

# *The Volunteer Monitor*

The National Newsletter of Volunteer Water Quality Monitoring  
Vol. 8, No. 2, Fall 1996

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## Special Topic: The Wide World of Monitoring

As volunteer monitoring programs become more holistic and comprehensive in their approach to protecting the environment, they are broadening their scientific scope as well, venturing into such diverse fields as [plant ecology](#), [epidemiology](#), and [geomorphology](#) (see articles on pages 7, 1, and 12, respectively). And they are proving once again that committed, well-trained citizens are capable of producing reliable data in just about any branch of science. In this issue we'll take a look at some exciting projects out on the frontiers of "the wide world of monitoring."

### Co-Editors: Coyote Creek Riparian Station

This issue was co-edited by Coyote Creek Riparian Station, a community-supported, nonprofit organization devoted to research, conservation, and education regarding riparian habitat in Santa Clara County, California. With the help of many dedicated volunteers, the Station gathers and analyzes information and disseminates it to the public. CCRS may be reached at P.O. Box 1027, Alviso, CA 95002; ph. 408/262-9204.

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## Notes from the National Conference

by Alice Mayo

Last August, about 225 people--volunteer monitoring coordinators, state agency representatives, academics, and volunteers--convened at the University of Wisconsin in Madison for the fifth National Volunteer Monitoring Conference. Gaylord Nelson, former Senator, former Governor of Wisconsin, and founder of Earth Day, set the tone for the conference with a keynote address focusing on the challenge of building a sustainable society. "The economy," he pointed out, "is a wholly owned subsidiary of the environment. When the environment is finally forced to file under Chapter 11, the economy goes down into bankruptcy with it."

The conference included over 60 workshops and panel discussions on topics as varied as the use of watershed indicators, monitoring nonpoint source pollution, building sustainable volunteer organizations, restoring stream habitats, diversity training, and developing quality assurance project plans.

Conference highlights included a computer lab, set up by Jeff Schloss of the New Hampshire Lakes Lay Monitoring Program and Ken Cooke of Kentucky Water Watch, that allowed attendees to "surf the net"; a roomful of interactive displays which included an actual working stream; a data presentation fair displaying examples of what to do--and what not to do--in getting your program's message out; and a canoe trip to Aldo Leopold's shack in the dells of the Wisconsin River. An energetic group of coordinators from the Australian Water Watch program enriched the conference with many innovative ideas for community involvement in "catchment" (Australian for watershed) protection--not to mention their rousing rendition of "Waltzing Matilda," performed at one evening's "Eco coffee house."

At a series of breakout sessions organized according to EPA region, conferees discussed pressing issues and initiatives for their regions. Their recommendations included holding regional volunteer monitoring conferences during "off" years (when no national meeting is held); establishing a listserver or chat room on the Internet to help meet the needs of volunteer programs nationwide; and encouraging more participation and leadership from the EPA regional volunteer monitoring coordinators.

The conference was cosponsored by the U.S Environmental Protection Agency, the Wisconsin Department of Natural Resources, the University of Wisconsin-Madison, and University of Wisconsin

Cooperative Extension. Proceedings will be available in spring of 1997 from Alice Mayo, U.S. EPA, 4503F, 401 M St. SW, Washington, DC 20460; ph. 202/260-7018; email [mayio.alice@epamail.epa.gov](mailto:mayio.alice@epamail.epa.gov). (Note: Conference attendees will automatically receive a copy of the Proceedings.)

*Alice Mayo is the National Volunteer Monitoring Coordinator for the U.S. Environmental Protection Agency.*



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## Duckweed Assay for Toxicity Testing

by Joe Rathbun

In the last issue of *The Volunteer Monitor*, I described a bioassay using lettuce seeds as the test organism. Here I will describe another very simple bioassay procedure that uses the common duckweed. Duckweeds are ideal for aquatic toxicity testing because they are easy to collect and culture. The test endpoint--plant growth--is ecologically significant, and this assay has been recommended by U.S. government agencies and the international Organization for Economic Cooperation and Development. Like the lettuce seed assay, the duckweed assay is more sensitive to herbicides and metals than to industrial chemicals (e.g., solvents or PCBs). (Editor's note: For information on sample collection, please see the lettuce seed article, Spring 1996 issue, page 18.)

Duckweeds are very small aquatic plants that are usually found floating on the water surface. They are very common on quiet water bodies like lakes and ponds, especially those suffering from eutrophication. Although duckweeds are flowering plants, they seldom flower. Instead they reproduce by vegetative growth and division, with new fronds (leaves) sprouting from buds that form at the base of older fronds.

Many factors, including pollutants like metals or herbicides and environmental factors like light or temperature, can cause a reduction in the number of fronds. This forms the basis of the duckweed bioassay, in which the number of new fronds on plants exposed to the test water is compared to the number of new fronds on control plants.

Below is a brief description of the procedure. For more detailed information, please contact me at the address at the end of the article. (This assay can also be used to test sediment or soil samples; see my letter on [page 2](#) of this issue for procedures.)

### Duckweed culture

The first step is to start a duckweed culture. Be sure to collect the plants from a clean water body. This is important because historic exposure to contaminants can result in a duckweed population dominated by pollution-tolerant plants. If used in a bioassay, these will be less sensitive to pollutants than normal plants. *Lemna minor* is the species most commonly used in this test, but other species of *Lemna*, as well

as members of the genus *Spirodela*, also work well. It's a good idea to use plants from the same genus for the test (using a single species would be even better, but some species are difficult to distinguish). *Lemna* has only a single rootlet, whereas *Spirodela* has multiple rootlets (see drawings).

During the winter, the plants are not available in much of North America, so plan ahead. (Duckweed plants are also available from Carolina Biological Supply at about \$5 per 100; call 800/334-5551.)

Maintain the plants in an aquarium or large glass jar placed near a sunny window or under cool-white fluorescent lights. Culture water can be either room-temperature tap water or water from the source lake or stream. Add culture water every three or four days to compensate for evaporation (a cover of glass or clear plastic film will reduce water loss). Once a week, add one to two teaspoons of commercial liquid plant fertilizer.

### **Bioassay procedure**

1. Label small glass beakers (200 to 250 ml) with sample number or name. If beakers are not available, you can use jars (e.g., 1/2 pint Mason jars) or plastic drinking cups. (Don't use paper cups, which may disintegrate during the experiment.)
2. Pour sample water into beaker to within 1 inch of top. Using three beakers per sample is recommended, for statistical purposes. Prepare control samples using culture water.
3. Remove duckweed plants from culture tank, being careful to avoid injuring rootlets (a small spatula works well). Choose healthy plants (dark green color) that have two fronds of approximately equal size and no frond bud (a magnifying glass may help in checking for buds).
4. Place 20 plants onto the surface of the water in each beaker.
5. Cover beakers with watch glasses or clear plastic film and incubate for 4 or 5 days under the same light and temperature conditions as the culture tank. Do not add additional water to the beakers during the test.

Reading and interpreting results: Use a magnifying glass under good light to count the number of new fronds on each plant. Recognizable protruding buds should be counted as new fronds.

Express the result for each test beaker as a percentage of the control sample result. For example, if you counted 7 new fronds in Sample A and 10 in the control, the percentage is  $7/10 \times 100\%$ , or 70%. In other words, Sample A exhibited 70% of the growth of the control sample. This suggests that something in Sample A inhibited growth by 30%. If replicate samples were tested, statistical tests can be performed to investigate the significance of the findings.

If desired, the plants can also be examined for chlorosis (light-colored fronds). Chlorosis can be caused

by pollutants or by growth conditions (low temperatures, low light, insufficient nutrients). In the assay, growth conditions are the same for the test and control samples, so if the test sample shows more pale plants than the control, this should reflect the effect of contaminants. However, chlorosis is a subjective endpoint because there is some natural variation in the color of duckweed plants.

***Joe Rathbun** is an Aquatic Biologist/Chemist for AScI Corporation (15300 Rotunda Dr., Suite 307, Dearborn, MI 48120; 313/336-7200) and a technical advisor for GREEN (Global Rivers Environmental Education Network).*



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## **About *The Volunteer Monitor***

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

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

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

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

### **Rotating Co-Editors**

*The Volunteer Monitor* has a permanent editor and volunteer editorial board. In addition, a different monitoring group serves as co-editor for each issue.





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## Back Issues

Because older issues of The Volunteer Monitor are out of print or nearly out of print, there is a charge of \$1 apiece for single copies of older issues.

- Fall 1991 -- Biological Monitoring (\$1)
- Spring 1992 -- Monitoring for Advocacy (\$1)
- Fall 1992 -- Building Credibility (\$1)
- Spring 1993 -- School-Based Monitoring (\$1)
- Fall 1993 -- Staying Afloat Financially (\$1)
- Spring 1994 -- Volunteer Monitoring: Past, Present, & Future (\$1)
- Fall 1994 -- Monitoring a Watershed (\$1)
- Spring 1995 -- Managing and Presenting Your Data (\$1)
- Fall 1995 -- Monitoring Urban Watersheds (\$1)
- Spring 1996 -- Managing a Volunteer Monitoring Program (\$1)

Postage is 78¢ for one issue, \$1.24 for two, and \$1.47 for three; \$3 for up to 15 issues. (For larger orders, call 415/255-8049 to check availability and charges.) Please send self-addressed envelope (9 x 12) or mailing label, plus stamps or check, to the [address](#) above.

*The Volunteer Monitor* is also available on EPA's web site, at [http://www.epa.gov/OWOW/volunteer/vm\\_index.html](http://www.epa.gov/OWOW/volunteer/vm_index.html)



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## From the Editor

### Next Issue: Science and Technology

The Spring 1997 issue of *The Volunteer Monitor* will be co-edited by Rhode Island Watershed Watch and will focus on the scientific and technical side of monitoring. Please let us know if you have an innovative method or a homemade piece of equipment you'd like to share with our readers, or if there's a technical topic you'd especially like us to address.



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## Bioassay Update

Since my article on the lettuce seed bioassay appeared in the last issue of *The Volunteer Monitor* (Spring 1996), several readers have called me with questions. The most common concern has been the difficulty of finding a water body toxic enough to cause a noticeable reduction in seed germination or root growth. This is, of course, good news for the environment. At the same time, teachers would like their students to be able to observe a positive reaction. I can think of two solutions: analyze sediments, or use a positive control.

Sediments usually contain much higher concentrations of most contaminants than does water (often thousands or even millions of times higher). Silty sediment usually contains higher concentrations than sand. To directly test sediment using the lettuce seed assay, cover the bottom of the petri dish with sediment, smooth the surface, place the filter paper on top, and add the seeds. (Sediment usually contains enough water to saturate the filter paper; if it does not, add a little distilled water.) Another technique, which can be used with soil samples as well as sediments, is to prepare a liquid solution called an elutriate. To make an elutriate, combine 1 part sample with 4 parts distilled water in a clean jar, shake vigorously for 3 minutes, let settle overnight, and draw off the overlying water (elutriate) to use in the assay. (For a more detailed protocol, please contact me.) Elutriates can also be used in the duckweed bioassay (see [page 22](#) of this issue) or the *Daphnia* assay (Spring 1993 issue).

