The Volunteer Monitor

THE NATIONAL NEWSLETTER OF VOLUNTEER WATERSHED MONITORING Volume 15, Number 1 • Winter 2003

ALLARM

Sherman's Creek Conservation Association members learn about macroinvertebrate monitoring at ALLARM workshop.

University Partnerships

the ALLARM Program

growth, change, and lessons learned

by Candie Wilderman, Alissa Barron, and Lauren Imgrund

*After 10 years of operation, we renamed our college-community partnership. The program formerly known as ALLARM would henceforth be called … ALLARM. Although the name change—from "Alliance for **Acid Rain** Monitoring" to "Alliance for **Aquatic Resource** Monitoring"—may have been subtle, it signaled a far-reaching change in the relationship between Dickinson College and volunteers from the surrounding community.*

The original ALLARM was started by the college's Environmental Studies Department in 1986 to collect more information about the impact of acid deposition on Pennsylvania's streams. The new ALLARM has a dramatically broader focus. While we have continued the acid rain monitoring, now the majority of our effort is devoted to helping community groups perform their own monitoring and research on issues of their own concern.

A continuum of models

"Citizen science" projects, including volunteer monitoring, rely on partnerships between citizens and professional scientists. These partnerships can take many forms, which may be arranged along a continuum of increasing community involvement and control. ALLARM's experience of evolving from a single-issue, "top-down" program to a multi-issue, "bottom-up" program has given us some special insights into the strengths and challenges of the different models.

The following five questions help situate a given partnership along the continuum:

1. Who defines the problem?
2. Who designs the study?
3. Who collects the samples?

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The Volunteer Monitor

The Volunteer Monitor is a national newsletter, published twice yearly, that facilitates the exchange of ideas, monitoring methods, and practical advice among volunteer monitoring groups.

Next Issue:
The theme for the next issue is "Monitoring Living Creatures." If you have ideas for topics or articles, please contact Eleanor Ely, Editor, 50 Benton Ave., San Francisco, CA 94112; 415-334-2284; ellieely@earthlink.net.

New Distributor!
Please note that *The Volunteer Monitor* has a new distributor. For subscriptions, address changes, and back issue orders, please contact Susan Vigil, Volunteer Monitor Distribution Office, 211A Chattanooga Street, San Francisco, CA 94114-3411; 415-695-0801; skvigil@yahoo.com; or use the order form on page 23.

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Letter to the Editor

Great issue on volunteer monitoring success stories! [Summer 2002]

One of the reasons I drifted away from the monitoring movement was my frustration that so many participants were frightened of, or at least uninterested in, enforcement. My principal motivation in starting a San Francisco Bay monitoring program with the Oceanic Society back in 1973 was using the information to stop polluters. Later, at San Francisco Baykeeper, that's exactly what we did!

But since moving to Maine and experiencing the kinder, gentler approach to improving water quality that is used here, I've become more appreciative of the important role monitoring programs play in creating good stewards. Case in point: Friends of Casco Bay/Casco Baykeeper. This program has never filed a lawsuit to stop pollution and probably never will. But Casco Baykeeper Joe Payne's program has been every bit as successful as many of the more litigious ones because of his style and the validity and reliability of the data. Joe is primarily a water quality scientist who believes in using data gently, to change bureaucrats' thinking.

So keep up your great work in producing and sustaining water monitors. They appear to be the stewards who maintain water quality and often become the early warning system that alerts waterkeepers of the need to take more aggressive action.

Mike Herz
[*Note:* Mike Herz founded San Francisco Baykeeper in 1989 and served as the organization's first Baykeeper.]

National Conference in 2004 ... Stay Tuned!

Plans are under way to combine the 7th National Volunteer Monitoring Conference with the National Water Quality Monitoring Council (NWQMC) conference that is being organized for May 17-21, 2004, in Chattanooga, Tennessee. Attendees at our 2000 national conference in Austin will recall that it included one combined day with the NWQMC meeting. This time around, our goal is a more integrated conference, with active participation from a wide variety of volunteer monitoring programs both in conference planning and in paper/poster presentations and session leadership.

The advantages of this approach are significant, both in monetary savings to EPA and in advancing our efforts to mainstream volunteer data into state, federal, and local monitoring programs. Stay tuned to this newsletter and the *Volmonitor* listserv for more information. (To subscribe to the listserv, send a blank message to: volmonitor-subscribe@lists.epa.gov.)

If you have suggestions for the 2004 conference or would like to help out, contact Alice Mayio, USEPA, at mayio.alice@epa.gov, 202-566-1184. In the meantime, here are some national conferences coming up in 2003 that can provide an opportunity for volunteer monitors to present papers, teach our colleagues about volunteer monitoring, and learn from our state, federal, and local partners:

- *National Conference on Coastal and Estuarine Habitat Restoration.* Baltimore, MD, April 13-16. Contact Heather Bradley, Conference Coordinator, 703-524-0248, hbradley@estuaries.org.
- *6th Annual National Conference: Enhancing the States' Lake Management Programs.* "Developing and Implementing TMDLs for Lakes and Reservoirs." Chicago, IL, April 22-25. www.nalms.org/news/events.htm.
- *American Wetlands Conference.* Minneapolis, MN, May 1-4. www.iwla.org/sos/awm/conference.
- *National Marine Educators Association (NMEA) 2003 Conference.* Wilmington, NC, July 20-24. www.vims.edu/nmea/nmea2003/.
- *NALMS 2003: Protecting Our Lakes' Legacy.* Mashantucket, CT, November 5-8. www.nalms.org/.

—Alice Mayio
National Volunteer Monitoring Coordinator, U.S. EPA

[*Editor's note:* For more on the American Wetlands and NALMS 2003 conferences, see page 24.]

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4. Who analyzes the samples?
5. Who interprets the data?

At one end of the continuum is what we call the "community workers model." The role of citizen volunteers is limited to sample collection, while professional scientists define the problem, design the study, identify the goals and methods, and do the analysis and interpretation. One example is the Maryland Department of Natural Resources' Stream Waders Volunteer Monitoring Program, in which volunteers collect macroinvertebrates at assigned sites, then send them to the Department for identification and analysis.

At the other end of the spectrum are partnerships that involve maximum community control and participation. In this "community-based participatory research" or "science by the people" model, community members identify their concerns and are then trained by the supporting institution to design the study, collect the data, analyze and interpret the results, and turn the data into action.

In between these two extremes many variations exist. For example, in the European "science shop" model (also called "science for the people"), the community sets the research agenda but scientists take over from that point. In other cases, issues and concerns are raised by community members and then scientists and community volunteers work together to collect the data needed to answer the questions.

The original ALLARM

A state representative provided the initial impetus for what became the Alliance for Acid Rain Monitoring. As part of his effort to introduce an Acid Deposition Control Bill in Pennsylvania, he suggested to a group of scientists—among them Dickinson College Environmental Science Professor Candie Wilderman—that a program be started for volunteers to monitor streams and observe the impact of acid rain.

Intrigued by the public education value of the project, and hopeful that the opportunity to apply their academic work to solving real human problems might inspire and motivate students, Wilderman took up the challenge. She wrote an article about the program for *Pennsylvania Angler* magazine, and within a few weeks had heard from some 50 anglers concerned about the effects of acid deposition on fish and ready to volunteer.


ALLARM

Volunteers learn to perform chemical testing at an ALLARM workshop.

With the help of an enthusiastic student, Wilderman trained the anglers, along with other community volunteers, to conduct weekly testing for alkalinity and pH at a stream site of their choosing. The volunteers measured alkalinity—the best indicator of how acid rain is affecting streams—with a chemical field test kit, and used paper pH strips to make the less-critical pH measurement. Over the years, the program has grown tremendously and now includes monitoring data from over 600 sites across Pennsylvania. This represents the Commonwealth's largest database on pH and alkalinity, and all the data have been collected by volunteers!

> THE MORE THAT WE HAVE CEDED CONTROL TO WATERSHED ORGANIZATIONS, THE HARDER ALLARM'S PROFESSIONAL AND STUDENT STAFF HAVE HAD TO WORK.

In terms of the community-control continuum, our acid rain monitoring program resembles the "community workers model," but with one difference: our volunteers go beyond simple sample collection to perform chemical testing. However, ALLARM established the agenda and designed the study, and ALLARM analyzes and interprets the data. We call this model "community workers model 2." Volunteer bird-monitoring projects in which volunteers count and identify birds fall into this same category.

The new ALLARM

As our volunteers became more knowledgeable about their streams, many wanted to investigate other issues in addition to acid rain. Some asked for our help in testing for metals in streams that were affected by mine drainage. A Sierra Club chapter was concerned about contamination from a Superfund site getting into Coplay Creek. The Conodoguinet Creek Watershed Association wanted to measure nutrients and dissolved oxygen to assess the impacts of nonpoint source runoff and increasing development in the watershed.

ALLARM was excited about expand-

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ALLARM

Acid rain monitor examines alkalinity results at streamside.

What Is Acid Rain?

Emissions from fossil-fuel-fired power plants, car and truck exhaust, industrial boilers, and other sources react with water, oxygen, and other chemicals in the atmosphere to form acidic compounds such as sulfur dioxide and nitrogen oxides. These acidic compounds are then "washed" out of the atmosphere as "acid rain." Fog, mist, and snow can also carry these compounds to the ground, so a more precise term for the process is *acid deposition.* Acid deposition into streams, lakes, and other aquatic systems can kill aquatic organisms, cause serious deformities in unhatched young, and interfere with reproduction.

ing our program to address the concerns of local watershed groups. In 1996, we hired a full-time Director (Lauren Imgrund); adopted our new, more inclusive name; and set about reshaping ALLARM into a partnership whose agenda would largely be set by the community.

More work

Paradoxically, the more that we have ceded control to watershed organizations, the harder ALLARM's professional and student staff have had to work. But then, as educators we already knew how much longer it takes to teach someone else to do a task than to do it yourself!

Right from the beginning, responding to community concerns meant choosing and developing methodologies for analyzing new chemical parameters (nutrients, dissolved oxygen, metals, etc.) and training volunteers to perform them. We have also trained a few groups to measure flow, sample macroinvertebrates, or perform habitat assessments.

Initially, our new community-centered approach did not extend to the first (study design) and last (data analysis and interpretation) steps in the watershed assessment process. But as time went on, we realized that without involvement in these steps the watershed groups lacked a sense of ownership of their project and their data.

ALLARM

Alissa Barron (left), ALLARM student staffer Clare Foster, and Candie Wilderman discuss study design with members of the Ridge and Valley Streamkeepers.

ALLARM

Elementary school teachers at a habitat assessment workshop.

With support from River Network and other Pennsylvania organizations, we began holding workshops to help groups design their own study. Because reaching consensus on a study design requires the group to hash out differences in goals and priorities, there is a risk that some members may become alienated and drop out. But those who make it through the process emerge with a stronger commitment to work together toward common goals.

