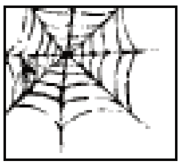
The Volunteer Monitor

The National Newsletter of Volunteer Water Quality Monitoring
Volume 6, No. 2, Fall 1994



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Special Topic: Monitoring a Watershed

"Monitoring a watershed" means studying an entire watershed as an interconnected system - streams along with lakes, wetlands, and estuaries; land uses as well as water quality; groundwater in conjunction with surface water; wildlife habitats in water and on land.

To monitor on a watershed basis, volunteer groups are acquiring new skills; and not just scientific and technical expertise, like methods for assessing habitat or monitoring groundwater, but communication and leadership skills as well. When you broaden your scope to include your whole watershed, you're encompassing a large and diverse group of people who are using the land in many different ways.

Watershed-wide monitoring is a far-reaching, holistic concept; It's also an ambitious one - much more daunting than, say, doing chemical testing on a small segment of a stream. Yet volunteer monitoring groups around the country are embracing the task with enthusiasm. They are recognizing that whereas water quality monitoring mainly tells you the *effects* of pollution, watershed-wide monitoring helps you track down pollution *sources*. Once you know where pollution is coming from, and you've got the various land users in the watershed working together, you've taken a giant step toward controlling and preventing pollution problems.

Co-Editors: Tip of the Mitt Watershed Council

This issue was co-edited by the Tip of the Mitt Watershed Council, a coalition of citizens, lake associations, businesses, and resorters working together to protect northern Michigan's water resources through a combination of water quality testing, education programs, consultation, and advocacy efforts.

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

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A Plan for Watershed-Wide Volunteer Monitoring

by Geoff Dates

How does one design a monitoring program for a large watershed? River Watch Network (RWN) has been wrestling with this question for years as we work with groups in several large watersheds: the Mississippi, the Rio Grande, the Connecticut, the Hudson, and the Merrimack.

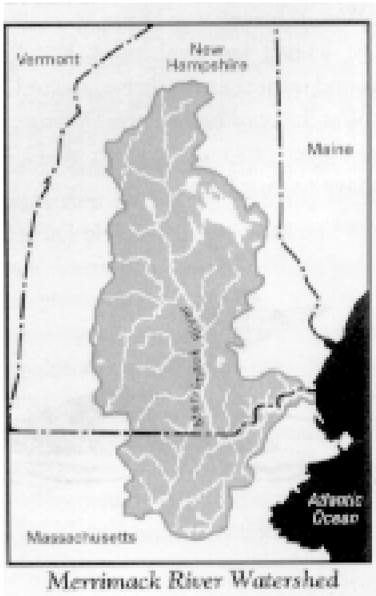
Our approach in each of these has been from the "bottom up" (in this case a euphemism for "piecemeal"). A local group contacts us and we help them set up a program for their area. That's OK, as long as the problems are local in nature and what's happening upstream does not affect that particular area. But we've found, more often than not, that the piecemeal approach has significant problems in a big river system. For instance:

- It's difficult, if not impossible, to interpret results. Suppose you find high bacteria levels. How do you know whether they're from local or upstream sources?
- Monitoring groups on the same river are frequently monitoring different indicators, for different reasons, using different methods. That makes it impossible to integrate all their results into a coherent picture.
- The condition of a large river may, in fact, be more a reflection of what's happening on its tributaries than what's happening on the main stem.

So, we've got to look at the whole watershed. But how? A large river watershed is a highly complex ecosystem. Within it is an equally complex system of federal, state, and local government jurisdictions, all making decisions that affect the watershed. Political and jurisdictional boundaries seldom follow watershed boundaries but instead overlap the natural boundaries (and each other) in a confusing patchwork. Add to all this an assortment of citizen groups working to protect resources in the watershed, but often without coordinating their efforts.

Obviously, monitoring a large watershed can be a mind- boggling scientific, organizing, and political challenge. A coalition of agencies and groups have designed an approach to tackle that challenge in the Merrimack River watershed.

The Merrimack River Watershed



The Merrimack River begins in New Hampshire's White Mountains as the clear cold Pemigewasset River. Sixty- five miles later, the "Pemi" joins the Winnipesaukee River to become the Merrimack. From there, it's 115 miles to the Atlantic Ocean near Newburyport, Massachusetts. The river system drains 5,010 square miles of watershed.

The upper watershed is in the White Mountain National Forest. As the river flows to the sea, it encounters major urban areas, including the cities of Concord, Manchester, and Nashua in New Hampshire, and Lawrence, Lowell, Haverhill, and Newburyport in Massachusetts. The river is used for hydropower, recreational boating, and fishing, and it provides drinking water for some 300,000 people. The mouth is an important harbor for recreation and commercial fishing.

The watershed faces a variety of threats, including:

- Periodic discharge of inadequately treated sewage
- Toxic pollution from historic and present sources
- Urban stormwater runoff
- Land development, causing increasing demands for water, increased numbers and densities of septic systems, increased use of landscaping chemicals, and loss of wetlands and wildlife habitat

Who's Doing What?

Seventy-four percent of the Merrimack watershed lies in New Hampshire and 26 percent in Massachusetts - two neighbors that are about as different as possible. Beyond the stereotypes - conservative, anti-tax, small-government New Hampshire versus liberal, "tax anything that moves," big-intrusive-government Massachusetts - the two states differ significantly in size and complexity as well as in resources devoted to monitoring.

And there's a lot of monitoring going on. The NH Department of Environmental Services; the MA Department of Environmental Protection; the MA Department of Fisheries, Wildlife, and Environmental Law Enforcement; the MA Department of Environmental Management; the U.S. Geological Survey; the U.S. Environmental Protection Agency; state and university-run lay lake monitoring programs; a number of volunteer river monitoring programs; water companies and agencies monitoring water supplies; and on and on.

To try to bring some order out of this chaos, the Merrimack River Initiative (MRI) was created in 1988 to coordinate efforts to protect and restore the system. The MRI is a collaboration of agencies, businesses, and nonprofit organizations. One of the projects that the MRI expressed an interest in was the development of a coordinated volunteer monitoring program. So River Watch Network (RWN), the Massachusetts Water Watch Partnership (MWWP), and the Merrimack River Watershed Council (MRWC) set about to design one.

The challenge we face is to figure out how volunteer monitoring fits into the complicated overall monitoring picture. How can volunteer monitoring programs be coordinated with each other, and with the other monitoring programs listed above, so that they produce meaningful and credible information that supplements rather than duplicates agency efforts? Further, how can we do this in a way that preserves each volunteer group's autonomy and strengthens the individual organizations?

A Volunteer Environmental Monitoring Network

What we developed, and what the MRI subsequently funded (at least partially), is the Merrimack River Volunteer Environmental Monitoring Network. We proposed a two- tiered model. Tier one is a watershed-wide support system coordinated by a team. This support team develops watershed-wide study designs and provides technical assistance to volunteer monitoring groups in the watershed, but does not perform the actual monitoring work. Tier two consists of the individual volunteer programs, who carry out the monitoring according to the watershed-wide study design while maintaining their own identity and autonomy.

Tier One: Watershed-wide support system and study design. The support team will include a watershed monitoring coordinator, consulting organizations (e.g., RWN, MWWP, and Cooperative Extension), and technical advisors from state and federal agencies, universities, and businesses. One of the team's first services will be to develop both watershed-wide and tributary-specific study designs.

The watershed-wide study design will consist of a **core set of studies** designed to answer watershed-wide questions. For example, if a watershed-wide question is whether the waters meet state water quality standards, the study package will guide groups to appropriate sampling locations, indicators, methods, and frequency, and will be designed to produce data that state water quality agencies can use in their assessments.

The support team will also develop **optional study packages** that will answer questions specific to a tributary, river reach, or issue - for example, a question about the impacts of a certain wastewater treatment plant.

For both types of study, the team will develop a range of sampling and analytical protocol options, from simple to complex. A monitoring group can choose the level of sophistication it will undertake according to its resources and its data quality goals. Individual groups' data quality goals will be based on who will be using the group's data and for what purpose.

The support team will also develop QA/QC protocols, provide hands-on training and written documentation (e.g., manuals) for use throughout the watershed, produce watershed-wide reports, and explore ways to provide long- term human and financial support for volunteer monitoring programs.

Finally, the team will help organize new monitoring programs in areas of the watershed where interest is high and the need is great.

SUE SMITH

Volunteers collect macroinvertebrates on a tributary to the Merrimack River.

Tier Two: Individual monitoring programs in subwatersheds or river reaches. The actual monitoring will be managed by new or existing volunteer monitoring organizations. They will be guided by the watershed-wide study design but will select the appropriate protocols (simple or sophisticated) for their group. Individual groups will have primary responsibility for their own fundraising; for recruiting, organizing, training, and managing volunteers; for managing and reporting the data they collect; and for taking action on the data. However, support and guidance for all these activities will be provided by the watershed-wide support system team.

Coordination & Cooperation

This is not a centralized, directive model. While it provides centralized coordination and guidance, it does not "take over" existing programs or manage new ones. Independent watershed groups will continue to own their programs, take credit for their success, and chart their own course. Groups will not be "required" to participate. If they do, however, they will gain access to an organizational and technical support system that will help them produce information that will be used by decision makers. In fact, it will connect them directly with decision makers in the study design and data analysis phases.

The program will be administered and managed by the Merrimack River Watershed Council (MRWC), with the support and guidance of a steering committee. As of this writing, we have hired a watershed coordinator, Alicia Lehrer, and are beginning the study design and organizational process.

The MRI and the VEMN present an opportunity to design a monitoring program that involves a broad spectrum of the watershed community - citizens, businesses, government, and nongovernment organizations. In the process, we hope to gain some insights that will be helpful to monitoring groups in other large watersheds.

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Aerial Photographs - A Useful Monitoring Tool

by Nancy M. Trautmann and Eugenia M. Barnaba

Identification of Contaminated Sites

In a small community in New York State, concerned citizens requested that their local Environmental Management Council investigate a site being considered for a youth recreation facility. Although the site appeared ideally suited to outdoor recreation, longtime residents knew that it had once been used as a landfill. The citizens raised many questions: What had been dumped, for how long, and in how large an area? Most importantly, did any environmental or health hazards exist? To answer these questions, the Environmental Management Council collected information from the general public and from historical records of the companies involved. They also contracted with the Cornell Laboratory for Environmental Applications of Remote Sensing (CLEARS) to conduct a land use survey.

CLEARS, a facility within Cornell University's Center for the Environment, conducts research and extension programs in remote sensing, geographic information systems, and resource inventories. Remote sensing means collecting and interpreting data from a distance, using techniques such as radar, satellite imagery, or aerial photography.

Aerial photographs, taken from aircraft or satellites, commonly are used for identification of potential sources of water or soil contamination and were a logical place to look for information about dumping practices at the landfill in question. Using 12 sets of aerial photographs, taken over a 34-year period, of the proposed recreational facility site, CLEARS analysts were able to precisely locate areas that had been used for active dumping and disposal. Soil and water tests by the state confirmed the presence of a variety of contaminants and led to placement of the site on the state's Superfund list. As a result, plans to develop the site as a recreational facility were dropped, the dumping area was capped to prevent continued leaching, and long-term monitoring studies were launched to assess the extent of soil contamination and its effects on surrounding ground and surface waters. Similar evaluations are being carried out in many New York State communities, stimulated by educational programs about remote sensing.

Educational Programs

CLEARS carries out a variety of educational programs aimed at teaching community officials, environmental professionals, teachers, and informal educators how to use aerial photographs and maps to analyze land uses and their potential effects on water quality. By looking at topographic maps and aerial photographs of their own communities, participants learn to place each piece of land into the context of a watershed, tracing where surface water comes from before it reaches each site and where it flows to as it continues its way downstream. The watershed context helps people to see beyond political boundaries, linking their water quality and water uses to land uses and management practices in a broader geographic region.

SHARRON BENNETT

At a CLEARS workshop, 4th-graders from Woodrow Wilson School in Binghamton, NY, study an aerial photograph of their neighborhood.

After attending programs such as these, participants have launched into a diverse range of activities. A teacher in Ithaca, New York, uses aerial photographs and maps with her third grade class to teach them to make detailed observations and measurements as they walk around the block next to their school. Teenagers in a Cornell Cooperative Extension 4-H program recently spent six days in the Adirondack Mountains, using aerial photographs and topographic maps to calculate the effects of acid rain on the ecosystem of the region. In New York City, high school classes are using aerial photography to study the effects of urban land uses on the neighboring coastal waters.

Aerial Photography

Aerial photographs, taken with a camera mounted in an aircraft that flies over a designated area, provide a bird's-eye view of land uses, management practices, drainage patterns, and potential sources of contamination of both ground and surface waters. Aerial photos can be viewed individually, or if they are taken in overlapping sections, they can be viewed in pairs for a three-dimensional image using a simple device called a stereoscope.

Analysis of aerial photographs provides a key tool in identification of potential sources of soil and water contamination. Because land use changes over time, a thorough analysis of possible contaminant sites includes an inventory of historic as well as present land uses. This can be accomplished by combining information from maps, business directories, local histories, and economic surveys with data obtained from current and historic aerial photographs.

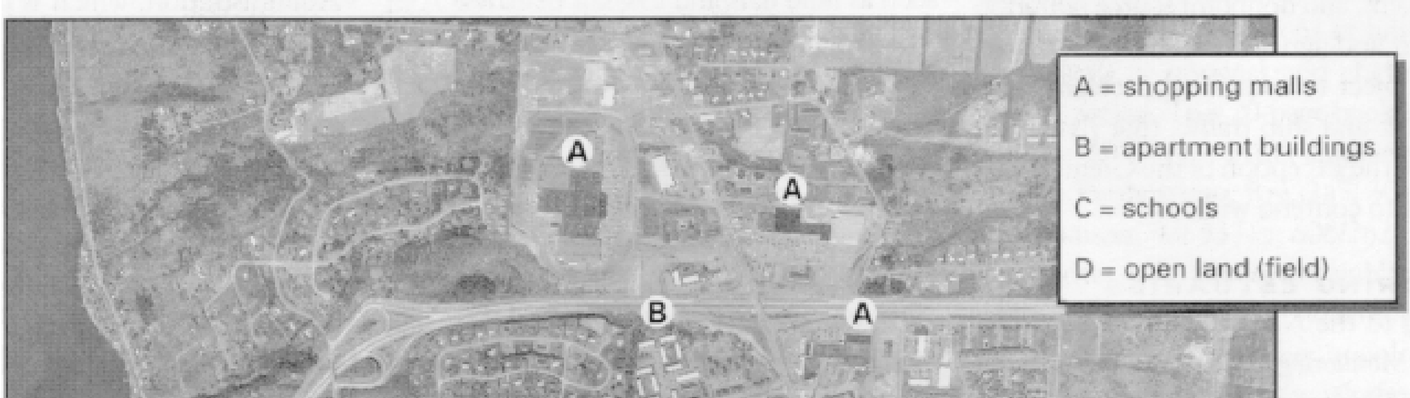
Historic Aerial Photographs

Odd as it may seem, aerial photographs were used in mapping and aerial reconnaissance even before the Wright brothers' historic first flight in 1903. The first known aerial photograph was taken in 1858 by a Parisian photographer riding in a hot air balloon. Following the earthquake and devastating fires in San Francisco in 1906, aerial photographs were taken for news reports using a giant camera suspended from 17 kites (the camera alone reportedly weighed more than the Wright brothers' airplane and pilot!). As early as the 1920s, government agencies and private firms began producing aerial photographs using more conventional aircraft.

Often, photographs of the same area were taken every few years, creating an extended record of land use changes over time. Historic aerial photographs such as these provide key information in the process of identifying, classifying, and prioritizing waste disposal sites. By comparing photographs taken at various dates, researchers can detect former landfills, dump sites, lagoons, pits, and above-ground storage tanks that currently are obscured by development or vegetation.