A positive control, or "reference toxicant," is an artificial sample containing a sufficient concentration of toxicant to cause a measurable toxic effect. Non-iodized sodium chloride (table salt; NaCl) is the most commonly used reference toxicant. I've found that a solution of 2 g NaCl per liter of distilled water will cause some seed mortality and reduce root growth by about 50% compared to the negative control. For the duckweed bioassay, use a concentration of 1g NaCl per liter, and for the *Daphnia* assay, 7.5 g/L.

Another reader called to ask me about using different seeds in the assay. The two species most commonly recommended for phytotoxicity tests are lettuce and millet.

Another question was whether seed germination and root growth react differently to different chemicals. The two endpoints do react differently to the *same* chemical, with root growth being more sensitive than seed germination. For example, 150 mg/L of phenol causes a 50% reduction in root growth, but it takes 1250 mg/L to cause a 50% reduction in germination. However, I don't think that different responses in

the two endpoints can be used to identify which contaminants are in the test sample.

Finally, a reader wanted to know why she got lower seed germination in her distilled water control sample than in the test water samples. It may be that the lack of dissolved salts in the distilled water stresses the seeds and roots. A solution would be to use dechlorinated tap water as a control.

I thank those who contacted me, and welcome further questions about bioassays. I also encourage anyone who uses bioassays to report their experiences in *The Volunteer Monitor*. Good luck to all of you.

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## No Incubator? No Problem

I am a high school teacher who is very active in monitoring our local river with my students. My students and I are diligent in our work and generally confident of our results. The one area of uncertainty for us has been fecal coliform testing. We use the method described in the *Field Manual for Water Quality Monitoring* by Mark Mitchell and William Stapp, which calls for membrane filtration followed by a 24-hour incubation at an exacting 44.5° Celsius, with a deviation of no more than 0.2°C. This requires the use of a rather sophisticated incubator, which we, like most schools, do not have. We have tried to get by as best we can with the incubator we have, and I'm sure others do the same.

I have now found a product that makes it possible to perform the fecal coliform test without the need to maintain the 44.5°C temperature. We still use the Millipore membrane filtration technique, but now, instead of placing the membrane filter in the small Millipore dishes, the students place the filter in a ColiChrome plate from RCR Scientific. The plate is then left out at room temperature for 48 to 72 hours. The results have been excellent, with my preference being for the room temperature incubation. For some reason, we never get to look at our plates within 24 hours, so the longer incubation is better for us.

The plates are easy to prepare--simply pour a bottle of ColiChrome medium into the plate, then let it sit for a few minutes to harden. If you don't have a membrane filtration system, you can add the test water directly to the bottle of medium, swirl, and then pour it into the plate.

I'm sure many readers of *The Volunteer Monitor* are in the position I was once in. I hope they can benefit from what I have learned.

Gerald Friday  
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*Editor's response:* Thanks very much for sharing your experience. After reading your letter, I called Dr. Jonathan Roth, who invented the method you describe. He told me that the plate now has a new name--Coliscan--and that Micrology Labs has been licensed by RCR Scientific to market the product. He also provided the following explanation of how the plate works. The medium contains two chromogenic

(color-producing) agents. One detects coliforms (pinkish-red colonies) and the other is specific for *E. coli* (purple colonies). Thus users can obtain counts for both *E. coli* (purple colonies) and total coliforms (sum of purple plus pink colonies). Non-coliforms appear as greenish or white colonies.

Although the plates can be incubated at room temperature, for best results Dr. Roth recommends a warmer incubation temperature of 85-99°F (or 29-37°C) for 24 to 48 hours. He suggests using a simple incubator made by installing a light bulb in a box.

Readers might also be interested to learn that Alabama's statewide volunteer monitoring network, Alabama Water Watch, recently started using the Coliscan plates. AWW volunteers don't use membrane filtration; they pipet 1 ml of unfiltered sample directly into the bottle of medium, pour it into the plate, and incubate at room temperature for 30 to 40 hours.

Tina Laidlaw, the Volunteer Monitor Coordinator for AWW, reports that "the method is really easy, and provides a great 'first alert.' We've already had three success stories in our first three months." One volunteer tested a stream just below a sewage treatment plant and found the plate covered with *E. coli* colonies--too many to count. The plant has now resolved the problem. In two other cases, volunteer monitors detected sewage contamination due to faulty or blocked sewer lines; city workers made the needed repairs.

The Coliscan plates cost about \$1.20 apiece for orders of 50 or more. For more information, contact Micrology Labs at P.O. Box 340, Goshen, IN 46526-0340; ph. 219/533-3351.



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## Getting a Better Look at Aquatic Insects

by Mason Sinclair

A neat viewing cell for observing aquatic insects can be made from a scrap of styrofoam and a small piece of glass. Cut the styrofoam into a block about 4 inches long, 3 inches wide, and 2 inches deep. Ask a hardware store to cut a piece of glass approximately 3.5 inches by 2 inches (cost: about 25 cents). Use silicone cement to make a "bead" between the glass and styrofoam (see diagram). You can vary the depth of the cell to accommodate various sizes of creatures; 2 millimeters is a good depth for many aquatic insects. Fill the cell with creek water, then use fine-tipped forceps to place the specimen in the cell.

The viewing cell allows you to use a hand lens (about \$5) to best advantage. By the way, many observers (including biologists) don't know how to use a hand lens properly. Just remember that the hand lens goes right up next to the eye and is held steady there. To focus, move the object that is being viewed, not the hand lens.

*Mason Sinclair is a Biologist with Metropolitan Government of Nashville and Davidson County, 1600 Second Avenue, North, Nashville, TN 37208-2206; ph. 615/862-4590.*



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## Getting the Stats on Marine Debris

by Jill Goodman Bieri

During Earth Week 1996, the Center for Marine Conservation (CMC) kicked off the National Marine Debris Monitoring Program. This five-year program, funded by the Environmental Protection Agency, was designed by a federal workgroup to provide statistically valid answers to two questions: (1) Is the amount of debris on our coastlines decreasing? and (2) Where is the debris coming from?

The Debris Monitoring Program focuses on 30 specific debris items that are common somewhere on our coastlines. Currently, 500-meter beach stretches at 40 sites in the Gulf of Mexico and the Caribbean--from Texas to the Florida Keys, as well as Puerto Rico and the Virgin Islands--are being monitored by trained volunteers on a monthly basis. The volunteers include scientists, students, oil company employees, U.S. Coast Guard officers, and many others. CMC is responsible for volunteer recruitment and training, site selection, and quality assurance. All the data is sent to CMC for analysis.

Preliminary data suggests that the majority of the ocean-based debris--such as light sticks (used by fishermen to light up fishing lines), floats, buoys, and fishing line--washes ashore in the western portion of the Gulf of Mexico. Volunteers at sites in southeastern Texas typically collect 25 to 30 bags of debris, most of it ocean-based, at each monthly visit. By contrast, their counterparts in Florida usually collect less than one bag per visit. The amount of land-based debris items (e.g., cotton swabs, straws, metal beverage cans) varies from site to site and is related to beach usage and proximity to effluent. For a more complete understanding of where the debris is coming from, the effects of currents, wind, and weather must also be factored in.

Recently the CMC was awarded additional funding from the Environmental Protection Agency to expand the program to two additional regions on the East Coast. Volunteers for these new regions will be trained in the spring of 1997.

*For more information on the National Marine Debris Monitoring Program, please contact Jill Goodman Bieri, Program Manager, at 757/851-6734; email [goodmaj@-hampton.mhs.compuserve.com](mailto:goodmaj@-hampton.mhs.compuserve.com).*





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## Resources

### Stream Restoration Video

"Restoring America's Streams," a new video from the Save Our Streams Program of the Izaak Walton League of America, is a companion to A Citizen's Streambank Restoration Handbook. This 28-minute video depicts bioengineering techniques for restoring degraded streambanks. It covers structural methods, such as placing logs and stumps, and vegetative methods, such as planting willows and dogwood. Both the video and the handbook stress a watershed approach to designing a stream restoration project. The video costs \$20, and the handbook is \$15 (prices include shipping). For more information, please call 800/BUG-IWLA.

### Holding Up (Stream) Banks

*How to Hold Up Banks: Using All the Assets* (1996) is an informative, well-illustrated booklet on controlling stream erosion. It was produced by the Boquet River Association (BRASS), a small nonprofit group with extensive experience in stream monitoring and restoration. The book is aimed at other citizen groups and emphasizes community involvement and low-cost approaches. Techniques covered include streambank shaping; planting grasses, seedlings, and live posts; and installing log cribbing and stone riprap. \$8 (includes S&H); order from BRASS, c/o Essex County Government Center, Box 217, Elizabethtown, NY 12932; ph. 518/873-3688.

### Learning About Wetlands

*WOW! The Wonders of Wetlands: An Educator's Guide* (1995) contains over 50 activities for grades K-12, plus background information on topics such as hydrophytic plants, wetland functions, and wildlife. 330 pages; \$15.95 plus \$4.50 S&H. Order from The Watercourse, 201 Culbertson Hall, Montana State Univ., Bozeman, MT 59717-0057; ph. 406/994-5392.

### Student Field Manual

*The Student Watershed Research Project: A Manual of Field and Lab Procedures, 3rd Edition* (1996) was designed for use by students in grades 8-12. It covers chemical, biological, and physical parameters

for stream assessment and includes background information, materials needed, techniques, waste disposal, and reporting results. \$30 plus \$5 shipping. For more information, please contact Marilyn Workman, ph. 503/690-1368; email [mworkman@admin.ogi.edu](mailto:mworkman@admin.ogi.edu).

## **Fighting Marine Pollution**

*Shoresaver's Handbook: A Citizen's Guide* (1996), by Tucker Coombe, packs a lot of information about coastal conservation into a small and very readable book. Readers of *The Volunteer Monitor* will particularly appreciate the extensive discussion of volunteer monitoring projects and other citizen activities. An American Littoral Society book, published by Lyons & Burford; \$12.95 in bookstores.

## **Coastlines Newsletter**

*Coastlines* is a free quarterly newsletter about coastal management. A joint project of the EPA Oceans and Coastal Protection Division and the Urban Harbors Institute, the newsletter is designed for agencies, community groups, and individuals who care about the coast. To be added to the mailing list, contact the Urban Harbors Institute, 100 Morrissey Blvd., Boston, MA 02125-3393; fax 617/287-5575. For an electronic version, visit the Coastlines web site at <http://www.epa.gov/nep/coastlines/coastlines.html>.

## **QA Guidance Document Published**

*The Volunteer Monitor's Guide to Quality Assurance Project Plans*, recently published by the EPA, is an easy-to-read 59-page guide written specifically for volunteer monitoring programs. The guide explains basic quality assurance/quality control concepts, describes the elements of a quality assurance project plan (QAPP), and outlines the steps involved in preparing the plan. It includes a glossary, a list of references and contacts, and a model QAPP form that volunteers may modify for their own use. For a free copy, contact Alice Mayo at the U.S. EPA, ph. 202/260-7018, email [Mayio.Alice@epamail.epa.gov](mailto:Mayio.Alice@epamail.epa.gov); or contact EPA/NCEPI, Box 42419, Cincinnati, OH 45242, fax 513/489-8695.

## **Surf Your Watershed**

The U.S. Environmental Protection Agency's new Internet program, Surf Your Watershed, allows users to find and share environmental information and maps for their community, watershed, or state. Users can search information by topic or watershed and see information in text, map, or chart form. The amount of information available will grow over time as more links to other organizations are made. Watershed organizations and volunteer monitoring groups are encouraged to add new information about their watersheds. The Internet address for Surf Your Watershed is <http://www.epa.gov/surf>. Questions or comments on Surf Your Watershed are welcome through the online comment form, or can be sent via email to [Surf-Link@epamail.epa.gov](mailto:Surf-Link@epamail.epa.gov).