> WHEN VOLUNTEERS FIND OUT FOR THEMSELVES WHAT STORY THEIR INFORMATION IS TELLING, THEY NO LONGER ASK *US* TO "DO SOMETHING" WITH THEIR DATA.

The final step, data analysis and interpretation, is usually the most intimidating for volunteers, so for a while ALLARM continued to perform these tasks on behalf of the watershed groups even as we began helping them create their own study designs. We would show up at watershed association meetings with our carefully prepared report, complete with graphs of the volunteers' data and our interpretation of what it all meant, only to be met with glazed looks as we made our presentation. When we were finished, the volunteers would say things like, Gee, do you think you could explain that to the local reporter?

Now we involve the groups in analyzing their own data. This is not simply a matter of providing some pointers and then leaving the volunteers on their own. We still do most of the "data-crunching," and we bring our graphs to meetings. But now we give the graphs to the volunteers and ask, What do you see? We act as facilitators, giving participants the background information they need to look at the graphs and identify patterns through time and space.

When volunteers find out for themselves what story their information is telling, they no longer ask *us* to "do something" with their data. They are ready to make their their own case to the media, local agencies, or elected officials, rather than having to rely on others to define and explain the issues for them.

Volunteer recruitment is almost the only task that has actually become easier. For our acid rain monitoring project, we put considerable effort into recruiting individual volunteers. But when we partner with community groups, volunteer recruitment is their responsibility.

Comparing the models

Both models—the original acid rain monitoring project, and our new com-

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College-Community Partnerships: Who Benefits?

The ALLARM program has at least three beneficiaries: the community groups, Dickinson College as an institution, and Dickinson's students.

The community

Whenever community-based volunteer monitors partner with a college or university, they gain access to an array of valuable resources, including faculty expertise, laboratory equipment, computers, and library resources. In our case, ALLARM is able to use the college's flowmeters and incubators, atomic absorption spectrophotometer, and GIS software both for our acid rain monitoring program and for the various monitoring projects initiated by community watershed groups with whom we partner.

Community members often tell us how much they appreciate ALLARM's teaching skills. Experienced professional educators, who are accustomed to translating complex information into understandable terms, are ideally equipped for training citizen scientists.

The institution

Dickinson College has benefited from ALLARM in countless ways, many of which we never anticipated until we started seeing them. By making undergraduate science more meaningful, ALLARM clearly promotes the college's primary mission of educating students. The program also enables the college to expand its mission to involve the broader community in the scientific enterprise. Because of its support of ALLARM, the college enjoys an enhanced reputation as a community-minded institution, which has helped attract more students, more grant monies and alumni contributions, and more media attention.

The students

Dickinson students may be the greatest beneficiaries of all. Undergraduate students typically see little connection between their science classes and contemporary social and political problems, instead viewing science in terms of facts to be memorized and lab "recipes" to be followed. By providing the opportunity to do substantial, creative scientific work that far exceeds what is usually available to undergraduates, ALLARM has the potential to transform this perception, thereby encouraging more students to pursue scientific careers.

At any given time about a dozen students are employed by ALLARM as paid staff, and over the years some 150 have worked for us. These student staff have important real-world responsibilities: conducting workshops, managing the laboratory, developing monitoring methods, performing quality assurance/quality control procedures, and analyzing and interpreting data.

But it's not only the paid student staffers who benefit. Many environmental science classes at the college also work on ALLARM projects—for example, analyzing data for community watershed association monitoring programs, or performing original research to provide community groups with information they could not obtain on their own.

We have seen that when students test volunteer-collected samples they feel a heightened sense of accountability and responsibility for the accuracy of the results, because they know that their work has the potential to bring about real changes in the community and the watershed.

Many of our students elect to broaden their expertise by taking additional classes—even the much-dreaded organic chemistry—or enrolling in classes outside of their major. For example, environmental science majors may take writing or political science courses.

Another benefit for students is the positive role model for learning that students encounter outside the walls of academia. While many of their fellow students seem to be caught up in a narrow preoccupation with grades, our students get to know citizen volunteers who view education as a lifelong quest, eagerly sought after and perceived as vital to community empowerment. What's more, these community people express respect for the students' skills and knowledge. The students come away with a new sense of appreciation for their own educational opportunities.

Last but not least, ALLARM places students in the contentious territory where science and social/political issues overlap. For example, students learn that the highest quality data may sometimes be beyond the reach of community groups, either because of the large number of samples required or the cost of highly accurate equipment. Thus, students come to recognize that "powerful" data may often be the privilege of the wealthy. Students also confront difficult questions about using data for advocacy and the public interest. When and how is it appropriate to act in the face of scientific uncertainty? The opportunity to think about such questions is invaluable to future scientists, yet rarely part of an undergraduate science education except in the context of community science projects such as ALLARM.

ALLARM

Student staffer Kara Sergeant at work in the ALLARM lab.

Institutional obstacles

In spite of the many excellent examples of community science projects based on strong university-community partnerships, there are some institutional obstacles to establishing such programs. One difficulty centers on the traditional ways in which faculty achievement has been defined and rewarded. For example, faculty efforts in support of community science are unlikely to result in publications in traditional peer-reviewed journals, one of the standard criteria for promotion and tenure. In order to get faculty involved in such projects, the college or university must be willing—as Dickinson ultimately has been—to accept such activities as equivalent to traditional scholarship.

The institution must also be willing to commit significant resources. As an example of the kind of support needed, Dickinson College provides our full-time director's salary, student wages, office and laboratory space, grant-writing support (through the college's development office), and release time for faculty. The returns on these investments, however, are felt throughout the institution.

—Candie Wilderman

Virginia SOS Modifies Method, Improves Reliability

by Eleanor Ely

In the spring of 1998, Virginia Save Our Streams (SOS) coordinator Jay Gilliam enrolled in Reese Voshell's aquatic entomology class at Virginia Tech. At the time, Virginia SOS was engaged in a push to encourage the Virginia Department of Environmental Quality (DEQ) to use the program's macroinvertebrate data; but some DEQ biologists were skeptical of the data's quality. So one day, Gilliam asked Voshell what he thought about the SOS data.

Voshell replied, "I'm a scientist—I'd have to study it scientifically in order to give you a scientific answer."

Out of this two-minute conversation grew an intensive two-and-a-half-year study that ultimately provided SOS with a modified method whose results correlate well with professional results. Even more significantly, according to Virginia SOS staff scientist Stacey Brown, the study "stands as a model that other volunteer monitoring groups can use to validate their work and find metrics appropriate to their area."

The study has been published in the journal *American Entomologist*, Fall 2002 issue. For a thorough discussion of the methods, findings, and analysis, readers are encouraged to read the published paper, which is available in a downloadable pdf format at www.vasos.org/ValidationStudy.htm.

STACEY BROWN

Jay Gilliam (left) and James Riverkeeper Lynn Ridley demonstrate the new SOS macroinvertebrate monitoring method.

Virginia SOS's original method

Since the Virginia SOS program's inception in 1988, volunteers had followed the macroinvertebrate monitoring method developed by the Izaak Walton League of America (IWLA) Save Our Streams program (see Kellogg 1994). The IWLA method calls for collecting three individual kick-net samples. Macroinvertebrates are sorted and identified in the field (mainly to order level) using the IWLA picture key.

To rate the stream's water quality, the protocol assigns each group of organisms to a sensitivity category (sensitive, somewhat sensitive, or tolerant). For example, mayfly nymphs are rated sensitive; clams, somewhat sensitive; and leeches, tolerant. A water quality rating score is calculated based on the number of taxa present in each of the three sensitivity categories. Note that the actual number of organisms is not a factor in determining the final score. Only taxa richness—the number of different taxa present in each category—is reflected in the water quality rating. A separate score is calculated for each sample, and the highest of the three scores is considered the most accurate indication of ecological conditions.

The study

For their study, Voshell and graduate student Sarah Engel chose 23 regular Virginia SOS monitoring sites that represented a range of ecological conditions. In 1998, Engel accompanied volunteer monitors on their visits to their sites and observed their technique. After the volunteers finished their sampling and identification, Engel preserved the samples for later verification in the laboratory. In addition, Engel preserved all debris left on the kick-net, to assess the completeness of the volunteers' picking.

Engel then collected her own sample (termed the "professional sample") at an undisturbed location at the same site, following the U.S. EPA's rapid bioassessment protocol (Barbour et al. 1999). The professional samples were preserved in ethanol, then sorted, identified to genus level, and counted in the laboratory. In addition, Engel sampled 122 "historical" sites that Virginia SOS volunteers had sampled during the past five years.

Two indexes were calculated for the professional samples: the Hilsenhoff biotic index (HBI) and a multimetric index called the macroinvertebrate aggregated index for streams (MAIS), which was specifically developed for streams in the mid-Atlantic highlands.

Stream quality overrated

Engel and Voshell compared the SOS water quality rating score for each site with the MAIS score and HBI value determined from the professional sample. They found that, for both concurrent and historical samples, volunteer scores did not correlate well with professional scores. R-values ranged from 0.36 to 0.58, well below the target value of 0.70 that Engel and Voshell had chosen as the criterion for acceptable correlation.

More importantly, the volunteer and professional methods also disagreed in categorizing stream water quality as acceptable or unacceptable. For the 23 concurrently sampled sites, conclusions about ecological conditions based on the SOS score differed from those based on the MAIS score in 8 cases, and each time the SOS method rated the stream acceptable while the MAIS score rated it unacceptable. Twelve sites were rated acceptable by both the volunteer and the professional methods, and 3 were rated unacceptable by both. The historical sites showed a similar pattern. In no case was a stream rated acceptable by MAIS but unacceptable by the SOS score.

> THE PATTERN WAS CLEAR: THE SOS METHOD WAS CONSISTENTLY OVERESTIMATING STREAM QUALITY. NOW THE QUESTION WAS WHY.

The pattern was clear: the SOS method was consistently overestimating stream quality. Now the question was why. Were the discrepancies caused by the volunteers' field methodology (sampling, sorting, identifying), or did the problem reside in the scoring method itself?

After careful analysis of the data, Engel and Voshell concluded that the problem lay with the scoring method. As they wrote in their paper, "The SOS score is not rigorous enough to distinguish impaired ecological conditions because it is based solely on the presence or absence of taxa, without consideration of their abundance."

Modifying the method

Engel and Voshell's next step was to see if they could modify the Virginia SOS protocol to bring it into closer agreement with professional results. An important constraint was that any modification must still allow field identification of organisms. Gilliam felt that only a small percentage of SOS's 350-odd active volunteer monitors would be interested in identifying preserved specimens to lower taxonomic levels in the laboratory. Nor did SOS want to send the samples to a professional lab for identification. As Voshell explains, "We knew the volunteers wanted to be involved with the whole process."

Engel and Voshell focused on making both sampling and scoring more quantitative. In the modified method, volunteers sort, identify, and count the entire contents of the kick-net, which must total at least 200 organisms. If there are fewer than 200 organisms in the initial sample, the volunteers must collect additional samples.

