The Volunteer Monitor

The National Newsletter of Volunteer Water Quality Monitoring
Volume 12, No. 1, Spring 2000

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Issue Topic: Monitoring Fauna

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Next issue: Flora

Ipomea Fistulosa

Originally this issue was going to be titled "Monitoring Fauna and Flora." But the fauna, especially the macroinvertebrates, soon filled up all the pages. (Just flip through the issue and you ll see that it s crawling with Edbugs. Also lizards, turtles, birds . . . even a bobcat.)

So, in fall 2000 plants will get their own issue. "Monitoring Flora" will be coedited by the New Hampshire Department of Environmental Services, home of the Weed Watcher program. If you have ideas for articles on monitoring plants or algae, please contact the editor.

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. The newsletter is also available online at http://www.epa.gov/owow/volunteer/vm_index.html.

Address all correspondence to: Eleanor Ely, Editor; ellieely@earthlink.net.

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The Great Herp Search

by Christopher Swarth

Southern Leopard Frog

On the first Saturday of June, 2000, 45 volunteers fanned out across the woods, meadows, and marshlands of Jug Bay Wetlands Sanctuary. With field guides in hand and binoculars at the ready, they spent four hours scouring the landscape for every lizard, snake, turtle, salamander, frog, and toad they could land their eyes on. It was our 12th annual Great Herp Search.

At the end of the day there were small adventures to relate:

> "We found a huge snapping turtle laying eggs right next to the road."
> "We counted 50 juvenile Marbled Salamanders near the vernal pool."
> "The Worm Snake we measured was more than 13 inches long-a record!"

The youngest participant was 2 years old; the oldest, 65. While a few of the searchers were professional field biologists, most simply had enthusiasm and curiosity. And everyone was intrigued by the idea of helping chart the status of herp populations and species.

Herps-the collective term for reptiles and amphibians-have captured the public's imagination in recent years. Sadly, one reason for all the attention is a serious concern about these animals' very survival. Salamanders, frogs, and turtles have declined precipitously in many areas of North America. Habitat loss (especially loss of wetlands) and air and water pollution are major threats to amphibians. Turtles run the added risk of being collected, either legally and illegally, for the pet trade.

Herp "blitz"

Eastern Fence Lizard

In response to herp declines, a number of conservation and scientific organizations have mounted efforts to monitor populations and habitats. There are many ways to monitor, but a short and intensive "blitz" like our Great Herp Search is one of the most fun, and it's a relatively easy way to assess herp diversity and abundance. If carried out for several years, such surveys can even track population ups and downs.

Since we initiated the Great Herp Search in 1988, over 450 volunteers have participated. People enjoy it so much that many return year after year, and one couple has helped with every survey.

Getting organized

Here are some things to do to get ready for a herp search:

- Choose the area you're curious about. Maybe it's a creek floodplain, a marsh, vernal pools, a mountain meadow, or a forest. For a half-day search with 20 to 30 volunteers, a 50- to 100-acre area may be about right.

- Divide the search area into smaller sections that can be well covered by a team of four to six searchers, and make section maps for the search teams. Hint: You'll avoid a lot of confusion during the search if you make sure the sections are bounded by easy-to-find landmarks like creeks, trails, shorelines, and roads. Another option is to "grid" your survey plot by using a compass and meter tape to place marker poles at regular intervals.

- Get familiar with your area ahead of time. Check access points, contact landowners, locate key herp habitats (vernal pools, marshes, rock piles), and identify any safety issues.

Marbled salamanders.

- Review relevant publications and species checklists, then make a short list of just those species that might be encountered within the study area. If needed, consult with local experts.

- Schedule the search for a weekend day in late spring or early summer to maximize the number of species that can be encountered (our count is always on the first Saturday in June). Since herps are more active when it's warm, the survey should be held during the warmest part of the day.

Training

We hold a one-hour training session the morning of the Great Herp Search. Volunteers are given a list of all species likely to be encountered, as well as a key or identification sheet with illustrations of the common herps. The trainer discusses the identification clues or field marks of the different species. We also encourage participants to bring field guides. The Peterson field guides to reptiles and amphibians-one for western North America and the other for the East-are the best guides for identifying herps and will help you put a name on most animals you might find. Binoculars and dip nets are helpful equipment.

Teamwork

We divide the group into teams of four to eight. Each team covers an assigned section. During the search, team members try to stay within voice contact to ensure thorough coverage.

We've found that a good team leader who is familiar with the area and knows how to identify the common herps is key to a successful search. Leaders carry rulers, calipers, or hand-held scales (Pesola brand scales are excellent) to measure and weigh those herps that are captured. The leader makes sure that data sheets are completed and that key field marks used to make a species determination are written down.

By the way, kids can be a great addition to the team. Being close the ground and sharp-eyed, they're often excellent searchers. I once worked with a Boy Scout troop that discovered six Box Turtles in a one-acre hardwood forest.

Counting and catching herps

Searchers are encouraged to capture animals when feasible. In particular, frogs, toads, and salamanders may need to be inspected closely to identify them. But we also remind the volunteers (especially the kids!) that it's not necessary to attempt to capture every animal that is observed.

During training, we teach the volunteers how to search for, observe, and capture herps without harming them or their habitats. For example:

- Logs and rocks should be rolled to inspect their undersides, then returned to their original position.
- Basking turtles and snakes must be approached furtively to avoid scaring them.

Eastern Garter Snake

- Frogs along shore can be scanned with binoculars from a distance so as not to startle them into the water.
- Listen as well as look. Frog and toad calls are excellent clues to identification.
- Lizards should not be grabbed by the tail, and snakes should not be handled at all unless you're certain what kind it is!
- Moisten hands before handling animals. Dry hands can wipe off the protective slime that covers some amphibians.
- Difficult-to-identify or rare animals should be carried to the survey organizers for thorough inspection or to be photographed-but all captured animals must be returned to the *exact* location where they were found.
- Plastic trays and bags can serve to temporarily house animals while they are being identified.

Teams plot the location of each animal on their section maps. They try to make their identifications as precise as possible, but we also tell our volunteers there's nothing wrong with calling an animal "unidentified small snake."

When the searchers return at the end of the survey their sightings are plotted on a map so everyone can see the distribution patterns of the animals that were observed.