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## Got Reliable Data? Can You Prove It?

*The Volunteer Monitor* is compiling evidence to make a case for the credibility of volunteer monitoring data. We know that lots of volunteer groups have compared their data to data collected by professionals, and that the volunteers usually come through with flying colors. But no one (as far as we know) has gathered all these pieces of evidence together in one place.

You can help! If you have used side-by-side comparison studies to document the validity of volunteer-collected data--chemical tests, Secchi readings, macroinvertebrate or bacterial counts, wildlife identification, or any other type of data--please let us know. Tell us how you carried out the comparison, and send in your results, graphs, and statistics. We'll publish the stories in the next issue. Send your information to *The Volunteer Monitor*, 1318 Masonic Ave., San Francisco, CA 94117; ph. 415/255-8049; fax 415/255-0199.



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## Reduced-Price Equipment

YSI, Inc. is selling off its inventory of used demo equipment. This multi-parameter water quality monitoring equipment is being sold at 30 to 50% off list price. Prices start at \$1,500, and detachable probes will be sold new, at 35% off list, with each used instrument. Up to 15 parameters, including dissolved oxygen, conductivity, temperature, and pH, are available. A 6-month warranty will be offered on all used instruments. For more information, please contact Mary Therese Gookin at YSI, 800/765-4974, ext. 222.



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## **Turbidity Tubes Available**

In the Fall 1994 issue, *The Volunteer Monitor* reported on nationwide turbidity testing in Australia using homemade turbidity tubes. The Australian-made turbidity tube is now available for purchase from Waterwatch Victoria for \$20 (US) plus \$5 shipping. Send a check or international money order made payable to "Reading the Land Educational Materials" to Waterwatch Victoria, attn. Vera Lubczenko, Department of Natural Resources and Environment, 6/232 Victoria Parade, East Melbourne VIC 3002, Australia. Alternatively, you may order the tube through Waterwatch's Internet site, <http://www.vic.waterwatch.org.au>.



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## Monitoring Wetlands: A Flexible Approach

by Chrys Bertolotto

Developing a volunteer wetland monitoring program can be a complex task. To begin with, wetlands themselves are extremely variable. Just walking through a single wetland from end to end screamingly tells all your senses that you are moving from one distinct community into another. And if a single wetland is complex and variable, comparing one wetland to another is something akin to comparing the moon and the sun. Say "wetlands" and most people imagine a marsh filled with ponds and reeds and pond lilies. And that is indeed one type of wetland--but a bare mud flat can also be a wetland, and so can a forest. Even the marshes that people typically equate with the term "wetland" can be classified into several different categories, depending on the type of vegetation.

Further complicating the design of a wetlands monitoring project is the broad range of questions that monitors may want to answer--questions like:

- Is the wetland changing? If so, could changes be due to increased flows of stormwater runoff? widening of a road? encroachment of noxious weeds?
- Are created or enhanced wetlands performing the way they were expected to? (for example, are they being used by amphibians?)
- Are management actions (such as revegetation, preservation, or stopping grazing) having the desired results?
- What kind of wetland is that, anyway?

The selection of monitoring activities will depend on the reasons a wetland is being monitored. For example, if you only want to characterize a wetland, taking a year's worth of monthly readings on maximum water levels probably won't be necessary. On the other hand, if you suspect that increased stormwater discharge is changing the wetland's vegetation composition, such detailed documenting of maximum water levels would be extremely relevant.

## **Wetland monitoring in King County**

In King County, Washington, a volunteer wetland monitoring program that is flexible enough to serve the needs of a variety of wetlands, monitoring program managers, and wetland regulators has been developed. The program arose out of concern that creation or restoration of wetlands mandated by County permits either was not occurring or was not successfully meeting permit requirements. Because County staff did not have the resources to visit each wetland, King County and Adopt a Beach agreed that training community organizations to monitor these wetlands would be an economical and effective way to get the needed data--while at the same time educating community members about wetlands and how to be better stewards of them.

In 1992, Adopt a Beach began working with six advocacy organizations to develop a program for volunteers to monitor wetland mitigation sites. We soon realized that other organizations and agencies could benefit from what we had learned, so Adopt a Beach collaborated with EPA Region 10 and King County to create a manual. The result, just published in October 1996, is a comprehensive guide entitled *Monitoring Wetlands: A Manual for Training Volunteers*.

*Monitoring Wetlands* provides a wealth of information on all aspects of wetland monitoring, from the initial steps of selecting a wetland and finding volunteers to the final steps of analyzing and using the data. Everything in the manual has been reviewed by an advisory board of scientists and volunteers and field-tested in two separate volunteer monitoring programs.

The manual details quantitative and qualitative methods for monitoring a variety of characteristics in both naturally occurring wetlands and created or enhanced wetlands. It begins with the method most groups will use first--a reconnaissance walk, in which volunteers walk the wetland to identify major vegetation communities, locate photo points, identify surrounding land uses, and establish locations of transects. Data gathered on the reconnaissance walk serves as a baseline for future monitoring. From that point, the monitoring group may choose to study certain wetland characteristics in more detail. The manual provides protocols for monitoring hydrology (for example, measuring the quantity of water that flows through an area, or the time water remains on site); wetland buffer condition; soil types; vegetation; topography (determining elevations); and wildlife. Monitoring wildlife can include such activities as bird diversity surveys or counting and identifying amphibian egg masses.

### **A choice of methods**

For most of the characteristics listed above, *Monitoring Wetlands* provides two or more alternative methods. This allows each monitoring program to choose an approach that best suits its monitoring goals, its volunteers' level of expertise, the amount of training that can be provided, and the available time and funding.

In this brief article, there is space for only one detailed example. The following summary of the three methods for vegetation surveys (presented in order of increasing complexity) will give readers a sense of

the variety of protocols available in the manual.

**Plant survival surveys** are specifically designed for use in wetlands or wetland mitigation sites where some planting has occurred. Volunteers are provided with a "planting plan" listing the species planted and their numbers. For each species, they count the plants they see and compare this number to the number planted (see illustration on page 7). They also note plant condition (live, dead, or stressed), and any colonization by invasive weeds or "volunteers" (plants that propagate on their own). Data from plant survival surveys can be used to evaluate the success of a planting, pinpoint areas for replanting, and identify species that should not be replanted in an area, given their low survival rates.

Volunteers require little training or prior knowledge to successfully complete a plant survival survey. Before conducting the survey, they can consult guidebooks to familiarize themselves with the particular species listed in the planting plan.

**Vegetation assessment surveys** provide qualitative information on the character of wetland vegetation communities. Volunteers walk the site to determine the major types of communities in the wetland, then find sample plot locations which best represent those communities. Plots are circular, with the radius depending on the predominant type of vegetation in the plot (10 meters for forested, 5 meters for scrub-shrub, and 1 meter for herbaceous). In each plot, volunteers record three to five of the most dominant species in each vegetation "layer" (tree, shrub, and herb). Data from vegetation assessment surveys can be correlated with other data (for example, hydrology or soil types) to get a better sense of how the wetland functions in the watershed and what its protection would require.

Although a vegetation assessment survey does not require extensive botanical skills, it is most appropriate for volunteers who are familiar with a site and have already keyed out its most common plants.

**Percent cover vegetation surveys** are the most time-consuming, quantitative, and complex of the three methods. The same plot sizes are used as in the vegetation assessment survey (above), but the plots are located every 50 feet along five transects which run across the wetland. Within each plot, volunteers identify all species and estimate the area they cover.

This method is excellent for showing changes in vegetation over time. If a planner or program manager suspects that adjacent land uses or changes upstream are impacting a wetland, percent cover surveys can indicate if those suspicions are justified. The data can also be used to document the vegetative evolution or colonization of a created or enhanced wetland.

The training required for this type of survey is extensive. Not only must volunteers be skilled at plant identification, they also must know how to set up transects and use compasses. Obviously the necessary level of botanical knowledge cannot be acquired immediately, so linking skilled botanists with volunteer groups is a must. In King County, we linked graduates of a Native Plant Stewardship course (offered at Washington State University Cooperative Extension/King County) with groups who did not already have botanical skills.



## **The bumps and bruises**

In the process of creating a comprehensive wetland monitoring program, Adopt a Beach and our numerous partners learned quite a few lessons. The first and foremost was that a uniform set of monitoring methods cannot be applied rigidly to every wetland, every volunteer group, and every situation. Our early belief to the contrary created some problems. For example, bushwhacking through a densely vegetated forested wetland trying to collect topographic data with a relatively inexperienced volunteer group brought on much hair-pulling. The dense growth made it difficult to move, let alone maintain a line of sight (as required for elevation measurements), and it took over five hours to take approximately 20 readings.

We also learned that volunteers need time to develop a sense of ownership and stewardship for a wetland. Early on, we asked volunteer groups to collect information at two or three different sites over a four-month period. These volunteers did not bond with any particular site. Later, we worked with 12 community groups who each monitored just one wetland over a year's time. These groups are now intimately familiar with "their" wetlands. They know the agency responsible for managing the wetland and they understand its role in the watershed. Many will continue to watch over the wetland for years to come. The more patient approach achieved both our goals: to create a lasting community of citizen stewards at the sites, and to collect quality data that is used by government managers.

One of the most valuable lessons we learned was that training for a multi-task, long-term monitoring project is better absorbed when doled out in little pieces. Our first training was an intensive week-long 40-hour session covering all the monitoring methods. It quickly became obvious that we were trying to convey too much information in too short a time. Our later training took place over a year's time, with sessions roughly every two months. Topics were scheduled chronologically, with each new monitoring activity preceded by specific training. We found that volunteers who attended the revised training required less follow-up help with their monitoring.

## **Resources**

*Monitoring Wetlands: A Manual for Training Volunteers*, by Tina Miller, Chrys Bertolotto, Janice Martin, and Linda Storm (1996). 106 pages, plus appendices. Includes protocols for all the methods listed in this article, plus equipment lists and data forms. To order, send \$15 (includes shipping) to Adopt a Beach, P.O. Box 21486, Seattle, WA 98111-3486; ph. 206/624-6013; fax 206/682-0722. A disk with an Access database to manage and analyze the monitoring data can also be requested.

*Wetlands*, by W. J. Mitsch and J. G. Gosselink (1986). Published by Van Nostrand Reinhold. This is the classic textbook.

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

## Monitoring the Monitors: Bird Banders Track Data Quality

by Chris Fischer

Volunteer monitors have long since broken the bounds of traditional water chemistry testing and qualitative assessment; throughout the world, they are taking part in increasingly technical research. As reduced financial and personnel resources have put many long-term, labor-intensive studies at risk, resource managers and researchers have turned to volunteers to "leverage" staff time. In some cases, public education and participation objectives are far from the hearts and minds of agency managers; good, clean, usable data is the primary goal, and quality assurance--especially quality assurance documentation--is the name of the game.

Landbird monitoring projects provide an excellent model for successfully integrating citizen volunteers with highly technical research. Throughout the Americas and Europe, government agencies, research organizations, and educational institutions are incorporating highly trained volunteers into such projects. At the Coyote Creek Riparian Station (CCRS) in Alviso, California, citizens have been monitoring Neotropical songbirds (those brightly colored warblers, sparrows, and other songbirds that breed in North America and spend the winter in Central and South America) for over 14 years, as part of a long-term research project. The main question we are investigating is when and how migrating and breeding songbirds use riparian revegetation areas, compared to their use of existing mature riparian forest.