In 1999, Engel repeated concurrent sampling with volunteers at 23 sites (not all the same sites as in 1998), but this time the volunteers used the new sampling method. The professional samples were collected in the same manner as previously. Engel and Voshell used the results of the 1999 sampling to evaluate 24 potential metrics,* all suitable for the level of identification that volunteers were performing. From these, they selected six: % EPT (percentage of sample that consists of mayflies plus stoneflies plus all caddisflies except netspinners), % net-spinning caddisflies, % lunged snails (commonly called left-handed snails), % beetles, % tolerant,

continued on next page

**Note:* A *metric* is a measurable attribute of a biological system that provides a reliable indication of biological condition across a gradient of human influence. For example, % EPT—a measurement of the relative abundance of certain pollution-sensitive species in the macroinvertebrate population of a stream—is a useful metric because it tends to decrease as stream biological condition becomes more degraded. A *multimetric index* integrates several metrics into an overall score.

Bias and Error in Bug Sorting and ID

Another academic who's been investigating volunteer macroinvertebrate monitoring methods is Julia Frost Nerbonne. For her master's thesis, Nerbonne examined some sources of bias and error in sorting and identifying macroinvertebrates, and for her Ph.D. she conducted an extensive survey of macroinvertebrate monitoring groups. She is still analyzing the results of this survey, which she promises to summarize in a future article in *The Volunteer Monitor.*

An article based on Nerbonne's master's thesis research has just been published in the *Journal of the North American Benthological Society.** The study identified errors made by previously untrained volunteers, mostly high school students, who received only a brief introduction to the methods. As Nerbonne notes in the article, it is critical that the findings "be evaluated in context and not be used to characterize all volunteer efforts." Briefly, the study revealed that when sorting macroinvertebrates from debris these novice volunteers were biased toward selecting larger rather than smaller organisms, and toward selecting organisms that moved slowly rather than those moving very fast or those not moving at all. These volunteers also encountered a number of difficulties with identification.

Clearly, Nerbonne's study underscores the need for thorough training, as well as the importance of using adequate lighting and magnification for both sorting and identification. Noting that "macroinvertebrate monitoring is difficult for volunteers," Nerbonne recommends that volunteer program leaders focus on attracting highly motivated volunteers who will commit sufficient time and effort to learning and performing the techniques. In addition, she suggests that volunteers work in teams so they can verify each other's sorting and identification efforts.

For more information contact Julia Frost Nerbonne at jaf@fw.umn.edu.

*Nerbonne, Julia Frost and Bruce Vondracek. 2003. Volunteer macroinvertebrate monitoring: Assessing training needs through examining error and bias in untrained volunteers. *Journal of the North American Benthological Society* 22(1):152-163.

SOS, continued

and % non-insects. These six metrics are combined to yield the Virginia SOS multimetric index.

The R-value for the correlation of the SOS multimetric index score with the MAIS score for the 23 sites was 0.6923, only narrowly below the target value of 0.70. In classifying stream ecological condition as acceptable or unacceptable, the SOS multimetric index showed 95.7% agreement with the professional conclusion for the 23 sites.

No one claims that the new SOS method is the equivalent of a professional assessment, but Voshell stresses that it almost always reaches the same overall conclusion about acceptable versus impaired water quality. To reach more detailed conclusions—for example, about degree of impairment or cause and effect—would require more detailed professional methods, he notes.

Voshell says, "Critics may say, 'They're not identifying organisms to species' or 'The net is too coarse,' and that's true, but the critics aren't looking at the end result. It's the ultimate decision that we're concerned about. We found a way to use a simpler method and still reach the same conclusion as the professional biologists in the state."

"I think most of the volunteers feel excellent about the transition to the new method," says Gilliam. "The only difficult aspect is that now we ask them to distinguish between the net-spinning caddisfly and the other caddisflies, because the netspinner is much more tolerant to pollution. But overall, the modified method requires fewer family-level identifications than the original method."

What's more, the new method only requires collecting one sample. Gilliam says, "You do need to carefully scrutinize your catch and count every single organism, but once you get used to the patience that's needed, it's a whole lot easier to do it one time thoroughly than to do it three times, the way we did before."

Broader implications

What does all this mean for other volunteer programs that monitor macroinvertebrates, particularly those that use simplified methods such as the traditional IWLA method? Should they undertake a similar study? Not necessarily, says Gilliam. "Which method is most appropriate depends on your goals," he says. "The traditional IWLA method is a tremendously valuable technique to introduce people to biological monitoring."

For groups that want their data used by state agencies, a validation study is critical. As Voshell notes, "State agencies are in the heat of battle and have to be able to justify their decisions. If volunteers want their data used for important decisions, they need to do validation and evaluation studies." But Voshell cautions that other groups cannot simply adopt the Virginia SOS method, which was developed specifically for the western part of Virginia. In fact, a separate validation study is required even for the eastern (non-mountainous) part of Virginia. Such a study, following Engel and Voshell's model, is currently being conducted at Randolph Macon College. Voshell says, "I think our modified method would work in rocky-bottom, steep-gradient, mountain streams in our ecoregion (West Virginia and parts of Kentucky, Maryland, North Carolina, Tennessee, and Pennsylvania), though I would recommend that people do their own validation study. But if you went out to California, there's no reason to think the same metrics would work." He adds that volunteer groups also need to make sure their methods produce results that agree with the results of their own state agency's protocols.

Engel and Voshell's study provides a model for other groups to follow. Those who are not able to partner with a nearby university may be able to get help from their state agency. Voshell suggests that the volunteers could monitor the same sites where the agency routinely monitors and see if they reach the same conclusions about ecological condition. They might also want to preserve their samples, and send them in to the agency for validation.

The payoff

The Virginia SOS study was possible because of the strong three-way partnership between Virginia Tech, Virginia SOS, and Virginia DEQ. The university provided not only the expertise of Voshell and Engel but also equipment and laboratory facilities. Virginia SOS staff enlisted volunteer monitors who were willing to participate in concurrent sampling, and helped coordinate the site visits. And the study was funded by Virginia DEQ—a testament both to the good relationship between Virginia SOS and DEQ and to DEQ's recognition of the potential value of citizen-collected data. "The DEQ only monitors about 18

RESOURCES

Barbour, M., et al. 1999. *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish*. 2nd edition. U.S. EPA, publication number EPA 841-B-99-002. Order from National Service Center for Environmental Publications, 800-490-9198.

Engel, Sarah R. and Voshell, J. Reese, Jr. 2002. Volunteer biological monitoring: Can it accurately assess the ecological condition of streams? *American Entomologist* 48(3):164-177. Available in pdf format at www.vasos.org/ValidationStudy.htm.

Kellogg, Loren. 1994. *Monitor's Guide to Aquatic Macroinvertebrates*, 2nd edition. Izaak Walton League of America. Complete instructions for the IWLA macroinvertebrate monitoring method, including picture key. $6. To order, call 1-800-BUG-IWLA or visit www.iwla.org/iwlastore.

Voshell, J. Reese, Jr. 2002. *A Guide to Common Freshwater Invertebrates of North America*. Field guide used by Virginia SOS volunteers. Over 200 illustrations. $29.95. Order from McDonald and Woodward Publishing Co., 800-233-8787; www.mwpubco.com.

percent of stream miles in the state," says Gilliam. "Once the Randolph Macon study is completed, SOS's contribution should bring that figure up to 30 percent or more."

Gilliam adds, "My main motivation for improving the reliability of our method was to be able to say to our volunteer monitors that the time and effort they were putting in was having significant usefulness to state and local governments in making decisions. And I think we've achieved that." As evidence, he points to the 2002 Letter of Agreement between Virginia SOS, DEQ, and others, which specifies that DEQ will use the Virginia SOS data for baseline information, as a red flag for problems, and in the state 305(b) report. "This wouldn't have happened without the study," he says.

For more information, contact Jay Gilliam, Coordinator, Virginia Save Our Streams, Raphine, VA; 540-377-6179; jay@vasos.org; or Reese Voshell, Department of Entomology, Virginia Tech, Blacksburg, VA 24061; rvoshell@vt.edu.

Secchi Dip-In

A university/volunteer monitoring partnership of unusually large scope is the Great North American Secchi Dip-In, which is directed by three scientists at Kent State University (Robert Carlson, David Waller, and Jay Lee), with sponsorship by the North American Lake Management Society and the U.S. Environmental Protection Agency.

Last July, more than 2,500 volunteers from volunteer monitoring programs in the United States and Canada measured transparency in their favorite lake, reservoir, river, or estuary and sent their data to the Dip-In website. The majority used the traditional black-and-white Secchi disk, but a few used an all-black disk and others—particularly those monitoring streams and rivers—used transparency tubes. (The Dip-In website includes some interesting articles about these different methods.)

Each year, the Dip-In data are displayed on maps which are posted at the website. Lakes in the northern part of the United States and Canada are typically the clearest, while those in agricultural regions of the Midwest tend to have some of the lowest transparencies.

The Dip-In also collects information on the volunteers' perception of water quality, which varies considerably from region to region. For example, a person in Maine might think a lake with a transparency of 6 feet was degraded, while in another state a lake with a transparency of only 1 foot might be considered of high quality. Another interesting finding has been that in some states personal watercraft now equal or surpass algae and weeds as the chief perceived water quality problem.

To find out how you can participate in July 2003, visit the Dip-In website at http://dipin.kent.edu.

ALLARM, continued from page 4

munity-driven partnerships—are valuable, but they have different strengths.

We feel very strongly that the bottom-up approach, in which we train community members to do their own work, leads to a much higher level of understanding and empowerment. Group members may initially be intimidated by their increased decision-making power and time commitments, but volunteers who have struggled with study design and data interpretation are better equipped to identify risks, assess mitigation options, and participate in policy decisions.

The bottom-up approach is also more effective at building a sense of community and an appreciation for the power of organized groups. It gives the volunteers a sense of ownership of the project, and encourages them to become environmental stewards and advocates committed to seeking community unity for action.

That said, the benefits of the acid rain monitoring project should not be sold short. Some volunteers prefer to work on a "ready-made" project rather than investing the time and energy required for community-designed programs. Our acid rain monitors are empowered by the strength of their numbers across the state, as well as an increased knowledge derived from frequent streams-site visits throughout the year.

Furthermore, the greater degree of institutional control over study design, methods, and data analysis has made possible more robust data that are more acceptable to the scientific community. Faculty and students have presented ALLARM's acid rain monitoring results—which indicate that the problem of acid deposition has been underestimated in Pennsylvania and that many more streams are impacted than was previously thought—at professional conferences. The data have also been used by state agencies to revise fish stocking practices, and by citizens to craft testimony in support of state and federal acid-deposition legislation.

