questions first. They considered the requirements of potential data users. They took stock of their capabilities, which in their case included access to university research labs. The result has been information that is truly useful, not only to DEM but to the Salt Pond Watchers. The volunteers themselves have taken their data to four local town governments to be used in land and water use decisions on issues such as sewer expansions, zoning changes, and development of harbor management plans.

The Volunteer Monitor, Vol. 6, No. 1, Spring 1994



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Citizens' Data Used to Set Phosphorus Standards

by Amy Picotte

When Vermont's Department of Environmental Conservation launched the Vermont Lay Monitoring Program in 1979, the goals were relatively modest. Citizen monitoring was seen as a way both to involve lake residents in the state's lake management programs and to obtain useful data at a low cost.

Now that the Lay Monitoring Program has run continuously for 15 years, the value and importance of the citizens' data has far exceeded the original expectations. Nowhere is this more true than on Lake Champlain - Vermont's largest lake - where citizen data were recently used as the basis for establishing numeric standards for phosphorus.

The only long-term data collected on Lake Champlain has been from the Lay Monitoring Program. For the past 15 summers, volunteers have monitored Lake Champlain stations on a weekly basis, measuring Secchi disk depth and collecting samples for chlorophyll a and total phosphorus (these samples are later analyzed at the DEC lab).

In 1989, the state legislature directed the Vermont Water Resources Board (a five-member appointed authority charged with setting state water quality standards) to develop numeric standards for phosphorus. The Board approached the DEC for advice, and the DEC turned to the data collected by the Lay Monitoring Program.

The Lay Monitoring Program was able to provide two kinds of information to help establish the phosphorus standards. One was the baseline data defining existing phosphorus levels at 35 stations on the lake. The other was information from a "user perception survey." From 1987 to 1991, every time the volunteers went out to monitor they completed this survey, which asked them first to rate the lake's physical condition on that day (from 1, "Crystal clear water," to 5, "Severely high algae levels") and second to give their opinion, again on a scale of 1 to 5, of how suitable the lake was on that day for recreation and aesthetic enjoyment (from "Beautiful, could not be any nicer" to "Swimming and aesthetic enjoyment of the lake nearly impossible because of algae levels").

The tabulated results of hundreds of survey responses provided a basis for correlating actual phosphorus measurements to user perceptions of algae levels and recreational suitability. Results for Lake Champlain showed that if the summer average total phosphorus concentration was below 0.014 mg/l, essentially no lake users found their enjoyment of the lake "substantially reduced" more than 1% of the time during the summer.

Because of its shape and size (109 miles long and 12 miles wide), Lake Champlain's water quality is described in terms of different lake segments. Phosphorus criteria were established for 12 segments of the lake, as shown in the table. Based on the user perception survey, the Water Quality Control Board established 0.014 mg/l as a starting point for developing the standards. In two lake segments, where existing water quality was better than 0.014 mg/l, a stricter criterion of 0.01 mg/l was applied. In some of the more nutrient-enriched bay areas of the lake, where it was doubtful whether the 0.014 mg/l value was realistically attainable, or even natural, the criteria were revised upwards. The criteria were incorporated into Vermont's new Water Quality Standards, effective in 1991.

The new phosphorus standards are quite strict - in fact, for all but one lake segment the standards are lower than the currently existing phosphorus concentrations. This means that substantial phosphorus reduction efforts will be needed to meet the criteria by 1998, as required - an especially challenging task since Lake Champlain is an international body of water shared by the states of Vermont and New York and the province of Quebec. Impressively, in May 1993 all three governments signed a pact in agreement with these phosphorus standards. As phosphorus control measures are implemented, Lay Monitoring Program data will play an important role in determining whether phosphorus goals are achieved.

Amy Picotte *is the Coordinator for the Vermont Lay Monitoring Program, Vermont Department of Environmental Conservation, 103 S. Main Street, Building 10-N, Waterbury, VT 05671-0408; 802/241-3777.*

Editor's note: Vermont isn't the only state that has used volunteer data to help set phosphorus criteria. In Minnesota, volunteers with the 20-year-old Citizens Lake Monitoring Program (the country's longest-running statewide volunteer lake monitoring program) take weekly Secchi disk measurements on over 400 lakes. In 1987, the program incorporated the same user perception survey that was developed in Vermont. The survey results were used in developing goals for phosphorus concentration for lakes throughout Minnesota.