### Volunteers make it possible

The bulk of the data for this research project is collected by CCRS's 40 volunteer bird banders, with the guidance of three staff biologists. These volunteers brave the elements year-round, doing work that requires a high level of expertise and accuracy (see [page 10, "What Bird Banders Do"](#)). Of the 12,000 or so birds handled each year, at least 10,000 are processed by the volunteers. Last year, volunteer banders dedicated over 5,000 hours to the project. Hiring field technicians to do the same work would cost about \$90,000--effectively doubling the current project budget.

The research is being conducted under contract with the Santa Clara Valley Water District, which is

required to monitor the site as a condition of Army Corps of Engineers flood control permitting requirements. The Water District is using this information to assess whether current riparian revegetation projects are succeeding in terms of wildlife habitat use, and to improve the design of future projects.

## **Working together**

Over the past several years, as our research became increasingly sophisticated, we began to wonder about methods for documenting the quality of our data. Our volunteers had similar concerns: "How can we be sure we're doing a good job?" they wanted to know. Recognizing that we needed better ways to assess and document the reliability of our information, we set up an Avian Research Committee made up of program staff, volunteers, and technical advisors. The committee's job was to review all aspects of our quality assurance program, then draw up specific guidelines for recruiting and training volunteers and for tracking and documenting data quality. This turned out to be an evolutionary process spanning several years, as we considered the standards we wished to achieve and the methods by which to achieve them.

At first, staff members and agency project managers were concerned about how the volunteers would react to this emphasis on testing and tracking accuracy. Would they resent the increase in their workload? Would they feel intimidated or insulted at being "tested"? Would they think we didn't trust them? As it turned out, our worries were unwarranted. In fact, the volunteers were excited by the prospect of both improving and proving the quality of the data. Including the volunteers in the process from the beginning was the key. "Even though I knew I was doing the best I could," says volunteer Vicki Silvas-Young, "I wasn't sure how good that was. I was really looking forward to some feedback."

The Avian Research Committee's first task was to take stock of existing protocols, and here the volunteers' input proved invaluable. The simple question "Where do you think error may be creeping in?" led to a series of wonderfully productive discussions. For example, CCRS biologists noted a surge of misread band numbers (that is, recaptured birds did not correspond to original captures). Banding volunteers felt that communication about the problem (in the form of a "Heads up!" memo), combined with better lighting in the trailer, would provide results. They were right--implementation of these two suggestions resulted in an immediate and sustained reduction in that type of error.

Following the initial assessment phase, the Committee set out to improve quality assurance in each of the major components of the monitoring program: recruitment, training, procedures manual, and evaluation.

## **Recruiting the right people**

For a highly technical monitoring project, the expertise of the volunteers is a key element in quality control. Good training and supervision are critical but not sufficient--first, you have to recruit people with "the right stuff." The fundamental abilities required for bird banding include excellent bird identification skills, good manual dexterity and eyesight, the physical ability to traverse rough terrain in the dark (volunteers begin their work well before sunrise), and other qualities even more difficult to measure, such as attentiveness to detail. The Avian Research Committee worked to make the screening

procedures for prospective volunteers as quantifiable as possible. For example, the committee developed a slide show to test bird identification skills and a "fact sheet" describing the physical demands of bird banding. Volunteers unable to pass the bird identification test or commit to the physical challenges were channeled into other, less rigorous volunteer opportunities.

The committee also set a goal of learning, and documenting, more about the educational and professional experience of all volunteers, both old and new. CCRS staff were surprised and impressed to learn how many veterinarians, laboratory technicians, and retired biologists were on our rolls. Documenting this kind of expertise supports the credibility of our volunteers' work. It also provides staff with great ideas on where to look for additional recruits.

### **Volunteer training: Never done**

One message that came across loud and clear from the volunteers on the Avian Research Committee was that there is no such thing as too much training. "The initial series of training workshops was very good," reports recent recruit Troy Obrero, "but with this kind of thing, there's always something more to learn."

The committee identified two types of training--initial and follow-up training for new recruits, and ongoing training and review for all volunteers. For new recruits, a mentorship program was recommended. Newer volunteers are teamed with selected experienced volunteers, who provide ongoing instruction and support for the first year. For seasoned and "rookie" volunteers alike, seasonal review workshops were instituted. These workshops are mandatory--if you want to band spring migration you must attend a spring migration review workshop. Once again, rather than resistance the staff encountered enthusiastic support. Volunteers welcomed the increase in opportunities to enhance and affirm their skills.

### **Standard operating procedures**

There simply is no substitute for writing down exactly what to do and how to do it, and making sure everyone has a copy. After thoroughly reviewing the program's 30-page "*Banders' Handbook*," our banding training manual, the committee added many new reference materials, began work on a detailed Quality Assurance Project Plan, and made a recommendation for annual review and update of the handbook. (Note: For information on ordering the handbook, see "[Resources](#)" at end of article.)

### **How are we doing?**

Testing and documenting the quality of the data takers is important, but it's not the same as testing and documenting the quality of the data itself. Unlike water chemistry testing, catch-and-release wildlife sampling does not lend itself to independent validation of the data by an outside lab. Observer variability, precision and accuracy of measurements, and other critical quality assurance elements must be documented, but the question is, How?

Once again staff and volunteers pooled their resources to develop an innovative system to track data quality. Because migrating birds stay in the area anywhere from several days to several weeks, it's common for the same bird to be captured more than once. Taking advantage of this fact, Avian Research Program Director Chris Otahal and volunteer Irene Beardsley designed a format for comparing original measurements on individual birds with data collected on the same birds when they were recaptured (see graph). The percentage of discrepancies, or "error rate," provides a measure of data quality.

"The tricky part," says Otahal, "wasn't so much figuring out how to track the error rate--it was determining what level of error was acceptable." CCRS staff began contacting authorities in the field, assuming they would have good numbers on standard rates of error in such studies. To our surprise, they didn't. "What we heard a lot," reports Otahal, "was 'Hmmm . . . that's a good question.' No one seemed to be tracking levels of error in the field or the lab." Through enough "brain-picking," however, CCRS staff set target maximum error rates for the key data sets, and began tracking to see how the program shaped up.

The first year of tracking showed us that by and large we were doing very well. The new system allowed staff to really home in on specific problems, and to provide the volunteers with prompt, clear feedback. For example, in late summer 1995 CCRS staff noticed a peak in the error rate for "age" (see graph). We realized that at that time of year recognizing age clues in birds hatched that spring becomes more difficult as young birds begin to take on more adult characteristics. Staff immediately alerted the banders to the problem and provided tips on improving age identification. Once again, the response in data quality was immediate.

Tracking collective error for the program provided impetus for volunteers to tackle problems as a team, while tracking each volunteer's individual effort allowed staff to provide feedback and assistance one-on-one in a more private setting. It proved a powerful combination.

## **The payoff**

The investment in quality assurance has paid off at every level. The volunteers have remained enthusiastic and supportive, reporting that quality assurance feedback reassures them that their efforts are valuable. The staff have benefited in many ways, including being able to focus and prioritize training efforts. "I sleep better at night," confides Otahal, "knowing we're on track." Most important, gaining and maintaining the confidence of planners and decision makers ensures that the information will be used. And it is being used. For example, our data revealed that the original revegetation project, planted 10 years ago, had too high a ratio of trees to understory plants, making the area less useful to some species of birds. Based on these findings, the Water District has planted the next revegetation area with more understory. Now the bird banders will monitor the success of the new design, in hopes of finding a good balance.

"The data collected by the volunteers has made an important contribution to our understanding of how birds use riparian revegetation areas," says Cindy Roessler of the Santa Clara Valley Water District.

"Using these data we have been able to redesign our riparian revegetation projects to increase their value to the wildlife." And that, of course, is what it's all about.

## **Resources**

*"Bander's Handbook."* Coyote Creek Riparian Station's step-by-step guide to field and lab methods; includes safety information and reference materials. Available for \$5 from CCRS (address below).

*Handbook of Field Methods for Monitoring Landbirds.* 1993. USDA General Technical Report PSW-GTR-144. Available from: Publications, USDA Forest Service, Rocky Mountain Station, 3825 E. Mulberry, Fort Collins, CO 80524; ph. 970/498-1703.

*Identification Guide to North American Passerines.* 1987. P. Pyle, R. Yunick, and D. DeSante. Slate Creek Press. Available from American Birding Assoc., 800/634-7736; \$23 + \$3.75 shipping.

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

## What Bird Banders Do

Coyote Creek Riparian Station's volunteer bird banders begin their work half an hour before sunrise. Working in teams of two in the pitch black of the riparian forest, they set up "mist nets" (so called because their mesh is so fine that they resemble mist). The nets are carefully placed to represent different habitats within and along the riparian zone.

Every 45 minutes, the banders check the nets and remove birds that have been caught in the pockets. After recording the time and location of capture, they bring the birds to the banding lab where they "band" each bird by placing a tiny (1 to 10 mm), uniquely numbered metal band on its leg. This permanent identification allows researchers to track the movements, health, and growth of individual birds over time.

After a bird is banded, the volunteer weighs it, measures its wing and bill length, makes various observations (e.g., plumage condition, evidence of breeding, amount of fat), and determines its age, if possible. All data are carefully recorded. Then the bird is returned to the place of capture and released.

At CCRS, volunteer banders make an initial commitment of two days per month for a minimum of one year. Most stay active in the program for many years.



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## Monitoring the Behavior of Streams

by Michael Rigney

It's late on a hot autumn afternoon in the San Francisco Bay Area. Since early this morning, fluvial geomorphologist Laurel Collins and I have been struggling to establish the location of thalweg points in San Leandro Creek (thalweg is German for valley way; as the name suggests, a thalweg point is the deepest point of the stream channel in any given section).

Collins, standing in the stream, holds the survey rod straight up on a thalweg point. On the bank, I stare through the 20X lens of the survey level at a fresh scratch on her finger. "Hand," I call, letting her know to move her hand away from the area where the crosshairs of the level meet the rod tick marks. We have to shout--not because of any raging torrent of water (at this time of year most of northern California's smaller streams are dry), but because of the traffic overhead on one of the Bay Area's busiest freeways. Straining to see whether the reading is 4.2 or 4.3 feet, I ask myself, "Does it matter?" and decide, "Yes. Discoveries are made in the details."

Later, Collins will graph the points we've measured and connect them with a line to show the stream's "thalweg profile." Then at some time in the future we can go back, re-measure the deepest points, and again find the thalweg profile--which may or may not be in the same place as before. Changes in the profile will tell us where the stream is scouring or aggrading (filling in) its bed.

### What is fluvial geomorphology?

As volunteer monitoring expands to encompass more and more activities once considered the sole province of trained professionals, volunteers are starting to take a closer look at stream channel morphology (see sidebar on [page 14](#)). In so doing, they are entering the domain of fluvial geomorphology. According to Collins, a fluvial geomorphologist is "a person who studies the processes that affect the shape and characteristics of the stream channel--processes like erosion, deposition, and sediment transport. This requires an understanding not just of hydrology but also of hill slope processes. Simply put, fluvial geomorphologists try to figure out why a stream looks the way it does."