Whichever model is used, volunteer monitors collect independent data that can be used to either uphold or challenge public agency and industry data. This opens previously closed doors for meaningful participation by citizens in environmental decision-making. This kind of dialogue leads to the mutual trust that is essential to cooperative efforts to solve environmental problems—a trust that is sorely lacking in most communities.

Candie Wilderman is a Professor of Environmental Science at Dickinson College and the founder and Science Director of ALLARM. Alissa Barron is ALLARM's Assistant Director, and Lauren Imgrund is the program's Director. For more information, contact ALLARM, Environmental Studies Department, Dickinson College, P.O. Box 1773, Carlisle, PA 17013; 717-245-1565; allarm@dickinson.edu.

A FLOATING Classroom for Lake Monitoring

by Janet Vail

JANET VAIL

"Instead of having a land-based field station, we will have a floating field station." So declared James Zumberge, the first president of Grand Valley State University (GVSU), in 1966. Zumberge was speaking of his plan to use a recently donated 50-foot vessel as a classroom and laboratory for GVSU students. But these days a visitor to one of the University's two "floating field stations" would be likely to encounter a fourth-grader performing a dissolved oxygen test or a group of senior citizens sorting through muck dredged up from the bottom of Lake Michigan.

The new community focus came about in 1986, soon after the University founded the Robert B. Annis Water Resources Institute (GVSU-AWRI), whose mission includes public education and outreach. The original vessel was replaced, and soon students in grades 4 through 12 were enjoying the opportunity for hands-on water-testing experiences. By 1996, the Institute's Outreach Education Program had become so popular that a second vessel was specially constructed for the program and I became the program's manager.

Altogether, over 77,000 people, about 12 percent of them GVSU students and the rest members of the larger watershed community (students, teachers, and community groups), have boarded the vessels for a hands-on experience in investigative science. For many, the trip marks the first time they have ever been on the waters of Lake Michigan.

Our ten boat instructors are retired K-12 educators, and there are two on each trip along with the Captain, a deckhand, and the students (generally about 24 per trip). Each instructor supervises four or five activities that are happening at the same time. GVSU-AWRI has produced a video, *Cruising the Lakes,* to prepare students for their cruise since there is so much happening all at once. As one seventh-grader observed, "I had a great time being a chemist, teacher, hydrologist, geologist, and biologist."

A typical cruise lasts 2-1/2 hours and includes visits to two water-quality sampling stations, one in Lake Michigan proper and the other in an adjacent lake that is smaller and more nutrient-rich. Participants use field kits to measure water quality parameters such as conductivity, pH, turbidity, and dissolved oxygen. We prefer using the kits rather than sophisticated electronic probes because the low-tech methods allow participants to learn more about the basic science. We also take Secchi disk readings, collect samples of sediment, and do a plankton tow to collect phytoplankton (tiny algae) and zooplankton. The plankton are displayed on a monitor for all to view.

In 1999, GVSU joined GLOBE (Global Learning and Observations to Benefit the Environment), a worldwide student environmental monitoring program (for more information see www.globe.gov). Becoming a GLOBE partner meant that we had to change some of our protocols. For instance, conductivity readings are now done in triplicate, and we use GLOBE turbidity tubes to supplement Secchi disk readings. Although this takes a little more time than our original methods, GLOBE has enriched the program through worldwide connections to other students. GLOBE models "good science" and we find that our trained GLOBE teachers appreciate the reinforcement of GLOBE.

JANET VAIL

We often receive letters and pictures from the students who take the cruises. One student wrote, "Thank you for the best two hours of my life!" The microscopic creatures that live in the water column and the lake sediment impress the students the most. A ten-year old girl wrote: "I really liked going through the muck looking for 'critters.'" We hear comments like "I didn't know that Lake Michigan had plankton, I thought only oceans did," and "I never thought about lake bottoms before and I didn't know they would be different from each other." A teacher commented, "Many of the children echoed a thought I had: how exciting it is to be a REAL scientist!"

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Resource

Visit *www.gvsu.edu/wri* to view a comprehensive online educator guide with detailed background information about all the parameters tested by participants in GVSU's Water Resources Outreach Education Program, as well as sample data sets.

LAKEWATCH Volunteers & Methods pass muster

by Amy Richard

The Florida LAKEWATCH program, founded in 1986 by University of Florida professor Dan Canfield, now encompasses 1,000 volunteers who sample nearly 600 lakes all over the state. The rich body of data collected by LAKEWATCH volunteers guides local lake management decisions, is used extensively by University of Florida researchers, and accounts for about 18 percent of the total information on Florida lakes that is provided to the Florida Department of Environmental Protection. (For more on LAKEWATCH data use, see *The Volunteer Monitor*, Summer 2002, p. 18.)

With so much data being collected and put to so many uses, LAKEWATCH naturally places a strong emphasis on data quality. And our affiliation with the University of Florida gives us access to scientists and graduate students who are ready and willing to conduct studies evaluating our methods and volunteers. The results of three such studies were recently published in *Lake and Reservoir Management*. Interested readers can download a copy of the article from lakewatch.ifas.ufl.edu/.

Taken together, the three studies attest to the reliability of LAKEWATCH data. We're particularly excited about the publication of this article because we think it goes a long way toward answering many of the concerns that have been raised over the years regarding volunteer-collected water quality data.

Volunteer vs. professional samplers

In the first study (carried out in 1991 and summarized in *The Volunteer Monitor*, Spring 1997, p. 17), professional staff from the university's Department of Fisheries and Aquatic Sciences conducted side-by-side sampling with trained LAKEWATCH volunteer monitors on 125 lakes. Both volunteers and professionals measured Secchi depths and collected water samples that were later analyzed at a university laboratory for nutrients (total phosphorus and total nitrogen) and chlorophyll. Results for all parameters were found to be equivalent whether samples were collected by volunteers or professionals.

Chlorophyll extraction methods

For chlorophyll analysis, LAKEWATCH initially followed the acetone extraction method described in APHA's *Standard Methods*, but in 1993 we switched to ethanol extraction because it is less hazardous to human health, involves fewer problems with disposal, and requires less technician time. A comparison study of duplicate samples from a number of lakes covering a range in chlorophyll concentration found no significant difference between measurements made by the two methods. This finding may be of interest to other volunteer monitoring programs since, according to an informal survey conducted by *The Volunteer Monitor* (see Fall 2000 issue, p. 16), the majority use the acetone method.

Fresh vs. frozen water samples

LAKEWATCH decided early on to ask volunteer monitors to freeze their water samples and the filters they prepare for chlorophyll analysis. Many volunteers live hours away from the university water chemistry laboratory, making it logistically impossible for them to deliver fresh samples within a 24-hour time frame. Freezing also avoids the use of dangerous chemicals sometimes used to preserve water samples. Volunteers keep the samples and filters in their home freezers for up to three months, then deliver them (still frozen) either to the university laboratory or to a regional collection site.

A Florida LAKEWATCH study found that samples frozen for up to 150 days still yielded valid results in several chemical tests.

To determine whether freezing is a valid means of preserving water samples prior to chemical analysis, researchers compared fresh water samples and freshly prepared filters with samples and filters that had been stored frozen for 15, 30, 60, 90, 120, and 150 days. The samples were collected from lakes of varying size, depth, and trophic category. All samples were analyzed for the three basic LAKEWATCH parameters (chlorophyll, total phosphorus, and total nitrogen) as well as three additional parameters (total alkalinity, specific conductance, and pH). For all parameters except pH, only small differences were found between fresh and frozen samples, even after 150 days of frozen storage. For pH values above 6.5, agreement was less close. This result was not unexpected, and confirmed that freezing is not a reliable method of preserving samples for pH determination, especially at higher pH levels.

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What Can University Scientists Offer to K–12 Schools?

by Nancy Trautmann

"I believe that the worst thing that has happened to science education is that the great fun has gone out of it.... Very few see science as the high adventure it really is." —*Lewis Thomas*[1]

ALAN FIERO

Alan Fiero's students in bug house they built to raise *Galerucella* beetles for biological control of purple loosestrife.

The contemporary movement for science education reform calls for the teaching of science to more closely reflect the way science is practiced. In other words, students should learn not only science facts but also the processes through which scientific discoveries are made.

To help meet this mandate, universities across the country have begun partnering with local schools to bring real scientific research into the classroom. These university/school partnerships take a number of forms, including developing research-based curricula and providing university students as classroom teaching fellows.

Curriculum development

In a project funded by the National Science Foundation, scientists and science educators at Cornell University have teamed up with middle and high school teachers to create the Cornell Scientific Inquiry Series, a collection of student and teacher manuals that enable students to design and conduct their own environmental science experiments. Through these research experiences, students begin to view science as a continuous process of discovery rather than a static collection of facts to be memorized in time for an exam.

The first book in the Cornell series, *Assessing Toxic Risk*, provides protocols for testing the toxicity of chemical solutions or environmental samples by using organisms such as lettuce seeds, *Daphnia*, and duckweed in the same sorts of bioassays used by professional scientists. The idea for this book developed out of school water-monitoring programs because students often wanted to address questions that couldn't be answered using test kits. Chemical tests for specific contaminants generally require equipment that is too expensive or reagents that are too hazardous for school use, but bioassay experiments provide a wonderful chance for students to learn about toxicology in a way that integrates concepts in biology, chemistry, environmental sciences, and human health.

Invasion Ecology, the second title in the series, incorporates ideas for designing and conducting experiments related to invasive species. For example, Alan Fiero's seventh-graders at Farnsworth Middle School near Albany, New York, are raising and releasing *Galerucella* beetles. These beetles, native to Europe, specialize in eating purple loosestrife, a non-native invasive species that is crowding out native wetland plants across the United States. Fiero learned about *Galerucella* during a summer of working side-by-side with Cornell scientist Bernd Blossey, who has spent over a decade studying these beetles and evaluating the viability of introducing them to North America for biological control of purple loosestrife. After teaming up with Cornell scientists and educators to write classroom instructions for raising *Galerucella* and studying their impact on local loosestrife populations, Fiero piloted this project with his classes. He concluded, "Students are excited about being part of an authentic

> Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry ... including asking questions, planning and conducting an investigation, using appropriate tools and techniques, thinking critically and logically about the relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments."
>
> – National Science Education Standards, 1996

[1] Presentation at the Sloan Foundation's "Conference on New Dimensions of Liberal Education," Key Biscayne, Florida, 1981.

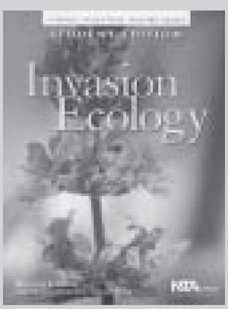
research project. They like the idea that what they are doing may make a difference by improving the ecology of our area."