The Volunteer Monitor, Vol. 6, No. 1, Spring 1994

Monitoring for Phosphorus

or
How Come They Don't Tell You This Stuff in the Manual?

If you've ever seen a river or lake choked with weeds or algae, you've seen the potential impacts of nutrients on aquatic ecosystems. You may even have seen a problem that could be traced to a particular nutrient: phosphorus.

Phosphorus is an important water quality indicator that many volunteer monitoring programs are already measuring - and no doubt many others would like to, if they could find a satisfactory method. Phosphorus is also the parameter that probably causes volunteer groups more confusion, frustration, and difficulty than any other. This is because even very low levels of phosphorus can be significant, yet such levels are difficult to measure accurately and precisely.

Before you take the plunge (or now that you're in over your head), you probably want to know the answer to the following:

> Is there a simple, economical, user-friendly method that is capable of detecting low levels of phosphorus?

This article will attempt to boldly go where no manual has gone before and answer that question.

Why Phosphorus Is Important

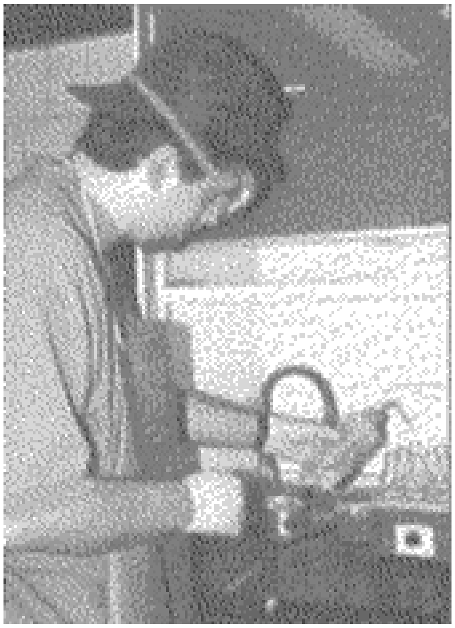
Both phosphorus and nitrogen are essential nutrients for the plants and animals that make up the aquatic food web. Since phosphorus is the nutrient in shortest supply in most fresh waters, even a modest increase in phosphorus can, under the right conditions, set off a whole chain of undesirable events in a lake or river, including accelerated plant growth, algae blooms, low dissolved oxygen, and the death of certain fish, invertebrates, and other aquatic animals.

Forms of Phosphorus

Phosphorus has a complicated story. Pure, "elemental" phosphorus (P) is rare. In nature, phosphorus is usually on friendly terms with four oxygen atoms in a relationship known as a *phosphate* molecule (PO_4^{-3}).

Phosphorus in aquatic systems occurs as *organic phosphate* and *inorganic phosphate*. Organic phosphate consists of a phosphate molecule associated with a carbon-based molecule, as in plant or animal tissue. Phosphate that is not associated with organic material is inorganic. Inorganic phosphate is the form required by plants. Animals can utilize either organic or inorganic phosphate.

Both organic and inorganic phosphate can either be *dissolved* in the water or *suspended* (attached to particles in the water column).



Eleanor Ely

The Terminology Quagmire

In the field of water quality chemistry, a bewildering proliferation of terms has evolved for describing various forms of phosphorus. Much of the confusion stems from the fact that some of these terms are chemistry-based (they refer to chemically defined compounds) and others are method-based (they describe what is measured by a particular method).