Analysis of Water Quality Trends

In addition to identification of specific contaminant sources, analysis of land use changes over time can provide insights into general trends in water quantity and quality. For example, consider the two aerial photographs at below, which show the same area of land in Ithaca, New York, in 1938 and 1991. Over the 53-year interval between these two photos, the land use in this area has changed from predominantly agricultural to residential and commercial. The resulting increases in highways, parking lots, roofs, and other impervious surfaces would be expected to cause a number of changes in water quantity, including an increase in the amount of runoff immediately following storms, a decrease in the amount of percolation to groundwater, and an increase in the degree of streamflow fluctuation. Higher streamflow peaks would be expected after storms, and lower flows during the intervening intervals.



The large black surface on the left in both photos is the southern end of Cayuga Lake, and the dark horizontal lines along its shore represent streams flowing into the lake. The 1938 photo (top) shows patches of land in various forms of agriculture, pasture, and forest, with a few scattered houses. By 1991, most of these open spaces have been filled with residential and commercial development.

Water quality would also be expected to change. Comparison of stream corridors in the two air photos shows a lower density of vegetation along stream banks in the 1991 photo, probably indicating a higher sediment load in the streams. The increase in highways, parking lots, and driveways between 1938 and 1991 would lead to increased runoff of road salt, oil, and other contaminants. Conversion of farm fields to residential and commercial uses could have caused either an increase or a decrease in runoff of fertilizers and pesticides, depending on the intensity of management of the farm land and of the lawns, golf courses, and parks that replaced it.

Sources of Aerial Photographs

Historic and current aerial photographs are readily available from a variety of sources including local, state, and federal governments as well as private firms. Local sources include planning offices, highway departments, assessment offices, health departments, and soil and water conservation districts. State departments of transportation usually have aerial photographic coverage of strips along state and federal highway systems and of some urban areas. Some states have coverage for the entire state. "Federal Sources of Aerial Photographs" is listed separately. Prices generally range from $3 to $5 for 10-by-10-inch black-and-white photos up to $30 for prints up to 40 inches.

For More Information

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Avery, T.E. and G.L. Berlin. 1985. *Interpretation of Aerial Photographs*, 4th ed. Burgess Publishing Co., Minneapolis. 554 pages.

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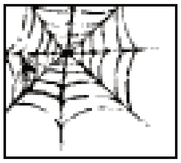

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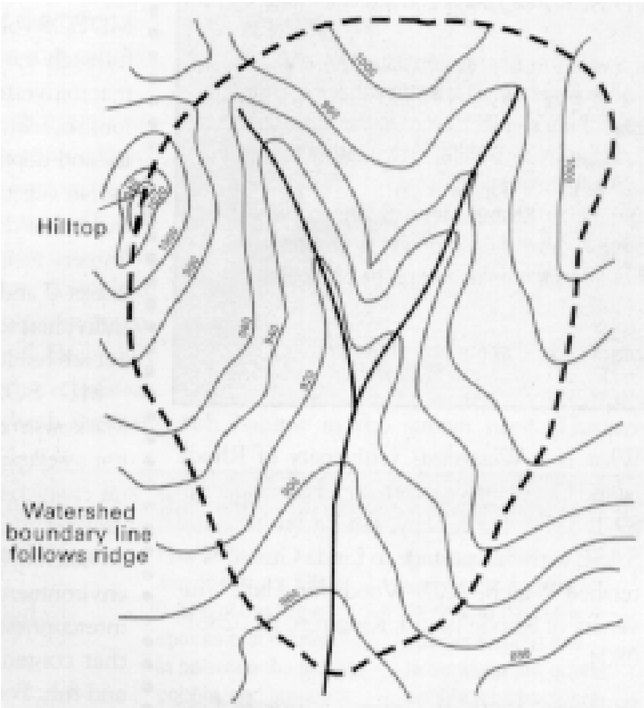
Delineating a Watershed

A number of articles in this newsletter talk about the value of a watershed approach to monitoring. But before you can get started on watershed-wide monitoring studies, the first step is to define your watershed's boundaries.

The U.S. EPA defines a watershed as "a geographic area in which water, sediments, and dissolved materials drain into a common outlet" - a stream, lake, estuary, aquifer, or ocean. This area is also called the drainage basin, drainage area, or catchment of the receiving water body. (*Editor's note:* Sometimes the word *watershed* is used to refer to a watershed boundary, or dividing line. In this sense, for example, the North American Continental Divide - the boundary between all waters flowing to the Atlantic Ocean and the Pacific Ocean - can be called a watershed. However, in this article, and in the other articles in this newsletter, the term *watershed* is synonymous with *drainage basin*.)

Since water flows downhill, watersheds are defined by topography; to draw a watershed boundary, you essentially connect high points and ridges on a topographic map. But even though the concept is simple, the actual task can be quite challenging for people without extensive experience in interpreting topographic maps - especially if the watershed lies in an area of varied and complex terrain.



Idealized watershed boundary. Adapted from Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire.

Watersheds Within Watersheds

The watershed of a large river, lake, or estuary can be divided into numerous subwatersheds (or subbasins). The watershed of the Mississippi River covers the entire central United States and is made up of hundreds of smaller subwatersheds, down to the individual watersheds of the smallest creeks. The drainage areas of estuaries can also be enormous.

How a monitoring group defines its watershed will depend on the group's goals, area of interest, funding, and resources. For example, if you are dealing with a lake, are you interested in only the immediate shoreline area, or the entire watershed encompassing the land drained by all the inflowing streams? For a river system, do you want to monitor the watersheds of tributaries? and the tributaries of the tributaries? When defining an estuarine watershed, you need to decide whether to study just the primary coastal drainage areas contributing direct runoff to the estuary, or whether to include inland areas also.

Obtaining Maps

Before undertaking the potentially daunting task of delineating your watershed boundaries "from scratch" on a topographic map, check to see whether a government agency such as your local conservation district, planning department, or state environmental agency has already done the work for you. Most likely, such agencies can provide you with maps showing the boundaries of at least the major watersheds. For smaller subwatersheds, you may need to draw the boundaries yourself. You'll need one or more U.S. Geological Survey topographic maps, preferably in a 1:24,000 scale. These can be ordered directly from USGS (call 1-800-USA-MAPS for catalog), or obtained at sporting goods stores, college bookstores, or state conservation agencies. The maps generally cost less than $4 each; however, a large watershed may require many maps. (In urban areas, you should also consult a map of the sewer system. Storm sewers may conduct runoff in a different direction than you would predict by looking at surface topography.)

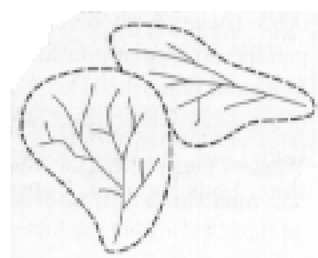
If you are not familiar with reading and interpreting a topographic map, see the box (next page) for some pointers.

Delineating Watershed Boundaries

Now that you've obtained topographic maps of your area, follow the steps below to draw your watershed boundaries.

1. Locate and mark the downstream outlet of the watershed. For lake watersheds, this will be the lake outlet. For rivers and streams, it will be the furthest downstream point that you are interested in.
2. Locate all water features (streams, wetlands, lakes, reservoirs) that eventually flow to the outlet. Start with major tributary streams and wetlands, then include smaller streams and drainage channels. To determine if a stream is flowing to or from a lake or river, compare the elevation of land features to that of the water body.
3. Use arrows to mark the direction of stream or wetland flow.
4. Now that the tributary waters have been identified, the watershed boundaries can be drawn. Find and mark the high points (hills, ridges, saddles). Then connect these points, following ridges and crossing slopes at right angles to contour lines. This line forms the perimeter of the watershed.
5. If desired, subwatersheds can be delineated by locating internal drainage divides that are bounded by ridges at lower elevations than the primary watershed boundary.

For some purposes, exact watershed boundaries may not be needed. For example, teachers who want to draw approximate boundaries to use as a classroom example can do so by looking at the pattern of stream flow and drawing dividing lines between stream systems, as shown at right.



Some of the steps outlined above for delineating a watershed are easier said than done. For the inexperienced, expert guidance is strongly recommended. Field checking the boundaries is also helpful (an additional benefit is that going out into the field allows you to identify human alterations, such as road ditches, that could change the direction of water flow and affect the boundaries). Finally, bear in mind that delineating a watershed is an inexact science - any two people, even if both are experts, will come up with slightly different boundaries.

References

Ammann, Allen, and Amanda Lindley Stone, *Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire*. 1991. Available for $12.50 from New Hampshire Department of

Environmental Services, PIP, P.O. Box 95, Hazen Dr., Concord, NH 03302-0095. (*Note:* A photocopy of the 6-page appendix on "Interpretation of Topographic Maps and Watershed Delineation Procedures" is available for $1 from Wildlife and Wetlands Dept., Audubon Society of New Hampshire, 3 Silk Farm Rd., Concord, NH 03301.)

What Is a Watershed? University of Rhode Island Cooperative Extension, Fact Sheet no. 89-1. 1989. For a copy, send a business-size SASE with 52¢ postage to Linda Green, Watershed Watch, 210B Woodward Hall, University of Rhode Island, Kingston, RI 02881-0804.

Williams, Scott. *A Citizen's Guide to Lake Watershed Surveys: How to Conduct a Nonpoint Source Phosphorus Survey*. 1992. Maine Department of Environmental Protection; Congress of Lake Associations. To order, send a check for $2 made out to COLA, plus a 9 x 12 SASE with $1.20 postage, to COLA, P.O. Box 391, Yarmouth, ME 04096.

__Ann Baughman__ (Tip of the Mitt Watershed Council), __Kathleen Leyden__ (Shore Stewards Partnership, Maine State Planning Office), and __Nancy Trautmann__ (Cornell Center for the Environment) contributed to this article.

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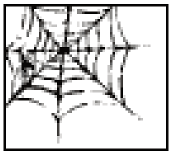

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Habitat Monitoring

Celeste Moen and Jerry Schoen

Aquatic biologists are beginning to recognize what interior decorators have long been telling us: that the space we live in is as important to life as what we eat and breathe. The National Research Council recently reported that habitat degradation is a primary factor limiting beneficial uses of the nation's surface waters. Webster defines habitat as "the place or type of site where a plant or animal naturally or normally occurs." If we want to enjoy good water quality and the beneficial uses that come with it, we ought to look into the living- space needs of aquatic plants and animals.

Many volunteer monitoring programs are doing just that with **habitat surveys**. By measuring physical, and in some cases biological, attributes of water bodies they hope to get a better picture of the water's ability to support life.

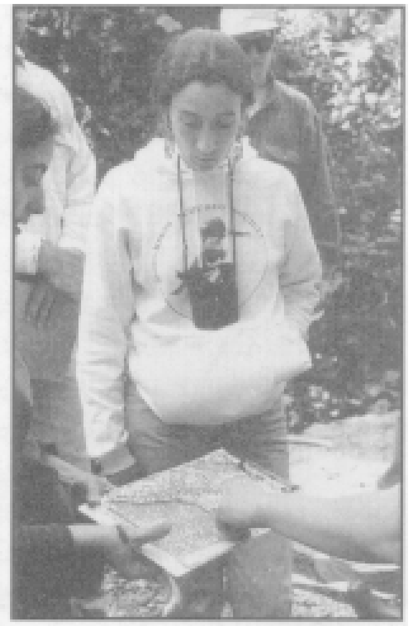
Getting Physical

Over the last 20 years, the fight for clean water has largely been waged with chemical and biological warfare, and we've only partly done the job. It's time to get physical. In many of our nation's waters, physical insults such as erratic stream flows (too high or too low), excessive sediments, and unnaturally elevated temperatures are the main culprits killing or driving off bugs, plants, and fish. Habitat monitoring documents these conditions, and gives us clues as to their causes and effects.

Habitat for Whom?

Whose habitat are we looking at? The majority of volunteer groups that do habitat assessments are evaluating macroinvertebrate and/or fish habitat in rivers and streams. But some are looking at habitat for birds, amphibians, and other wildlife.

There's a good reason why habitat assessment so often goes hand in hand with macroinvertebrate surveys. Bug counts can tell you if *something* is adversely affecting the macroinvertebrates in your stream . . . but what? A habitat assessment can help you decide whether any imbalance you detect in the macroinvertebrate community is due to habitat limitations (for example, heavy sediment deposition or lack of macroinvertebrate attachment sites) or a water quality problem (such as a toxic discharge or low dissolved oxygen).



ELEANOR ELY

Volunteers studying a creek watershed near San Francisco Bay.

Bugs & Fish: Maryland SOS

Maryland Save Our Streams (MD SOS), for instance, couples habitat assessments with macroinvertebrate population surveys in Project Heartbeat, its volunteer biological monitoring program modeled on the EPA's *Rapid Bioassessment Protocols* (For More Information) . For the habitat assessment, MD SOS volunteers evaluate a stream reach for such variables as attachment sites for macroinvertebrates, embeddedness, shelter for fish, sediment deposition, stream velocity and depth, condition of banks, and riparian vegetative zone width. Using a data sheet that describes what to look for, volunteers assign each variable a score between 0 and 20 (see next illustration). Individual scores are combined to yield an overall habitat rating.

Parameter	Optimal	Suboptimal	Marginal	Poor
Embeddedness	Fine sediment surrounds and fills in 0-25% of the living spaces around and in between the gravel, cobble, and boulders.	Fine sediment surrounds and fills in 25-50% of the living spaces around and in between the gravel, cobble, and boulders.	Fine sediment surrounds and fills in 50-75% of the living spaces around and in between the gravel, cobble, and boulders.	Fine sediment surrounds and fills in more than 75% of the living spaces around and in between the gravel, cobble, and boulders.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Attachment sites for macroinvertebrates	Well-developed riffle and run; riffle is as wide as stream and length extends two times the width of stream; cobble predominates; boulders and gravel common.	Riffle is as wide as stream but length is less than two times width; cobble less abundant; boulders and gravel common.	Run area may be lacking; riffle not as wide as stream and its length is less than 2 times the stream width; gravel or large boulders and bedrock prevalent; some cobble present.	Riffles or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Shelter for Fish	Snags, submerged logs, undercut banks, or other stable habitat are found in over 50% of the site.	Snags, submerged logs, undercut banks, or other stable habitat are found in 30-50% of the site.	Snags, submerged logs, undercut banks, or other stable habitat are found in 10-30% of the site.	Snags, submerged logs, undercut banks, or other stable habitat are found in less than 10% of the site.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Excerpt from habitat assessment data sheet used by volunteers in MD SOS's Project Heartbeat (the actual data sheet contains a total of 10 parameters).

MD SOS Project Director Abby Markowitz explains that MD SOS's habitat assessment is designed to look at habitat characteristics that affect both macroinvertebrates and fish, with a primary focus on macroinvertebrates. Because the aquatic environment is one of interdependence and interconnectedness, a healthy stream is one that contains good habitat for both bugs and fish. For example, riffle areas are good "neighborhoods" for bugs since they provide oxygen, round-the-clock food delivery, and rocks to live on; but fish prefer slower, deeper pool areas in which to rest and hide from predators. A stream reach that contains both types of environment - pools and riffles - rates higher for this parameter than if one of these habitat types were missing. If pools are present, but riffles are not, fish as well as macroinvertebrate habitat will be impaired. The fish may have good shelter, but they will most likely be lacking a critical food source.

MD SOS's habitat assessment method is quite demanding; it takes a full day to train volunteers. But the time spent is well worthwhile. "I can think of no other method that better demonstrates to volunteers and to the public how a water body functions," says Markowitz.

Bugs: River Watch Network

Vermont-based River Watch Network (RWN) provides training and technical assistance to groups carrying out macroinvertebrate surveys in nine states. RWN groups analyze macroinvertebrate samples according to a rigorous, EPA Region 1-approved procedure. In conjunction with these surveys, RWN groups assess many of the same habitat characteristics as MD SOS; but they leave out those characteristics, such as optimal fish cover, that are important only to fish. The reason, explains RWN New England Coordinator Geoff Dates, is that the sole purpose of RWN habitat assessments is to evaluate those characteristics that determine the types and numbers of macroinvertebrates that can live there.