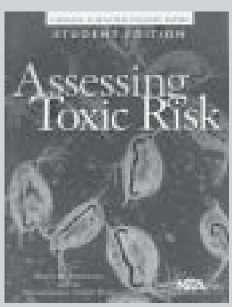
The Cornell series will conclude with two books to be published in the coming year. *Decay and Renewal* will focus on natural processes of biodegradation, and how humans can harness these processes to prevent or clean up pollution through composting, wastewater treatment, and bioremediation. *Watershed Dynamics* will include techniques for stream habitat assessment and for modeling impacts of human activities on stream water quality and stormwater discharge.

Graduate students as teaching fellows

At the launch of the National Science Foundation's (NSF) Graduate Teaching Fellows in K-12 Education Program in 1999, NSF Director Rita Colwell said, "We cannot expect the task of science and math education to be the responsibility solely of K-12 teachers while scientists, engineers and graduate students remain busy in their universities and laboratories. There is no group of people that should feel more responsible for science and math education in this nation than our scientists and engineers and scientists- and engineers-to-be." Today, this program provides fellowships that enable graduate and advanced undergraduate students at over 70 universities across the United States to work as teaching partners in local schools.

The projects undertaken by teaching fellows from Cornell are wide-ranging, based on their own individual expertise as well as on the interests of the participating classes. Last year, fellow Dave Warner worked with a high school environmental studies class designed to help struggling students succeed in science. For one of Dave's projects, the students used remote sensing technology and lake zooplankton levels to predict alewife populations in the Great Lakes. In the course of another project, students used nitrate test kits and noticed that they sometimes got different readings for the same water sample. Seeing a "teachable moment," Dave led them through an investigation of the types of error involved in scientific measurements. After discussing accuracy, precision, and the role of bias, the students drew conclusions about these factors in their own water monitoring data. Their teacher, John Signorelli, says, "Dave brings real science into the classroom. Most kids don't realize that science is numbers, crunching numbers, and not just the gee-whiz stuff that they see on TV. But they also see his excitement about his own research and about what we are doing in class."





Invasion Ecology and *Assessing Toxic Risk* are available from the National Science Teachers Association (800-277-5300 or http://store.nsta.org/). The Teacher's Guides cost $9.95 and the Student Editions cost $5.95 apiece, with discounts for multiple copies.

For more information about the publications and programs discussed in this article, see http://ei.cornell.edu.

Curriculum resources developed by Cornell's teaching fellows are downloadable at http://ceirp.cornell.edu. These resources include lesson plans and project descriptions designed to help teachers try new ideas in teaching high school or middle school science.

Universities interested in applying for funding to participate in the NSF Graduate Teaching Fellows in K-12 Education Program can find grant proposal information at: www.ehr.nsf.gov/dge/programs/gk12/.

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While frozen water samples might not be acceptable for certain types of research work, Dan Canfield, the lead author on the paper, says the study shows that "frozen water can be used any time you're interested in broad trends." He adds, "The use of frozen samples has enabled us to collect more data, on more lakes, in a more cost-effective way."

The authors of the paper conclude that "volunteer monitoring provides a source of credible data." Apparently others agree, at least as far as LAKEWATCH is concerned. Mark Hoyer, a coauthor on the paper, points out that local, state, and federal agencies regularly use our data for their reporting purposes and also that some two dozen manuscripts based in whole or in part on LAKEWATCH data have been accepted for publication in peer-reviewed scientific journals. He says, "This is a clear indication that the scientists reviewing these articles have accepted the integrity of LAKEWATCH water quality data."

Note: Other volunteer monitoring groups who may be interested in freezing water samples for nutrient analysis should be sure to conduct their own comparison studies first, as results may differ from region to region depending on characteristics such as water hardness or nutrient concentrations.

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Community-based Water Monitoring in Alabama and the Philippines

by Bill Deutsch

Alabama Water Watch's (AWW) recent celebration of our 10th anniversary inspired us to reflect on what has gone right, what could have been done better, and how such citizen volunteer monitoring programs can be duplicated in other settings. Because of our involvement with similar water projects in other countries, we also took this opportunity to compare and contrast both the technical and the human side of community-based monitoring cross-culturally. This article will briefly explore some similarities and differences between Water Watch programs in Alabama and the Philippines.

BILL DEUTSCH

Participants at the first training workshop for citizen volunteers in the Philippines.

Origins and approach

AWW began in 1992 with primary funding from EPA Region 4 and the Alabama Department of Environmental Management to Auburn University. The goal is to conduct broad-based public education on water issues statewide and provide training and technical backstopping for volunteer water monitoring.

Most AWW participants are from existing groups such as lake associations, environmental clubs, and schools, and are middle-class people with the time and interest to collect data for protecting or restoring their waterbody. Monitors' concerns often focus on learning about water; saving stream ecosystems; swimming, fishing or other aspects of water recreation; and overall quality of life.

AUBURN UNIVERSITY

Training of Trainers workshop for Philippines Water Watch, led by Bill Deutsch of Auburn University and Jim Orprecio of Heifer International/Philippines.

The Philippines Water Watch (PWW) began in 1994 as one project of many in a large Sustainable Agriculture and Natural Resources Management initiative funded by the U.S. Agency for International Development and spanning three continents, with primary sites in the Philippines, Ecuador, and Mali. Auburn University was one of several university partners in the initiative. The particular topics of study in each country were selected based on a consensus of community members and scientists, following an extensive appraisal of the biophysical and social aspects of the region.

The water-related research in the Philippines that led to the formation of the PWW was done with representatives of Auburn University and local community members in the mountainous Manupali River watershed of central Mindanao. Water Watch later spread to Ecuador, Thailand, and Brazil.

Most participants in PWW are local farmers with less than a high school education and annual incomes of $500-1,000. Their concerns often focus on drinking water quality and public health, particularly the problem of bacterial contamination, and on soil erosion and sedimentation, which directly affect farmers' livelihoods. Because the Filipino participants are dependent on untreated water from springs, wells, and rivers, and in addition many are aware that their environment has degraded substantially in their lifetime, they have a more immediate concern than their counterparts in Alabama. Environmental problems are more obvious and urgent, so the commitment level of the PWW members is high.

Interactions and synergies

The AWW and PWW have interacted and had mutual benefits on several levels. The PWW program was initially modeled on the established AWW approach and methods, with research partners in the Philippines helping to customize techniques for the local situation and translating instructions into local dialects.

But soon the sharing of techniques became a two-way street. For example, after PWW volunteers used the Easygel rapid method for *E. coli* testing, it was adopted by AWW. (*Note:* See *The Volunteer Monitor* Fall 1998 issue for more on this technique.) Methods for total suspended solids (TSS) and stream discharge that were first used in the Philippines were also later used in Alabama. The TSS method involves using a portable apparatus and hand pump to pass a known volume of water through a preweighed glass fiber filter. An accurate balance is required to weigh the filters before and after river sampling, so a university or professional lab partner is usually needed. Stream discharge (cubic meters/sec) is measured by multiplying estimates of stream cross-sectional area (square meters) and current velocity (meters/sec). Area is estimated by measuring water depths at intervals along a rope stretched across the stream, and current velocity is estimated by timing an object (usually an orange) that is floated down a known length of stream. TSS (mg/L) and discharge measurements may, in turn, be used to estimate sediment yield (mg/sec), which is the amount of suspended solids (e.g., soil) passing a point each second.

Both AWW and PWW volunteers are motivated by knowing that their monitoring techniques are being used in other countries and that they have the same basic goals of protecting and restoring water resources. Ties have been strengthened among Filipino and Alabamian water monitors by international visits for study tours and training, an Environmental Pen Pal program between schools in the Philippines and the U.S., and regular exchanges of images and success stories in various presentations.

Outcomes and impacts

There are presently about 80 active groups in AWW who monitor hundreds of sites on a regular basis. Over the last 10 years, about 1,500 sites on more than 500 waterbodies have been tested by 180 groups. This information is some of the most extensive and significant for many streams and lakes, and has recently been incorporated into the development of total maximum daily loads (TMDLs) and other aspects of remediation. About 40 experienced AWW volunteers have become certified trainers and quality assurance officers who conduct about 90 percent of the 50-60 workshops offered each year. The program has stabilized and diversified its funding base, with buy-in from Cooperative Extension and partnerships with several other agencies and organizations.

LAKE WATCH OF LAKE MARTIN

Dick Bronson of Lake Watch of Lake Martin (one of the first AWW groups) teaches stream biological assessment to Birmingham students.

The PWW program now has three active groups on the islands of Mindanao and Bohol. Together, they have collected thousands of samples on several streams. This multi-year information documents a clear gradient of declining water quality across four subwatersheds of the Manupali River, which is related to human population, deforestation, and agricultural development. Contaminated drinking water supplies have been identified and public health risks have been minimized by remediation. PWW volunteers have been active in educating their neighbors in water issues by giving presentations at village meetings and in schools.

Although the PWW has far fewer monitoring groups than AWW, their pioneering effort has attracted local and national attention, with great potential to impact water policy. The data and the process of community-based water monitoring have been incorporated into the Natural Resource Management Plan of the Municipality of Lantapan, Bukidnon. The local government of the Province of Sarangani initiated a similar water monitoring program in their region. By invitation, representatives of PWW have addressed the Philippine Congress in Manila. The PWW water data have recently been used by the Philippine Institute for Development Studies to advise the Congress on the value of community-based water monitoring as it formulates the first Clean Water Act of the Philippines.

In spite of considerable differences in socioeconomic status and culture, both AWW and PWW monitors have similar interests in making life better for the next generation. Both value education and community service, enjoy group activities, and have a strong sense of democracy and grassroots efforts. Both have been truly empowered and have surprised their neighbors, water professionals, and government officials with their commitment and the quality of information that may by collected by nonspecialists. Their joint work has personalized the slogan "Think Globally, Act Locally."

Bill Deutsch is Program Manager for Alabama Water Watch and Principal Investigator of the USAID-funded water project in the Philippines. He is based at the International Center for Aquaculture and Aquatic Environments, Auburn University, Alabama 36849; wdeutsch@acesag.auburn.edu.

Citizen Science & Delaware Sea Grant

by Joe Farrell

When the Town of South Bethany in coastal Sussex County, Delaware, wanted to know more about the water quality in their extensive system of canals, Councilman Sal Aiello turned to the University of Delaware Sea Grant Marine Advisory Service for some answers.

At the time, Sea Grant had already been working with volunteer monitors for three years through our Inland Bays Citizen Monitoring Program, which we started in 1991 to collect baseline water quality information on the bays. So we suggested training local residents to collect data for the study. The Town agreed, and Sea Grant trained a dozen canalfront homeowners who conducted weekly physical and chemical water quality testing over the course of the summer.

Thus began our "mini-research" program. Since that first experience in South Bethany, the Inland Bays Citizen Monitoring Program has undertaken a number of small-scale projects, often to investigate questions raised by the volunteers themselves.

We've found that these special projects are a great way to invigorate monitors whose enthusiasm may be flagging after years of collecting routine baseline data. While our ongoing monitoring has yielded important information used by the state in the 305(b) report and for setting TMDLs (total maximum daily loads) for nutrients, it doesn't produce the same kind of immediate, visible results as the mini-research projects.