Difficult-to-identify species

While common, slow-moving, or large species can often be identified by eye or with binoculars, some herps can only be identified to species by close-up inspection with a

good field guide or an identification key in your hand. Toads are often abundant but can still present a challenge to correctly identify. For example, Fowler's and American Toads are very similar in appearance (hybrids are common in some areas, complicating the picture further), and their range overlaps broadly in most of eastern North America. The only way to distinguish between these two is to hold them in the hand. With a firm grip on a hind thigh you're in a position to count the warts in the spots on the back and to inspect how close the tiny cranial ridges are to the parotid glands. Two other "look-alike" pairs that often give Jug Bay volunteers difficulty are Red vs. Mud Salamanders and Mud vs. Musk Turtles.

Painted Turtle.

Effectiveness of the survey

A single survey will certainly not provide you with a complete list of all the herp species in your area. And you'll tally just a small fraction of the numbers of individual herps. (A single searcher might see only a dozen animals all day.)

Hands should be moistened when handling amphibians, such as this Mud Salamander.

On a typical survey our searchers turn up about 50 percent of the 40-plus species that we know to be actually present. Six species known to live in our study area have never been found on a survey. However, over the years our Great Herp Searchers have documented 37 species.

As with most monitoring efforts, the value of the data increases as the sampling is repeated. We keep track of "search-hours" (one person searching for one hour equals one search-hour) so we can compare search effort among surveys. The effectiveness of a survey is also related to several other variables:

- The number of rare, cryptic, or secretive species
- The size of the area surveyed
- The number of searchers, and their skills and experience

- The weather and air temperature on the day of the survey

A Herp Searcher's section map makes a handy surface for measuring a Green Snake.

Our survey takes place on the same day each year. Depending on interest and the number of volunteers available, surveys could be conducted monthly or they could be carried out in several locations simultaneously. This survey technique works well because it's simple, it attracts a sizable group of eager searchers, and it's a fun experience for people of all ages. For the results of our surveys, check our Web page at http://www.jugbay.org/.

EXIT EPA

Christopher Swarth *is the Director of Jug Bay Wetlands Sanctuary, 1361 Wrighton Rd., Lothian, MD 20711; 410-741-9330; jugbay@clark.net.*

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Macroinvertebrate Data:

by Eleanor Ely

Volunteers identifying macroinvertebrates for the parallel-testing study.

Because of her experience and interest in macroinvertebrate monitoring, Leska Fore is frequently invited to make presentations to volunteer monitoring groups in the Seattle area. This she is happy to do. "Macroinvertebrate monitoring is a wonderful tool for volunteers," she says. "It's scientifically tested, it's used by agencies to monitor freshwater biology under the Clean Water Act, and it's simple to use and understand." Besides, Fore loves talking about "bugs" with such a receptive audience.

But through talking with the volunteers, Fore became aware of a problem: "The volunteer groups told me they were meeting a lot of resistance in trying to get their data used," she says. Fore, by profession a statistical consultant specializing in biological monitoring, reasoned that a scientifically designed parallel-testing study comparing volunteer and professional data would help volunteer groups establish their credibility. She asked Kit Paulsen, then coordinator of Bellevue Stream Team, and Kate O'Laughlin, who was coordinating several volunteer monitoring programs for King County Department of Natural Resources, if they'd be willing to help carry out such a study, and both of them agreed.

The comparison study was done in 1997, with funding from Kind County and the participation of 77 volunteers from a variety of Seattle-area monitoring programs.

A range of stream sites

Fore chose seven streams for the study, ranging from a relatively undisturbed stream whose watershed was about 90 percent forested to a highly impacted stream whose watershed was about 85 percent developed. (To characterize the streams, Fore used satellite images to estimate the percentage of impervious surfaces--roads, rooftops, parking lots, etc.--in each stream's surrounding watershed.)

Collecting the bugs

Volunteers and professionals followed identical collection methods. Each group sampled one site on each stream, using Surber samplers to collect three replicate samples.

In the lab, both groups attempted to pick all the animals in each preserved sample. For the volunteers, this came to an average of 400 per sample (or 1,200 per site).

"The field collection was easy as pie," says Fore, "but the identification was harder and took longer than any of us expected." Part of the problem was logistical. "We were using a high school lab," she explains, "and we had to bring in all our equipment--sorting pans, dissecting scopes, books, preserved specimens, even tweezers and alcohol--every night. People were working from 7 to 10 p.m. in uncomfortable chairs, with bad light and poor microscopes, looking at itty-bitty bugs."

In spite of the difficult conditions, the volunteers not only stuck it out but, says Fore, "they were really *interested.* They loved learning about the bugs--all the weird body parts and what each one is used for."

Taxonomy made simple

The volunteers learned to identify the major orders of stream insects--mayflies, stoneflies, caddisflies, beetles, and true flies. From this point, volunteers used a "morphological sorting" method to subdivide the mayflies, stoneflies and caddisflies into groups based on obvious differences such as head shape, gill shape, or gill position. Since the sorting was based on many of the same characteristics scientists use to distinguish families, the result was roughly equivalent to identification to family level. Volunteers did not attempt to carry the classification to genus or species level, as a professional taxonomist would.

Volunteers calculated five metrics: mayfly taxa fichness, stonefly taxa richness, caddisfly taxa richness, total taxa richness, and percent dominance. (A metric is a biological attribute that is an indicator of stream health. For more on metrics, see

Benthic Macroinvertebrate Metrics) Taxa richness is the number of different types of organisms present, and percent dominance is the percentage of animals belonging to the most abundant group.

A healthy stream typically is home to a diverse population of macroinvertebrates. As stream disturbance increases, diversity declines. Thus, as urbanization increases taxa richness tends to decrease and percent dominance tends to increase.

Research questions

The study consisted of three parts, which evaluated the volunteers' data in three different ways:

1. Correlation of volunteer data with urbanization in the watershed.
2. Comparison with professional field collection.
3. Correlation with professional metrics.

Part 1: Correlation with urbanization

The first question was, Would volunteer data provide a good indication of the degree of human disturbance?

The answer was yes. All five of the volunteer metrics were strongly correlated with intensity of human disturbance in the watershed (Figure 1 shows the results for one of the five metrics, total tzxa richness). As urbanization increased, the four taxa richness metrics showed a steady decline while percent dominance increased--exactly the results one would expect.

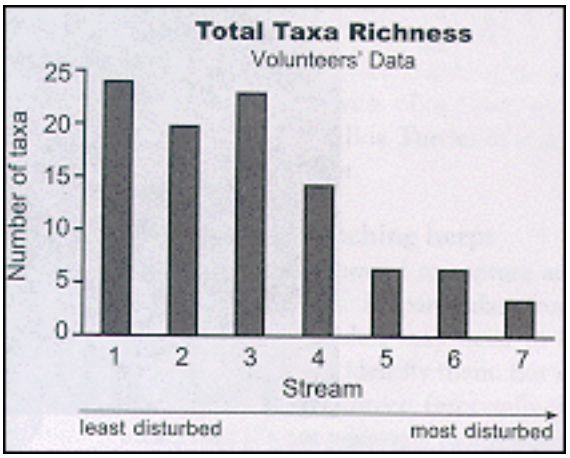

Figure 1: Volunteer data for total taxa richness showed a strong correlation with disturbance. A similar correlation was seen for the other four metrics calculated by volunteers.