The three primary habitat characteristics assessed by RWN groups are bottom composition (percent of each of seven bottom types), current velocity (in feet per second), and embeddedness (percent of cobbles covered in sand or silt). According to Dates, these three have the greatest effect on the types and numbers of macroinvertebrates found. Secondary characteristics include riffle characteristics, channel flow status, velocity-depth regimes, overhead canopy, and others. While these affect the community, they are not as critical. No scoring system is used. Most of the parameters are recorded in terms of either percentages (e.g., embeddedness, bank vegetation) or actual measurements (e.g., current velocity, distance between riffles).

Dates gives the following example of how RWN habitat assessment data are used: Suppose you want to assess the impact of a wastewater discharge on a stream. Say the macroinvertebrate survey reveals a different community below the discharge than above. If habitat characteristics are similar at both sites, then the differences between the communities are attributed to the discharge. On the other hand, suppose that the cobble is significantly more embedded at the downstream site. Then poorer habitat quality might explain at least part of the differences between the macroinvertebrate communities.

Riparian Habitat in the Arid West

"Back East," says Coyote Creek Riparian Station (CCRS) Director Mike Rigney, "from a migrating bird's point of view there's not that much difference between a riparian forest and another deciduous forest. But out here in the arid Western states, river and stream corridors are the only places where you find a deciduous forest." At the southern end of San Francisco Bay, where CCRS is located, these "ribbons of refuge" are severely threatened by development, yet little information exists on the extent of remaining intact riparian habitat. So in 1992 CCRS launched Community Creek Watch, a volunteer-conducted survey of local stream habitats.

Creek Watch volunteers are looking at wildlife habitat in the stream corridor and fish habitat in the stream itself. Through stream mapping and vegetation surveys, teams of volunteers are assessing riparian habitat for birds, amphibians, and reptiles - all of which are highly dependent on the riparian zone for survival. "The mapping gives us a general, *qualitative* description of the entire stream corridor," explains Rigney, "while in the vegetation survey we are collecting quantitative information at specific points - like number of trees, height and diameter of trees, or width of the riparian corridor."

In the stream itself, volunteers are evaluating habitat for fish - specifically salmon and steelhead - using a classification system modeled on the one used by the California Department of Fish and Game. The system is very detailed; habitats are broadly classified into four types - riffle, pool, glide, or run - and then subtyped into over 20 different categories, such as "low gradient riffle," "step pool," or "lateral scour pool" (illustration not included in online version). The volunteers also record such parameters as substrate composition, instream shelter, and overhead canopy.

So far, Creek Watch does not include macroinvertebrate surveys. That's because four of the six creeks being studied are intermittent, explains Rigney. "If we find pollution-sensitive bugs, we know water quality is good; but the converse is not necessarily true. Some species might be absent just because they don't have time to complete their life cycle before the stream goes dry." Rigney is investigating ways that macroinvertebrate survey methods developed for use in wetter regions might be modified for use in the West.

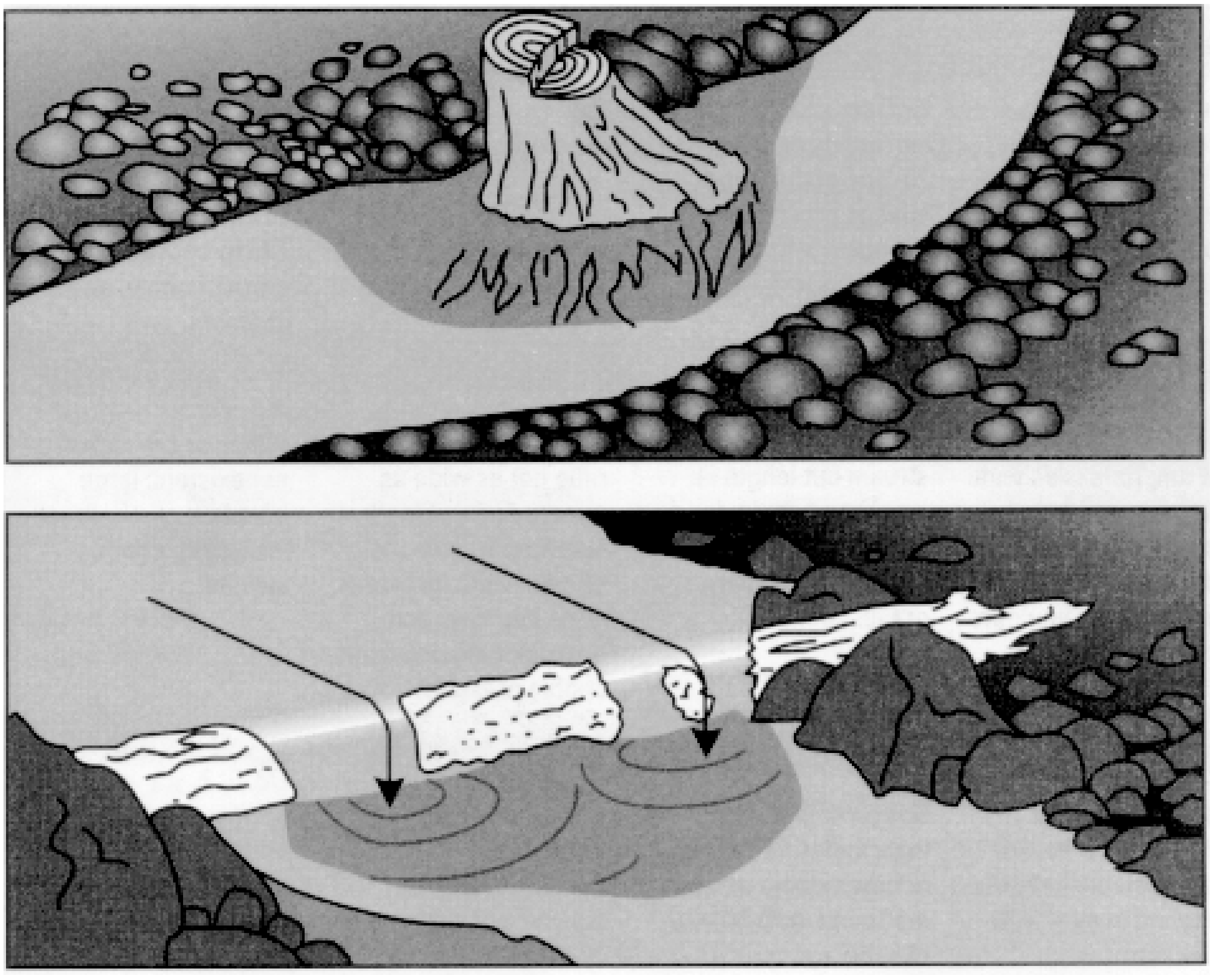
A Range of Methods

The methods discussed above are quite rigorous. However, a number of other methods, with varying degrees of rigor, are used by volunteer programs around the country. Some of these programs combine habitat assessments with chemical or biological monitoring. Others, like EPA Region 10's widely used Streamwalk, incorporate habitat assessment into an observational monitoring approach.

Streamwalk leads volunteers through a checklist of stream and riparian characteristics that includes habitat-related parameters like stream bottom composition, presence of pools and riffles, and streamside vegetation. The questions are fairly simple and tend to be more qualitative than quantitative; for example, for stream bottom, the worksheet lists six general types and directs volunteers to "check those most common." Volunteers also record the presence and severity of specific problems (such as degraded plant cover, eroded banks, mud or garbage in the stream), as well as probable causes, which are selected from a list of suspects that includes construction, logging, mining, agricultural activities, and urban/suburban land uses. The information from the survey provides a broad assessment of a stream's ability to support aquatic life and identifies areas that need protection or restoration.

In Washington State, where salmon is king but with its reign in jeopardy, the city of Bellevue's Stream Team Program supplements the basic Streamwalk method with information on specific habitat preferences of different salmonid species. King salmon, for instance, prefer streams that are made up of 50 to 100 percent pools and have gradients of less than 2 percent, while steelhead (sea- going rainbow trout) do fine with streams that have less than 50 percent pools and gradients of up to 5 percent.

Simple or sophisticated, habitat surveys have several things in common that are good for volunteers. First, they don't require expensive equipment (usually measuring tape, thermometers, paper, pencils, and clipboards are all that are needed). Second, properly trained volunteers can generally do as good a job as professionals. And finally, they're great for teaching participants about watershed ecology. Because habitat surveys commonly include observations of the land-water interface, such as width and condition of the riparian corridor, presence of streamside vegetation, and eroding or channelized banks, they encourage volunteers to make connections between what we do on the land and how the water body and its inhabitants react to these events.

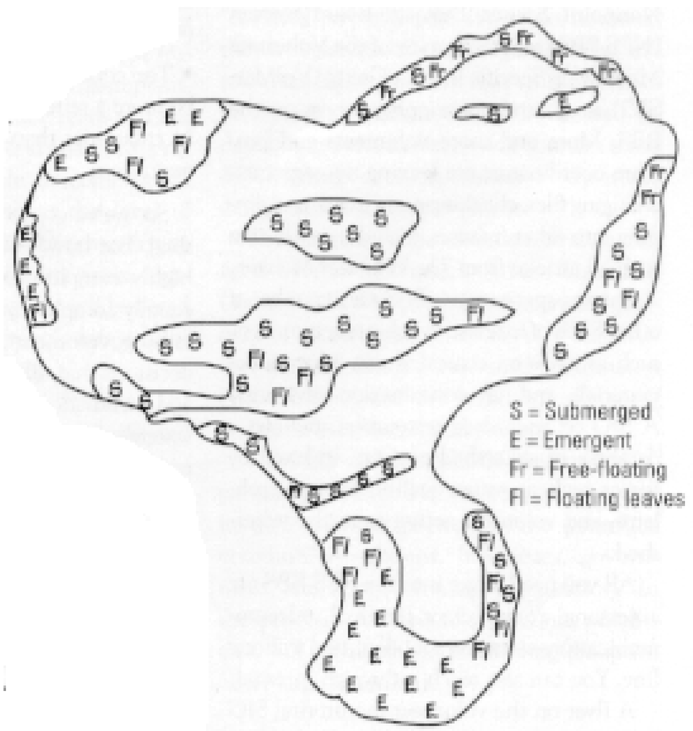


Community Creek Watch volunteers use drawings like these to help classify fish habitat. Top, "lateral scour pool, root wad enhanced" (important habitat for juvenile fish hiding from predators). Bottom, "plunge pool" (deep pool that allows fish to "run up" to jump over a barrier). Adapted from CCW manual, Habitat Inventory of Santa Clara County *(based on CA Fish & Game stream habitat manual).*

Assessing Lake Habitat

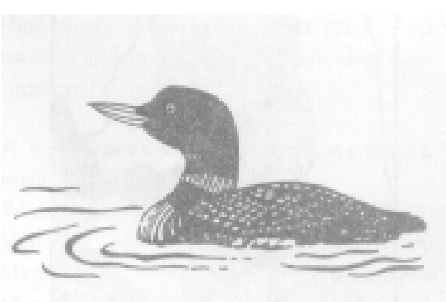
Many lake monitoring groups are involved in habitat assessment without labeling it as such. A case in point is aquatic plant mapping, which many lake monitoring programs perform in order to understand the role of plants in a lake ecosystem. Aquatic plants provide nest- building materials and food for fish, birds, reptiles, and amphibians. Fish spawning areas and nurseries are found in aquatic plant beds, and the vegetation provides cover for large and small fish. Small organisms that live on the plant stems and leaves provide food for fish and wildlife. And emergent vegetation near the shoreline may provide habitat for birds and muskrats.

The Wisconsin Self-Help Lake Monitoring Program, sponsored by the Wisconsin Department of Natural Resources, is one program that includes an aquatic plant monitoring component. Volunteers boat around their lakes, recording on a lake map the location, bed boundaries, and general types of aquatic plants found (i.e., submerged, emergent, free-floating, or floating leaves; see illustration below). The presence of a diverse mix of plant types indicates that the lake can provide good habitat for a variety of creatures. Interested volunteers are encouraged to take their plant identifications a step further by referring to plant keys, and are also trained to press and mount samples to be mailed to the DNR for verification (see photo above).



Plant map. From Wisconsin Self-Help Lake Monitoring Program manual, Aquatic Plant Monitoring Procedures.

Monitoring the aquatic plant community can help determine the sensitivity of a lake to runoff and physical disturbance. The very presence of invasive exotic species can be post-facto evidence of disturbances such as shoreline development or boat traffic, which disrupt the native plant community and allow exotics to take hold. Many of these exotics produce habitat which is inferior to that of their native predecessors. Thick stands of the exotic Eurasian watermilfoil, for example, can block the passage of large fish. Excessive aquatic plants of any kind may indicate pollution (i.e., excessive nutrients) from nonpoint sources.

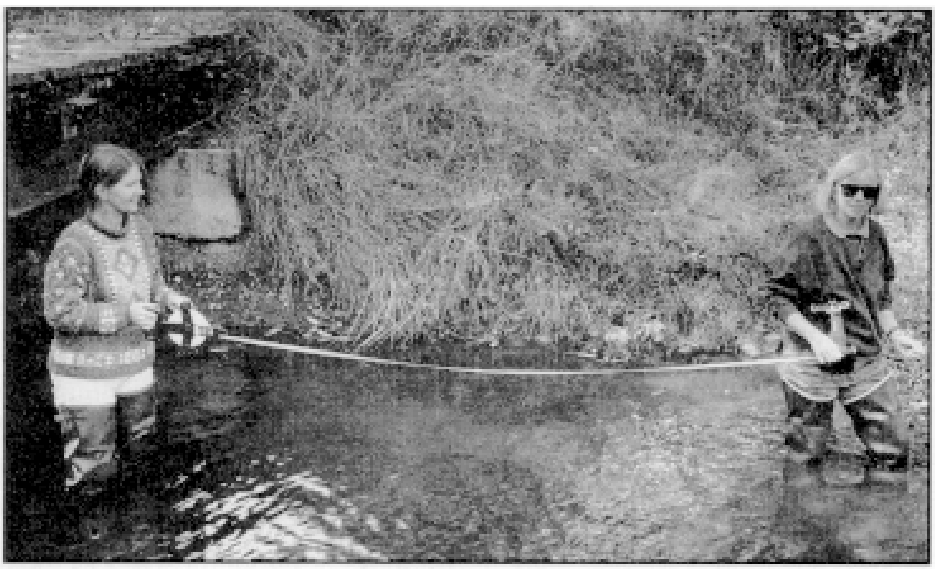


Another example of habitat monitoring that isn't *called* habitat monitoring is the LoonWatch Program, begun in 1978 by the Sigurd Olson Environmental Institute of Northland College in Ashland, Wisconsin. The program now involves over 250 volunteer Loon Rangers throughout the state. Besides counting numbers of adult loons and chicks, Loon Rangers collect data on nest location (on shore, on islands, or on artificial platforms), chick nursery areas (small protected back bay areas), and human activities that threaten loon habitat (e.g., shoreline development and near-shore boating traffic). The information is turned over to agencies for use in assessing permits, selecting public access sites, and regulating development. The LoonWatch survey was begun to preserve a specific valued resource: loons. People like loons, and want them to thrive. According to LoonWatch coordinator Terry Daulton, similar volunteer programs exist in all 11 states that have nesting loons.

Salamander Habitat in Wetlands

Klaus Richter, senior ecologist for King County, Washington, has ventured into wetlands to evaluate salamander habitat. Richter has found that Northwestern salamanders (*Ambystoma gracile*) prefer specific conditions for egg laying. They rarely utilize water less than 30 cm deep, and they look for plants whose stems are 6 mm or less thick; as water levels drop, the plants bend and keep the eggs submerged. Salamanders also like the early spring sun. So Richter tells his students to look for thin-stemmed plants such as soft rush and spike rush, water depth over 30 cm, and a southwest orientation when evaluating Northwestern salamander habitat. Richter has also found other species of both salamanders and frogs that have their own particular preferences of water depth and plant species for attaching their eggs.

Streamwalk volunteers take measurements in a Washington State stream.