Though the phrase "fluvial geomorphology" may sound intimidating, volunteers need not feel daunted by



the prospect of assessing physical stream processes. Stream behavior and morphology are governed by simple principles of physics and gravity. The necessary equipment is simple too: a surveyor's level, surveyor's rod, and measuring tapes. These tools are used to collect a series of measurements of elevation change--raw data that yields, upon analysis, a wealth of information about channel stability, sedimentation, erosion, potential for flooding, and fish habitat.

The insights gained from studying fluvial geomorphology are especially valuable in guiding stream restoration or flood control projects. Rather than looking for quick solutions to specific problems, the fluvial geomorphologist seeks to understand the natural processes that have maintained the channel, and the stream's living resources, for thousands of years. Structures like bank revetments, dams, and levees often interfere with these processes, limiting the channel's ability to laterally migrate, erode its bed, or flood its floodplain. If flood control and restoration projects can be designed to take into account the stream's natural behavior, they will be less costly and more effective.

### **Getting into the stream**

As a first step toward understanding a particular stream, groups often conduct a field reconnaissance of the stream, sketching representative cross-sections and marking their locations on a standard topographical map. The map can also be annotated with locations of bridges, confluences of major tributaries, and obstructions to flow such as debris jams, cement culverts, and grade control structures.

Information from the reconnaissance survey can be used to establish stream reference sites or reaches for more intensive, long-term observations. If desired, the channel can be divided into broad categories of interest (e.g., urban vs. grazed, or perennial vs. intermittent vs. ephemeral), and reference reaches established for each category.

Some important questions to consider when designating reference reaches are:

- What do we want to know about this stream or drainage? Are we looking for broad, watershed-wide characteristics or localized effects of bridges, culverts, or dams?
- What changes, past and future, do we want to investigate? For example, a group might want to study the impact of a new dam on stream gradient, or of bridge construction on bank erosion.
- What parameters (geology, elevation, land use) affect the stream most? For example, are sediments coming from channel erosion or from a construction site?
- What level of change can we detect and explain with our current resources of funding, time, and expertise?

Guidelines for choosing and marking permanent reference sites are given in the U.S. Forest Service's *Stream Channel Reference Sites: An Illustrated Guide to Field Techniques* (for ordering information see

box on [page 15](#)). Volunteer groups will probably also need the help of a local hydrologist, geologist, or geomorphologist to properly locate sites. After you establish reference reaches, you'll need to locate any existing benchmarks and obtain government documents about local engineering projects.

## **Drawing a "plan view"**

Now, you're almost ready to get your feet wet. First you should draw a "plan view" (i.e., a view looking down on the stream) of your reference reaches. You don't need any surveying equipment at this point, just a compass and measuring tape.

The plan view is vitally important as documentation of prominent features for future reference. Five or ten years from now, you--or someone else--will rely on this map to locate reference points and measure any changes that have occurred.

Laurel Collins' intricately detailed plan view of a portion of the Fraser River in Colorado is shown on pages 12-13 of this article. This drawing--almost a work of art--represents the pinnacle of what can be done. Obviously, a volunteer group's drawing will be much simpler. You may want to start by just mapping pools and major debris jams.

## **Profiles and cross-sections**

Two of the most fundamental methods for measuring the effects of stream processes are the longitudinal profile and the channel cross-section. A longitudinal profile portrays what you would see if you could slice through the stream and its bed along the length of the stream, while a cross section portrays a "slice" across the stream. (See figures on page 13.) Longitudinal profiles can be constructed for many stream features, including water surface, water depth, bankfull height (an indicator of the "normal" flow pattern), and low flow channel or thalweg.

To map profiles and cross-sections you will need a surveyor's self-leveling level (mounted on a tripod), a surveyor's rod marked in increments of feet or meters, a 100-foot measuring tape, and a field book or form for recording the measurements. Surveying equipment may be purchased from suppliers such as Ben Meadows Company (800/241-6401) or Forestry Supplies (800/647-5368). Local surveying companies are also a potential source of equipment. Many are switching from optical to laser-based survey instruments, and may well donate outdated but still useful equipment to your organization.

Step-by-step instructions for measuring profiles and cross-sections are found in Stream Channel Reference Sites. Briefly, the procedure involves establishing benchmarks or reference points, then making a series of elevation measurements either along the length of the stream (for a longitudinal profile) or along a transect across the stream (for a cross-section). One person places the surveyor's rod at points where the topography changes, while another looks through the level and reads elevation by lining up the crosshairs in the level with the tick marks on the rod. The readings should be roughly plotted in the field to see if any gross errors leap off the page. Later, the data are plotted using a computer

spreadsheet program (see graphs, page 13).

A longitudinal profile allows you to calculate average pool depth (an indicator of fish habitat), riffle/pool ratios (important for evaluating both fish and macroinvertebrate habitat), stream gradient (crucial information for determining how much, and what size, sediment will be moved by the stream), and many other indices. Channel cross-sections yield information on channel volume, width, and contour (used in calculating flooding potential) and on the height and width of flood plain terraces (used to determine what sites are suitable for restoration, and to guide the selection of species to plant).

### **Pebble counts**

Stream bed composition plays an important role in determining stream behavior. "Pebble counts" provide a simple yet quantifiable way to characterize the stream bed. The method requires two people, one in the stream and one on shore. The person in the stream reaches down without looking, picks up the first particle he or she touches, and measures it along its intermediate axis (i.e., neither the shortest axis nor the longest). The onshore partner records the measurement. The instream observer then takes a step and repeats the process, continuing until 100 pebbles have been measured. (Particles too large or too embedded to pick up are measured in situ.)

To analyze pebble count data, classify the particles according to size and construct a graph of size class versus frequency. Pebble counts performed over a period of time indicate whether stream bed composition is changing. For example, a pronounced shift toward finer particles indicates stresses leading to channel instability and potential loss of fish or macroinvertebrate habitat.

### **Going further**

The physical measurements described above--cross-sections, profiles, pebble counts--provide important pieces of the watershed "puzzle." But effective watershed management requires more than just pieces; it requires a comprehensive understanding of how the whole system works. Such understanding requires collecting information on a variety of natural processes and human activities. For example, landslide and soils maps, together with bank surveys, help identify sediment sources. Rainfall and flow data are needed to calculate runoff rates. Historical data on flooding may be required to explain channel incision (cutting) or aggradation (building up).

Some of this information can be gathered from the U.S. Geological Survey, local water and flood control districts, or city and county public works or planning departments. Other important information must be acquired from field measurements. Volunteer monitors can play an active role in obtaining both existing information and new field data.

As with any community involvement program, volunteer groups should seek partners within the academic or engineering community to assist in the more technical aspects of data interpretation and study design. The good news is that gathering these kinds of data on rivers and streams will yield new

perspectives and a true appreciation of the dynamic nature of water acting upon the land through which it flows.

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## Case Studies: Volunteers Monitor Channel Morphology

Around the U.S., volunteers are beginning to get involved in fluvial geomorphological studies. (Note: Other groups who are doing this work are invited to contact *The Volunteer Monitor* or Mike Rigney.)

Maryland Save Our Streams volunteers, working under contract with the State Highways Administration, are using two measures of stream channel stability (pebble counts and stream cross-sections), along with macroinvertebrate monitoring and some basic water quality tests, to monitor the impact of highway construction projects such as bridges and culverts. The Highways Administration supplies rods and levels for measuring the cross-sections. Volunteers sample both upstream (control) and downstream from the construction site. Baseline measurements are made before a project starts, and monitoring continues during and after construction.

The volunteers' data are used to assess both the impacts of construction itself (mainly increased sedimentation from excavation) and the long-term impacts of the completed structure (for example, a bridge can act as a sediment trap, leading to erosion downstream). This project began in spring of 1994, and tracking of long-term impacts is expected to continue for many years into the future.

On the West Coast, volunteers at Coyote Creek Riparian Station, near San Jose, are working with engineers from the Santa Clara Valley Water District to incorporate cross-sectional survey data with vegetation assessments. At each point where elevation is measured, data on vegetation structure and species are recorded as well.

A little further north, volunteers are surveying cross-sections of the Napa River and its tributaries. Their data are used in a computer model, developed by Napa County Resource Conservation District staff, that simulates the hydrodynamics of the river. The model helps the District study the effects of management activities on flows.

Bob Zlomke, a Napa County RCD hydrologist who helped train the volunteers, says, "The work is not difficult, but it requires keeping an accurate field book with a lot of numbers. You have to really care about details." Collecting the data does involve some physical challenges, like climbing steep banks or

encountering poison oak, blackberries, or ticks. "You need to go across the whole transect in a straight line," Zlomke points out, "so you end up going through spots you might otherwise avoid." Still, the volunteers are equal to the task. Zlomke says, "When I tell colleagues what the volunteers have done, they're really surprised."



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## Getting Started: A Resource Guide

Since studying river behavior involves the unification of several fields of science, any complete reference list would be tremendous in scope. However, the following resources provide a good starting point.

The U.S. Forest Service's *Stream Channel Reference Sites: An Illustrated Guide to Field Techniques (General Technical Report RM-245)*, by Cheryl C. Harrelson, C.L. Rawlins, and John Potyondy, provides an excellent introduction to basic techniques, including cross-sections, longitudinal profiles, and pebble counts. Free copies are available from: Publications, USDA Forest Service, Rocky Mountain Station, 3825 E. Mulberry, Fort Collins, CO 80524; ph. 970/498-1719.

For a "general hypothesis of river action" Luna Leopold's classic *A View of the River*, published by Harvard University Press, is a must. This book draws together all the pieces from a wide variety of fields in understandable terms (although there are lots of charts and graphs, and a few equations). For more in-depth coverage of the science of geomorphology, see *Fluvial Processes in Geomorphology*, by Luna Leopold with M. Gordon Wolman and John P. Miller; available as a paperback from Dover Publications.

A wonderful book that explains river processes from an ecological perspective (and is also well endowed with illustrations of homemade monitoring gadgets) is *Stream Hydrology: An Introduction for Ecologists*, by Nancy Gordon, Thomas McMahon, and Brian Finlayson; published by John Wiley and Sons.

*Applied River Morphology*, a recent publication by stream restorationist and hydrologist David Rosgen, will quickly become an addition to the library of anyone interested in taking their field measurements to the next level--that of restoring natural stream function. This book is based upon Rosgen's many years of using field data to guide successful stream restoration and stabilization projects that do not compromise the stream's natural behavior. It is available only from the author, at Wildland Hydrology, 1481 Stevens Lake Road, Pagosa Springs, CO 81147.

To make the recording of field data easier and provide a handy guide to important stream process principles, Luna Leopold and David Rosgen have teamed up to produce the *River Field Book*, a pocket-sized notebook with pre-printed pages for recording standard field measurements. It is available from David Rosgen at the address above.

--Michael Rigney





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

## Surveying the Shoreline

by Leslie Grella

The Beach Watch Volunteer Program was started in 1993 by the Gulf of the Farallones National Marine Sanctuary (GFNMS), largely in response to a series of oil spills in the 1980s that killed thousands of seabirds. After the spills, Sanctuary staff realized that long-term baseline data--in particular, information on the natural ebb and flow of wildlife mortality--was needed to adequately assess environmental damages from future human-caused catastrophes such as oil spills. Accordingly, GFNMS Research Coordinator Jan Roletto designed a project in which volunteers routinely monitor beaches, recording such observations as live and dead animal counts and use of beaches by marine organisms and humans. The protocols for Beach Watch surveys are based on a 1989 NOAA report, "Central California Oilspill Contingency Plan: Assessment of Numbers and Species Composition of Dead Birds," by Harry Carter and Gary Page.