Part 2: Field collection: Volunteer vs. professional

Using identical equipment and protocols, volunteers and professionals sampled the same sites within one month of each other, and sent the preserved specimens to the same professional lab for analysis.

The results were very similar for the two groups. "There was just no difference in the field collection," says Fore.

Part 3: Metrics: Volunteer vs. professional

For Part 3, volunteers and professionals analyzed the same samples (which were collected by volunteers). The volunteers used morphological sorting to identify insects to approximate family level, while the professionals identified most of the insects to genus or species.

Of course, the metrics obtained by the professional biologists were more sensitive and precise because they were based on a more complete identification. The questino was, How much better would professional metrics be? Or, to put it another way, How close would the volunteers come?

In fact, the volunteers came impressively close. Metrics obtained by volunteers and professionals were highly correlated, with correlations between 92% and 99%. "I was amazed at how well the volunteers did," says Fore. "They were really conscientious in their labwork."

As Fore is quick to point out, the excellent volunteer results don't mean that volunteer assessments are equal to professional assessments. The volunteers identified many fewer taxa, for two reasons. First, when picking invertebrates from the samples, they tended to miss the smaller insects (they found about 85% of the invertebrates the professionals found). Second, they did not identify to genus or species.

In addition to comparing the individual metrics, Fore combined metrics to calculate a multimetric index for each group's data. The professional index values were higher (see Figure 2) because they included additional metrics based on genus and species data. Nevertheless, the two indexes showed a 98% correlation.

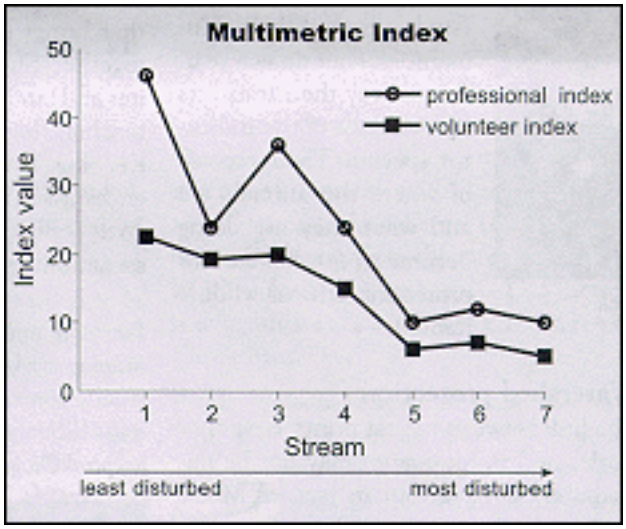

Figure 2: Professional and volunteer multimetric indexes were strongly correlated. (Professional values were higher because professionals calculated 10 different metrics while volunteers calculated only 5.)

Overall, professional analysis increased the precision of the assessment by 13%. The professional results were better--but by a relatively small amount.

Summing up the results, Fore says, "For field collection, volunteers were really comparable to professionals. In the lab, with the methods we used, they probably wouldn't be able to distinguish small differences between streams. But they could clearly distinguish the sites in the study, which represented a rather large range."

Kit Paulsen adds, "Volunteer data are really useful at the 'reconnaissance' level. Volunteers can put a stream into a major category--good, medium, degraded. For fine precision, you need professional data."

"The volunteers really exceeded my expectations," says Fore, "and I had high expectations to begin with."

For more information, contact Leska S. Fore at Statisctical Design, 136 NW 40th St., Seattle, WA 98107; leska@seanet.com.

Note: A detailed scientific report on the above study, titled "Assessing the Performance of Volunteers in Monitoring Streams," will be published in an upcoming issue of Journal of Freshwater Biology, *a peer-reviewd journal.*

Other Comparison Studies

Two fairly extensive studies of volunteer versus professional macroinvertebrate analysis are currently under way. The first is taking place in Virginia, where Virginia Tech professor Reese Voshell is assessing the validity of data collected by volunteers using Izaak Walton League of America (IWLA) protocols. The study is being funded by the Virginia Department of Environmental Quality and includes comparison data from over 100 sites. The volunteers' stream health assessments, based on mainly order-level identification (with some families), will be compared to professional assessments based on identification to genus or species. Both the "classic" IWLA method and several different modifications will be evaluated. Results should be available in summer 2000; for more information contact Sarah Engel at sengel@vt.edu.

In the other study, Maryland Save Our Streams (SOS) and the Maryland Department of Natural Resources (DNR) are collaborating on a study to compare MD SOS volunteer methods with DNR methods. In contrast to the IWLA volunteers, MD SOS volunteers carry their identification to the family level. About 45 sites will be sampled. Dan Boward, a biologist at DNR, says, "If we can show that SOS methods provide statistically similar ratings of stream quality, DNR could better use the volunteers' data in our watershed assessments and water quality reports, such as the 305(b) report." For more information contact Dan Boward at 410-260-8605; dboward@dnr.state.md.us.

Several earlier studies also compared volunteer and professional macroinvertebrate data. See *The Volunteer Monitor* Spring 1997 issue for a short description of two such studies, one conducted by Illinois RiverWatch Network and the other by Connecticut RiverWatch. And see David Penrose and Samuel Call's 1995 article, "Volunteer Monitoring of Benthic Macroinvertebrates: Regulatory Biologists' Perspectives" (*Journal of the North American Benthological Society* 14(1):203-209) for a discussion of three studies.

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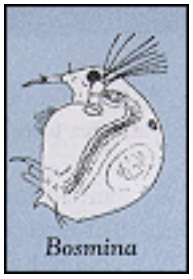
That's Not *Daphnia!*



Bosmina

As a Ph.D. graduate of Cornell's Natural Resources Program and an avid fan of exposing students to real science, I really enjoyed Nancy Trautmann's article in the recent *Volunteer Monitor* (Fall 1999, "Bioassays Bring Real Science to the Classroom"). It was a fine example of how a complicated issue can be simplified to be both meaningful to students yet yield "real" results appropriate to environmental management.

I would point out, however, that the drawing of a *Daphnia* shown in the article is actually a *Bosmina*. This is akin to showing a picture of a dachshund in an article about sheep-herding dogs-while closely related, these are functionally very different organisms. I fully support simplification to build understanding, but accuracy need not be sacrificed in cases like this. Please be careful about this in the future, as it reflects on all of us trying to bring science to the public.