ELEANOR ELY

An Ecological Perspective

As these examples indicate, habitat monitoring is an increasingly used, and useful, tool. Our local and national water quality concerns have been evolving over the years from cleaning up end-of-pipe pollution to preventing nonpoint source pollution. Nonpoint source pollution is a major producer of habitat degradation: silt, high temperatures, altered shorelines and erratic flows all have impressive non-point pedigrees. By focusing our attention on these physical constraints to the biological community, habitat surveys complete the "holistic trinity" (physical, chemical, biological) that is the cornerstone of the Clean Water Act, and which is essential to the concept of integrated watershed management. Habitat monitoring helps us understand the land-water connection. As our understanding increases, so does our ability to preserve, protect and restore watersheds. And the ecological perspective gained goes a long way toward changing how we view our environment: not simply as a sum of separate parts, but a whole in and of itself.

For More Information:

Plafkin et al. *Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and*

Fish. 1989. EPA/444/4-89/001. Available free of charge from U.S. EPA, Assessment and Watershed Protection Division, 4503F, 401 M St., SW, Washington, DC 20460.

Dates, Geoff and Jack Byrne. *River Watch Network Benthic Macroinvertebrate Monitoring Manual.* 1994. Available for $20 from River Watch Network, 153 State St., Montpelier, VT 05602; 802/223-3840.

Streamwalk Manual. 1992. U.S. EPA, Region 10. Available free of charge from Laurie Mann, Region 10 EPA, 1200 6th Ave., Seattle, WA 98101; 206/553-1583.

Project Heartbeat Volunteer Monitoring Handbook. 1994. Available for $12 from MD SOS, 258 Scotts Manor Dr., Glen Burnie, MD 21061; 410/969-0084.

Riparian Habitat Inventory of Santa Clara County: Protocols and Procedures. 1994. Available for $20 from Coyote Creek Riparian Station, P.O. Box 1027, Alviso, CA 95002; 408/262-9204.

Aquatic Plant Monitoring Procedures: Self-Help Lake Volunteer Training Manual. 1994. Available free of charge from Celeste Moen, WR/7, WI-DNR, P.O. Box 7921, Madison, WI 53707-7921; 608/266-8117.

Celeste Moen *is Co-coordinator of the Wisconsin Self-Help Lake Monitoring Program, WI Dept. of Natural Resources, P.O. Box 7921, Madison, WI 53707-7921.*

Jerry Schoen *is Coordinator of Massachusetts Water Watch Partnership, Blaisdell House, University of Massachusetts, Amherst, MA 01003.*

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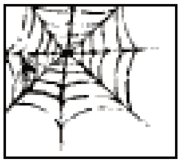
	Note: This information is provided for reference purposes only. Although the information provided here was accurate and current when first created, it is now outdated.

Tips on Topographic Map Reading

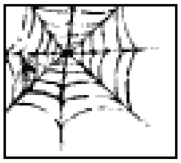
Basic Terms and Conventions:

1. Contour lines are brown; water features are blue; vegetation is green; cleared areas (fields, developed areas, and farmland) are white; and roads, buildings, and other non-natural features are black. Urban areas are gray.
2. All points along any one contour line are at the same elevation. Contour lines never cross each other.
3. Elevation, in feet above sea level, is indicated on contour lines and on the summit of many hills and mountains.
4. The difference in elevation between two adjacent contours is called the contour interval. It is usually given in the map legend. If the contour interval is 20 feet, you would need to climb or descend in elevation 20 feet to go from a point on one contour to a point on the next.

Recognizing Features on the Map

- **Slopes:** Contour lines that are closely spaced represent steep slopes, and those that are widely spaced represent shallow or flat areas.
- **Valleys and ridges:** Contour lines that represent a valley or depression usually are V-shaped, with the tips of the V's pointing toward higher elevations. Lines that show a ridge are also shaped like V's (or rounded V's), but in this case the V's point toward lower elevations.
- **Hills:** Hills and mountains appear as a series of successively smaller, irregularly shaped concentric circles. The smallest circle represents the highest point.
- **Water flow:** Water flow is perpendicular to contour lines. Streams tend to form in the V-shaped contours on sideslopes, with the V's pointing in the direction of higher ground (i.e., upstream). When two streams converge, the V formed by the point where the two come together points downstream.

(The above pointers were adapted from the references listed at the end of the article, "Delineating a Watershed.")



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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.

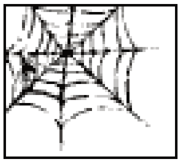
Reprinting Articles

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.

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 as of the printing of this issue:

- Fall 1991 - Biological Monitoring (photocopy)
- Spring 1992 - Monitoring for Advocacy
- Fall 1992 - Building Credibility
- Spring 1993 - School-Based Monitoring
- Fall 1993 - Staying Afloat Financially
- Spring 1994 - Volunteer Monitoring: Past, Present, & Future

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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Staff at *The Volunteer Monitor*

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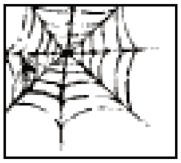

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To the Editor

The Spring 1993 issue of *The Volunteer Monitor* contained an article from the Colorado River Watch Network (CRWN) with instructions for building a homemade water bath incubator from a nonstyrofoam cooler. In the Spring 1994 issue, Mary Gilroy of CRWN updated that article, describing some design modifications and also mentioning some problems with heater breakage and water leaks. In response, we would like to share the incubator design we have been using successfully for the last year in the Indian River Lagoon Volunteer Water Quality Monitoring Network. This design avoids the abovementioned problems.

Our incubator design was developed by Tom Saam, one of our volunteers, and costs about $25 to build. Like CRWN, we use a nonstyrofoam cooler. We cut a 6-inch-diameter circular opening in the lid, and through this opening we insert a piece of 6-inch-diameter PVC tubing long enough to reach from the bottom of the cooler up through the lid with approximately 3 inches extending above the lid (see photograph). Using waterproof epoxy or PVC cement, we glue PVC caps to both ends of the PVC pipe, then glue the PVC pipe to the cooler lid. Now the lid and the pipe are a single unit.

Next we drill a 2-inch-diameter opening in the top cap of the PVC tube, near the edge of the tube. We pour water through the opening, then insert an aquarium heater into the water-filled tube. The top of the heater covers the opening. (Note that the heater is not permanently attached to the tube.)

When the heater is turned on, the water-filled PVC tube acts like a radiator to heat up the air inside the cooler. This design gives us an air incubator - unlike the CRWN model, which is a water bath.

We have used the incubator for performing the multiple tube fermentation test for total coliforms, which requires incubating tubes of broth medium at a temperature of 35°C. Temperature, measured by a thermometer placed in the rack with the tubes, has been easily maintained. We will soon be evaluating our method by sending split samples to be analyzed at Harbor Branch Oceanographic Institute.

Gilroy's letter also brings up the issue of the various methods used by volunteer groups to sterilize equipment. We have had good results using a simple stovetop pressure cooker for sterilizing both equipment and tubes of broth medium. The cooker is inexpensive (around $40) and easy to set up. The process requires about 10 minutes for heating and 4 hours for cooling. One drawback is the burn hazard (especially for younger children). Also, a small leak or a bump to the cap can result in rapid decompression, which causes the broth medium to boil off.

We would be more than happy to discuss our methods with other volunteer groups and to hear any suggestions they might have. Feel free to contact us at 407/ 952-0194.

John Eckert
Quality Control Assistant
Indian River Lagoon Volunteer WQM Network
P.O. Box 22892
Melbourne, FL 32902-2892

Editor's note: It is important to note that the Indian River Lagoon Volunteer WQM Network uses their homemade incubator only in performing the total coliform test, which calls for incubation at 35 ± 0.5°C. Groups using any method that requires incubation at 44.5 ± 0.2°C (i.e., most methods that test for fecal coliforms or *E. coli*) should be aware that an air incubator, such as that described above, is NOT recommended for these methods, in which maintaining a precise temperature is extremely critical. Only a water bath incubator is capable of holding temperatures within the required range of ± 0.2°C.

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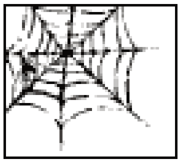

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Changing Tides: Special Challenges of Estuary Monitoring

by Esperanza Stancioff

Estuaries are, in a word, complex. So it's not surprising that monitoring an estuary presents a volunteer group with a unique set of challenges not encountered when monitoring freshwater systems.

By definition, an estuary is a semi-enclosed coastal body of water that has free access to the ocean and within which seawater is measurably diluted by fresh water. Our nation's coast is a mosaic of estuarine environments: salt marshes and mud flats, tidal rivers and creeks, bays and coves.

"Everyone lives downstream," the saying goes - and estuaries live downstream of just about everyone. As rivers flow into estuaries, they carry with them the accumulated load of pollutants from the streams, rivers, and lakes throughout the whole drainage basin. Thus, an estuary shares all the same water quality problems as the freshwater systems in its watershed - point source pollution from industrial and municipal discharges and private septic systems, and nonpoint source pollution from urban and agricultural runoff. Estuaries are also subject to additional problems, like oil transport and ship traffic, that rivers and lakes (with the exception of the Great Lakes) don't have to contend with.

Monitoring Estuaries

According to the *National Directory of Environmental Monitoring Programs*, rivers are the environment most commonly monitored by volunteer groups. Lakes follow, and estuaries come in third. This article is aimed at volunteer groups who are familiar with freshwater monitoring and want to find out what's different about monitoring an estuary.

Estuaries are chemically and hydrologically different from lakes and rivers. As zones where fresh water and seawater meet and interact, estuaries are subject to tidal influences and characterized by salinity gradients. Estuarine monitoring groups must take these differences into account when designing their studies.

Chemistry

Since most of the contaminants that pollute estuaries come from fresh water, it is useful to understand the differences between fresh and saltwater chemistry. In areas of the country where fresh water is slightly acidic (eastern continent), many metals, pesticides, and other contaminants flow in a dissolved form toward the ocean. However, when they encounter the alkaline saltwater of an estuary, they often flocculate or attach to other particles. Thus, instead of being flushed out to sea, these chemicals precipitate in the estuary, where they accumulate in bottom sediments or become concentrated in the food chain. This phenomenon needs to be taken into account when deciding what samples to collect and where. For example, in designing a toxic monitoring strategy for an estuary, one might decide to look more closely at sediments and tissues, rather than the water column itself.

Tides

Rivers flow in one direction, and most lake levels remain relatively unchanged over a day or even a month. But estuaries, because of the influence of tides, flow in several directions during the course of a day and experience cycles of wetting and drying in intertidal areas such as mud flats and low salt marshes.

Some parameters, such as dissolved oxygen, need to be monitored at different stages of the tide. For example, if one monitors dissolved oxygen only at high tide and finds that levels are sufficient, one might conclude that all is well when in fact oxygen might be depleted during low tide. Such a situation could occur if a pollution discharge were adequately diluted at high tide but not at low tide. Also, at low tide the sun might warm the water enough to lower dissolved oxygen levels (since colder water holds more oxygen than warmer water).

Contrary to popular belief, pollutants that enter the estuary are not washed quickly out to sea with the next tide. The flushing rate (time it takes for all the water in the estuary to be moved out to sea) varies from days to weeks.

Salinity

Salinities in estuaries vary from less than 1 part per thousand (ppt) to over 30 ppt (equivalent to seawater). Fluctuations in salinity, due both to the tide and to seasonal changes in freshwater inputs, exert a major influence over the type, abundance, and distribution of organisms found in an estuary.

Knowing salinity is useful in deciding where to locate sampling stations. Most pollutants volunteers monitor come from the land and are carried to the estuary via fresh water. Locating sampling stations at various points along the salinity gradient helps determine whether pollutants are coming from land or sea.

DONALD BLOMQUIST

Esperanza Stancioff trains estuary monitors at Castine Harbor, Maine.

Bacteria

In fresh water, environmental agencies generally monitor bacteria levels for the purpose of protecting swimmers. In coastal areas, however, bacterial monitoring has a dual purpose: to protect both swimmers and seafood safety. Each purpose requires a different test with different procedures. The U.S. Food and Drug Administration, which is the federal agency that oversees the regulation and classification of shellfish-growing areas, recommends that state environmental agencies monitoring shellfish areas use fecal coliform as the indicator bacteria and multiple tube fermentation as the method of testing. Meanwhile, swimming standards in saltwater are overseen by the U.S. Environmental Protection Agency, which recommends enterococci as the indicator and membrane filtration as the method.

The important point here is that, as with all monitoring studies, the objectives must be clearly defined. So, determine what your purpose is for collecting bacterial data, speak with the people who will be using the data, consult with microbiologists, and then decide what makes sense for your program.

Refreshingly Unique

The complexity of estuarine systems means monitors will need to expend extra time and effort to carefully design their studies, and probably extra money as well. While this may cause frustration at the outset, all in all the increased complexity and challenges are what make estuarine monitoring a refreshingly unique and interesting experience.

Esperanza Stancioff *is Statewide Coordinator of the Clean Water Program for the University of Maine Cooperative Extension.*

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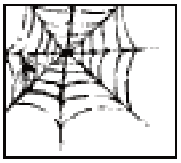

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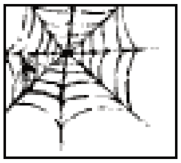
Conference Proceedings

The Proceedings of the Fourth National Volunteer Monitoring Conference, held in Portland, Oregon, in April 1994, will be available early in 1995. The Proceedings includes texts of all plenary speeches and over 70 presentations, plus summaries of breakout discussion sessions and a list of addresses of conference presenters and attendees.

To reserve a free copy, contact Alice Mayio, Volunteer Monitoring Coordinator, U.S. EPA, 4503F, 401 M Street, SW, Washington, DC 20460; 202/ 260-7018. (Conference attendees will automatically receive a copy.)



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Land-Use Surveys

by Eleanor Ely

Land uses in a watershed profoundly affect both water quality and water quantity. As Robin Ulmer, director of the Boquet River Association, puts it, "Water is our mirror. It reflects everything we do. All acts of pollution end up in water."

Paved surfaces constitute one of the more extreme examples. Water flows much more rapidly over paved surfaces than over a naturally forested area, and little is able to soak into the ground. Thus, in built-up areas a large volume of water, heavily charged with pollutants that did not have a chance to be filtered through soil, quickly reaches nearby water bodies. Cropland is another case in point: it's more easily eroded than forest land, plus it contains fertilizers and pesticides that wash into nearby waterways.

In fact, from sewage disposal to logging to car driving to gardening, actions on land sooner or later impact the water. That's why more and more volunteer monitoring groups are going out into their watersheds to track down land-based sources of water pollution.

Stream Watershed Surveys

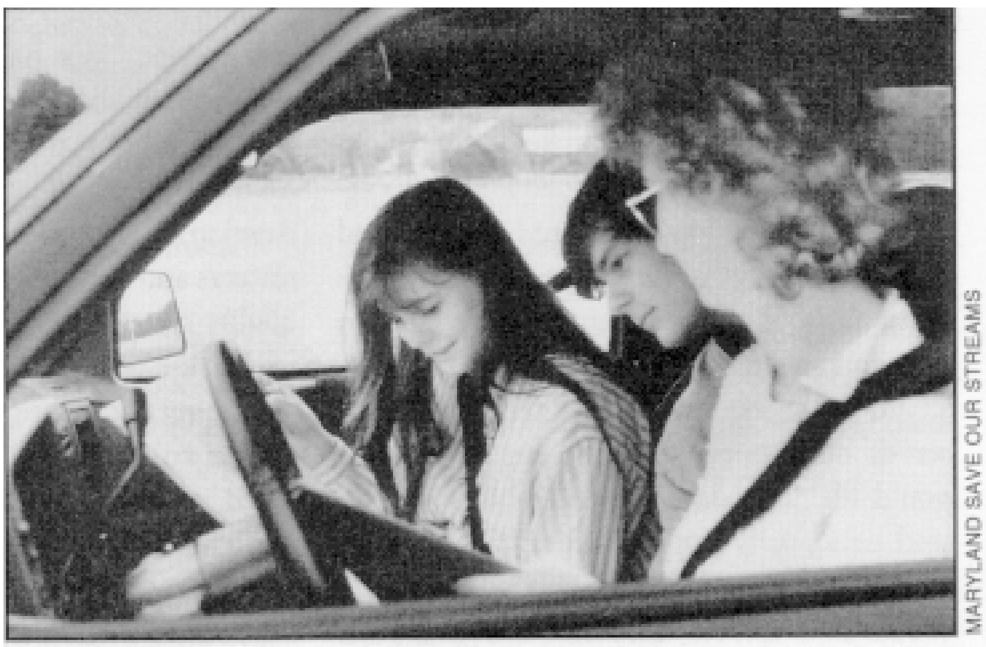
The watershed survey packet that Maryland Save Our Streams provides to community groups is a virtual "do-it-yourself kit" for surveying land uses in a stream watershed, starting with advice on recruiting survey volunteers and proceeding through step-by-step instructions for planning and conducting the survey. The packet also contains master copies of all the materials survey volunteers will need - data sheets, list of codes for marking land uses on maps ("CF" for crop fields, "CS" for construction site, etc.), and instruction sheets on what to look for and why.