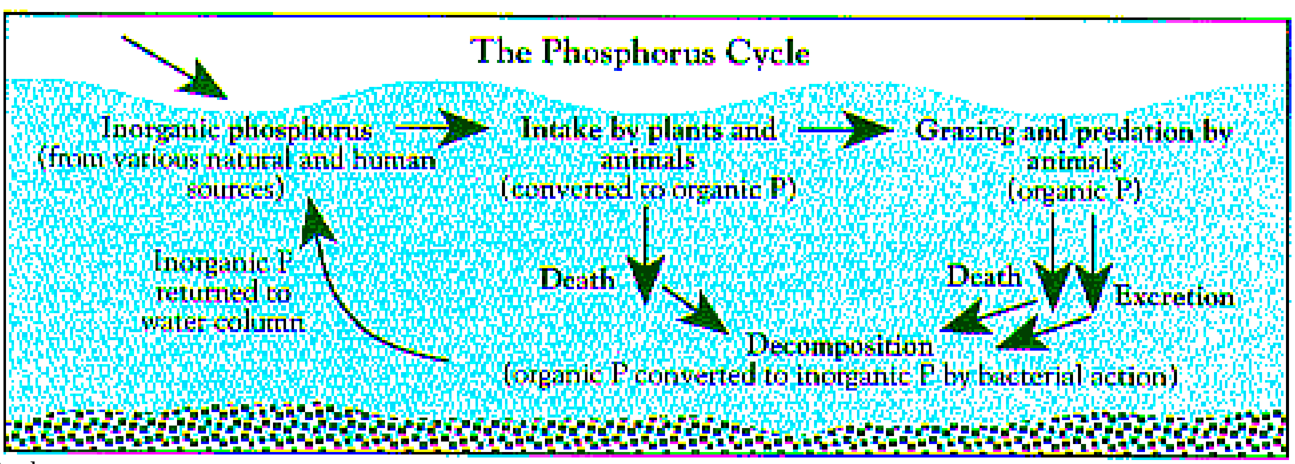
The term "orthophosphate" is a chemistry-based term that refers to the phosphate molecule all by itself. "Reactive phosphorus" is a corresponding method-based term that describes what you are actually measuring when you perform tests for orthophosphate. Since the lab procedures aren't quite perfect, you get mostly orthophosphate but you also get a small fraction of some other forms.

More complex inorganic phosphate compounds are referred to as "condensed phosphates" or "polyphosphates." The method-based term for these forms is "acid-hydrolyzable phosphate."

The Phosphorus Cycle

Things would be a little simpler if phosphorus stayed put in one form - but it doesn't. It cycles. Aquatic plants and animals take in dissolved inorganic phosphorus and convert it to organic phosphorus as it becomes part of their tissues.

As plants and animals die or excrete, the organic phosphorus they contain sinks to the bottom, where bacterial decomposition converts it back to inorganic phosphorus. This inorganic phosphorus gets back into the water column when the bottom gets stirred up by animals, chemical interactions, or water currents. Then it's taken up by plants and the cycle begins again.



In lakes that undergo seasonal stratification (layering of the water column by temperature differences from top to bottom), the availability of phosphorus in the water column varies seasonally. In summer and winter, when the lake is stratified, the phosphorus on and near the bottom is trapped by the cooler, more dense bottom waters. During spring and fall overturn, as the surface and bottom water reach the same temperature and mix, this trapped phosphorus becomes available in upper layers of the water column.

Under anoxic conditions (i.e., no detectable dissolved oxygen in the water), phosphorus from lake sediments is released into the water column, via a chemical reaction.

Sources of Phosphorus

There are many sources of phosphorus, both natural and human. These include soil and rocks, wastewater treatment plants, runoff from fertilized lawns and crop land, failing septic systems, runoff from manure storage areas, disturbed land areas, drained wetlands, road salt (which incorporates phosphorus compounds as anti-caking agents), and commercial cleaning preparations. These sources may be connected to the water body either by a pipe or by the myriad paths stormwater runoff follows from the land to the water. The large number of sources and the variety of routes that phosphorus can take make it difficult to monitor or correct problems with phosphorus over-enrichment.

Monitoring Phosphorus

Monitoring phosphorus is challenging. Not exactly news to people who are already struggling with this test. It's difficult because very low phosphorus concentrations - down to 0.01 milligrams per liter (mg/l) or even lower - can have a dramatic impact on rivers and lakes. Amy Picotte's article ("Citizens' Data Used to Set Phosphorus Standards") shows Vermont's phosphorus standards for Lake Champlain as ranging from 0.01 mg/l to 0.054 mg/l. Fragile high-altitude lakes and streams may respond to even lower concentrations.

The implication for monitoring is that you really need a method that will measure levels as low as 0.01 mg/l if you want to detect levels and changes that may be affecting your water.