The shoreline is often governed by multiple resource agencies--federal, state, and local--and it is imperative that all of them understand and participate in the development and maintenance of long-term beach monitoring programs. In the case of Beach Watch, six state and federal agencies and two local organizations reviewed our protocols for survey design and data collection.

The Beach Watch survey area includes 58 beaches in the GFNMS and the northern portion of the Monterey Bay National Marine Sanctuary, currently being monitored by 120 volunteers. We use established beach boundaries shared by the National Park Service and California Department of Fish and Game.

Following are a few protocols and techniques we've instituted that might be valuable to others who are considering developing a beach monitoring program.

### **Systematic monitoring**

To ensure data quality, each beach should be monitored in a consistent, systematic way. Our volunteers survey their beaches a minimum of once every four weeks (with a five-day window in which to do the survey). The same person (or group) monitors the same beach, using the same survey techniques, each

time.

Beaches are monitored at either the same tide or same time of day, whichever provides the peak abundance for the wildlife species found on that beach. For busy or urban beaches, it's generally best to monitor early in the morning before lots of people arrive. A remote beach might have more wildlife at high tide. And some beaches are so narrow they can only be surveyed during low tide.

## **Training and equipment**

We require our volunteers to attend an 82-hour training course, complete with written tests and practice surveys. The training covers such topics as identifying and counting live and dead birds and mammals, collecting oil samples, and documenting beach profiles.

Basic equipment for beach monitoring includes binoculars, camera and film, clipboard, survey forms, writing materials, gloves, tide book, and field guides.

## **Conducting the survey**

The first step in a beach survey is to record the time, tide height, visibility, and wind force, all of which may affect survey results. Volunteers also count people and dogs (both of which greatly affect the counts of live marine animals), and note human activities ("on beach," "surfer," "bather," etc.). This data can be used to look for correlations between human activities and shark attacks.

On each survey, volunteers photodocument the beach profile every kilometer. They take the profile at the high tide or berm line. Beach profiles change dramatically from season to season and are useful in determining whether sand is being deposited or washed away. Surveyors also record observations on the opening and closure of lagoons and stream mouths.

## **Live animal count**

Live and dead animal counts are the heart of the beach survey. Birds are by far the most abundant live animal that monitors encounter (followed by marine mammals). Birds are counted on the beach area and for 300 feet landward and seaward. Marine mammals are counted beyond the 300-foot range--for instance, whales spouting offshore.

As the monitors pass a live animal, they count and identify, using a clicker to count abundant species. We instruct our surveyors never to guess at identification, but to carry the identification only as far as they are certain. This can mean recording a choice between two species ("Western/Clark's Grebe"), identifying to taxon level only ("gull sp."), or simply noting "landbird species" and a brief description.

In nesting areas, nests are counted, and in pinniped (e.g., seal, sea lion) rookeries, pups and adults are recorded separately. Tagged or marked animals are noted, and the information reported to the U.S. Fish

and Wildlife Service and the National Marine Fisheries Service. Animals in distress are reported to the appropriate government or rehabilitation agencies.

Monitoring of live intertidal invertebrates (anemones, barnacles, crabs, sea stars, etc.) requires different techniques and is not included in the Beach Watch program.

## **Dead animal count**

If a beach area is narrow and small, live and dead animals can effectively be counted at the same time. However, for most areas it's best to count live animals as you walk in one direction and beach-cast specimens on the return trip.

As with live counts, monitors identify dead specimens only to the level of which they are certain. When only part of an animal is left, or the carcass is very decomposed, identification becomes difficult--but surveyors often enjoy this challenge. Some-times identification can be made with just one bone, as in the case of sea lion scapulas.

Monitors also note other characteristics of dead specimens, such as age, sex, signs of decomposition or scavenging, presence of oil, and evidence of the possible cause of death (e.g., gunshot wound, entanglement, oiling, broken wing). Gunshot wounds are difficult to detect in pinnipeds, so monitors carry a wire for probing possible gunshot injuries.

Our volunteers photodocument all dead specimens, taking dorsal and ventral views when possible, as well as close-ups of key identifying features. Later their slides are examined by experts to verify the identification. This photodocumentation strengthens the reliability of our data.

Volunteers mark dead birds by clipping their wings or toes to prevent recounting them on future surveys. When dead marine mammals are found, volunteers notify the Marine Mammal Stranding Network, which often sends personnel to collect skeletal parts or tissue samples.

## **Monitoring for oil**

Beach Watch volunteers are trained by the California Department of Fish and Game's Office of Oil Spill Prevention and Response (OSPR) to collect "tar balls"--small, weathered balls of oil. Tar balls are potential evidence in oil incidents, especially since lab analysis can sometimes "fingerprint" the sample (determine its source). For example, lab analysis of some Beach Watch tar ball samples has shown that they are of non-coastal California origins. Because contamination can interfere with lab analysis and make results indefensible in court, volunteers must adhere strictly to OSPR protocols, such as using special gloves and containers. Volunteers also look for oil on dead specimens, and collect oiled feather samples. They do not collect fresh oil, which is toxic, unless they have the appropriate training.

If an oil incident occurs, beach monitors are contacted to conduct pre- and post-spill surveys. It is useful

to do a survey right before oil hits a beach. Dead animals are marked and sometimes removed; later, the beach is surveyed for new arrivals.

## **The value of beach monitoring**

GFNMS is committed to the Beach Watch program for the long term (25 years), and this long-term data will have many uses. Baseline data such as rates of dead birds washing up, bird oiling rates, tar ball fingerprinting, and tar ball deposition rates are very useful in the event of an oil spill. Beach monitoring can also detect other die-offs, either natural or human-caused.

Over time, beach monitors become intimately familiar with their areas and become local experts. They will know if a lagoon or river mouth is open or closed on their beach, what's the easiest access to an area of the beach, whether nest sites are active, and which part of the beach is the collection zone where dead things wash up. Their intimate knowledge not only contributes to a valuable monitoring program, but provides personal satisfaction to the volunteers as they evolve into stewards and protectors of our magnificent ocean resources.

Note: Just before this article went to press, the Sanctuary implemented the Beach Watch program in response to the Cape Mohican oil spill, which occurred in San Francisco Bay on October 28, 1996. Numerous organizations, including OSPR, the U.S. Coast Guard, the U.S. Fish and Wildlife Service, the National Park Service, and the Pacific Coast Federation of Fishermen's Association publicly praised the volunteers for making a significant contribution to the evaluation of affected wildlife.

*Leslie Grella is Volunteer Coordinator for Beach Watch, Gulf of the Farallones National Marine Sanctuary, Fort Mason, Building 201, San Francisco, CA 94123; ph. 415/561-6622.*



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## Volunteer Monitoring: No Limit

by Eleanor Ely

What can volunteers monitor? Maybe the best reply to that is, What can't they? The following quick tour to a few of the farther corners of the wide world of monitoring demonstrates that volunteers can, and do, keep tabs on everything from underwater reefs to atmospheric ozone to infant birth weights.

### Coral Reefs

On a typical day in the Florida Keys, thousands of diving enthusiasts rove silently through the underwater world of North America's most extensive living coral reef system, enjoying the spectacular beauty of brightly colored reef fish, corals, and sponges. In recent years, some of these divers have also been collecting data to help track the distribution and abundance of reef fish. Others have been surveying the reef surface itself.

Concern about the "information gap" in scientific understanding of the reef ecosystem motivated two marine life photographers, Paul Humann and Ned DeLoach, to found an organization called REEF (Reef Environmental Education Foundation) in 1991. Humann and DeLoach reasoned that recreational divers' skills in fish identification could be put to use in the same way that birders' expert knowledge has been used for decades to collect population and diversity data on birds. The basic concept was, as DeLoach puts it, to transform divers from underwater sightseers into underwater naturalists. From this idea grew the Reef Fish Survey Project, a joint endeavor of REEF--which trains the volunteers and conducts trips--and The Nature Conservancy, which provides data analysis, interpretation, and quality control.

Divers participating in the reef fish survey record their observations on a specially designed underwater slate. Later they transfer the information to a computer-scannable data form, which they send to REEF headquarters in Key Largo. To date, over 9,000 data forms have been sent in.

One use for the fish survey data is to evaluate a new "underwater zoning" system that is being implemented in the Florida Keys National Marine Sanctuary. In an effort to protect the reef and its inhabitants, the Sanctuary has designated several zones in which diving and fishing are restricted to various extents. For example, some zones are "no-take" (diving is permitted, but nothing may be

removed), and four small research zones are "no dive/no take."

Fish aren't the only form of reef life that is being monitored by volunteers. Volunteer divers participating in The Nature Conservancy's Coral Watch program examine the reef surface, estimating the percent cover of different life forms, such as algae, sponges, and corals. Mark Chiappone, a marine biologist with The Nature Conservancy, explains that the reef surface can be thought of as "a thin living skin covering a chunk of rock." (The "rock" is the calcium carbonate laid down over hundreds of years by corals and algae, and continuing to be deposited by the living organisms on the reef's surface.)

Coral Watch was designed to document the state of reefs in the Florida Keys National Marine Sanctuary. The most active participants are divers from Walt Disney World's Epcot Center--professional divers with scientific experience who are willing to donate their time and expertise to help conserve reefs. They receive training in identifying the reef's major life-form types, and in methods for visually estimating percent cover.

"The reef ecosystem is very complex, and it's hard to tease out human impacts from natural influences," says Chiappone, who supervises the Coral Watch project. "To assess the reef's condition we have to examine a number of parameters, then try to piece together the puzzle." Some of the pieces are coming from the Coral Watch volunteers. For more information on the Reef Fish Survey Project, please contact REEF at P.O. Box 246, Key Largo, FL 33036; ph. 305/451-0312.

*For more information on Coral Watch, contact Mary Enstrom at Marine Stewardship Programs, P.O. Box 500368, 5550 Overseas Highway, Main House, Marathon, FL 33050; ph. 305/743-2437.*

## **Air**

Air quality can be monitored with a sophisticated piece of equipment that costs over \$10,000. It can also be monitored with a homemade device that basically consists of a small rubber band mounted on a piece of wood. The choice of methods depends on what you want to find out, and what your resources are.

The lowest-cost alternative is the "TERC ozonometer," which students can build using a thin band of natural rubber, a wooden board, a plastic coffee stirrer, and some simple hardware. This device tests the level of ground-level ozone, which is a major smog component and very damaging to the human respiratory system. The TERC ozonometer is based on the fact that natural rubber deteriorates rapidly in the presence of ozone. Instructions for making the ozonometer are found in *Air Pollution: Ozone Study and Action*, by Jeffery Frank, Gail R. Luera, and William B. Stapp. The book also contains learning activities and suggestions for action-taking. It is available for \$19.95 plus shipping from GREEN, 206 S. Fifth Ave., Suite 150, Ann Arbor, MI 48104; ph. 313/761-8142.