The packet reflects MD SOS's commitment to encouraging volunteer leadership. Although MD SOS staff members do provide assistance, the packet is complete enough to allow community groups to take primary responsibility for the survey. In the same spirit, MD SOS has produced similar self-explanatory packets for a number of activities - stream surveys, cleanups, tree planting, storm drain stenciling, and construction site monitoring.

According to program director Abby Markowitz, "Watershed surveys take more planning, more logistical work, and more volunteers" than other activities volunteer groups usually undertake. Over the last year and a half, three watershed surveys have been conducted by groups working with MD SOS.

Windshield Surveys in Rural Areas

MD SOS recommends allowing about five hours for the survey, including about an hour and a half for training. After training (which includes a narrated slide show produced by MD SOS), participants are divided into teams, assigned "turfs," and given maps and materials. Except in dense urban areas, surveys are usually done by car ("windshield surveys"). Markowitz says it's ideal to have four people per team, if possible - one to drive, two to navigate and observe, and one to record - and she recommends ¾ square miles as a good turf size (larger turfs are feasible in sparsely developed areas). After teams complete their surveys, they return to the training site to turn in their data and enjoy some socializing and refreshments.



MD SOS volunteers conduct a "windshield survey" in a rural area.

During the survey, features such as developed land, residential areas, construction sites, landfills, mining operations, crop fields, overgrazed pastures, livestock areas, forested areas, and logging are recorded on both road maps and data sheets. Volunteers also estimate the percentage of impervious surfaces and the percentage of the turf that is residential, developed, forested, or agricultural.

"What I like about the survey," says Markowitz, "is that it gets people to really look at the micro as well as the macro level." For example, under the "residential areas" category the survey worksheet asks volunteers to record whether downspouts (gutters) discharge onto grass, a driveway, or a street.

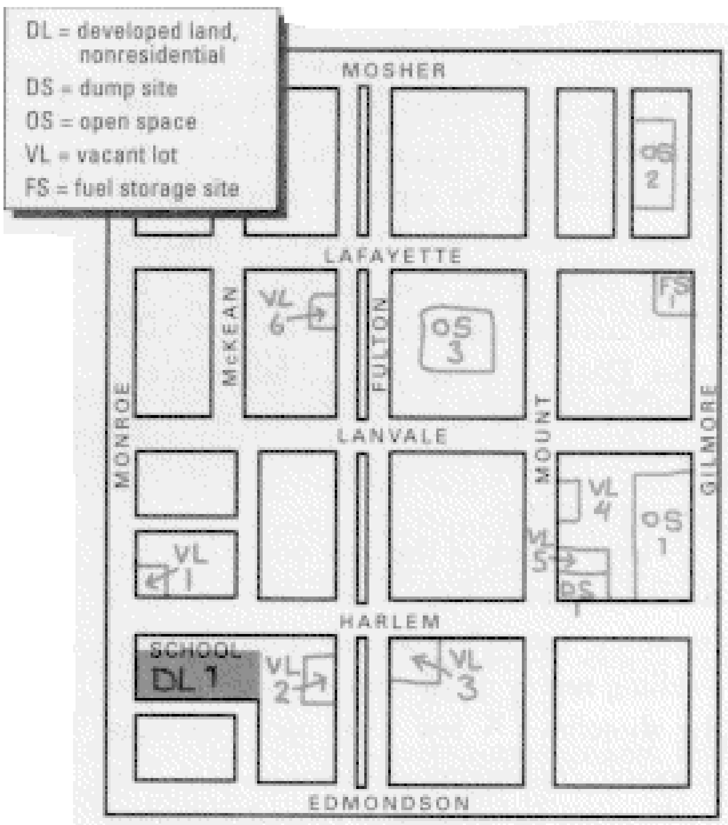
Data sheets and maps are returned to MD SOS, where the information is entered into a database and a report is generated. MD SOS also sends the survey data to the Maryland Department of Natural

Resources and county Departments of Public Works.

Surveying an Urban Watershed

Recently, MD SOS modified its basic watershed survey for use in an ambitious survey of an entire urban watershed in the heart of Baltimore. The survey is part of a major initiative called "Revitalizing Baltimore: Restoring Our Environment, Restoring Our Community," whose participants include a number of private groups and government agencies. The project's goal is to encourage grassroots community action and to help communities make the connection between environmental problems and social issues.

For the survey, the Gwynns Falls watershed (one of three watersheds in the city) has been divided into 176 turfs of about 10 blocks each. All 176 are being surveyed - most on foot - by teams of two or three.



Survey map of an urban "turf" from MD SOS's Gwynns Falls watershed survey.

To tailor the survey worksheet for an urban environment, several traditional categories ("overgrazed pastures," "crop fields," and "logging operations") were dropped and new categories - "vacant lots," "vacant housing," and "dump sites" - were substituted. A nontraditional unit of measurement also appears on the worksheet: For dump sites, volunteers record the amount of trash in terms of "number of dumpsters" they estimate the trash would fill. The data on vacant lots will be used to identify potential sites for planting trees or starting community gardens.

The data sheets from the Gwynns Falls survey are being sent to the Yale School of Forestry, where the information is entered into a geographic information system (using ArcInfo). The digitized information is then provided back in a form that can be used with MD SOS's ArcView software to create and print maps that can be used to help direct community restoration efforts.

Estuaries: Protecting Public Health

Whereas MD SOS's watershed survey takes a comprehensive look at all land uses that could affect water quality, volunteers in Maine are conducting shoreline surveys with a very specific focus and goal: They are helping the state Department of Marine Resources (DMR) identify potential sources of sewage contamination and other pollutants to the state's economically vital shellfish- growing areas.

It's DMR's job to determine which areas should be open to shellfishing and which should be closed. These decisions are based on a detailed Sanitary Survey Report prepared by DMR personnel, and gathering the information for the report is a huge, labor-intensive effort. Paul Anderson, a microbiologist with DMR, says, "If you walked the whole coastline of Maine, you'd cover 5,000 miles. DMR only has 8 or 10 full-time employees to do the survey work, and we're under pressure from towns and from diggers to open up the beds."

A large chunk of the data needed for the Sanitary Survey Report is collected via a "shoreline survey" - basically a dwelling-by-dwelling survey of all sanitary facilities near the shoreline. A few years ago, Esperanza Stancioff, coordinator of Maine's Clean Water Program (a network of coastal volunteer monitoring programs), suggested that DMR consider using citizen volunteers to conduct shoreline surveys. Anderson recalls, "We had to think about that a lot in the Department. We asked ourselves, 'Can we develop a program for volunteers and still maintain quality control? How can we be sure the volunteers are seeing everything?'"

The answer, DMR decided, was intensive training: a full day of classroom training, including a slide show and a written exam, followed by a field review during which DMR personnel observe the volunteers in the field. Anderson has now conducted seven of these training sessions - two in 1993 and five in 1994 - in various parts of the state. Out of a total of some 75 participants, Anderson reports, about a dozen have started doing survey work and as many more are ready to begin. "This type of work isn't for everyone," Anderson stresses. "In fact, during the training I try to scare people away. I want them to realize how serious this work is. I don't want anyone who isn't really committed."

The reason strong commitment and thorough training are so important, Anderson explains, is that "we're dealing with public health. It's critical for me to be able to look FDA in the face and say, 'We know our volunteers are doing a good job. We can base a public health decision on their work.'"

What's actually involved in conducting the shoreline survey? First the volunteers "do their homework" by reviewing information from previous surveys and town office records. Then, working in pairs, they go out in the field. At each house or farm, they conduct an interview. As Anderson points out, "To do the survey, you have to be the kind of person who can walk up to someone and say, 'Where's your septic system? How old is it? Can we take a look?'" Using the knowledge gained during training, the volunteers look around the property for possible septic system problems. Volunteers also document anything else they see that could affect water quality, such as pipes or discharges, flocks of birds, erosion, landfills, or oil slicks. In some cases they may collect a sample to be analyzed by DMR for bacteria. "We don't ask volunteers to evaluate - just to observe," says Anderson. "Any potential problem that they report is investigated by the Department."

Usually property owners are cooperative, Anderson says. If not, volunteers politely take their leave, and a DMR staffperson visits the site at a later date.

Identifying erosion sites is an important component of land use surveys.

Volunteers record their observations on special data sheets. The information is subsequently incorporated into DMR's official Sanitary Survey Report, along with other data (for example, water quality data) collected by DMR personnel. This report provides the basis for determining whether the area is opened or closed to shellfishing.

Anderson says the effort that DMR puts into the volunteer program is definitely worthwhile. "Lots of areas around the state are making progress in cleaning up sewage pollution," he says, "but without someone to document the changes, we can't respond by opening up areas to shellfishing. Even more important is the educational part of the program, and empowering local people. That's what really lasts."

Lakes: Pinpointing Nonpoint Pollution Sources

A number of lake associations in Maine have conducted watershed surveys following the methods set forth in a comprehensive manual titled *A Citizen's Guide to Lake Watershed Surveys*, jointly published by the Congress of Lake Associations (COLA) and Maine's Department of Environmental Protection.

The approach described in the manual focuses particularly on tracking sources of sediment input from soil erosion. According to Scott Williams, author of the manual and chief technical advisor to Maine COLA, there are two reasons for this focus. First, sediment is a critical problem in lakes and tributaries. It's a major source of phosphorus and other pollutants that attach to soil particles, and it's a direct destroyer of habitat. Second, sediment sources - namely, soil erosion and runoff problems in the watershed - are easy for volunteers to identify.

The manual advises volunteers to divide the watershed into sectors small enough for two or three volunteers to cover in two or three days. During the survey, volunteers should look for such problems as exposed soil, road washouts, runoff from developed areas discharging into streams, bare-earth road ditches, eroding croplands, and timber harvest areas, and document these problems both in writing and with photographs.

The manual also stresses the unfortunate fact that the very best time to document runoff and erosion problems is during a storm event. Couple this with the fact that early spring is the best time of year for the survey (and remember this is Maine we're talking about), and it becomes obvious that the ideal volunteer needs both fortitude and dedication, not to mention a flexible schedule and sturdy raingear. Williams stresses that going out in a storm is only a recommendation, not a requirement - but adds that the photo documentation volunteers bring back offer convincing proof that many do in fact brave the elements.

Most often a lake association is the prime mover behind the survey, but involving all segments of the community is vital to success. "What gives a project like this credibility," says Williams, "is having a diverse mixture of players, so it's clear that no one interest is steering the project."

Survey findings lead to numerous opportunities for improvement projects and community education activities. Williams recalls, for example, a watershed survey of Taylor Pond, for which he served as a consultant. Members of the Taylor Pond Association identified 115 problem sites throughout the 15-square-mile watershed. Many of these were related to public or private roads - unvegetated road ditches, road ditches that emptied directly into streams, washed-out culverts. Soil erosion from residential properties was also a common finding. One direct result of the survey was the adoption of a phosphorus control ordinance by the city of Auburn, in which Taylor Pond is located. Williams says, "The survey was without doubt the factor that convinced local planners of the need for the ordinance."

Another outcome was that the Taylor Pond Association received funding under Section 319 of the Clean Water Act to develop a program to raise public awareness about the relationships between land use and water quality. The program adopted a three-pronged approach to community education: (1) Demonstration projects to show private landowners how erosion problems could be fixed using low-cost, simple methods (such as creating shoreline buffers or improving road maintenance); (2) Technical assistance to towns and landowners; and (3) Educational workshops for a variety of community groups, including school students, town planning boards, realtors, developers, and loggers.

For More Information

"Conducting a Watershed Survey" (packet). Available for $10 from MD SOS, 258 Scotts Manor Dr., Glen Burnie, MD 21061; 410/969-0084.

Williams, Scott. *A Citizen's Guide to Lake Watershed Surveys: How to Conduct a Nonpoint Source Phosphorus Survey*. 1992. Maine Department of Environmental Protection; Congress of Lake Associations. To order, send a check for $2 made out to COLA, plus a 9 x 12 SASE with $1.20 postage, to COLA, P.O. Box 391, Yarmouth, ME 04096.

Eleanor Ely *is the editor of* The Volunteer Monitor.

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The Streamwalk Game

Children intuitively know the health of a stream. They know pollution is not good and they know pollution is not right, but they don't have the reasoning or the tools to explain their knowledge. The Streamwalk Game is a stream monitoring tool that allows first- through fifth-graders to go to a stream and determine whether it is healthy or unhealthy. The game is based on EPA Region 10's Streamwalk program and was created by Environmental Services, City of Portland. (Although the game is designed to be used along an actual stream, it can also be used indoors with an illustration of a stream.)

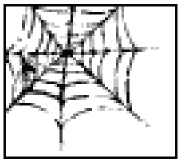
The Streamwalk Game begins by reading aloud the Murky Water Mystery, a story about animals who are upset about the increasing pollution in their stream neighborhood. The animals need a private detective. That's where the players come in.

Using the Investigation Report and their stream detective pencil, the detectives check off things they observe about the stream neighborhood. What kinds of buildings are around the stream? Are there many or only a few trees hanging over the stream? What is the bottom of the stream covered with - mud, sand, huge rocks? Clue Cards and a Stream Detective Map help the detectives evaluate the stream and discover the things they can do to help make their stream neighborhood a healthy place to live.

Once the Investigation Report is completed, it is sent to Environmental Services and each detective receives an official Streamwalk Detective Badge and License. The Streamwalk Game is available to all Portland schools, community groups, and organizations at no charge; and to groups outside the Portland area for the cost of printing. For more information, please call 503/823-7740.

- Ivy Frances

Portland Department of Environmental Services



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Volunteer Monitoring Electronic Bulletin Board

Traffic is getting heavier on the volunteer monitoring information superhighway! EPA's Nonpoint Source Bulletin Board System (NPS BBS) reports that use of the Volunteer Monitoring Specific Interest Group (VolMon SIG) is up, and outstripping others on the BBS. More and more volunteers and program coordinators are leaving messages, exchanging files, checking news items, and dipping into other features, including a file area with all articles from *The Volunteer Monitor*.

Sharing space on the BBS are a number of other SIGs of interest to volunteer monitors, such as SIGs on coastal issues, educational materials, and fish consumption advisories. A SIG on watershed restoration includes a database of watershed projects, indexed by topics such as water quality, habitat problems, and volunteer activities in the watershed.

All you need to get into the NPS BBS are a personal computer or terminal, telecommunications software, a modem, and a phone line. You can also reach it through Internet.

A flyer on the volunteer monitoring SIG is available from Alice Mayio at U.S. EPA, Volunteer Monitoring, 4503F, 401 M St., SW, Washington, DC 20460; 202/260-7018.

Groundwater Inventory Goes Binational

A citizen inventory of sources of potential groundwater contamination in El Paso, Texas, has grown to a cooperative effort between U.S. and Mexican citizens to protect their shared aquifers. The story begins in 1990, when 23 retired people, aged up to 83, surveyed possible sources of contamination (such as underground gasoline storage tanks, abandoned wells, cesspools, and garbage dumps) in the vicinity of all 138 public water wells in the city of El Paso. The volunteers used a combination of methods - reviewing historical records, consulting their own memories, and conducting door-to-door surveys - to locate the sources.

The inventory was a joint effort of the El Paso Retired Senior Volunteer Program (RSVP), Texas Natural Resource Conservation Commission, and the U.S. EPA. "Older persons were targeted for the project because they have historical knowledge of where old wells, old gas stations, and other potential sources of contamination might be located," says Brad Cross, the TNRCC geologist who headed the project.