Phosphorus Tests

The two basic references for phosphorus analysis methods are EPA's *Methods for Chemical Analysis of Water and Wastes* (hereafter *EPA Methods*) and the American Public Health Association's *Standard Methods for the Examination of Water and Wastewater* (hereafter *Standard Methods*). These two manuals use different labels for some of the same tests. We'll use the *EPA Methods* terminology here, and give the equivalent *Standard Methods* term in parentheses if it is different. (Note: We will use "total phosphorus test" even though *EPA Methods* calls this same test the "phosphorus test," because the name "total phosphorus test" is so widely used.)

EPA Methods and *Standard Methods* both include a mind-boggling total of twelve different tests for phosphorus. Of these twelve, only the following four are likely to be performed by volunteer monitors:

1. The **total orthophosphate** test ("total reactive phosphorus" in *Standard Methods*) is largely a measure of orthophosphate. (A small fraction of the more complex phosphate compounds is unavoidably measured as well, which is why *Standard Methods* uses the term "total reactive phosphate.") Because the sample is not filtered, the procedure measures both dissolved and suspended orthophosphate.

2. The **total phosphorus** test measures all the forms of phosphorus in the sample (orthophosphate, condensed phosphate, and organic phosphate). This is accomplished by first "digesting" (heating and acidifying) the sample to convert all the other forms to orthophosphate, then measuring the orthophosphate. The sample is not filtered, so both dissolved and suspended phosphorus are included.

3. The **dissolved phosphorus** test ("total dissolved phosphorus test" in *Standard Methods*) measures that fraction of the total phosphorus which is in solution in the water (as opposed to being attached to suspended particles). It is determined by first filtering the sample, then analyzing the filtrate for total phosphorus.

4. **Insoluble phosphorus** ("total suspended phosphorus" in *Standard Methods*) is calculated by subtracting your dissolved phosphorus result from your total phosphorus result.

All of these tests have one thing in common - they all depend on measuring orthophosphate. The total orthophosphate test measures the orthophosphate that is already present in the sample, while the others measure both that which is already present and that which is formed when other forms of phosphorus are converted to orthophosphate by digestion procedures.

The EPA-approved method for measuring orthophosphate is known as the ascorbic acid method. Briefly, a reagent (either liquid or powder) containing ascorbic acid and ammonium molybdate reacts with orthophosphate in the sample to form a blue compound. The intensity of the blue color is directly proportional to the amount of orthophosphate in the water.

Study Design

In designing a phosphorus study, start by deciding what questions you want to answer about the water body. Then you'll need to decide on methodology, weighing such factors as whether or not you want to perform testing in the field, what your financial and technical resources are, and who will be using the data.

Questions that phosphorus testing may help answer include:

- What is the impact of a wastewater treatment plant on a water body?
- What is the impact of a polluted runoff source on a water body?
- What's causing excessive weed growth or algae blooms?
- Does the water body meet state standards?

Which Test to Use

The total orthophosphate (total reactive phosphorus) test measures the form most available to plants. Therefore, it may be the most useful indicator of immediate potential impacts - like weed growth and algae blooms. It is also the easiest to measure.

Total phosphorus is the form of greatest interest to many state agencies. States that have numerical phosphorus standards usually define them in terms of total phosphorus. Since total phosphorus includes potentially available as well as immediately available phosphorus, it is a better indicator than total orthophosphate of how much phosphorus is actually in the water. If measured in conjunction with various flow conditions, total phosphorus can also be used to determine "loading" - how much phosphorus is getting into the ecosystem over a period of time (e.g., kilograms per day or tons per year).

Measuring both dissolved phosphorus and total phosphorus will enable you to calculate the insoluble (total suspended) phosphorus. This may tell you something about the source. For example, if a high proportion of your phosphorus is insoluble, the source may be erosion (the phosphorus is attached to soil particles) and/or manure or sewage (the phosphorus is bound in organic particles). Or there may simply be a lot of organic material (such as algae) in the water column. If a high proportion of the phosphorus is dissolved, the source may be chemical fertilizer in polluted runoff, or septic system leachate.