Ken Wagner
Water Resources Manager
ENSR Consulting and Engineering
Northborough, MA
kwagner@ensr.com

Daphnia

Reply from the editor:

Whoops! Thank you for pointing this out. Nancy Trautmann is not responsible for the incorrect drawing-in fact, I recycled the drawing from a previous Volunteer Monitor (Fall 1993). Too bad nobody pointed out the mistake the first time! Here is a real

Daphnia, taken from the BIODIDAC Website (http://biodidac.bio.uottawa.ca/  *).*

Hazards of Mercury Thermometers

I was very disturbed to see the Fall 1999 front cover of The Volunteer Monitor-two students, representing the GLOBE (Global Learning and Observations to Benefit the Environment) program, outside with what appears to be a mercury maximum/minimum thermometer. Because of the severe toxic effect of mercury to humans and to the environment, equipment containing concentrated sources of mercury should never be used outdoors. Mercury is a known toxin and can cause nervous system and organ damage through breathing vapors or by adsorption through the skin. It bioaccumulates in the environment and can be extremely detrimental, especially to species that are higher on the food chain.

I also advocate not using mercury thermometers indoors with children. Mercury spills from a broken thermometer can be very hazardous and difficult to thoroughly clean up without the proper cleanup and monitoring equipment. Where I work, at the EPA New England Laboratory, we are extremely careful with instruments containing mercury. Our water quality monitoring section never uses mercury thermometers for field monitoring. Even in the lab, we are in the process of eliminating all mercury thermometers except for a few NIST-certified thermometers that are used to calibrate other thermometers and to make certain critical measurements.

I feel strongly that mercury thermometers should not be used for this type of monitoring and the public should be aware that there are alternatives. Some of the alternatives may require some research and more money, but in my mind this is a very worthwhile expense.

Tom Faber
Water Quality Engineer
EPA New England Laboratory
Lexington, MA
faber.tom@epa.gov

Reply from GLOBE:

Tom Faber makes a good point. In fact, this issue has already been raised by schools in states with strict rules about mercury exposure and students.

The problem is finding a safe, low-cost max/min thermometer that also meets GLOBE's requirement for accuracy to 0.5°C. To get away from mercury, the only alternative of which I am aware is an electronic temperature probe. The cheaper electronic max/min thermometers are only accurate to within a degree or so. The more accurate ones are more expensive and must be read by a computer. In GLOBE, we need to offer instruments that are affordable for schools all over the world and also involve students in directly taking scientific measurements. It was for these reasons that GLOBE chose the mercury-containing horseshoe-shaped max/min thermometer.

Note that with the mercury-containing max/min thermometers, mercury exposure can only happen if the thermometer breaks. Breakage is very unlikely because the thermometers are mounted in an instrument shelter and are not taken down except for occasional calibration.

Ultimately the choice belongs to the schools who participate. Some have elected not to take the maximum-minimum temperature measurements because of their concern about the mercury-filled thermometer. GLOBE would dearly love to have an electronic thermometer that is accurate to 0.5°C, affordable, and easily read by students without recourse to downloading to a computer.

Dixon Butler, Chief Scientist
GLOBE Program
Washington, DC
dbutler@globe.gov

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National Conference:

Volunteers Moving Into the Mainstream

by Alice Mayio

Austin, Texas, was the setting this April for the 6th national volunteer monitoring conference, built around the theme of "moving into the mainstream." About 230 volunteer coordinators, volunteers, and government agency representatives attended. The conference was launched with a series of field trips to interesting waterways in the Austin area. Attendees also had the opportunity to attend the wrap-up session of the National Water Quality Monitoring Conference at a nearby hotel.

The conference itself was a fast-paced mixture of workshops, panel discussions, exhibits, and breakout sessions. Session topics included everything from data management to wetlands monitoring to TMDLs (Total Maximum Daily Loads), and reflected the fact that volunteer programs are, in fact, moving into the mainstream of monitoring and water quality decision making. Social highlights included a rousing Eco-Coffee House (who knew we were such a talented bunch?) and a trip into downtown Austin for good food and great music. The conference was sponsored by the U.S. Environmental Protection Agency (EPA), the Lower Colorado River Authority, and the Ground Water Protection Council.

Conference proceedings will be published later this summer and sent to all who attended. The proceedings will also be posted on EPA's volunteer monitoring Website at www.epa.gov/owow/monitoring/vol.html. For those who want to order the printed document, ordering information will be available in the next issue of *The Volunteer*

Monitor.

If you couldn't make it to Austin, we hope to see you at the next national volunteer monitoring conference, to be held sometime in 2002. Watch this newsletter or EPA's volunteer monitoring Website for details.

Alice Mayio *is the National Volunteer Monitoring Coordinator for U.S. EPA. She may be reached at USEPA, 4503F, 1200 Pennsylvania Ave. NW, Washington, DC 20460; 202-260-7018; mayio.alice@epa.gov.*

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Paw Prints and Preservation

by Eleanor Ely

For millennia, the ability to read animal tracks and sign was common knowledge, a basic survival skill. Now, for most Americans, it's a lost skill. But a number of community groups across the country are reviving that traditional knowledge. They're not after meat or pelts, though. Their goal is habitat preservation.

These volunteers have been trained through a nonprofit organization called Keeping Track, founded in 1994 by naturalist and expert tracker Susan Morse. The training regime is fairly rigorous. Over the course of a year, Morse takes the volunteers out for six full days in the field, where she teaches them to identify animal tracks (paw prints) and sign (such as bear claw scratches on trees or animal hairs snagged on branches). The first challenge is simply learning to see; the next, to interpret.

During training Morse stresses data credibility, telling the volunteers not to record an observation on their data sheet unless they are sure of the animal's identity. "When in doubt, follow it out," she says, explaining that they may need to patiently follow a trail for a good distance to get definitive evidence.

By tracing claw marks on a tree, a Keeping Track volunteer gains insight into bear behavior.

Indicator species

The Keeping Track approach is to zero in on

a few focal species of wide-ranging carnivores. The particular animals vary somewhat from region to region; in northern New England, they are bear, otter, mink, bobcat, and fisher (a close relative of the weasel). Like pollution-sensitive stoneflies or mayflies in streams, these species serve as indicators-their well-being is a reflection of the health of the entire ecosystem. Protecting habitat for these species protects other species too.

"The indicator animals are all 'area-sensitive,' meaning that they need a fairly large area of unbroken habitat," explains Lars Botzojorns, Keeping Track's Executive Director. "If that area is broken up by development or other human activities, they won't survive."