TNRCC staff provided the RSVP volunteers with maps delineating wellhead protection areas for each well. The volunteers' inventory covered all the ground within the protection areas. The agency also trained the volunteers in identifying potential sources of contamination and marking them on maps.

Once the inventory was completed, TNRCC compiled all the information, together with recommendations for best management practices to deal with the potential contaminant sources, into a report that was given to El Paso city officials. One result was that the city passed a hazardous materials storage ordinance.

WAYNE BAKER

RSVP volunteers conducting a door-to-door survey in El Paso.

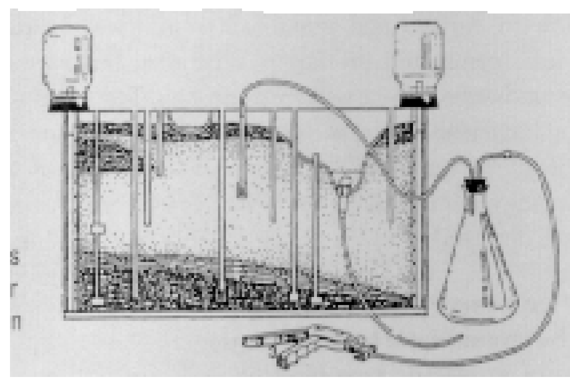
The effort has recently expanded across the U.S.-Mexican border to Ciudad Juarez - a natural step, since the approximately two million residents of these two adjacent cities take their drinking water from the same aquifers. Contamination originating in either city would affect both; groundwater knows no borders.

Using the El Paso inventory as a model, Cd. Juarez officials have developed a similar project for their city. Volunteers will use Spanish translations of the same manual and materials developed for the RSVP volunteers. If the pilot is successful, the program will be expanded nationwide.

Another spinoff from the RSVP model is an AmeriCorps project (under the new Corporation for National and Community Service) in which 20 students from the University of Texas at El Paso are identifying and mapping potential groundwater contamination sources, entering the information into a binational geographic information system, and educating the public.

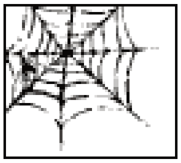
Groundwater Model

This groundwater model, designed and built at the University of Wisconsin-Stevens Point, is a very effective tool for demonstrating the hydrologic cycle, the effects of well pumping, and how human activities can contaminate groundwater. The model, along with a teacher's manual and activities packet, is available on two-week loan from the Idaho Water Resources Research Institute. To reserve a model, contact Dottie Shuman at Idaho WRRI, 106 Morrill Hall, University of Idaho, Moscow, ID 83843-3011; 208/ 885-6429. (Preference given to people who have participated in the Project WET Idaho workshop.)



The model may be purchased from the University of Wisconsin-Stevens Point for $250 plus $10 shipping. To order, contact Groundwater Model Project, College of Natural Resources, UW-Stevens Point, Stevens Point, WI 54481; 715/ 346-4613.

A number of other groundwater models are available from various institutions. For a list of addresses, contact Dottie Shuman at Idaho WRRI (address above).



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The Hydrologic Cycle

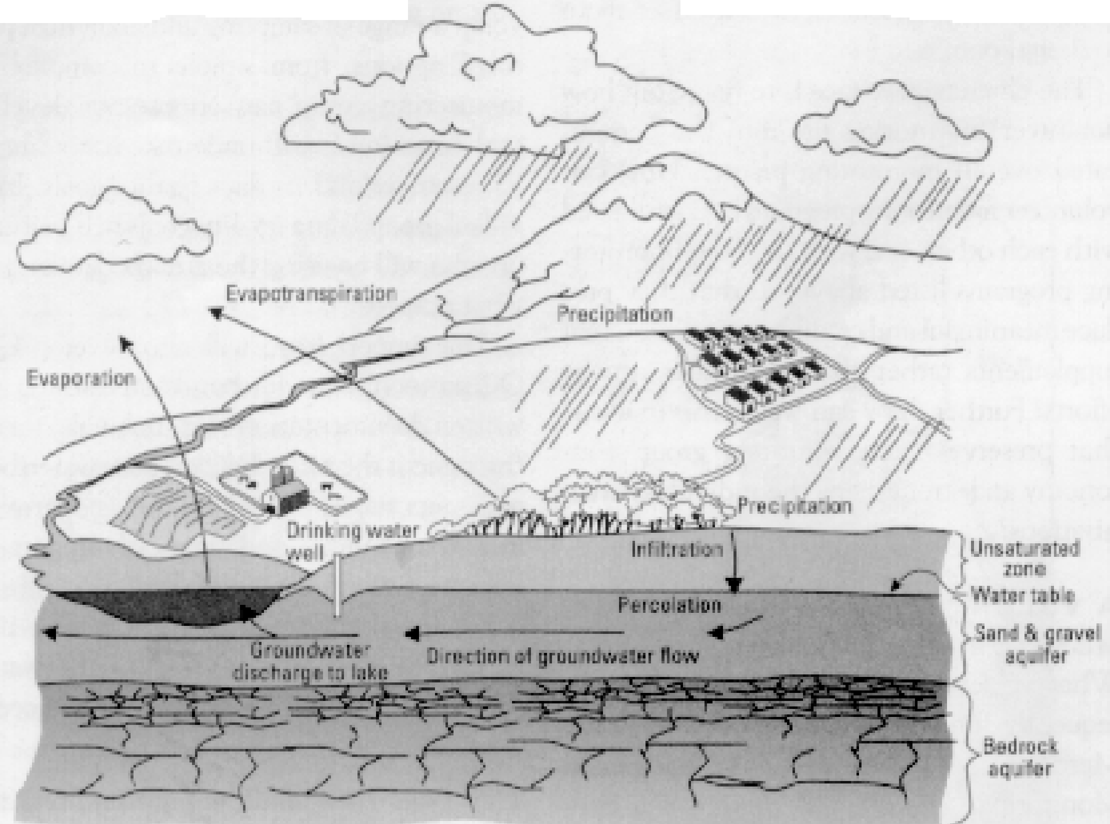
The hydrologic cycle is the movement of water through the atmosphere, ground surface, and subsurface. Watersheds are defined by precipitation, physiography, and gravity. As precipitation reaches the ground, some of it moves downstream in a particular watershed, and some of it goes underground. In fact, excluding water frozen in ice caps and glaciers, 99 percent of all fresh water is groundwater.

As water infiltrates the ground, a new water geography is created, consisting of aquifers. Aquifers are permeable and porous water-bearing areas in the water-saturated zone underground; groundwater is not found in "underground lakes" or rivers, as people sometimes imagine. Aquifers frequently are comprised of sand and gravel (called "unconsolidated materials"); the water flows through the naturally occurring spaces, or pores, around these sand and gravel particles. Sometimes aquifers are found in consolidated rock ("bedrock"), such as limestone; in this case, the water flows along interconnected cracks and fractures in the layers of rock.

Groundwater is dynamic. It can discharge into surface water (streams, lakes, oceans) under certain hydraulic conditions. In fact, such discharge accounts for the base flow of all perennial streams. You may have wondered how many streams can still have running water after weeks of dry summer weather. The answer is that the stream is being replenished by groundwater.

To make the hydrologic cycle even more interesting, surface waters can recharge groundwater, especially during and immediately after precipitation events.

Aquifers underlie and cross watershed boundaries. We therefore need to monitor on both a watershed and an aquifer basis.



Adapted from Groundwater Protection & Management in Pennsylvania: An Introductory Guide for Citizens and Local Officials. *Pennsylvania Groundwater Education Project. 1993.*

The Volunteer Monitor, Vol. 6, No. 2, Fall 1994

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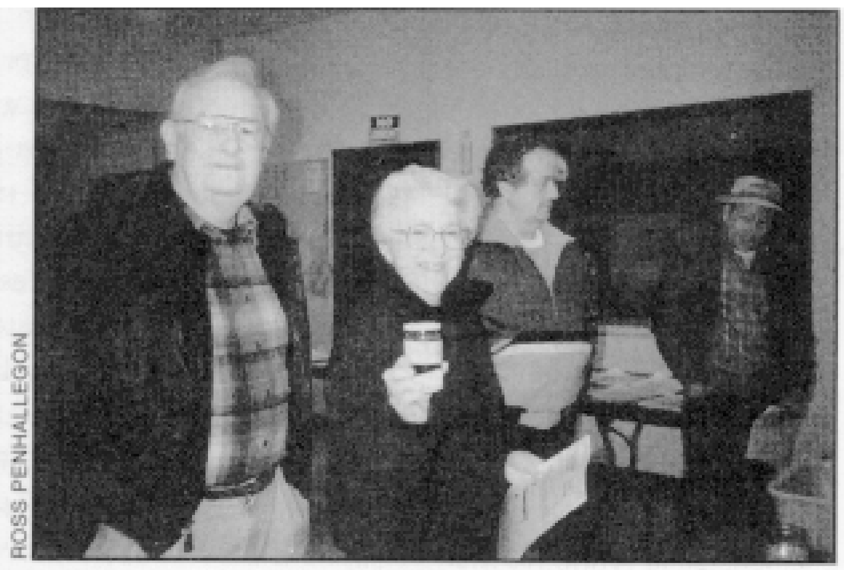
Testing Oregon Wells for Nitrates

Between 1991 and 1993, Oregon's Volunteer Well Water Nitrate Testing Project held 28 "nitrate-testing days," each one in a different community. On the designated day, volunteers equipped with Hach field test kits set up shop in the community at a county fair, in a school, at a Cooperative Extension, or in another community location. Local residents brought in samples of well water to be tested, free of charge, for nitrate contamination. Through the program, sponsored by the Oregon Department of Environmental Quality (DEQ) with funding from EPA, volunteers tested a total of 1,600 wells.



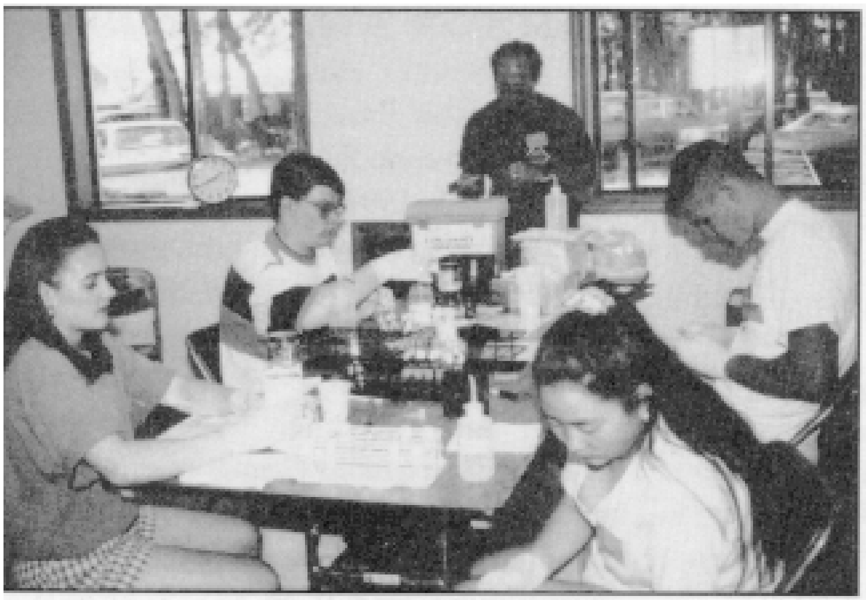
"Nitrate-Testing Day": Lane County, Oregon, residents bring well water sample to Lane County Extension for nitrate testing.

If well water nitrate levels were 7 mg/L or greater, well owners were instructed to confirm the results with a certified lab test. EPA's Maximum Contaminant Level for nitrates in drinking water is 10 mg/L. Higher levels are a health risk for infants and pregnant women because they can cause "blue-baby syndrome" (methemoglobinemia), a condition that interferes with the oxygen-carrying capacity of the blood.

Besides helping individual well owners find out the nitrate level of their well water, the volunteer nitrate-testing results were used in conjunction with Oregon's real estate transaction data to create a map showing nitrate levels around the state. This map has helped the DEQ decide which areas to target for more extensive groundwater studies and further community involvement programs.

In 1993, lack of funding forced the volunteer nitrate- testing program to close. But this story has a happy ending after all, because in 1994 the concept was resuscitated, with a new partner - the Oregon Water Resources Research Institute, based at Oregon State University - and a new name - the Oregon Groundwater Community Involvement Program.

"We're expanding the nitrate testing to new communities," says program coordinator Loretta Brenner, "and increasing the level of involvement in communities with histories of higher nitrate levels. But the biggest challenge is to make the program more autonomous, so that communities can do most of the coordination themselves." To help make this happen, Brenner is developing a packet called "A Citizens' Guide to Conducting a Groundwater Education Event in Your Community." The packet, due to be completed in 1995, will include chapters on organizing a Nitrate Testing Event, sponsoring a Groundwater Forum, working with local agencies and schools, and other community projects. There will be specific examples on getting publicity, recruiting volunteers, and finding and using existing sources of information on groundwater and wells in the community.



LORETTA BRENNER

High school students and other volunteers test well water samples for nitrates in Benton County, Oregon.

The Groundwater Community Involvement Program provides volunteer training, resource materials, a groundwater model for loan, and nitrate test kits. During training, volunteers learn not only how to perform the nitrate test but also how to answer questions from the public about why nitrates in drinking water are a problem, where nitrate contamination comes from, and what steps they can take if their water tests high for nitrates.

Through the nitrate testing events, groundwater forums, and educational materials, the program works to increase citizen awareness about potential and existing groundwater contaminants and their sources, health effects of contaminants, and how to become involved in protecting the community's groundwater resources. As Brenner describes it, "The idea is not to point fingers at specific community members and say, 'OK, you're the problem.' Rather, the program aims to demonstrate how groundwater pollution can come from many sources, and since we're all part of the problem we all need to work together to clean up and prevent groundwater contamination." For example, sources of nitrates in groundwater include animal feedlots, manure piles, excess nitrogen fertilization, and septic systems. Homeowners and farmers can recognize how they both are impacting groundwater, and can work together in managing nitrate contamination.

The newest effort of the Community Involvement Program is an ongoing well-monitoring project - the Groundwater Monitoring Network - started in fall 1994 with a pilot project cosponsored by Lane County Cooperative Extension Service. Lane County has had a very active volunteer base that tested over 800 wells in two years, and the volunteers were interested in expanding their activities. Volunteers in the Network will do nitrate testing in selected wells four times per year, to monitor seasonal changes in nitrate concentrations. In addition, they will measure well water conductivity and temperature as a way to help characterize the aquifer, and will test for other possible contaminants. Brenner is hoping to expand this program to other communities, and to include high school students as volunteers.

For more information contact Loretta Brenner, Groundwater Community Involvement Program Coordinator, 210 Strand Ag Hall, Oregon State University, Corvallis, OR 97331-2208; 503/ 737-5736.

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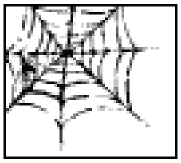

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The Web of Water

Peter Weber and Frank Dowman

Ecology teaches us that the environment is interconnected. Like the web of life, the web of water pervades the environment. To truly understand the water cycle, we need to monitor water throughout its movements and forms - as groundwater, surface water, and atmospheric water.

A watershed includes both a visible and an invisible portion. We are usually much more aware of the visible part - the surface water. However, the amount of water in the invisible portion - the groundwater that lies beneath the surface in saturated soils, sand, gravel, and cracks in the bedrock - is actually larger (see "The Hydrologic Cycle").

Water is continually on the move through the water cycle. And as the water exchanges between the ground and the surface, it can carry pollutants with it. When we see contaminated surface water, the pollutants might actually be coming from groundwater. If we have contaminated well water, the pollutants might be from surface sources.

Clearly, then, investigating the groundwater-surface water connection is critical if we are to truly monitor the whole watershed. Yet volunteer monitoring groups (like most professional monitoring efforts) have traditionally focused their attention almost entirely on surface water. If there is groundwater monitoring, it is usually confined to well sampling, so that the dynamic groundwater-surface water relationship is not explicitly investigated. In the Crum-Ridley Volunteer Monitoring Program (CRVMP), we are evolving toward full-fledged monitoring of the water wherever it occurs in nature. This article will introduce our first steps toward understanding and monitoring groundwater.