In sum, which forms of phosphorus you measure will depend on your questions and your resources. If your resources are limited, and you want to know about gross problem areas and the likelihood of immediate impacts, total orthophosphate is the logical choice. Consider testing for the other forms if the information gained will be useful to you and you have the resources to perform digestion procedures.

What Analytical Methods to Use

For analysis in the field, the only test that River Watch Network recommends is the total orthophosphate test, because it does not require pretreatment (digestion and/or filtration) of the sample. Pretreatment takes too much time and too much equipment to be practical in the field, may pose hazards to volunteers, and is prone to errors and inaccuracies in a field situation. Therefore analysis for forms other than total orthophosphate should be handled in a laboratory.

If you expect your data to be useful to decision makers, use the following EPA-approved methods (or variants thereof):

- For **total orthophosphate**: Ascorbic acid method, using a spectrophotometer to read the color
- For **total phosphorus**: Persulfate digestion followed by ascorbic acid (with spectrophotometer)
- For **dissolved phosphorus**: Filtration followed by persulfate digestion followed by ascorbic acid (with spectrophotometer)

To perform the ascorbic acid method, you can either follow the procedures given in *EPA Methods*, or you can follow one of the adaptations commercially available in kits. A kit is simply some combination of pre-packaged reagents, sampling equipment, labware, and instruments assembled by the manufacturer for convenience in ordering.

River Watch Network does recommend kits, both for ease of use and for quality assurance reasons, as long as the kit you choose meets two criteria: (1) It is based on or adapted from the ascorbic acid method, and (2) It includes an instrument that is able to read the color produced by the test down to the concentration you would like to detect.

By the way, if you look in the catalogues at the ranges that these kits will supposedly detect, you may see something like "0 - 2.5 mg/l." Does that mean this kit will detect down to 0.001 mg/l? Not likely! The lower limit of detection may actually be anywhere from 0.01 to 0.05 mg/l, or even higher. Call the manufacturer (be sure to talk to someone in the technical support department) and ask. If you already have the kit, you could also perform quality checks and see for yourself.

Colorimetric Equipment

There are two basic ways to read the blue color produced by the ascorbic acid method. You can use a color wheel or color comparator, which requires you to visually match the color in the sample to preprinted colors; or you can use a colorimeter or spectrophotometer, which reads the color electronically. If you purchase a kit, remember that it is only as good as the method used to measure the color.

Color comparators or color wheels are simple to use and inexpensive. Unfortunately, though, they are not appropriate for this test if you wish to detect concentrations of phosphorus below 0.1 mg/l. This is because they rely on the subjective judgment of the analyst to compare the color of the sample to the colors on the comparator. At low concentrations, there simply isn't much color to compare.

A colorimeter or spectrophotometer can better detect the color produced by low concentrations. (A spectrophotometer operates at a narrower wavelength band than a colorimeter, and therefore may be more accurate and precise.) These instruments shine a beam of light through the sample and measure the amount of light absorbed by or transmitted through the sample at a certain wavelength. The absorbance or transmittance is converted to mg/l by plotting the results on a standard curve and reading the concentration off the x-axis (see article titled "The Ascorbic Acid Method at a Glance"). Some instruments have standard curves preprogrammed into the instrument so that results can be read directly as mg/l. Some of these also give you the option of programming in your own standards.

It may be tempting to use those preprogrammed standards and read directly in mg/l. But if the meter gives you an inaccurate reading, how will you know? River Watch Network recommends making up your own standard concentrations (using a purchased stock solution) and standard curve. This enables you to spot problems - for example, if your standard curve is not a straight line, you know something is wrong.

In selecting a colorimeter or spectrophotometer, consider its cost, portability (if you want to use it in the field), ease of use, and sensitivity. Approximate costs range from $250 to $700 for a colorimeter and from $1,200 to $2,000 for a spectrophotometer. In general, the more expensive instruments have better optics.

The sensitivity of the meter depends primarily on the length of the light path (the width of the sample cell) and the quality of the optics. *EPA Methods* recommends at least a 1-cm light path. River Watch Network recommends the longest light path your instrument comes with (or can be refitted with), preferably 2.5 cm or longer. The instrument must also be capable of running at the wavelength that matches the method you intend to use. It is relatively simple and inexpensive to make the above refits on a Milton-Roy (formerly Bausch & Laumb) Spectronic 20.