Cuke drifter study

Of all our mini-projects, the one that captured the most attention was our "cuke drifter" study. Two towns discharge municipal wastewater directly into the Lewes-Rehoboth canal, which connects Delaware Bay to the Inland Bays, and our drifter study was designed to investigate the potential for this discharge to reach the Inland Bays. Although we knew that oranges or lemons could be used to measure flow, we had never heard of anyone using cucumbers. However, we found them to be neutrally buoyant and we liked the idea of using a Delaware-grown farm product. Best of all, a local pickling plant, Vlasic Foods, was willing to donate cucumbers to the cause.

Television cameras were rolling as we released the cukes, color-coded with bright pink, yellow, or orange paint to identify their point of origin, at several points along the canal. By the end of one tidal cycle (about six hours later), the drifters from a site adjacent to one of the discharge pipes had made the trek almost all the way down the canal. This information was used by the state in issuing an NPDES permit that set a timetable for removing a discharge pipe.

Clam project

It was pretty easy to recruit volunteers for a clam-reseeding project when the volunteers learned they would be feasting on the research subjects. Thumbnail-size clams were placed in sites throughout the bays and protected from predators with netting. Volunteers made periodic measurements of survival and growth until the following summer, when the clams were harvested and ceremoniously consumed at the Citizen Monitoring Program picnic. The project demonstrated that it is feasible to grow clams at many sites around the bays and that seeding may provide a successful method of restoring clam stocks to both commercial and recreational fisheries.

WAYNE STOCHAJ

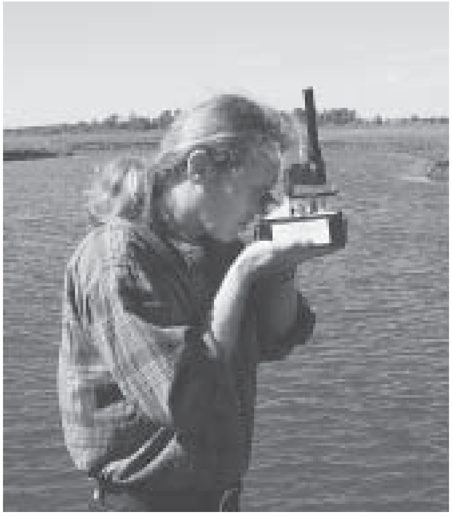
Volunteers measure clams for the clam-reseeding project.

Other mini-research projects in which our volunteers have participated over the years have included a study of the perceived "holiday weekend boater effect" (i.e., increased turbidity in some areas after summer holiday weekends), a macroalgae survey of the bays, and a variety of University of Delaware student research projects.

Partnerships

The Citizen Monitoring Program affiliation with a highly regarded academic and research institution, the University of Delaware Graduate College of Marine Studies, has helped us tremendously, both with our small research projects and with our ongoing routine monitoring. The college has provided the Citizen Monitoring Program with its own laboratory space and access to analytical equipment, including an autoanalyzer and a fluorometer. We are privileged to have a direct link to university staff and students, who are always willing to lend a hand with labwork and data analysis or to lead seminars for our volunteers.

The college benefits as well. Having students involved in our monitoring program helps the college fulfill one of its primary goals: to develop well-rounded marine scientists and managers. The opportunity to work with our volunteers



JOE FARRELL

Volunteer Coordinator Ed Whereat uses field microscope to identify phytoplankton.

provides students with project management experience and outreach skills that open doors with future employers.

Then there are the less tangible benefits. Through our program, the university has become a true "player" and steward of the bays, rather than a distant "ivory tower." At the same time, I believe that the credibility of our program and data is enhanced because of the university connection.

As the lead partner, Sea Grant provides the Citizen Monitoring Program with staff and administrative support, volunteer training and education, data management and quality assurance, and news media relations. What's in it for us? In founding the program, we at Sea Grant saw an opportunity to extend our watershed education mission. Instead of having one educator conducting watershed education programs, we now have 40 volunteers well-versed in our watershed and its problems out in the community educating their families, friends, and neighbors. In addition, our monitoring program puts us in "real time" contact with what is happening in our watershed.

New harmful algae program

Perhaps the project that best exemplifies the valuable working relationship that has been forged between the Citizen Monitoring Program and the College of Marine Studies is our new Phytoplankton Monitoring Program, started in the summer of 2001. The source of inspiration for this project was a feature article in the Fall 1998 issue of *The Volunteer Monitor* highlighting several programs in which volunteers use plankton nets and field microscopes to screen shellfishing waters for toxic algae. While Delaware waters don't produce a lot of shellfish, recently we have had several large fish kills related to harmful algal blooms, which have raised public concern about possible human health effects.

It would have been hard to initiate a successful phytoplankton monitoring program without the College of Marine Studies connection, and especially the assistance of marine scientist Dave Hutchins, who has been studying a variety of phytoplankton species in the Inland Bays. Hutchins and his team were particularly helpful in the initial volunteer training session, where they shared live and preserved samples to help the volunteers learn species identification, and in providing species identification support when the program got up and running. It also didn't hurt that Volunteer Coordinator Ed Whereat was well-versed in microscopy, having taught botany labs while earning his Ph.D. in plant ecology.

It turned out that the volunteers were pretty good at identifying a variety of harmful algal bloom (HAB) species. Even during the first summer, they were playing a key role in the state of Delaware's HAB Monitoring Program. Phytoplankton blooms are often patchy and ephemeral. Because the volunteers live in places where algal blooms are likely, they are able to notice unusual conditions and to collect and evaluate samples as blooms are occurring.

> OUR VOLUNTEERS HAVE FOUND PHYTOPLANKTON SPECIES NOT PREVIOUSLY KNOWN TO BE PRESENT IN THE INLAND BAYS.

When large blooms of HAB species occur, immediate alerts are provided to the state Department of Natural Resources and Environmental Control. Our volunteers have detected several major blooms of *Chattonella verruculosa*, a species that has been implicated in fish kills and has the potential to cause symptoms such as upper respiratory irritation and itching skin in humans. They have also found phytoplankton species not previously known to be present in the Inland Bays, and their monitoring efforts suggest that some of the species of concern are frequently present in the bays, albeit in low numbers.

Our volunteers enhance the efforts of both university researchers and state agency personnel by providing greater spatial and temporal coverage, supplying scientists with live algal samples for culture, and collecting and relaying samples that would be difficult for university or agency staff to obtain.

Creating opportunities

The Citizen Monitoring Program is all about connections. In these days of belt-tightening, none of our institutions has the resources to do it alone, yet we all have unique talents and niches. Working together, we have been able to accomplish much more than we could by working alone.

With hiring freezes, downturns in state budget projections, and even massive layoffs in some states, it would appear harder than ever to go with hat in hand to state agencies or legislatures for support. Yet maybe this is precisely the time to sell cost-effective monitoring programs. There may be real opportunities for Sea Grant and other university-based programs to take advantage of this collaborative model as a way to extend their programs even in tough economic times.

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COOPERATIVE EXTENSION / Volunteer Monitoring PARTNERSHIPS

by Elizabeth Herron and Kris Stepenuck

Cooperative Extension is uniquely poised to carry out volunteer water quality monitoring programs. Extension has an established framework within communities and is structured to provide the kind of community education and training that is vital to volunteer monitoring efforts. In fact the very mission of Extension—to bring science to the people, conduct educational outreach, and encourage "better practices"—could be lifted right out of the stated goals of most volunteer monitoring programs. This extraordinarily good fit led Extension in a number of states (for example, New Hampshire, Florida, Rhode Island, and Maine) to support volunteer monitoring even before the 1992 Extension National Water Quality Initiative.

In 1995 the University of Rhode Island Cooperative Extension (URI) received funding from Extension's national headquarters to conduct the first comprehensive assessment of Cooperative Extension volunteer monitoring programs and their benefits to Extension and communities. Four years later, URI and the University of Wisconsin-Extension (UW) jointly were awarded a National Facilitation Grant to build on that work and create a comprehensive support system for Extension volunteer water quality monitoring efforts.

A crucial first step for the Facilitation Project was to update and expand the earlier assessment. We found 29 programs in 26 states or territories in which Extension plays a significant role, and from them we gathered detailed information about why they started, how they operate, and their successes and failures.

One thing we have learned is that no two programs are alike! Different communities have different water quality issues, and each Extension program is unique in the specific resources it can offer. Extension programs around the country have been very creative in finding the best ways to support volunteer monitoring efforts.

Grassroots origins

While Extension volunteer monitoring programs started for a variety of reasons, we found one important similarity: these programs are typically community-driven. Many began when individuals or groups set out to respond to local water quality problems and discovered that little reliable, long-term data existed for the waterways they were concerned about. In attempting to find good technical advice about monitoring they turned to their neighborhood Cooperative Extension, which responded by working with local groups to create programs based on the best current science while focusing on specific community resources and needs.

For example, New Hampshire Lakes Lay Monitoring Program Coordinator Jeff Schloss told us that the program originated due to a "lack of timely and adequate sampling to discern any water quality changes." Statewide Marine Educator Esperanza Stancioff reported that Maine's Shore Stewards began in response to a crisis in the shellfish industry: bacterial water pollution from a variety of unknown sources was forcing the closure of many shellfishing areas.

Some Extension programs—including the Water Action Volunteers in Wisconsin, the Hoosier Riverwatch in Indiana, and the Volunteer Stream Monitoring Partnership in Minnesota's Twin Cities Metropolitan Area—were established to help standardize monitoring methods among existing volunteers. According to Barb Liukkonen of the Volunteer Stream Monitoring

Origins of Cooperative Extension

Q: What is one thing that all U.S. states and territories have in common?
A: A land-grant university.

The name *land grant* comes from the Morrill Act of 1862, which provided states with federal funds equivalent to 30,000 acres of land for each Congressional senator and representative. These funds, known as "land scrip," provided an endowment to establish a people's university. Today there are a total of 105 land-grant colleges, with at least one located in every state and territory (American Samoa, Guam, Northern Mariana Islands, Puerto Rico, the Virgin Islands, and the Trust Territories).

Over time, these land-grant universities assumed a variety of duties to better serve the people in their home states. To support these efforts, Congress passed the Smith-Lever Act in 1914, which created the Cooperative Extension Service, housed in the U.S. Department of Agriculture. Essentially, Extension was charged with taking practical information generated by land-grant university scientists directly to the people and encouraging citizens to adopt better practices in agriculture, home economics, and rural development.

As our society has shifted from a rural agriculture focus to more urban and suburban, so has the mission of many Extension programs. In 1992, water quality impacts from nonpoint sources became a priority with the establishment of the Extension National Water Quality Initiative, which opened the door to Extension support of volunteer monitoring efforts.