Crum-Ridley Volunteer Monitoring Program

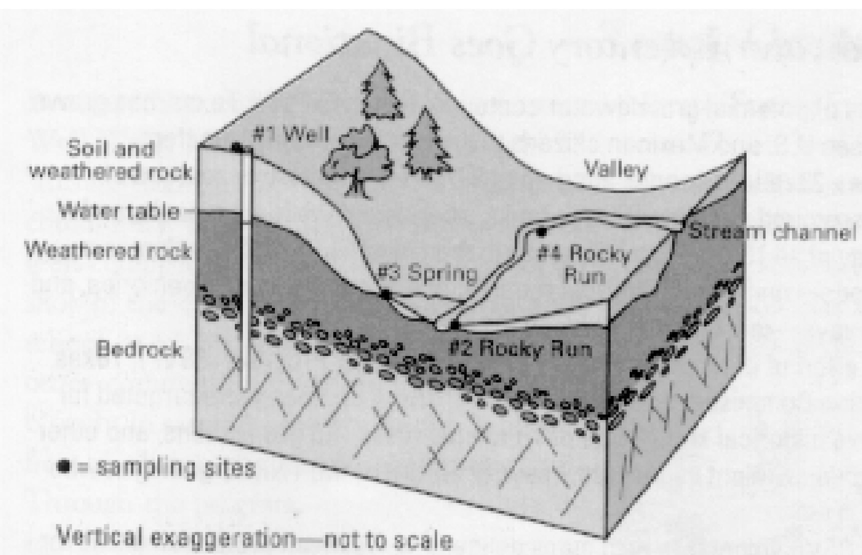
The purpose of the CRVMP is to foster stewardship of two watersheds, the Crum and Ridley, located in a highly varied land-use setting (agricultural, recreational, suburban, and industrial). Begun in 1990 with funds from EPA, the program is a partnership between the Region 3 office of EPA and local citizen conservation groups throughout Pennsylvania's Delaware and Chester counties.

The program began as a traditional surface-water sampling effort, with monthly monitoring of 16 sites on streams, a spring, and a spring-fed pond for a variety of chemical and physical parameters. Quarterly meetings are held to review monitoring results, train and retrain monitors, and hear guest speakers. We recently expanded our efforts by including benthic macroinvertebrate monitoring at many of our existing sites.

Groundwater Monitoring

In the summer of 1994, the EPA connection proved crucial to the next dimension of the monitoring program: groundwater monitoring. One of the coauthors of this article, Peter Weber, is employed by EPA in groundwater protection. EPA is mandated by the Clean Water Act and the Safe Drinking Water Act to protect the groundwater resource, particularly as a drinking water supply. Accordingly, EPA has technical expertise in groundwater hydrology and protection techniques.

Other key new partners have also been brought into our groundwater monitoring effort: colleagues from the U.S. Geological Survey (USGS), the federal agency mandated to perform field research and report on groundwater quality and quantity, and from the Pennsylvania Department of Environmental Resources (DER), which receives funding from EPA to implement groundwater protection at the state and local level.



We launched our new effort by holding an introductory groundwater workshop and monitoring session in August 1994 at Tyler Arboretum, the location of one of our regular monitoring sites (site 4 in the diagram, above). The Arboretum staff had been essential in starting the CRVMP in 1990, and continue to support the monitoring.

The session was led by staff from USGS (who also provided all the instruments for field measurements, except the nitrate field kits), EPA Ground Water Protection Section, and the DER. Over 30 participants, including both CRVMP volunteers and other interested citizens, were shown how to measure the depth to the water table; spring and stream flow rates; and the specific conductance, temperature, and nitrate concentration in surface and groundwater samples. These parameters are key to characterizing groundwater-surface water relationships. Testing was carried out at two groundwater sites -- a drinking water well and a spring - and two surface water sites along the Rocky Run stream (see diagram above).

Parameters Tested

The **groundwater level** was measured by lowering an electric tape into the well until it contacted the water, giving the depth from the land surface to the water table (top of the saturated groundwater zone). This level tends to fluctuate over time because of seasonal changes in recharge rates. Also, groundwater extraction by well pumping causes a temporary drop in the water table level near the well. Data on groundwater level should be collected over a period of time to show seasonal effects and to record any long-term trends, such as depletion of the aquifer due to over-pumping.

Because groundwater flows down-gradient (high water level to low water level), knowing water table levels near a stream can indicate whether there is a potential for groundwater to discharge to the stream or for the stream to recharge the groundwater. At the location of our sampling session, the water table was higher than the stream level, creating conditions for groundwater discharge to the stream.

Flow rate (discharge) was measured using a flume (an instrument resembling a flat funnel, with a gauge to measure water flow) set in the water and flanked by sand bags (to prevent any water from bypassing the flume). Flow rates of surface water are another way to help determine where water is coming from or going to. Streams can either gain water from, or lose water to, the groundwater system. Flow rates that are higher than can be accounted for by upstream flow indicate probable areas of groundwater discharge, while a decrease in flow rate indicates an area where the stream is recharging the groundwater.

Specific conductance, which we measured using a meter, indicates the capacity of water to conduct an electrical current and commonly reflects the amount of dissolved minerals in the water. At our testing location, groundwater has a lower specific conductance than surface water (in other places, though, the reverse might be true). Changes in specific conductance along a stream reach can be used to help detect areas where groundwater is discharging to surface water.

Temperature was measured using an alcohol thermometer (to avoid possible mercury contamination of the environment). In our region, groundwater temperature is usually constant at around 13°C (55°F). This means that groundwater will be cooler than surface water during the summer, and warmer during the winter; so temperature provides another way to detect groundwater inputs to streams.

Nitrates were measured by LaMotte field test kits. High levels of nitrates in drinking water are a human health problem (see "Testing Oregon Wells for Nitrates,").

Interpreting the Results

Taken together, our test results (see table below) led us to conclude that groundwater was discharging to the stream between sites 2 and 4. Site 4 showed higher water flow than could be expected from upstream flow alone - i.e., combined flow rates from sites 2 and 3 add up to only 0.028 cfs (cubic feet/second), whereas site 4 has a flow rate of 0.035 cfs. The difference - 0.007 cfs - comes from groundwater input. The lower temperature and lower specific conductance measured at site 4 (compared to site 2) also reflect the input of groundwater, both from the spring and from the groundwater system.

	Site 1 Well (groundwater)	Site 2 Stream (surface water)	Site 3 Springhouse (groundwater)	Site 4 Stream (surface water)
Altitude (above mean sea level) of water table or stream surface	345 ft	327 ft	340 ft	326 ft
Flow rate (cubic feet/second)*		0.021	0.007	0.035
Specific conductance (mhos/cm)	175	300	200	250
Temperature (°C)	13	21	13	19
Nitrate (mg/L)	< 0.2	> 8.8	8.8	> 8.8

*Net groundwater input = flow at site 4 – (flow at site 2 + flow at site 3) = 0.035 - (0.021 + 0.007) = 0.007 cubic feet/second.

We were able to document a nitrate contamination problem associated with the spring and the stream, but not in the well water (site 1). The high nitrate level found at site 2 indicates a source of nitrate contamination upstream of site 2. The high nitrate level at the spring (site 3) suggests an additional source of nitrate contamination (possibly a septic system) between the well and the spring.

"Vertical Monitoring"

The groundwater-surface water relationship is only one of many parts of the hydrologic cycle. If we extend our water monitoring upward to precipitation, and downward to aquifer sampling, then we will have achieved vertical monitoring - the air, surface, and underground dimensions of water. The CRVMP has obtained precipitation records for the monitoring area (based on data collected by citizens, government agencies, and the local water company). In addition, some CRVMP monitors have now installed rain gauges in their backyards. All of this water data will be combined to give a fuller picture of the water budget in our local area.

What lessons have we been learning from our water monitoring program? First, the more we monitor, the more we want to monitor more parts of the hydrologic cycle. Second, the more we monitor, the more we need cooperative effort among the various stakeholders. Third, the more we monitor, the more fully we can assess water quality, which then leads to active protection and restoration. Our message to you is: Monitor all waters, wherever the water occurs in the cycle. We invite you to do more of this holistic water monitoring (atmosphere, surface, lithosphere), and to share your experiences.

References

Fetter, C. W. *Applied Hydrogeology*, 2nd ed. 1988. Merrill Publishing, Columbus, OH.

Freeze, R. A. and J. A. Cherry. *Groundwater*. 1979. Prentice-Hall, Englewood Cliffs, NJ.

Domenico, P. A. and Schwartz, F. W. *Physical and Chemical Hydrogeology*. 1990. John Wiley & Sons, New York.

Peter Weber *is an environmental protection specialist in the Ground Water Protection Section, EPA Region 3. He also volunteers as the Associate Coordinator of the CRVMP.*

Frank Dowman *is Program Coordinator for CRVMP and also teaches environmental science at Sun Valley High School, Aston, PA.*

For more information, contact Peter Weber at EPA Region 3, 841 Chestnut Building, Philadelphia, PA 19107; telephone 215/ 566-4283.

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.

Federal Sources of Aerial Photographs

- **U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service**
  USDA ASCS Aerial Photography Field Office
  222 West 2300 South
  P.O. Box 30010
  Salt Lake City, UT 84103-0010
  Tel.: 801/524-5856

- **U.S. Department of the Interior, U.S. Geological Survey**
  Earth Science Information Center
  U.S. Geological Survey
  507 National Center
  Reston, VA 22092
  Tel.: 1-800-USA-MAPS

- **National Archives and Records Administration, Cartographic and Architectural Branch**
  Cartographic and Architectural Branch
  National Archives and Records Administration
  8601 Adelphi Road
  College Park, MD 20740-6001
  Tel.: 301/713-7040

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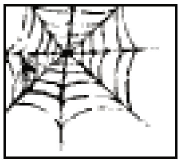

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Groundwater Resources

Citizen's Guide to Ground-Water Protection. 1990. U.S. Environmental Protection Agency, #440/6-90-004. 33-page pamphlet on sources of groundwater contamination and actions communities can take to protect groundwater. Free. Write to U.S. EPA, Water Resources Center, Mail Code 4100, 401 M St., SW, Washington, DC 20460; or call the Safe Drinking Water Hotline, 800/ 426-4791.

How-To Manual for Groundwater Protection Projects. 1992. Based on the El Paso survey (described in "Groundwater Inventory Goes Binational" of this newsletter). Available at no charge from David Terry, TNRCC, P.O. Box 13087, Austin, TX, 78711.

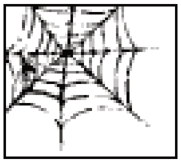
Killham, Amy. *Making Waves: How to Put on a Groundwater Festival.* 1993. Step-by-step guide for organizing a groundwater festival to educate children and adults. Available for $12 from the Groundwater Foundation, P.O. Box 22558, Lincoln, NE 68542-2558; 800/858-4844.

Liner, E. B. and Morley, E. *Assessing the Experience of Local Groundwater Protection Programs.* 1994. The Urban Institute. Case studies of six groundwater protection programs. Available for $13.50 from The Urban Institute, P.O. Box 7273, Dept. C, Washington, DC 20044; 202/857- 8687.

Mueller, Christine. *Protect Your Groundwater: Educating for Action.* 1994. League of Women Voters, Pub. #980. Covers the water cycle and tools for community education; includes case studies and resource list. Available for $6.95 from LWV, 1730 M St., NW, Washington, DC 20036; 202/429-1965.

Protecting Local Ground-Water Supplies Through Wellhead Protection. 1991. U.S. Environmental Protection Agency, 570/9-91-007. 18-page pamphlet. Available for $6 from ERIC (Environmental Resources Information Center); 800/ 276-0462.

Volunteer-Based Wellhead Protection Area Inventory Training Guide. Idaho Water Resources Research Institute. How to use volunteers to inventory potential contamination sources in wellhead protection areas. Available January 1995. For price and ordering information, contact Dottie Shuman, Idaho WRRI, 106 Morrill Hall, University of Idaho, Moscow, ID 83843-3011; 208/ 885-6429.



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More Resources for Volunteer Monitors

Watershed Publications from EPA

Watershed Events is a regularly published bulletin that updates readers on the development and use of watershed protection approaches. To be placed on the mailing list, write to Louise Gilbert, U.S. EPA, 4501F, 401 M St., SW, Washington, DC 20460.

The Watershed Protection Approach, 1993/94 Activity Approach. Summary of activities EPA carried out in 1993/94 to support the watershed protection approach. Free. Available in early 1995 from U.S. EPA, NCEPI, P.O. Box 42419, Cincinnati, OH 45242-2419. Order publication EPA 840-S-94-001.

Watershed Protection: Catalog of Federal Programs. 1993. Directory of federal programs oriented toward water quality and ecosystem management. Free. Write to U.S. EPA, Watershed Branch (4503F), 401 M St., SW, Washington DC 20460. Order publication EPA 841-B-93-002.

New Manuals from IWLA

The Izaak Walton League's Save Our Streams program has published two new manuals, one for teachers and one for volunteer trainers. *Hands On Save Our Streams: The Save Our Streams Teacher's Manual* (199 pages) is designed for both science and nonscience teachers of grades one through twelve. Emphasizing a watershed approach, it covers topics like "Measuring Stream Health" and "The Relationship Between Land Use and Water Quality" and includes both classroom and field activities.

Save Our Streams Volunteer Trainer's Handbook (100 pages) was written for people interested in starting and coordinating Save Our Streams projects. It covers volunteer recruitment and training, designing a monitoring plan, working with government agencies, using volunteer-collected data, and many more topics of interest to trainers.

Both publications include an extensive volunteer water monitoring bibliography. Each manual costs $10 without a binder, or $15 including looseleaf binder. Order from Save Our Streams, IWLA, 707 Conservation Lane, Gaithersburg, MD 20878; 800/BUG-IWLA.

New from River Network

The Summer 1994 issue (vol. 5, no. 2) of *River Voices*, River Network's quarterly newsletter, is devoted to watershed protection. Articles cover watershed activism, watershed management, "watershed lingo," and more.

Also new from River Network is *How to Save a River: A Handbook for Citizen Action*, a 266-page book by David Bolling that tells how to mount a grassroots campaign to save a river. Especially impressive is a chapter that guides readers painlessly through the maze of federal and state environmental legislation. Throughout this highly readable book, examples of successful citizen campaigns are used to illustrate the basic principles.

River Voices costs $4 per issue. *How to Save a River* costs $14 plus $4 shipping. Both are available from River Network, P.O. Box 8787, Portland, OR 97207-8787; 800/423- 6747.

Manuals for Lake Monitors

Understanding Lake Data (1994), published by University of Wisconsin-Extension, gives clear, detailed explanations of how to interpret results of physical and chemical water quality testing. This 20-page booklet is available for $2.75 plus $1.05 shipping from Extension Publications, Rm. 245, 30 N. Murray St., Madison, WI 53715; 608/262-3346.

Another UW-Extension publication, *Life on the Edge . . . Owning Waterfront Property* (1994; 100+ pages), offers useful advice on environmentally friendly lakefront living. Available for $2 plus $2.90 shipping from UWEX-Lake Management, CNR-UWSP, Stevens Point, WI 54481; 715/346-2116.

For Students

Environmental Resource Guide: Nonpoint Source Pollution Prevention is a supplementary curriculum for grades 9 - 12. Developed by Tennessee Valley Authority's Environmental Education Section for the Air and Waste Management Association (A&WMA), this 237-page curriculum offers classroom activities about nonpoint source pollution - what it is, how land uses contribute to it, and how to control and prevent it. The curriculum is available for $40 (discounts on orders of 15 or more) from A&WMA, Publications Order Dept., One Gateway Center, Third Floor, Pittsburgh, PA 15222; 412/232-3444.