Reporting and Interpretation

As if monitoring for phosphorus isn't hard enough, just when you think you're done there's yet another source of confusion - results can either be reported "as P" or "as PO_4." Now, you thought you were measuring PO_4, right? Well, you are. It's just that you can either limit your report to the P part of the molecule or you can include the oxygen as well. The PO_4 molecule is three times as heavy as the P atom, so if you report, for example, 0.06 mg/l as PO_4, that's equivalent to 0.02 mg/l as P. To convert PO_4 to P, divide by three. To convert P to PO_4, multiply by three.

To avoid confusion, and since most state water quality standards are reported as P, River Watch Network suggests that results always be reported "as P." This means you should order your stock solution as P.

Interpreting phosphorus results can be a challenge because many states don't have numerical standards for phosphorus. In addition, the response of water bodies to phosphorus varies considerably. What would be an alarmingly high phosphorus level for one water body may by normal or even low for another. In general, high-elevation, naturally nutrient-poor waters will be more sensitive to additions of phosphorus.

In states that have no numerical standards for phosphorus, the best approach is to talk to your state water quality agency. Even if they don't have formal standards, they may be able to provide guidelines or advice. Perhaps your monitoring data - like that of the Vermont Lay Monitors - will even help the agency establish standards (see article titled "Citizens' Data Used to Set Phosphorus Standards").

(For rivers in New England, River Watch Network has developed some phosphorus guidelines that we will be glad to share; call for more information.)

Watch the Details

Phosphorus is tricky to analyze accurately, even in a laboratory. Accuracy in measuring reagents is very important, as is scrupulous care to avoid contamination. In other words, it's easy to screw up this test!

To eliminate the possibility that reagents containing phosphorus will contaminate the labware, all containers that will hold water samples or come in contact with reagents used in this test must be "dedicated" - that is, they should not be used for other tests. Also, all labware should be acid-washed.

Sample containers made of either Pyrex glass or some form of plastic are acceptable to EPA. If sample containers are to be re-used, they must be acid-washed to remove traces of phosphorus from previous samples. Therefore, the container material must be able to withstand repeated contact with hydrochloric acid. Plastic containers, either high density polyethylene (HDPE) or polypropylene (PP) may be preferable to glass from a practical standpoint because they will better withstand breakage. Disposable sterile plastic"Whirl-pak" bags are used by a number of programs.

Running quality checks like blanks, duplicates, and split samples is essential. Of course, split samples (in which one subsample is analyzed at the project lab and the other at a quality control lab) are only useful if you've found a quality control lab you trust - and River Watch Network's experience has shown that even certified labs have trouble with the phosphorus test. At the very least, you should check your results by running knowns (samples of known concentration acquired from a quality control lab) before, during, and after you analyze your water samples.

Dealing With Phosphorus Over-enrichment

If your monitoring reveals that phosphorus levels in the water body are too high, what can be done to fix the problem? A thorough treatment of this topic is well beyond the scope of this article. Briefly, the basic strategy is to identify and reduce sources of phosphorus. For wastewater treatment plants, that may mean a special (and expensive) kind of advanced treatment that removes phosphorus from the wastewater prior to discharge. If the problem is associated with land use, there are a host of "best management practices"designed to reduce polluted runoff from urban areas, farms, forestry, and construction operations. Most of these involve stabilizing disturbed areas quickly, managing runoff to reduce erosion, and leaving "buffer" areas around water bodies to trap sediment and attached and dissolved nutrients. For lakes with elevated phosphorus levels in sediments, a common way to inactivate the phosphorus is to add alum to the lake.

The Bottom Line

So, what is the answer to the question posed earlier? Is there a simple, economical, user-friendly method that is capable of detecting low levels of phosphorus? Well, not really. Measuring *high* concentrations (greater than 0.1 mg/l) of total orthophosphate can be relatively simple, user-friendly, and cheap if you use a kit and a color wheel. However, this is useful only if you're simply screening for sites with serious orthophosphate enrichment.

The hard truth is that there is no cheap, user-friendly, economical method to detect any form of phosphorus at low concentrations. To detect low concentrations, you must purchase an instrument capable of reading low absorbances. You must make up standards in the low range you're trying to detect. You must have rigorous quality assurance to determine the accuracy and precision of your results.