Keeping Track volunteers are also trained to monitor species that are threatened or endangered in their region.

Once trained, the volunteers establish transects (study areas) in their communities. Four times a year, they survey their transects for evidence of the indicator species. Their records of where the animals are and what they are doing become a powerful tool for protecting critical wildlife habitat.

Watershed protection

The link between bobcat prints, bear claw marks, and water quality may not be immediately obvious, but in fact, as Morse points out, "protecting habitat for wide-ranging carnivores is often synonymous with protecting watersheds." One reason is that riparian zones and wetlands often serve as connecting corridors. "Upland habitat 'core areas' are often joined by stream and wetland habitats that knit it all together," says Morse. Protecting these corridors is key to preserving wildlife. As Morse puts it, "Habitat fragmentation is doom to these animals."

Morse also points out that watershed groups can build a larger constituency if their goals include protecting wildlife habitat. "Often communities are more enthusiastic about protecting water quality and wildlife than just protecting water quality by itself," she says. If a town planning council opts to preserve a riparian area as a wildlife corridor, obviously fish and aquatic insects will benefit as well.

The Piscataquog Watershed Association (PWA) in New Hampshire took the Keeping Track training four years ago. "We usually establish Keeping Track transects through private land that connects protected open spaces," says PWA founder Gordon Russell. "We keep careful records over the course of a year, then share our information with the landowners. Most of them really don't know how much biodiversity they have on their land, and most have been extremely appreciative of the information we provide. Time after time our effort has translated into a conservation easement, or even getting the land deeded to the PWA."

Morse is a strong believer that a shared concern for wildlife can be a rallying point that brings all segments of a community together. She says, "We work with urbanites and farmers, hunters and anti-hunters, teachers, loggers, poets. What's fun about Keeping Track is we can put our differences aside to work toward our common goal-collecting reliable data to guide community planning and protect wildlife."

For more information about Keeping Track's training workshops and other educational programs, contact Keeping Track at P.O. Box 848, Richmond, VT 05477; 802-434-7000; keeptrak@together.net.

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Critters on You Computer

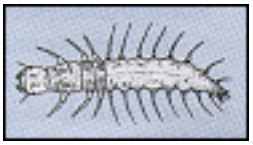
by Geoff Dates and Angie Reed

For some time we have been intrigued by the potential of the Worldwide Web not only as a source of information, but as an interactive educational tool. So we set out to find out whether there were Websites for a particularly interactive use: the identification of benthic macroinvertebrates. We were looking for, and found, interactive taxonomic keys. In fact, we found dozens and dozens of sites with images and information on the taxonomy, ecology, behavior, and life history of these critters.

Truth to tell, we were somewhat disappointed at many of the sites we found. Some were simply species lists of critters. Academic sites were frequently . . . well, academic. Others were too basic. There seems to be a lack of sites geared toward intermediate-level users of benthic macroinvertebrates as indicators.

Nevertheless, we did find some sites that Volunteer Monitor readers might find useful for the following purposes:

- As a source of information
- As an online critter identification key
- As a source of images for downloading



Since, like a river, the Internet is alive and always changing, we tried to include only sites that look as if they are going to be around awhile. But, obviously, we make no guarantees.

If you don't find what you're looking for on any of these sites, try this tip from Ken

Cooke of Kentucky Water Watch: "To find information on a particular organism, simply type the genus and species, or the family name, into any search engine and you'll be amazed what comes up."

Macroinvertebrate ecology

First, here are a few sites with extensive links to other sites on the taxonomy, behavior, and ecology of benthic macroinvertebrates. These are good places to start.

Dragonflies: A homepage by John Carsten, with basic information on dragonflies and links to numerous other sites. http://www-marketing.wharton.upenn.edu/~johnc/dragonfly.html EXIT EPA

Freshwater Benthic Ecology and Aquatic Entomology Homepage: A homepage produced in Canada by S.M. Mandaville, with a comprehensive set of links to various sites for critters, biomonitoring, and impacts. http://www.chebucto.ns.ca/Science/SWCS/benthos.html EXIT EPA

Nearctica - Natural History - Insects: A site focusing on mayflies, stoneflies, and caddisflies. http://www.nearctica.com/nathist/insects/aquatic.htm EXIT EPA

Waterose Aquatic Ecology of Links Index Page: A page with links to aquatic life and ecology Websites. http://www.geocities.com/RainForest/Vines/4301/links.html EXIT EPA

Identification keys

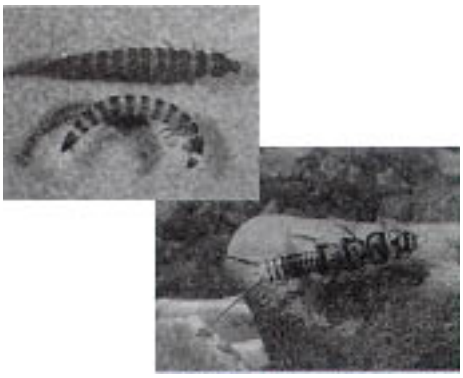
These keys are all to higher taxonomic levels. We were unable to find keys to taxa lower than orders (e.g., families).

Guide to Freshwater Invertebrates: A simple guide to the orders of benthic macroinvertebrates, with some ecological information, by Leska Fore. (Editor's note: Several drawings from this site are included in this issue; see pages 10-11.) http://www.seanet.com/~leska/Online/Guide.html EXIT EPA

Izaak Walton League of America Key. The IWLA's online key to benthic macroinvertebrates. http://www.people.virginia.edu/~sos-iwla/Stream-Study/Key/MacroKeyIntro.HTML EXIT EPA

Kentucky Water Watch Key: A key to the orders of aquatic insects.
http://fluid.state.ky.us/ww/bugs/orderkey.htm#2

Simple Aquatic Insect Identification: A key to orders of aquatic insects by Los Alamos National Laboratory Science and Education Outreach Office.



http://www.education.lanl.gov/RESOURCES/NTEP95/Aquatic_Insects/Aquatic_Insect_ID.html

Critter pictures

Many of the above sites include photos and drawings. For additional images, check out the sites below.