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Displaying Secchi Data

by Jennifer Koser

At Minnesota's Citizen Lake-Monitoring Program, we've come up with several good ideas for presenting Secchi disk results. The photo below shows a display we constructed for the Minnesota Lakes Association conference. The top part of the display is a poster with a topographic map of Lobster Lake in the center. The lake's two Secchi sampling sites are marked on the map. On either side of the map are data tables (one for each site) showing Secchi depths for the season. Two fishing bobbers, mounted on fishing line that is drawn taut from the poster to the base of the display, are used to indicate the most recent Secchi reading (*Note:* the fishing line is not visible in the photo).

The beauty of this design is that it's easy to slide the fishing bobbers up and down on the fishing line. A similar display could be placed in a local cafe or bait shop. Each time a new Secchi reading is taken, the bobbers could be repositioned.

RALPH PRIBBLE

Simultaneously displaying your data in several different forms makes it easier to understand. For example, the display in the photo shows the data in both a scalar and a tabular form. You may also want to use a graph. Here's one suggestion: On a stiff-backed poster, use a marker to draw and label the axes (Secchi depth on the x-axis, sampling date on y-axis). Instead of using the marker to plot the points and draw in the graph, use push-pins to indicate Secchi depths, and connect the pins with colored string or yarn. This way, the display can be used more than once.

One final point: No matter how you choose to display your data, always be sure to include the name of the volunteer who collected it. Volunteers work hard, and they deserve some recognition for their energy and dedication.

Jennifer Koser *is the Statewide Coordinator for the Citizen Lake-Monitoring Program, Minnesota Pollution Control Agency, 520 Lafayette Rd., St. Paul, MN 55155; 612/296-6300.*

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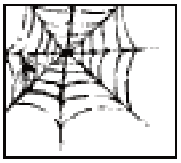

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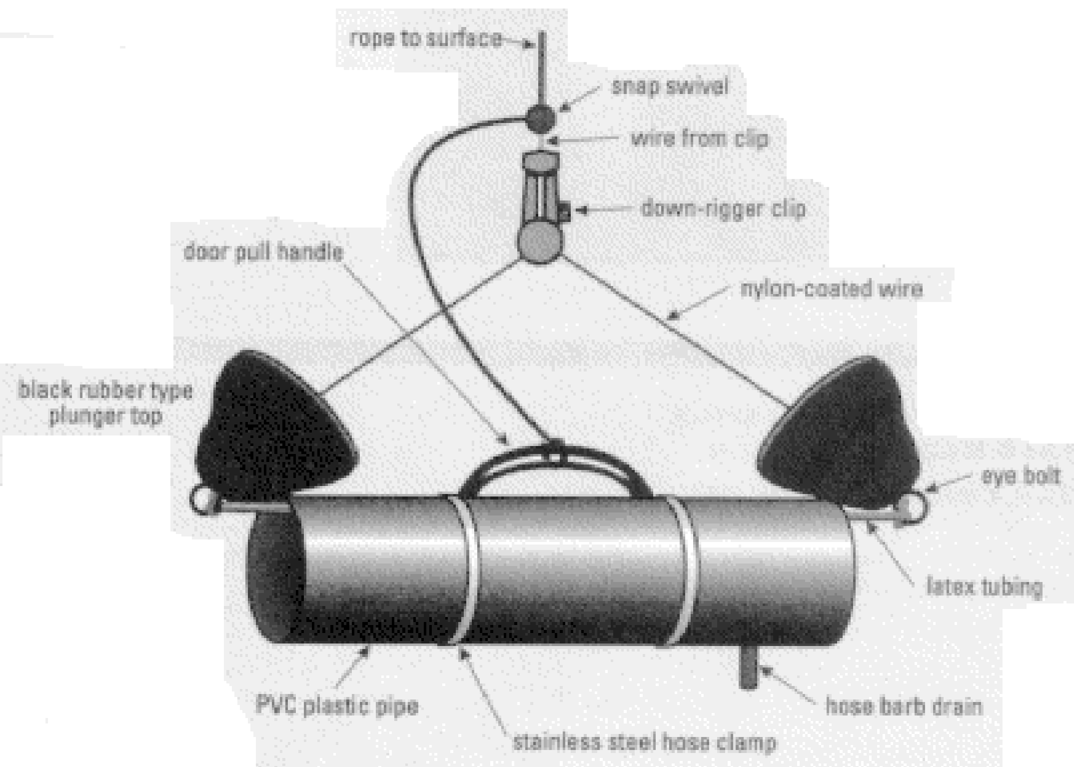
Low-Cost Van Dorn Water Sampler

by Larry Caton

This homemade Van Dorn style water sampler is used to collect samples at depth. It can be built for about $35 - which is 5 to 10 times less than commercial models.



The unique feature is the release mechanism. Whereas typical Van Dorn samplers use a weighted "messenger" that is sent down the rope to strike a trigger and release the plungers, this homemade version uses a sportsfishing down-rigger clip. These clips are normally used when trolling for fish, and are designed to release when a fish strikes the bait. Similarly, a sharp tug on the rope releases the plungers when the water sampler is at the desired depth.

For instructions, contact Larry Caton, Oregon Department of Environmental Quality, 1712 SW 11th Ave., Portland, OR 97201; 503/229-5983.

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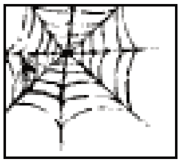

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Nationwide Turbidity Testing in Australia

by Terry White

"Too Thick to Drink, Too Thin to Plough"

Here in Australia we live in one of the world's driest continents - but when the rains eventually come, they cause havoc, eroding river banks and washing huge amounts of sediment into streams. In my home state of Victoria, the Yarra River gets so turbid that people say it "flows upside down" or that it's "too thick to drink, too thin to plough." The effect of all this sediment and organic matter is to raise the cost of water treatment, block the light needed for growth of aquatic plants, reduce the visibility fish need for feeding, and smother bottom- dwelling aquatic life.

Monitoring Turbidity

In 1991, Noel Morgan made the first Aussie attempt to get a cheap and accurate turbidimeter into the hands of the people most likely to do something about the problem - farmers. As a farmer himself, a former water quality chemist, and chairman of his regional watershed committee, Morgan was aware of the way soil loss on farms contributes to the turbidity of streams. He also knew that monthly turbidity records from the few government monitoring sites in the watershed were seriously misrepresenting the turbidity problem because 90 percent of soil loss and erosion damage occurs during rainfall.

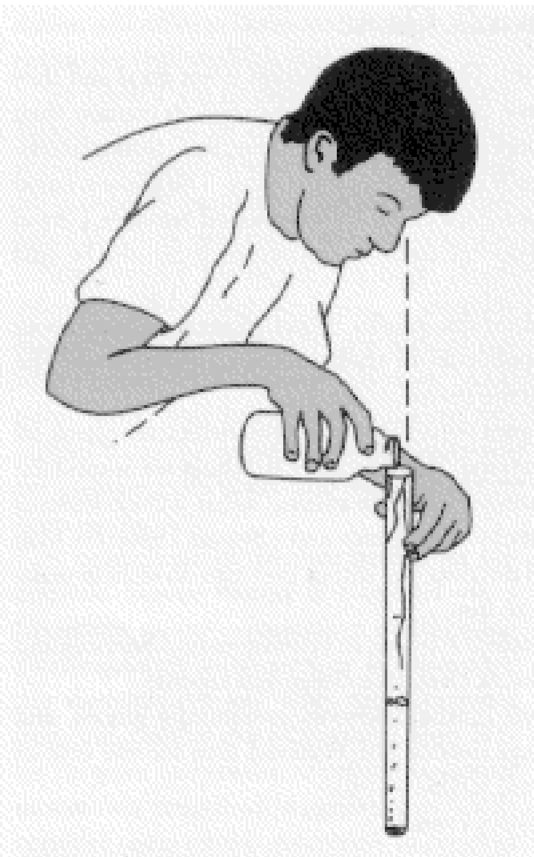
Morgan reasoned that involving the farmers themselves in widespread turbidity monitoring exercises before, during, and after storm events would quickly pinpoint those areas where turbidity problems were severe and where farm management changes were most needed. It would also be the strategy most likely to result in on-the-ground action. We change our behavior more as a result of insights arising from our own actions than from any amount of external urging.

Farmer friends across the watershed were ready and willing to take samples. The challenge was to find a cheap and accurate method of measuring turbidity.

The Secchi disk is a widely used method for measuring water clarity, especially in lakes, but it isn't practical in our creeks. During droughts our creeks are not deep enough to get a reading, and during floods they are flowing too fast.

Professionals generally measure turbidity with a fairly expensive piece of electronic equipment called a nephelometer, which works by passing a beam of light through a water sample and electronically measuring the amount of light scattered at right angles to the beam. This is an accurate method, but it would have been much too expensive for Morgan's purposes.

The third option was to use some kind of turbidity tube based on the classic Jackson candle turbidimeter, used in 1900 by Whipple and Jackson to make the first standard measurements of turbidity. Jackson's method involved holding a flat-bottomed, calibrated glass tube over a special candle and pouring the water sample into the tube while looking down the tube until the turbidity of the sample completely blocked the view of the candle flame. The tube was calibrated with measured dilutions of a standard solution of diatomaceous earth in distilled water.



One drawback of the Jackson turbidimeter, and later models of turbidity tubes based on it, is that it is not sensitive enough to detect very low levels of turbidity, such as those found in treated water. But Morgan knew that low turbidity would definitely not be a problem in the water samples he wanted to test.

So Morgan invented the "Morgan Bottle Turbidimeter" - simply a plastic soft-drink bottle, 1.5- or 2-liter size, on the bottom of which Morgan drew a standard symbol with black felt-tip pen and white paint. Using a nephelometer as a standard, Morgan calibrated each bottle and marked the sides in NTUs (nephelometer turbidity units) with the felt-tip pen. He distributed these gadgets to farmer friends. With a calibrated bottle always available in the back of the pickup, farmers found it relatively easy to take a series of turbidity readings in local creeks during heavy rains. Once problems were identified, the farmers could often trace the cause - such as bank collapse or poor farming practices.

A Snapshot of Turbidity in Australia

Morgan's initiative and ingenuity triggered a series of events which ultimately led to a nationwide "snapshot" of turbidity across Australia. In August 1994, representatives of community-based water quality monitoring groups from around the country met together and decided to have 700 turbidity tubes manufactured here in Australia, at a cost of approximately $15 (U.S. $11) each, for use nationwide during National Water Week, held October 23 - 29. (Similar turbidity tubes are commercially available, but at a cost of about $100 they are beyond the reach of most community groups.)

Morgan's bottles were accurate, but because of their height they could register only highly turbid waters. The model manufactured for Water Week was 2 feet long and made from polycarbonate tubing (1.5-inch diameter) with a white plastic base glued on to the bottom. A black symbol was painted on the base, and the tubes were calibrated using a standard Formazin solution (the same standard that is used to calibrate nephelometers).

During Water Week, over 1,000 school and community groups used the locally manufactured turbidimeter to monitor creeks and rivers. Each state is now putting together a publication called "Snapshot," including photographs, comments, and watershed maps depicting volunteers' results.

Do-It-Yourself

Because of the large number needed, we had our turbidity tubes mass-produced; but the design could easily be adapted by individual groups wanting to make their own turbidity tubes. Any clear to semi-clear plastic can be used. Tube diameter is not critical. The symbol on the base could be an X, a black spot, or even a black-and- white Secchi disk. What is most important is that each turbidity tube is calibrated using the Formazin standard.

Terry White *is a community water monitoring consultant from Melbourne, Australia, and a member of the Australian Waterwatch Advisory Committee. He may be reached at 36 Lambeth Pl., St. Kilde, Victoria 3182, Australia; phone 011-61-3-537-1935; fax 011-61-3-525-5949.*

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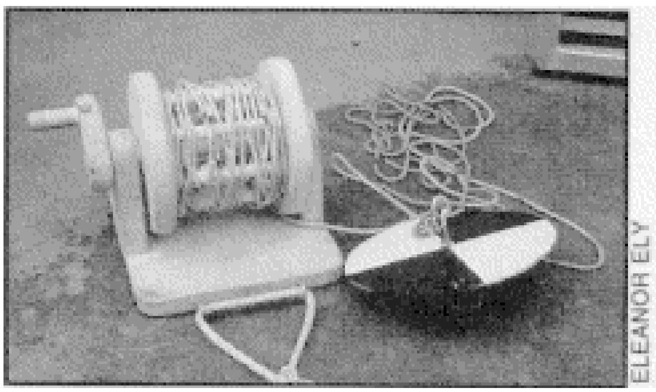
Secchi Disk Line Storage Reel

The convenient wooden reel pictured below was designed and built by Bill Fairhurst, Water Quality Committee Chair of the Walloon Lake Association in Michigan. The reel may be constructed from clear cedar or marine plywood. Fairhurst, who is also a volunteer with the Tip of the Mitt Watershed Council's Lake Monitoring Program, says the reel is very handy for preventing the Secchi line from getting tangled between samplings.



A complete set of instructions is available from the Tip of the Mitt Watershed Council, P.O. Box 300, Conway, MI 49722. Please enclose a business-size SASE with 29¢ postage.

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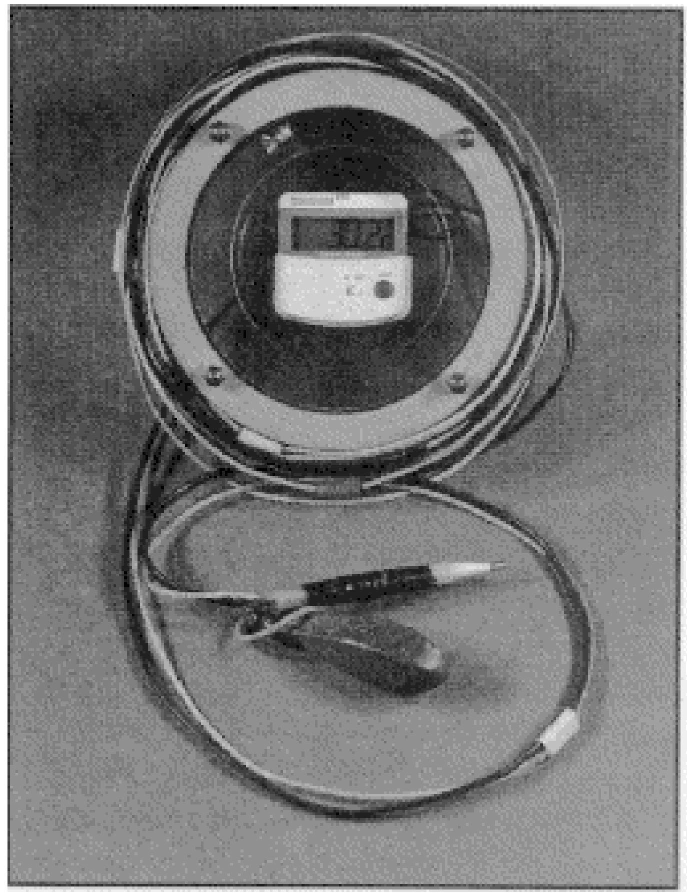
Temperature Profile Tool

Rick Wilkey, a volunteer with the Eagleville Pond Association in Massachusetts, has designed a useful homemade tool for obtaining temperature profiles in lakes and ponds. The device, pictured below, is made from an inexpensive (around $20) indoor-outdoor digital thermometer.

The thermometer comes with the outdoor temperature sensor attached to the display by a relatively short wire lead, which needs to be lengthened for lake monitoring purposes. Wilkey accomplishes this by cutting the original wire lead and soldering on a 20-foot length of 20-gauge lamp cord. To protect the solder joint and make it waterproof, Wilkey uses a device made from the plastic tube of a Bic pen.

To strengthen the wire lead, Wilkey tapes a nylon cord along its length. The cord is taped to the wire at ½-meter intervals, making it easy to gauge depth as wire and cord are lowered into the lake. A weight is attached to the end of the nylon cord.

Wilkey builds a reel from Plexiglass to keep the wire and cord neatly coiled (other materials, such as Masonite or wood, could also be used). He recommends recessing the display down inside the reel to prevent damage.


RICHARD NEWTON

So far, Wilkey has built three of these temperature profile devices for use by volunteer monitors. He will be happy to provide detailed instructions to anyone who is interested. Please send a business-sized SASE to Rick Wilkey, 64 Eagleville Rd., Orange, MA 01364.