Another inexpensive device for testing ground-level ozone is the "Eco-Badge" kit. Gary Short, who designed the Eco-Badge, estimates that students in at least 1,000 schools around the U.S. are using it. His favorite story is that of a 15-year-old Texas student who used the Eco-Badge to demonstrate that

photocopy machines in the school district superintendent's office were generating harmful levels of ozone. The badge, which is pinned to clothing and worn for 8 hours, contains a piece of chemically treated filter paper that changes color when exposed to ozone, allowing the measurement of ozone levels between 10 and 350 parts per billion (ppb). (The National Ambient Air Quality Standard for ambient ozone averaged over a one-hour period is 120 ppb). For more information on the Eco-Badge kit and accompanying lessons books, contact Gary Short at Vistanomics, Inc., 230 N. Maryland Ave., Suite 310, Glendale, CA 91206; ph. 818/409-9157.

Since living organisms are vulnerable to air pollution, it's possible to use a variety of bioindicators. For example, air pollution can be measured by the type and size of lichens present in an area (for more information on lichens as bioindicators, see the book *Air Pollution*, mentioned above). In North Carolina, Brian Morton, a senior economist with the Environmental Defense Fund, conducted a pilot project in which volunteers monitored the effects of ozone pollution on four plant species--tulip poplar and black cherry trees, blackberry, and milkweed--in the Appalachian Mountains. With technical assistance from the U.S. Forest Service and the National Park Service, Morton trained the volunteers to identify the target species and recognize symptoms of ozone exposure, especially patterns of discoloration in leaves (see photo). Volunteers measured both the extent of injury (that is, the proportion of leaves showing any symptoms of injury) and the severity of injury (the amount of injury on a representative leaf). A copy of the field methods used in the study is available for \$2.50 from North Carolina Environmental Defense Fund, 128 E. Hargett St., Suite 202, Raleigh, NC 27601; ph. 919/821-7793.

One project that uses the high-end equipment mentioned at the beginning of this article is AIRNET, a multidisciplinary high school air quality monitoring project in New Hampshire. AIRNET was started in 1992 by Marian Baker at the Harris Center for Conservation Education. "We had been doing water monitoring projects for 12 years," Baker explains, "and we wanted to expand to air monitoring. Air is a universal resource--no buses required for a field trip!--and it can be done in urban as well as rural schools." Baker was surprised to find a dearth of materials for air quality education and monitoring, and she set about researching various methods.

Baker began by investigating all the cheapest methods available. She found the various bioindicators--particularly lichens, leaf yeasts, and white pines--to be valuable, and the Center continues to use these methods. For chemical and physical monitoring, Baker reports, methods such as the TERC ozonometer and Eco-Badge were "good for education, but not as useful for collecting longer-term, continuous data that could be analyzed statistically." So the program decided to invest in an ACCESS Air Analyzer (manufactured by PAX Analytics)--a portable, battery-operated apparatus that uses direct probes to measure 12 parameters, including carbon monoxide, carbon dioxide, nitrogen dioxide, sulfur dioxide, ozone, background ionizing radiation, and EMF/ELF (extremely low frequency radiation). These measurements are taken every 10 seconds, and the data downloaded into a Macintosh computer.

AIRNET now owns three of the analyzers, and each participating school has the use of the equipment for one month. Students design their own projects, interpret the data they collect, and share their findings with other schools via the Worldwide Web. Many students have found poor ventilation (indicated by high carbon dioxide levels) in school rooms, and some have been able to use their results to get the

problem corrected. One class compared snowmobiles to pickup trucks and found the snowmobiles were far worse in emissions of carbon monoxide, carbon dioxide, and nitrates. Students also learn that a variety of factors, such as temperature and wind direction, affect ozone readings.

"It's been really exciting to get some real data," says Baker. "At present, we're interested in encouraging others to form local clusters of schools or organizations, copy our methods, and share their data via our web site."

*For more information, contact Marian Baker at 603/525-3394; email [m\\_baker@mentor.unh.edu](mailto:m_baker@mentor.unh.edu); or visit AIRNET's web site at <http://www.info@airnet.org>.*

## **Sea Turtles**

Very early one morning, about 10 years ago, Wilma Katz accompanied a friend on "sea turtle patrol." From that day, Katz was hooked. She became a member of the Manasota Key Sea Turtle Patrol, joining the ranks of volunteers who monitor Florida beaches daily during sea turtle nesting and hatching season to collect data that helps track the turtles' population and nesting success.

There are five species of sea turtles in Florida waters (loggerheads are the most common), and all of them are protected as either threatened or endangered. Male sea turtles spend their entire lives in the ocean, but females come ashore to lay their eggs. At night, the female turtle drags her heavy body (adult loggerheads weigh from 200 to 350 pounds) up the beach. There she digs a flask-shaped hole in the sand and deposits her eggs, which look like ping-pong balls. The average clutch size is about 100 eggs. After covering the nest with sand, she returns to the sea. About two months later, the babies hatch and make their own way to the sea.

The nesting season runs from the beginning of May to the end of August, and the hatching season from about the Fourth of July to Halloween. During the entire six-month nesting and hatching season, volunteers like Katz patrol their beaches every morning. At the height of nesting season, there's usually at least one new nest every day. The nests themselves are so well covered that they're hard to spot, so monitors look for the telltale tracks left by the female. ("It looks as if a little tractor has come out of the water," says Katz.) Volunteers mark the nest with a wooden stake, placed about a yard away and labeled with the date.

Once hatching season begins, the volunteers start watching out for baby tracks as well. The hatchlings are only about two inches long, and their tracks are hard to see; Katz describes them as resembling tiny zippers. After the first signs of hatching, monitors wait two or three days to give "late bloomers" a chance to hatch, then dig up the nest and count the number of shells, unhatched eggs, and dead baby turtles. This information is used to determine the average clutch size and percentage of live hatchlings.

The Manasota Key volunteers, like other turtle monitoring projects around the state, send their data to the Florida Department of Environmental Protection (DEP). Allen Foley, a marine biologist with DEP's



Marine Turtle Recovery Program, explains that anyone who wants to monitor sea turtles needs a permit from DEP, and one condition of the permit is that they send their data to DEP. Currently there are about 100 permit holders--including universities, conservation organizations, private labs, and small citizen groups like the Manasota Key Sea Turtle Patrol. "The data we get from the permit holders is very useful to us," says Foley, "and we can't get it any other way."

Some permit holders gather other kinds of data on the turtles. For example, in addition to monitoring nests, the Mote Marine Laboratory in Sarasota tags nesting females by attaching a noncorrosive metal tag to each front flipper. The tagging program provides valuable information about migration patterns, the number of times a turtle nests per season, and the intervals between nesting by a given turtle.

Katz says that people who see her patrolling the beach are always fascinated. "People love turtles," she says. "Children love them, adults love them. And they need all the help they can get."

*For more information on sea turtle monitoring, please contact Jerris Foote at Mote Marine Laboratory, 1600 Ken Thompson Parkway, Sarasota, FL 34236; ph. 941/388-4441.*

## **Community Sustainability**

Every volunteer monitoring project faces the fundamental question of what indicators to track. A stream monitoring program, for example, might weigh the relative benefits of chemical tests versus macroinvertebrate counts. But a project that seeks to monitor community sustainability is faced with an almost limitless choice of potential indicators.

Sustainability itself depends on complex relationships among a host of social, economic, and environmental factors, all linked to each other in ways difficult to measure or predict. Around the country, groups seeking to monitor the sustainability of their communities have chosen such diverse indicators as:

- population growth rate
- miles of road, bike lanes, and sidewalks added per year
- number of species in an annual bird count
- acres of wetlands
- adult literacy rate
- number of salmon returning to spawn
- infant birth weight
- pounds of solid waste landfilled per capita per year
- rate of volunteerism

Sustainable Seattle, founded in 1991, was one of the first community sustainability projects in the United States. With few models to draw on, the group assembled a panel of citizen leaders, government representatives, educators, and others to research and recommend a set of indicators. The process took

several years and resulted in an initial list of 99 indicators. Several more months were required to winnow the list to a more practical 40.

In the course of this effort, Sustainable Seattle developed a set of criteria for sustainability indicators. A good indicator is:

- A bellwether test of sustainability (i.e., it reflects something basic to the long-term health of a community)
- Accepted by the community
- Attractive to local media
- Statistically measurable
- Logically or scientifically defensible

One question confronted by the panel was whether the availability (or lack) of data should determine whether an indicator was kept. While some indicators were dropped for lack of data, others were considered too important to drop. As Sustainable Seattle co-founder Alan AtKisson notes, lack of data "is itself an indicator that the issue is receiving insufficient attention."

Hundreds of volunteers went to work to compile data on the 40 indicators, and in 1995 Sustainable Seattle published the results. The report revealed that 8 indicators were improving, 14 were moving Seattle away from sustainability, and the remainder were stable or did not yet reveal a trend. But, as the report writers note, "measuring progress is not the same as making it." The indicators must be used to guide change "in our priorities, in our collective decision-making and policy development, and in our individual and organizational behavior."

Today nearly 150 community indicator projects are active around the country, according to Redefining Progress, a nonprofit public policy organization that is creating a nationwide Community Indicators Network to facilitate information exchange among existing projects. For more information about the Network and web page, or about the Community Indicators Handbook (due out in early 1997), contact Kate Besleme, Redefining Progress, One Kearny St., 4th floor, San Francisco, CA 94108; ph. 415/781-1191 x312; email besleme@ progress.org.

Some other helpful resources on tracking sustainability are:

Three booklets published by the Izaak Walton League of America--*Securing Your Future: Pathways to Community Sustainability*; *Monitoring Sustainability in Your Community*; and *Community Sustainability* (a mini-curriculum for grades 9 -12)--are available for \$2 apiece (includes shipping) from IWLA, Carrying Capacity Project, 707 Conservation Lane, Gaithersburg, MD 20878; ph. 301/548-0150.

*Indicators of Sustainable Community 1995* discusses the results for 40 indicators tracked by Sustainable Seattle. Available for \$15 (includes postage) from Sustainable Seattle, Metrocenter YMCA, 909 Fourth St., Seattle, WA 98104; ph. 206/382-5013.



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## Volunteers Include Human Health in Monitoring Programs

by Cynthia Lopez

Along the U.S.-Mexico border in Texas, volunteer monitors with the Rio Bravo River Watchers are going door-to-door interviewing people about their health, their contact with river water, and their use of water from shallow wells. The survey results are being combined with fecal coliform counts from the group's routine water quality testing to evaluate the human health risks of contact with contaminated water.

Meanwhile, in Vermont, the Missisquoi River Keepers are interviewing anglers about their fishing habits, fish consumption, and health. Again, the survey results are being used in conjunction with water quality data to assess health risks--in this case, risks associated with exposure to mercury contamination in water, sediments, and fish.

What both these groups are doing is *epidemiology*--a branch of science that studies disease distributions in human populations. Epidemiologic studies are an important component of health risk assessment, and are highly valued because--unlike animal experiments--they reflect real-life human exposures and situations.

While some public health experts might cringe at the idea of volunteers gathering and analyzing data for epidemiologic studies, people familiar with volunteer water monitoring won't find the concept surprising. Why should health monitoring, any more than water quality monitoring, be solely the domain of expert scientists? If volunteers can be successfully trained to collect reliable water quality data, why can't they be trained to collect equally credible data on human health?