Dr. Bill Stark's Website: The homepage for a professor of biology at Mississippi College. Click on "American Stoneflies" for descriptions and photos of stonefly families, and on "Spirit Nymphs" for whimsical drawings like the one at right.
http://www.mc.edu/~stark/

Common Aquatic Insects: A page with images of orders of aquatic insects and links to other pages of images and keys by Tim Driskell.
http://members.tripod.com/tdriskell/insecta.html

Missouri Stream Team - Macroinvertebrate Pictures: Very nice color photos of a variety of benthic macroinvertebrates. http://www.mostreamteam.org/macroinv/index.html

Geoff Dates *is River Watch Program Director and* ***Angie Reed*** *is Science and Tribal Services Manager for River Network.*

Unless otherwise indicated, the above drawings are from the IWLA online key and Tim Driskell's "Common Aquatic Insects" page.

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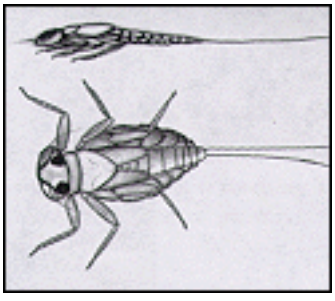
Bugs in Your Face

by Leska S. Fore

"Oooh, what's that?!"
"What are those things for?"
"Yuck!"
"Cool!"

You always get a reaction from people when they start looking in the scope at bugs. Whenever I introduce volunteers to freshwater invertebrates, I love to hear the squeals as they notice the variety of shapes and forms that have evolved to live in fast-running streams. On first look, the variety of shapes is bewildering, but after thinking about where these creatures live, you begin to see and understand their adaptations for survival.



"Why are they called mayflies and stoneflies? I don't see any wings!" Most of the animals you collect from a stream are youngsters, called larvae or nymphs. They don't grow wings until they are ready to fly around and mate. The time they spend out of the water as adults is relatively brief. In fact, the Latin name for mayflies is Ephemeroptera because their adult lives are so ephemeral, sometimes lasting only a few hours.

"Why are mayflies so flat when you look at them from the side?" Mayflies are small and water is strong; without a way to hold on, they would spend all their days spinning and tumbling downstream to the ocean. One way to avoid the current is to be skinny; some mayflies are very flat when viewed from the side. Their flat shape allows them to

take advantage of the relatively still water at the interface between embedded rocks and moving water by squeezing into the boundary layer.

Mayflies also have a grappling hook on each foot to help them hang on, or cling. Stoneflies, which are not as flat or skinny, have two grappling hooks. Some fly larvae actually have suction cups on their abdomens to stick themselves to rocks.

"Why do caddisflies have cases?" Notice that some caddisflies have a rather large and soft abdomen. They probably make a tasty little morsel for a fish or bird. These caddisflies build houses out of rocks or sticks so that the predator must weigh the advantage of the tasty caddisfly against a mouthful of rocks that come with it. The cases also make a great place to hide because they provide camouflage against the bottom of the stream. Caddisflies get very still and duck their heads inside the case if the see your shadow overhead.

"Where do the cases come from?" Unlike turtles who are born with portable homes, caddisflies must make their own cases by using silk to stick together bits of rocks, sand, or twigs.

Some species build square houses by carefully bending small twigs into squares and glueing them together.

Some species build square houses by carefully bending small twigs into squares and gluing them together. Others create houses out of tiny grains of sand that they meticulously glue together so they look like a beaded purse. Caddisflies are very particular about the materials they use and the construction plan. Any two animals in the same species will build identical houses.

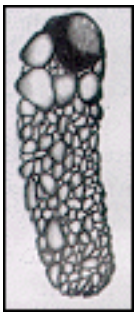
Others create bouses out of tiny graines of sand that they meticulously glue together so they look like a beaded purse.

These houses aren't simple shacks-they have all kinds of adaptations depending on where their owner lives and how it makes a living. Caddisflies that live in fast current will build heavier stones into their cases near the opening and smaller stones in the back. The large stones help to keep their heads down so they aren't swept away.

Others build a rudder made out of a pine needle into the back of the rock case. Most solid cases also have portholes at the back end for the water to flow through and keep the house clean.

Some clever biologists have even recruited caddisflies to work as jewelry-makers. Kathy and Ben Stout in West Virginia raise caddisflies in a simulated stream

environment, and give them gemstones to make cases. After the caddisflies grow wings and fly away, their cases are made into earrings, necklaces, and bracelets (see http://www.wildscape.com/ EXIT EPA for examples).



Caddisflies that live in fast current will build heavier stones into their cases near the opening and smaller stones in the back. The large stones help to keep their heads down so they aren't swept away.

The caddisfly cases we've seen so far are Winnebago-type accommodations that the critters drag around with them as they look for their food-leaf particles, fungi, dead bugs, and other small pieces of organic matter. Other caddisflies don't move around; instead they build fixed retreats by fastening sticks and rocks together with their silk. They can also spin the silk into nets. These caddisflies have large hooks on their rear ends to hold them in place so they won't be swept away downstream. The hooks allow them to have their "hands" free to remove bits of food from the "fishing net" waving in the current.

"Do all caddisflies build houses?" No, some have abandoned the safety of home for a more mobile lifestyle. These free-living caddisflies have big eyes and long legs, and they move fast. People can usually guess that these guys are hunters. You wouldn't want to meet one of these coming around a corner if you were a tasty little mayfly.

The other terror of the benthos is the dragonfly. A close look under the scope reveals enormous eyes ("The better to see you with, my dear") and a long tongue-like thing (the labium) that shoots way out of its head to grab surprised mayflies.

"Why are planaria so squishy?" These guys are masters at sneaking through tight places. If you use a 500-micrometer mesh net to sample, you can watch these guys, who are much bigger than the holes in the net, slowly squeeze through.

"Why are some fly larvae so gross?" This one I can't answer. Tipulid fly larvae are similar to the crane fly larvae you find in your lawn. They are big and gray and squishy and pulsate like a living sausage. I've been looking at these things for years and have never been able to think of a reason for why they are so ugly.

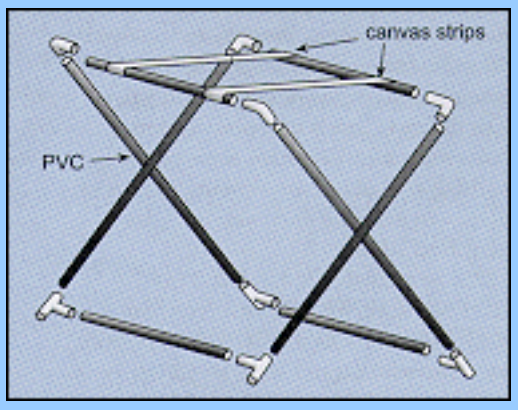
The cutest bugs (yes, after looking through a scope for awhile we all start to have some favorites) are certainly the mayflies, or Ephemeroptera. They have long elegant tails and delicate gills along their sides that wave like diaphanous, watery wings. The gill shapes and sizes differ according to species. Some are shaped like fluttering pancakes, others like long finger-shaped tendrils, still others like disks that can flap and rotate.