KRIS STEPENUCK

Jim Congdon of WI Department of Natural Resources points out macroinvertebrates on a river rock during a Water Action Volunteers training session.

Partnership, “Many separate local programs were in place, but there was virtually no communication between or within basins or between volunteers and agency staff or decision makers.” The Volunteer Stream Monitoring Partnership was formed to fill a need for more consistency in methods and data management, and more coordinated use of the data.

As the report summarizing the initial URI assessment concluded, “The overall success of Cooperative Extension volunteer programs is due in large part to their grassroots, bottom-up approach. These programs often become embedded in their communities, as well, as individuals and businesses take personal responsibility for the health of their community’s water bodies.”

Different roles for Extension

Our assessments revealed that Extension interactions with volunteer monitoring take a variety of forms. Extension often plays a lead role, with overall program coordination provided by Extension staff. It’s probably not a coincidence that several of the longest-running Extension programs (the New Hampshire Lakes Lay Monitoring Program, now entering its 25th year; and URI Watershed Watch and the Maine Shore Stewards, both started in 1988) have enjoyed this kind of substantial support from Extension.

Cooperative efforts with state environmental agency programs are also quite common, with Extension typically providing technical or staff support, and sometimes funding. In Wisconsin, two programs (Adopt-A-Lake and Water Action Volunteers) are cosponsored by the University of Wisconsin-Extension and the Department of Natural Resources, with assistance from other partners and local organizations. The Hoosier Riverwatch in Indiana is run through a similar partnership between Extension and the state environmental agency. Alabama Water Watch was formed as a cooperative effort between the Auburn University Fisheries Department and the Alabama Department of Environmental Management; Alabama Cooperative Extension recently joined forces with these groups to manage the program.

Sometimes Extension’s role is less apparent, with Extension staff providing training assistance, technical consultation, or educational materials. In Georgia, Extension agents assist with well-established state-run Adopt-A-Lake and Adopt-A-Stream programs. Several staff members with the University of Missouri Extension have taken advanced training with the Missouri Stream Team Program, qualifying them to lead or teach Stream Teams.

Regardless of the role played by Extension, Extension-supported programs are not immune from the challenges faced by most volunteer monitoring programs—concerns about the critically important elements of stable funding and stable staffing. Because Extension overall is a federally managed program, changes in national policies or funding priorities can jeopardize locally important projects like volunteer monitoring. Long-term Extension programs are generally those that have diversified funding sources and program elements, ensuring program flexibility while maintaining the core priorities of the local community.

Beneficiaries

The advantages to stakeholders, to the monitoring program, and to Extension from Extension involvement with volunteer monitoring are many and varied. First, of course, the community gets answers to their concerns and the ability to respond to problems or protect their resources. In addition, the volunteers gain access to current scientific research and methods, as

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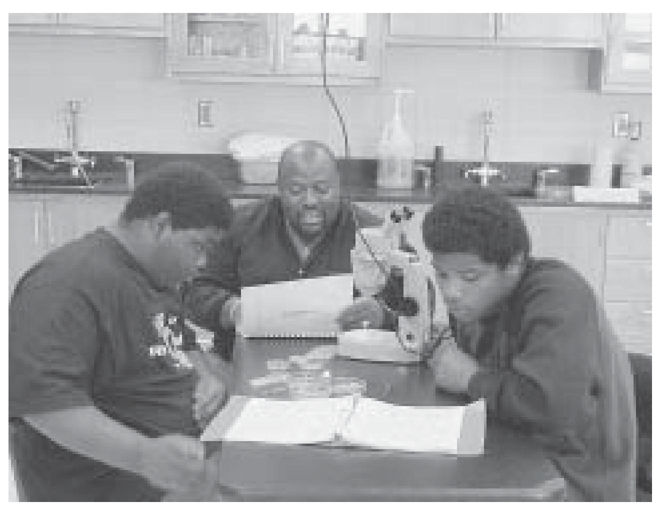
JAMIE SCHURBON



Crossroads Vocational School students and teacher D. C. Randle identify macroinvertebrates as part of the Volunteer Stream Monitoring Partnership.

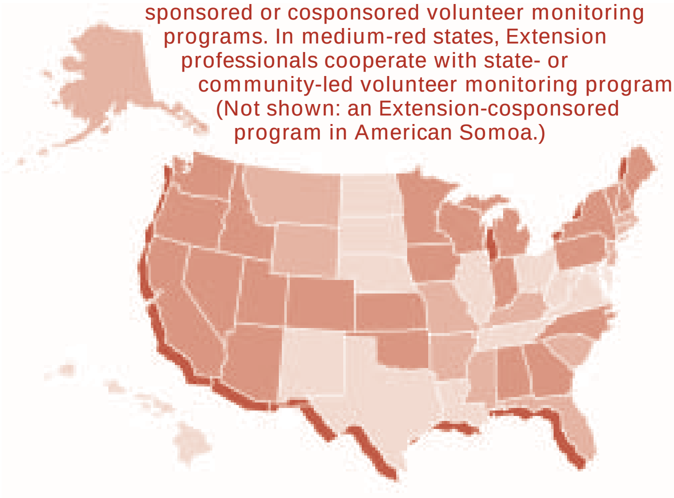
well as other university resources, which can enable them to expand their monitoring activities and improve the scope and credibility of the data.

The large number of Extension programs that have elected to sponsor or support volunteer monitoring efforts is a clear testament to how well volunteer monitoring fulfills Extension's three core goals:

Educating the public. Volunteer monitoring programs disseminate water quality information broadly in the community through citizen-to-citizen interactions and provide an opportunity for hands-on science education for youth.

Encouraging citizens to "adopt better practices." Through monitoring, citizens learn how our actions on land affect the quality of surface and groundwater. This leads directly to voluntary adoption of recommended best management practices (BMPs) for water quality protection.

Dark-red-shaded states have Cooperative Extension-sponsored or cosponsored volunteer monitoring programs. In medium-red states, Extension professionals cooperate with state- or community-led volunteer monitoring programs. (Not shown: an Extension-cosponsored program in American Somoa.)



Bringing university science to the community … and community science to the university! Volunteer monitoring programs can turn the Extension link between university researchers and citizens into a two-way street. The volunteer monitors benefit from university expertise, and the data they generate can in turn be useful to university scientists—especially since volunteers frequently gather data in areas where few others are monitoring, and often for longer periods of time than most universities or agencies. Applied researchers can especially benefit by targeting their efforts toward locally identified concerns.

In addition, Extension support of volunteer monitoring benefits Extension by:

Heightening the credibility and visibility of Extension within the community. Community-wide volunteer monitoring efforts attract solid press coverage, increasing local awareness of Extension activities and drawing diverse audiences to other Extension water quality programs. The value of Extension activities is underscored when government agencies, community groups, or researchers use volunteer data.

DANIEL HUFF

The Volunteer Stream Monitoring Partnership teaches standardized methods to volunteer monitors in the Twin Cities Metropolitan Area. These students are monitoring the Vermillion River in Dakota County, MN.

Forging new links between Extension and other organizations. Volunteer monitoring lends itself to collaboration among citizens, educational institutions, private organizations, and governmental agencies.

National Facilitation Project

Given the multitude of benefits to all parties, our National Facilitation project is interested in expanding Extension/volunteer monitoring collaborations. We plan to do so by developing training materials and programs to strengthen existing efforts and encourage the formation of new ones. Because Extension programs around the country have already created so many good resources, we are gathering many of these together to create our "Guide to Growing Extension Volunteer Monitoring Programs." We also are working to support sharing between Extension volunteer monitoring groups through a project website and electronic listserv. Finally, to enhance data management and sharing, a web-based data entry tool has been developed and is currently undergoing testing through the Water Action Volunteers.

So the next time you are looking for some information about water quality, watershed education, or good management practices, consider Cooperative Extension at your local land-grant university—they just may have the answer, or may be able to help you find it. After all, it is the people's university.

For a complete listing of programs that are sponsored or cosponsored by Extension across the nation, or to learn more about this National Facilitation Project, visit our website at www.usawaterquality.org.

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United We Monitor

by Steven Hubbell and Alice Mayio

The first-ever National Water Monitoring Day was held on October 18th, 2002, to mark the 30th anniversary of the date the Clean Water Act was signed into law. Preliminary tallies reveal that about 75,000 people participated, either by sampling water quality or by attending educational and cleanup events around the country.

National Water Monitoring Day was designed to encourage experienced volunteer monitors, be they citizens, school kids, or agency staff, to monitor four key water characteristics (dissolved oxygen, temperature, pH, and turbidity) nationwide and to learn—and teach others—about water quality and water pollution. Another key goal was to foster partnerships between volunteer monitoring groups and water quality agencies.

First-time monitors tested their waters using simple National Water Monitoring Day kits from LaMotte Company, while established volunteer monitoring groups and agency staff used their standard equipment. Data for the four key parameters collected at about 2,700 sites around the country were entered into a special database developed by Earthforce/GREEN and accessible through the Year of Clean Water website (www.yearofcleanwater.org).

National planning for National Water Monitoring Day was spearheaded by America's Clean Water Foundation (ACWF) in partnership with a variety of federal, state, and volunteer organizations. While ACWF and the planning committee provided leadership, in everything from selecting the test kit to developing the Year of Clean Water website, responsibility for local involvement was placed squarely upon the shoulders of local watershed groups and individual citizens. Participants benefited from this event in proportion to the energy they invested in it. For some it was a chance to enlist new volunteers; for others it was an opportunity to educate and connect with the public; for still others, it provided a special incentive to get out of the office and into the waters of America.

USGS

At a USGS-sponsored National Water Monitoring Day event, students collect basic water quality data on the Contoocook River in Hopkinton, New Hampshire.

An important outcome of National Water Monitoring Day was certainly the coverage by newspapers, newsletters, TV, and radio, which featured many stories about the Clean Water Act, the condition of local waters, and the volunteer organizations that work to monitor and protect those waters. ACWF provided help with press releases and other communication tools, but it was local dedication and know-how that ensured that interviews were arranged, reporters contacted, and fact sheets readied.

Among the many highlights of National Water Monitoring Day:

• In Kansas City, a Metro Week of Water celebration featured an array of creative activities: canoe trips down the Missouri River; stream testing by middle and high school students; visits to a local wastewater treatment plant; helicopter trips to view environmentally friendly development; educational forums; marsh restoration activities; hands-on monitoring workshops and demonstrations; and a major celebration at the Missouri Department of Conservation's Discovery Center. The events were sponsored by a consortium of 21 water quality agencies and local organizations.

• The Monterey Bay Sanctuary Foundation, California Coastal Commission, and the Coastal Watershed Council, working with eight coastal coordinators, organized a series of monitoring events that involved 2,370 people at 280 sites within the coastal watersheds of California. Special funding from EPA Region 9 enabled organizers to purchase many test kits and distribute them to prospective volunteers. "The kits are providing a valuable resource, even after the national event, for teachers and parents to continue working with children's programs and monitoring local water quality," says Bridget Hoover, coordinator for the Monterey Bay Sanctuary Citizen Watershed Monitoring Network.