In order of increasing difficulty and expense, the tests River Watch Network recommends are total orthophosphate, total phosphorus, dissolved phosphorus ("total dissolved phosphorus"), and insoluble phosphorus. In any case, we suggest that you monitor for phosphorus only to answer specific questions. And, if you want to monitor for low levels, you should either spend the time and money to do it right or find someone else to do it for you.

References

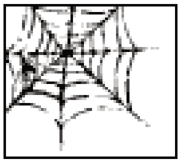
American Public Health Association. 1992. *Standard Methods for the Examination of Water and Wastewater* (18th edition). $160. Available from APHA, 1015 15th St., NW, Washington, DC 20005.

U.S. EPA. 1983. *Methods for Chemical Analysis of Water and Wastes*. Pb84-128677. $52. Available from National Technical Information Service (NTIS); call toll-free, 800/553-6847.

Geoff Dates *is the New England Coordinator for River Watch Network, 153 State Street, Montpelier, VT 05602; 802/223-3840*.

River Watch Network *provides technical assistance to a number of volunteer programs that are monitoring phosphorus*.

The Volunteer Monitor, Vol. 6, No. 1, Spring 1994



Note: This information is provided for reference purposes only. Although the information provided here was accurate and current when first created, it is now outdated.

Phosphorus Survey: Who's Doing What

(And What They Think About It)

In preparation for this special section on phosphorus testing, *The Volunteer Monitor* newsletter sent a questionnaire to the 201 volunteer monitoring groups in the 4th edition of the national directory who reported that they test for phosphorus. We received responses from 50. Here's what they said:

(*Note: Totals may add up to more than 50 because some programs checked more than one response*.)

Q: In what water bodies does your program perform phosphorus testing?

37 - rivers or streams 20 - lakes, reservoirs, or ponds 6 - wetlands 6 - estuaries 1 - caves/springs

Q: What form(s) of phosphorus do you measure?

26 - total orthophosphate (total reactive phosphorus) 24 - total phosphorus 3 - dissolved phosphorus

Q: Where (and by whom) is phosphorus testing performed?

24 - in the field, by volunteers 17 - in a lab, by volunteers 15 - in an outside laboratory 11 - in a lab, by program staff 2 - in the field, by program staff

Q: What testing method(s) do you use?

26 - Hach adaptation of standard methods 10 - *Standard Methods for the Examination of Water and Wastewater* 9 - LaMotte adaptation of standard methods 7 - EPA method 5 - other or "don't know"

Q: Why did you choose the phosphorus testing method(s) you are using?

In their responses to this question, programs using *Standard Methods* or an EPA method usually mentioned detection limits, accuracy and reproducibility of results, and/or a desire to follow the method preferred by a data user (such as a government agency or a researcher). None mentioned low cost or ease of use. By contrast, those using kits often cited ease of use, convenience, and/or low cost as the reasons for their choice.

Q: How satisfied are you, overall, with the phosphorus method(s) you are using?

Respondents' level of satisfaction with their method turned out to be strongly related to whether their method uses a visual method or an instrument to measure the color produced in the test. Of the 22 groups using an instrument (spectrophotometer or colorimeter), 80%

were very satisfied with their method and all the rest were well satisfied with one or more reservations.

For the 20 groups using a color wheel or color comparator, it was a different story. Only 15% were very satisfied; 25% were well satisfied with some reservations; another 25% rated the method as merely "adequate"; and 35% were outright dissatisfied. Some typical comments from the dissatisfied group: "Not sensitive enough for the streams we monitor"; "Hard to be sure of color wheel matching"; "Not at all sure our low readings are accurate."

The Monitor's Basic Library

EPA Volunteer Monitoring Publications

The following publications are available at no charge from:

Alice Mayio
U.S. EPA Volunteer Monitoring Coordinator
Office of Wetlands, Oceans, and Watersheds
4503F
401 M Street
Washington, DC 20460
(202) 260-7018

Volunteer Water Monitoring: A Guide for State Managers. Basic guidelines on starting and managing a volunteer water quality monitoring program. 80 pages. U.S. EPA, 1990.