Have a look in a scope-you might be surprised at how interesting these critters are. I know I was.

The insect drawings in this article are from Leska Fore's Website, http://www.seanet.com/~leska/. *They may be downloaded and copied for educational use, but not for resale.*

Leska S. Fore *is a statistical consultant specializing in biological monitoring. She may be reached at Statistical Design, 136 NW 40th St., Seattle, WA 98107; leska@seanet.com.*

Oh, My Aching Back!



Bending over to pick macroinvertebrates off a net can be a pain in the back. Some resourceful Missouri Stream Team volunteers designed a "bug rack" that makes streamside bug sorting and identification a lot more comfortable. The bug rack is a lightweight portable folding frame similar to a jack tray used in restaurants or folding suitcase rack found in hotel rooms. At the stream, the frame is opened up and the net is draped over it at about waist height. No more bending!

The bug rack can be made of either wood or PVC pipe. Instructions for both types are available for free from Missouri Stream Team; copies may be requested from streamteam@mail.conservation.state.mo.us or 800-781-1989 (be sure to provide your mailing address).

Stream-less Stream Assessment

No stream needed! The BIO-ASSESS game lets players be armchair stream ecologists.

BIO-ASSESS comes with a drawing of a stream that flows past a farm, factory, sewage treatment plant, etc. The stream is marked with three sampling sites, and each site has its own corresponding deck of "bug" cards. The decks contain different assortments of critters, to reflect the different macroinvertebrate populations living at the three sites.

To play the game, teams pick a stream site and "sample" it by drawing 100 cards from the appropriate deck. They analyze their catch by identifying and sorting the bugs and calculating a biotic index.

BIO-ASSESS was designed by Bill Deutsch, Program Manager of Alabama Water Watch, primarily for classroom use. If students have access to a real stream, the game is good preparation for fieldwork; if not, they will still learn basic principles of stream ecology and macroinvertebrate monitoring.

The complete game, including a manual with picture keys, 6 decks of cards, vials of preserved specimens, and a carrying case, sells for $225; or you can order just 3 decks of cards plus the manual for $75. For more information, see the Alabama Water Watch Website (http://www.auburn.edu/aww/ 

) or call 888-844-4785.

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Macroinvertebrate Resources

Here's a sampling of some resources for volunteer macroinvertebrate monitors. Two more books, and two videos, are reviewed on page 16. The SalmonWeb Website, www.salmonweb.org, has a nice list of macroinvertebrate-related books, many with a special focus on the Pacific Northwest. And the Spring 1997 issue of The Volunteer Monitor lists several more macroinvertebrate manuals produced by volunteer programs.

Volunteer Monitoring Manuals

The four manuals below are listed approximately in order of the rigorousness of the methods described, starting with the simplest.

Save Our Streams Monitor's Guide to Aquatic Macroinvertebrates, by Loren Larkin Kellogg. 1994. A 60-page nontechnical guide to the major orders of aquatic insect larvae and crustaceans. Includes drawings, descriptions, and dichotomous key. Follows the Izaak Walton League Save Our Streams biomonitoring method, based on streamside identification of macroinvertebrates.

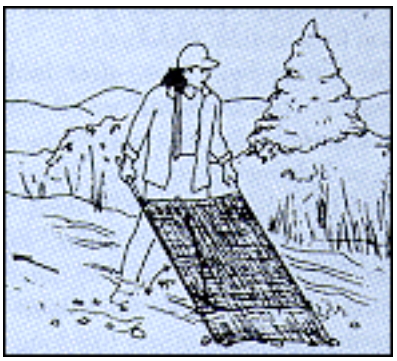
Order from Save Our Streams Program - Catalog Orders, Izaak Walton League of America, 707 Conservation Lane, Gaithersburg, MD 20878; 800-BUG-IWLA (284-4952). $5 + S&H (quantity discounts available). (Check out the Save Our Streams online catalog at http://www.iwla.org/SOS/catalog/ EXIT EPA for additional monitoring books, videos, and equipment.)

Streamkeeper's Field Guide: Watershed Inventory and Stream Monitoring

Methods, by Thomas B. Murdoch and Martha Cheo. 1996. Adopt-A-Stream's comprehensive (300-page) stream monitoring manual; sizable chapter on macroinvertebrate monitoring describes procedures for both a simplified field survey and a more detailed lab method. Includes a picture key and a dichotomous key. Illustrated with numerous drawings and cartoons.

Order from Adopt-A-Stream Foundation, 600 - 128th St. SE, Everett, WA 98208; 425-316-8592; aasf@streamkeeper.org. $29.95 + S&H. (Also see the online catalog at http://www.streamkeeper.org/ EXIT EPA for more resources.)

Volunteer Stream Monitoring: A Methods Manual. 1997. EPA 841-B-97-003. EPA's 210-page stream monitoring guidance document includes an extensive section on macroinvertebrate monitoring and habitat assessment. Provides protocols for several different levels, or tiers, of biomonitoring, from a Stream Habitat Walk to an Intensive Stream Biosurvey (in the latter, preserved specimens are identified in the lab). Includes detailed instructions for collecting specimens, guidance on data interpretation and metrics, and sample field data sheets. No identification key.



From Volunteer Stream Monitoring (EPA)

Order by title and publication number from EPA's NSCEP (National Service Center for Environmental Publications), 800-490-9198. Free. May also be downloaded from http://www.epa.gov/owow/monitoring/vol.html.

Living Waters: Using Benthic Macroinvertebrates and Habitat to Assess Your River's Health. (To be published in late 2000.) A comprehensive guide with detailed procedures for macroinvertebrate collection and analysis. Offers instructions for several options (for example, streamside or lab identification) with different levels of sophistication. Covers macroinvertebrate ecology, methods for habitat assessment, and use of metrics to evaluate data; also includes identification key.

Will be available in late 2000 from River Network, 520 SW 6th Ave., Suite 1130, Portland, OR 97204; 503-241-3506. For those who cannot wait, an earlier version is available for $25 + S&H.

Advanced Identification Guide

Aquatic Entomology: The Fishermen's and Ecologists' Illustrated Guide to Insects and Their Relatives, by W. Patrick McCafferty. 1983. Identification keys and color plates, plus chapters on life cycles, habitat, sampling equipment, and more. 450 pages; $50 paper.

Available from both Izaak Walton League and Adopt-A-Stream Foundation (see above for contact info), or from the publisher, Jones and Bartlett, Boston, MA, 617-859-3900.