Probably what worries the experts most are the many kinds of bias that can easily slip into an epidemiologic study if it is not carefully designed and administered. One of these is "selection bias," in which the researcher selectively recruits into the study people who are both exposed and diseased. Another is "observation bias," which can result if the interviewer knows the exposure status of participants and therefore--perhaps unconsciously--encourages people to over- or under-report symptoms. "Confounding bias" arises when another risk factor (such as poverty or smoking) is linked

with the exposure and clouds the relationship between exposure and disease.

Public health professionals undergo rigorous training in how to minimize these and other sources of bias. They worry that well-meaning but overzealous (and undertrained) volunteers will unwittingly fall into one of these bias "traps."

In the two studies mentioned above, great care is taken to prevent bias. For example, the volunteers are trained to avoid selection bias by selecting random samples and to avoid observation bias by developing study methods that blind them to participant exposure status.

## **Health in Rio Grande colonias**

The Rio Bravo River Watchers work in the El Paso/Juarez region (see map), where many people live in poor communities called colonias--unregulated human settlements whose residents lack services most U.S. residents take for granted, like sewage treatment, access to potable drinking water, paved roads, and electricity. Most colonia residents, at least in the U.S., are victims of a political system that allows developers to subdivide and sell land at unfavorable interest rates, without providing services.

Colonias are located in the Rio Grande floodplains along both sides of the Texas-Mexico border, with the greatest concentration being in the El Paso/Juarez area. (Rio means river, and this river, which Mexicans call the Rio Bravo, serves as the distinguishing U.S.-Mexico border feature for approximately 1,000 miles.) Over 55 million gallons per day of untreated sewage and industrial waste are dumped into the Rio Grande/Rio Bravo at El Paso/Juarez. In this region, rates of disease are staggering. For example, rates of hepatitis A are as much as five times the U.S. average.

Colonia residents are exposed to contaminated water from the Rio Grande/Rio Bravo watershed in many ways. Most U.S. colonia residents obtain water for bathing, cooking, and washing from floodplain wells only 15 to 25 feet deep. Such shallow wells are susceptible to infiltration by contaminated water from septic systems and from the river. In addition, many residents fish in the river, for food or to supplement their incomes, or use the river for recreation, especially during the summer when temperatures often rise above 100°F. All these activities place colonia residents at risk for diseases related to exposure to river contamination.

## **Rio Bravo River Watchers**

I became involved with the Rio Bravo River Watchers through a research project for my dissertation in public health. I was studying the health of colonia residents in the El Paso/Juarez region, focusing particularly on assessing the risk of infectious disease from contaminated water.

Like any researcher studying the relationship between illness and water contamination, I needed to know (1) what contaminants were in the water, and in what amounts; (2) how people were coming into contact with the contaminated water; and (3) what illnesses and symptoms people were experiencing.

In 1993, I learned that River Watch Network (RWN)--a nonprofit organization headquartered in Vermont that works with community groups to establish monitoring programs--was assisting individuals from the El Paso/Juarez region in forming their own local river monitoring organization. Naturally, I was eager to gain access to any reliable water quality data that might be collected by the new group. This would provide me with the first type of information I needed for my study--information about contaminants in the water.

In the winter of 1994-95, the group--by that time named the Rio Bravo River Watchers--began monitoring at 15 river sites, including several near the colonias or near colonia residents' favorite fishing and swimming spots. Volunteers were trained and certified by the Texas Natural Resource Conservation Commission's Texas Watch Program to conduct field testing for dissolved oxygen, conductivity, pH, and temperature. RWN provided training for fecal coliform testing, which is performed in the River Watchers makeshift laboratory. (Not surprisingly, the volunteers have been finding high fecal coliform counts. For example, in the summer of 1995, counts of up to 2,000 colonies per 100 ml--ten times the level considered safe--were frequently found at river sites where people come into contact with the water.)

Meanwhile, I was interviewing colonia residents. The survey, which I developed in Spanish, included questions about river contact; well water use; symptoms associated with exposure to coliform bacteria (e.g., gastrointestinal disturbance, skin rash, respiratory disease); and medical history (e.g., miscarriages, birth defects, family deaths). Questions about "confounding factors" such as smoking or occupation were also included so as to control for these factors in the statistical analysis.

Within a few months, the River Watchers had shared with me enough fecal coliform data to enable me to finish my dissertation fieldwork. The results were interesting--for example, I found a correlation between swimming in the river and respiratory infections. But the story continues. By that time I had become more involved with the Rio Bravo River Watchers, not only as a data user but as a volunteer monitor myself, and RWN staff and I were intrigued by two ideas. First was the potential for conducting a long-term health assessment of colonia residents. My research project had involved just single interviews, but following a group of residents over time would provide more information about the relationship between exposure and disease.

Second, and even more exciting, was the possibility that volunteers could be trained to conduct all facets of a health study themselves. The River Watchers had already demonstrated that volunteer-collected water quality data could be used in an epidemiologic study. Now the question was whether the group could evolve from being data suppliers to taking ownership of an entire health assessment project. Could the volunteers be trained in the basics of epidemiology and statistics so that they could systematically collect water-contact and health information, and analyze this data?

To answer those questions, River Watch Network and I proposed to establish two model health assessment projects, one with the Rio Bravo River Watchers and the other with the Missisquoi River Keepers in Vermont. Funding to develop the models was obtained from the EPA Environmental Justice Fund and the Switzer Family Fund (managed by the New Hampshire Charitable Foundation).

## **Volunteers take ownership**

In spring of 1995, the process of transferring ownership of the project to the Rio Bravo River Watchers began. One early step was to expand the monitoring program to include the other water source that affects colonia residents' health--that is, the shallow wells. The program also added tests for other contaminants that affect human health, such as metals and organic compounds. These were analyzed at the Citizens Environmental Laboratory in Cambridge, Massachusetts (see "[Resources](#)" section at end of article).

The River Watchers recruited several bilingual volunteers with some public health or social work training. During the summer of 1995, we interviewed the same colonia residents who had been surveyed the previous winter, using essentially the same questionnaire developed for my research. The study required going door-to-door and conducting 15-minute interviews, primarily in Spanish, with over 400 colonia housewives on both sides of the border. Since the volunteers didn't have to be trained in designing a questionnaire, training focused on survey administration. Through practice interviews, the volunteers learned techniques for putting participants at ease, recording responses, and dealing with uncooperative respondents.

Survey interviews were conducted again the following winter. After the data collected to date is evaluated, the study will continue over the next year.

We have been careful to minimize bias in the interview process. For example, observation bias was a potential problem, especially since volunteer survey administrators are past or current colonia residents who might know the survey participants. We took two steps to avoid this. First, the volunteers did not interview in their own colonias. Second, the survey was designed so that questions about exposure come last, after questions about symptoms and illnesses, to prevent interviewers from encouraging over- or under-reporting of symptoms.

Training the volunteers in data entry has just begun. The next step will be training in data interpretation, including the use of basic statistics. Throughout, we are using a "train the trainer" approach: train one or two enthusiastic people, who in turn train others. Recognizing the need for ongoing technical support, Rio Bravo River Watchers is currently recruiting members for a local advisory board.

## **Monitoring mercury in the Missisquoi**

Not every epidemiologic study is as demanding as the Rio Bravo River Watchers project. The model project being conducted by the Missisquoi River Keepers is much less complex; it involves interviewing 150 anglers at a single point in time to assess their risk for one adverse health outcome--neurologic disturbance related to mercury exposure. Interviews take about 10 minutes.

Many citizens of the aboriginal Abenaki Nation live along the Missisquoi River and have historically

relied on the river for much of their livelihood. In 1994, with organizational and technical help from River Watch Network, the community established the River Keepers program to monitor and protect the river.

One of the group's concerns is the potential for health impacts, mainly neurologic damage, from eating fish contaminated with mercury. Fish from the Missisquoi, and fish-consuming game species, are an important protein source for the Abenaki. Based on levels of mercury found in fish across the state (including fish from the Missisquoi), the Vermont Department of Health has issued advisories for most fish species, recommending that women of childbearing age and children under seven eat no more than two to three servings per month. For walleye, the favorite fish of the Abenaki, the advisory is even more stringent--zero servings per month.

The River Keepers collect samples of water, sediments, and fish and send them to Green Mountain Labs (a private laboratory in Montpelier, Vermont, that is donating its services) for mercury analysis. Volunteers have been trained to conduct interviews and will survey anglers about their fishing behavior (e.g., how often they fish, where they fish, what types of fish they catch), fish consumption, symptoms of neurologic disturbance, and possible confounding factors. The study results will be shared with the Vermont Department of Health and used by River Keepers to design remediation strategies and a community education plan.

### **Getting started in health monitoring**

How does a volunteer monitoring group go about incorporating health assessment into its work? Several different levels of involvement are possible. As a first step, a group may wish to simply share its water quality data with public health experts, relying upon them to use the data in epidemiologic studies. (Although volunteer monitoring groups may not realize it, their water quality information is a potential gold mine for epidemiology researchers.)

Groups that want to take a more proactive role and collect health data themselves will need a study design. Some questions to consider are: Will you gather data by using hospital records? death certificates? surveys? If you decide to use a survey, will you interview people just once, as in the Missisquoi study, or follow them over a period of time, as in the Rio Bravo study? How will you minimize bias?

To answer these and many other questions, expert guidance will be needed. Organizations that can help include local clinics or hospitals, state public health agencies, local schools of public health, and River Watch Network (address below). If possible, form an advisory board of local experts to help you select methods and interpret data.

Incorporating health assessment into a volunteer monitoring program brings many benefits. For one, health issues are wonderful motivators for organizing a community. Not only are people likely to care about a project that is connected to their own health, but also a health survey itself is a great opportunity

for spreading the word about your organization and recruiting new volunteers. To maximize the outreach potential of their surveys, both the Rio Bravo River Watchers and the Missisquoi River Keepers concluded their interviews with questions like "Would you like a copy of the results from this survey?" "Would you like to be on our mailing list?" and "Are you interested in collecting water samples?"

A pragmatic benefit of including health in a monitoring program is that it opens up new funding opportunities. Many grant programs--for example, EPA and the National Institute of Environmental Health Sciences-- specifically fund organizations that study linkages between environment and health.

Health monitoring is especially valuable because it often addresses environmental justice issues. In my experience, the people most at risk from adverse health consequences are those who are most disadvantaged: the poor, people of color, or minority groups. For example, those most likely to eat fish from the Missisquoi are those who cannot afford other sources of protein. To get government attention and remedial action, a community often needs to credibly establish the link between contamination and health effects. However, poor and minority communities are least likely to have either the scientific expertise to conduct research themselves or the resources to hire scientists.

When volunteer groups combine health assessment with water monitoring, they put epidemiologic data--typically expensive to collect--into the hands of the community. Ultimately, such projects empower communities to monitor their own health and take remedial action to reduce health risks and protect their waterways.

## **Resources**

An epidemiology software program called Epi Info, developed by the Centers for Disease Control, is useful for basic survey design and statistics. The software (\$3) plus a manual (\$16) are available from Brixton Brooks, 740 Marigny, New Orleans, LA 70117; ph. 504/944-1074. Send check or money order, and add \$3 for postage.

*The Health Detective's Handbook: A Guide to the Investigation of Environmental Hazards by Nonprofessionals*, by Marvin Legator et al. (John Hopkins University Press, 1985) is a good introduction to designing your own environmental epidemiology study.

The Citizens Environmental Lab is a nonprofit group in Cambridge, Massachusetts, that provides technical assistance and lab testing for community groups. Chemical analyses are performed at or below cost. For more information, please call 617-876-6506.

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