JACOB APODACA

Steven Hubbell (left) joins Austin Youth River Watch and Texas Watch volunteers in a public monitoring demonstration in Austin, TX, for National Water Monitoring Day. Television news teams from local CBS and NBC affiliates covered the event.

• In Texas, 86 sites were monitored in the Colorado River Basin, with television coverage at two sites and a radio interview at a third. Monitors found two suspicious plumes and reported them to the City of Austin.

• EPA Administrator Christine Whitman and Region 2 Administrator Jane Kenny participated in monitoring events with students from Alexander D. Sullivan School at Liberty State Park in New Jersey. Meanwhile, at all 10 EPA Regional offices, staff participated in monitoring and educational events with local watershed groups, schoolchildren, and state and federal agencies.

• The U.S. Geological Survey's (USGS) District Offices sponsored 67 events around the country that attracted 5,795 attendees and resulted in 40 print articles, 27 stories on TV, and 8 on radio. Many of these events were attended by dignitaries—from governors and congressmen to mayors and local commissioners.

Once all information from National Water Monitoring Day is gathered and assessed, ACWF will produce and distribute a national report summarizing the event. The organizers intend to build on the momentum of this year's success to establish an annual event. Monitoring groups who would like to contribute to the planning process for next year are invited to contact Ed Moyer of America's Clean Water Foundation at e.moyer@acwf.org.

Steven Hubbell is Program Coordinator for the Lower Colorado River Authority's Colorado River Watch Network; steven.hubbell@lcra.org; 800-776-5272. Alice Mayio is the National Volunteer Monitoring Coordinator for U.S. EPA; mayio.alice@epa.gov.

Participatory Research: Linking Citizens to Scientists

by Jeff Schloss

The New Hampshire Lakes Lay Monitoring Program, founded in 1978, was conceived by University of New Hampshire (UNH) faculty as a way to involve local residents in collecting baseline lake water quality data for detecting long-term trends and locating problem areas. Our original outreach intentions were twofold: to provide unbiased data for informed local watershed management, and to create an opportunity for participants to gain hands-on understanding of water resource concepts and issues.

What we did not anticipate was that our statewide "army" of volunteer scientists would prove invaluable in advancing applied research important to lake and watershed management decisions.

Not too long into the program we were made aware of the various concerns of our participants about specific lake and watershed conditions. It became clear that in many cases the research-based knowledge to fully answer their questions was lacking. After consulting with state agencies and researchers, and usually finding that their limited resources would not allow for obtaining the data needed to start answering some very important questions, we decided to incorporate into the Lakes Lay Monitoring Program a new participatory research program to address the concerns of our monitors.

What is participatory research?

At this point I should introduce our concept of what "participatory research" entails. We see this as a collaboration that meets a certain set of criteria:

1. Community members should be directly involved in the design and implementation of research projects.
2. Research processes and outcomes should benefit the local community as well as the scientific community.
3. Community members should be part of the analysis and interpretation of the data and should have input into how the results are distributed.
4. Productive partnerships between researchers and community members should be encouraged to last beyond the life of the research project.

All of our participatory research projects are based on the use of low-tech (and extremely cost-effective) data gathering coupled with high-tech analysis methods. Having a network of trained volunteers outfitted with sampling equipment and located on sites throughout the state allows for exceptional coverage that would be logistically and financially difficult for an agency or research group to duplicate.

> The NH LLMP is jointly administered through the UNH Center for Freshwater Biology, a multi-departmental research group, and UNH Cooperative Extension, whose mission is to provide research-based outreach support to individuals and communities throughout the state. The LLMP relies on UNH Cooperative Extension for staff support and facilities, collects lab fees from participants to cover analysis costs, receives occasional research and foundation grants, and has a very small endowment to help support a summer intern.

Fish condition study

Our earliest experience with the participatory model was our fish condition study. Our volunteer monitors' perceptions were that their fisheries were declining, but we could not be sure that this was in fact occurring. When we approached our state fish and game agency they told us they only had limited data due to the sampling effort required.

Our statewide network of volunteers was able to collect data on the health of important warm- and coldwater species on many different types of lakes over a wide geographic area. The volunteers conducted length-to-weight measurements to assess fish condition (the heavier the fish for its length, the better its condition) and also obtained fish scales which they sent to UNH for analysis (fish scales have annual growth rings that reflect their growth history). Some volunteers caught their own fish while others approached anglers and asked to sample their catch.

Analysis of the data by a postdoctoral student at the university gave us a much better picture of how important fisheries were doing and how they compared from lake to lake, as well as a baseline from which to document future changes. The information was readily put to use by agencies and volunteer groups alike. For example, after learning of the impact of an overpopulation of yellow perch on Bow Lake, the Bow Lake Campowners Association initiated an annual yellow perch fishing derby for kids and also worked with fish tournament groups to remove perch when caught. In other lakes where important fishery species were found to be in poor condition the agency moved to enhance forage fish populations.

Boat impacts depend on lake factors

Boat impacts are another great concern within our stakeholder communities. Until very recently there was limited

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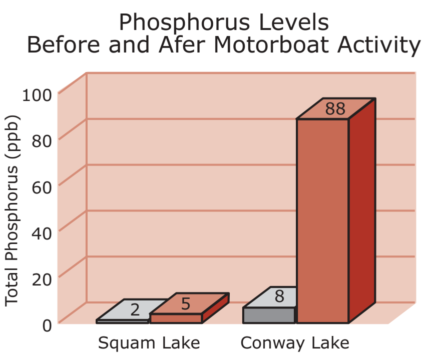

Intensive motorboat activity had little effect on total phosphorus levels in Squam Lake, but dramatically increased levels in Conway Lake. The different response was largely due to differences in lake bottom composition.

data on motored watercraft impacts, particularly those impacts not related to fuel. We have worked with a variety of lake groups in designing studies that met their information needs. Some studies were set up to address cumulative impacts throughout a busy boating weekend while others used a single watercraft to compare impacts at various areas of a lake.

The interesting conclusion from all of these studies is that the actual impacts of watercraft are highly dependent on lake characteristics. A good example is the very different results seen on Conway Lake versus the Squaw Cove area of Squam Lake (see graph). At the Squam Lake site, intensive motorboat activity increased total phosphorus (the limiting nutrient responsible for algae blooms) by only 3 parts per billion (ppb), while on Conway Lake an equivalent level of boating activity resulted in a substantial increase from 8 ppb to 88 ppb. One factor accounting for these very different responses is the difference in lake bottom type. The bottom of Conway Lake is characterized by fine particles that are easily suspended into the water column and take a long time to resettle. In contrast, the sandy bottom of Squam Lake's Squaw Cove area consists of heavy particles that are harder to suspend and that settle back down quickly.

Our studies of watercraft impact on a number of lakes revealed that impacts are determined by many different factors including lake area, mean depth, and bottom type; shoreline configuration, condition, and development; weed bed extent; and shoreline and lake-bottom slope.

The fish condition and boat impact studies are only two of numerous participatory research efforts undertaken by the University of New Hampshire and the Lakes Lay Monitoring Program. Our participatory projects have led to significant gains in our understanding of our lakes while at the same time bringing great benefits to the university's faculty and students, the volunteers, and their communities. In the future, this type of collaborative research effort is likely to become even more relevant in helping to supply needed information in a cost-effective manner.

Jeff Schloss is the Coordinator of the New Hampshire Lakes Lay Monitoring Program, a Water Resources Specialist for UNH Cooperative Extension, and a Research Scientist at the UNH Center for Freshwater Biology. He may be reached at jeff.schloss@unh.edu; 603-862-3848.

The Volunteer Monitor
211A Chattanooga Street
San Francisco, CA 94114-3411

NALMS Conference: Volunteer Monitors Wanted!

Citizen monitoring groups are encouraged to participate as presenters at the North American Lake Management Society (NALMS) conference to be held November 5-8 in Connecticut. The conference organizers are hoping for a strong volunteer monitoring component (not limited to lake monitors!). Topics to be covered at the conference include invasive species, watershed education and outreach, bioassessment, agricultural runoff, TMDLs, and many others of interest to volunteer monitors. Abstracts for oral or poster presentations are due by Wednesday, April 30, 2003. For more information about submitting an abstract, visit www.nalms.org/symposia/newengland/callforpapers.htm.

American Wetlands Conference

This comprehensive national conference on wetland conservation, sponsored by the Izaak Walton League and its partners, includes presentations and workshops on such topics as restoration, mitigation, volunteer monitoring, invasive species, conservation of ephemeral wetlands, and many more. May 1-4, 2003, Minneapolis, MN; for details see www.iwla.org/sos/awm/conference, or call 800-BUG-IWLA.

Resources

Special Issue *News-Notes*

The September 2002 issue of *Nonpoint Source News-Notes* featured volunteer monitoring, with stories on a number of programs around the country. *News-Notes* is available online at www.epa.gov/owow/info/NewsNotes/.

New from River Network

River Network has published two hands-on guides for activists working to protect and restore watersheds.

Permitting an End to Pollution: How to Scrutinize and Strengthen Water Pollution Permits in Your State provides all the tools citizens need to get involved in reviewing and commenting on National Pollutant Discharge Elimination System (NPDES) permits. 80 pages; $15 + S&H.

Tracking TMDLS: A Field Guide for Evaluating Proposed Watershed Restoration Plans is a straightforward guide to reviewing and commenting on TMDL watershed cleanup plans. 36 pages; $10 + S&H.

The latest issue of River Network's newsletter, *River Voices,* features visual surveys and assessments, including aquatic habitat assessment, monitoring for erosion, streamwalks, invasive species monitoring, and others. $3 + S&H.

Publications may be ordered from River Network in Portland, OR; 503-241-3506. To order online: www.rivernetwork.org.

A Sense of Place

A new publication from the the U.S. EPA, *Community Culture and the Environment: A Guide to Understanding a Sense of Place,* explores concepts of community and culture and provides guidance on understanding social dynamics and local values connected to environmental protection. Free. Order publication number EPA 842-B-01-003 from the National Service Center for Environmental Publications (NSCEP) at 800-490-9198 or ncepimal@one.net; or order online at www.epa.gov/ncepihom/index.htm.

New Methods Board Newsletter

Folks interested in issues of methods and data comparability may want to check out a new newsletter, *Across the Board,* launched by the Methods and Data Comparability Board. The Board and its parent organization, the National Water Quality Monitoring Council (NWQMC), are multi-agency/organizational partnerships charged with developing a voluntary, integrated nationwide water quality monitoring strategy that facilitates collaboration and yields comparable data.

The current issue of *Across the Board* is available at the WHAT'S NEW section of the NWQMC website, http://water.usgs.gov/wicp/acwi/monitoring/. For information about joining the Board's mailing list, send email to MDCBinfo@tetratech-ffx.com.