Volunteer Lake Monitoring: A Methods Manual. 121 pages. U.S. EPA, 1991.

Volunteer Estuary Monitoring: A Methods Manual. 176 pages. U.S. EPA, 1993.

National Directory of Volunteer Environmental Monitoring Programs. 4th edition. 531 pages. U.S. EPA, 1994.

Proceedings of the Third National Citizens' Volunteer Water Monitoring Conference (held in April 1992). 183 pages. U.S. EPA, 1992.(Note: The proceedings of the fourth national conference will be available in the fall.)

"Volunteer Monitoring on the Nonpoint Source Electronic Bulletin Board System." 2-page fact sheet. U.S. EPA, 1994.

Additional References

Although the following manuals are intended for professionals, they are essential references for volunteer groups that want to do relatively sophisticated tests.

Standard Methods for the Examination of Water and Wastewater (18th edition). American Public Health Association, 1992. $160 + $12 shipping. Available from APHA, 1015 15th St., NW, Washington, DC 20005.

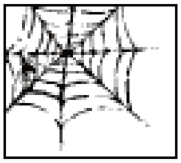
Rapid Bioassessment Protocols for Use in Streams and Rivers: Macroinvertebrates and Fish. U.S. EPA, 1989. EPA/444/4-89/001. Free. Available from U.S. EPA, AWPD, 4503F, 401 M Street, SW, Washington, DC 20460.

Methods for Chemical Analysis of Water and Wastes. U.S. EPA, 1983. Pb84-128677. $52. Available from National Technical

Information Service (NTIS); call toll-free, 800/553-6847.

Publications by Volunteer Groups

Many volunteer monitoring groups produce methods manuals, newsletters, videos, and other materials that can be very helpful to other groups. EPA's Nonpoint Source Electronic Bulletin Board System (NPS BBS) contains an extensive on-line listing of such resources. A compilation of selected manuals and newsletters from the NPS BBS database is available in print form from Alice Mayio (see address above).



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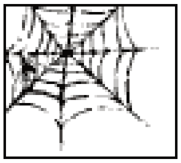
The Ascorbic Acid Method at a Glance

- 1) Make a set of standard concentrations in acid-washed, dedicated containers. Use a purchased stock solution of 1.0 mg/l as P and dilute it with pure distilled water to make concentrations in the desired range. Typical standard concentrations might be 0 (just distilled water), 0.04, 0.08, 0.12, 0.16, and 0.2 mg/l.
- 2) Add ascorbic acid reagent to standards and wait for blue color to develop (10-20 minutes)
- 3) Use the 0 mg/l standard to set the meter to zero.
- 4) Pour each standard into a cuvette and read absorbance with the meter.
- 5) Plot results on a graph - concentration on the x-axis, absorbance on the y - and draw a "best fit" curve through the points. This is the "standard curve." You should have a straight line, ideally with the points right on the line. If your points are far off the line, you should start again.
- 6) Measure water samples into acid-washed, dedicated containers. Add ascorbic acid reagent to the water samples and wait for color to develop.
- 7) Read absorbance of samples.
- 8) Plot absorbance of samples on standard curve and read concentrations off the x-axis.

The Volunteer Monitor, Vol. 6, No. 1, Spring 1994



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Phosphorus Testing Tips

After several years of chasing the elusive "best method" for doing total phosphorus analysis in a volunteer water quality monitoring program, I have learned some tips that I'd like to pass along:

- 1. Always, always, always use acid-washed sample bottles and glassware. Never use phosphate-based detergents to clean glassware or sample bottles.
- 2. Be sure to use replicates or split samples to check your results, and to run a sample of known concentration along with your water samples.
- 3. For the persulfate digestion method, many kits provide the sulfuric acid and sodium hydroxide in dropper bottles. We DO NOT recommend using these droppers, because we have found that they can be off by as much as 0.1 to 0.2 ml, which is enough to drastically influence results. Use standard pipets or automatic pipetters.
- 4. Use the same glass cuvette in your spectrophotometer for all your samples. Not all cuvettes allow light to pass through them equally. Triple rinse the cuvette between samples.
- 5. When using prepackaged reagents, be sure to set the spectrophotometer to the wavelength recommended by the manufacturer of the reagents.

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