Fun with Critters

Wonderful Wacky Water Critters. A 24-page booklet providing drawings and "fun facts" for 50 common pond and stream animals. Simple flow-chart key is easy to follow. Not a monitoring guide, but could be a useful supplement, especially for school classes.

Order from University of Wisconsin-Extension Publications, 630 West Mifflin St., Madison, WI 53703; 608-262-3346. $2.00 + $1.50 S&H (quantity discounts available).

Poster

Detailed pen-and-ink drawings, shaded in pastel colored pencil and water color, depict critters and habitats in this particularly beautiful poster produced by Indiana's Hoosier Riverwatch.

Detail from poster.

Order from Adopt-A-Stream Foundation, 425-316-8592; aasf@streamkeeper.org (ask for benthic macroinvertebrate poster). $3.00 + S&H.

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Benthic Macroinvertebrate Monitoring In Streams: Where Is It Going?

by Geoff Dates

Many volunteer monitoring groups are monitoring benthic macroinvertebrates in streams. They're using a variety of methods ranging from field-based protocols that yield simple "stream ratings" to rigorous and quantitative field and lab protocols with many "bio-metrics" that describe the results in complex ways. Some of us have been using the same methods for 20 years or more! Yet, the science keeps changing.

At the more rigorous end of the spectrum, volunteer monitoring methods tend to resemble-or even be identical to-those used by some agencies to assess the state of the waters in their jurisdiction (see the EPA's Volunteer Stream Monitoring: A Methods Manual or River Network's Living Waters). As one moves even further along this continuum, one enters the rarefied realm of academics, researchers, and agencies that use rigorously quantitative methods and sophisticated statistics to assess their waters. Yet this end of the spectrum is not so completely rarefied as to be irrelevant to volunteer monitors, because many of the methods we use today were pioneered here. So, I think it's helpful for volunteer monitors to understand some of the trends further out toward the edge.

In this article, I'll summarize what I've learned in researching the more rigorous end of the spectrum and by attending the 28th annual meeting of the North American Benthological Society. In a nutshell, benthic macroinvertebrate monitoring is becoming regionalized, more rigorous, less prescriptive, and more statistical. What's driving much of this is the development of numerical biological criteria. To make matters especially challenging for volunteer monitors, the experts themselves disagree as to the "right" way

to do just about every aspect of benthic macroinvertebrate monitoring.

Before diving into the trends and disagreements, let's back up and review a few basics about this type of monitoring.

What's the point of macroinvertebrate monitoring?

The point of monitoring benthic macroinvertebrates is to determine the biological health of our waters. I've seen many definitions of biological health, but the one concept they all have in common is that the biological community of a stream should resemble that which results from natural evolutionary processes in a region with minimal impacts from humans.

What's involved?

It seems as though there are as many approaches to monitoring benthic macroinvertebrates as there are critters themselves. But there are some basic steps that any benthic macroinvertebrate monitoring program will need to follow:

1) Select the sites
2) Collect the critters
3) Process the samples
4) Identify the critters
5) Summarize and interpret the results

Florida LAKEWATCH volunteer Susan LaSalle examines macroinvertebrates.

It's safe to say that benthic macroinvertebrate monitoring has evolved considerably in each of these areas over the past 10 years. Here's a brief summary of the trends.

Site selection

There are two basic types of sites: "reference sites" and "test sites." Reference sites are those sites minimally affected by humans, where you would expect to find benthic macroinvertebrate communities in something approaching their natural condition. Test sites are the sites you are monitoring to see how they've been affected by humans. So, reference sites are your real-world definition of biologically healthy waters.

If your state has been monitoring reference sites for a long time, it may have developed a set of biocriteria that take the place of actual reference sites. Biocriteria define biologically healthy conditions-that is, the desired endpoint-in terms of one or more attributes of the benthic macroinvertebrate community (for example, the number of

different species to be expected, or the percent composition). Stream management is considered successful if streams meet this endpoint.

If your state does use biocriteria, this is good news because it means that you may not need to actually monitor reference sites. You may simply have to compare the results from your test sites to the biocriteria.


A kick-seine net works well in a rocky-bottom stream

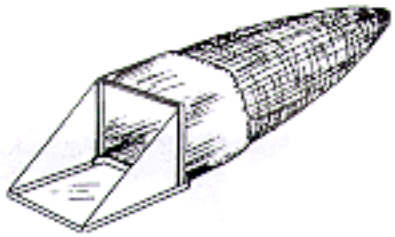
If your state has not developed biocriteria, you may have to find reference sites in your watershed. This can be a daunting challenge. It may be difficult to find sites with minimal human impacts in some areas. On top of that, the reference sites might need to be classified into groups in which similar communities can be expected. Classifying reference sites can involve fairly sophisticated statistical analyses and is likely well beyond the capabilities of most volunteer monitoring groups, but you may be able to get help from your state's biologist.

Because state and federal monitoring programs usually operate on a large scale encompassing tens of thousands of square miles, some (for example the USGS National Water Quality Assessment and EPA's Environmental Monitoring and Assessment Program) have moved to a "probabilistic" process for selecting reference and test sites. In this design, a small number of sites are selected randomly to represent the larger group (as public opinion polls are used to sample a much larger population). This is fairly controversial in some states and is not universally accepted. But the use of probabilistic design seems to be growing. It's important to recognize that such large-scale sampling strategies may not provide data at a scale that's useful to your group trying to solve site-specific problems. Your program may need to "fill in the gaps" with your own monitoring sites.

Collection

Collection methods seem to be less controversial than subsampling and data analysis (see below). The level of effort is usually standardized either by specifying a time (e.g., "disturb the bottom for 2 minutes") or by defining the area of bottom to be disturbed. I tend to prefer standardizing the area whenever sampling will be done by different people. That's because I've observed big differences in sampling efficiency among different people when time is standardized.

Collection devices haven't changed much, with different devices designed for different purposes. Collection nets are designed to grab critters off the bottom of wadeable streams. Most of us have used seines or metal-frame "D" nets or rectangular nets. Other nets, like Surber and Hess samplers, prescribe the area disturbed as that contained within a metal frame or bucket. Artificial substrates (e.g., a basket full of rocks or a set of spaced, stacked tiles) are also frequently used. They are placed on the bottom and the critters colonize them over a period of weeks.



Surber sampler. Only the portion of the streambed within the metal frame is disturbed. The current carries the sample into the net.

There is disagreement about the use of artificial substrates. Those criticizing their use argue that they don't accurately represent the stream bottom and are biased toward or against certain types of critters. Those favoring their use argue that they rigorously standardize the habitat, are more quantitative, allow sampling of deep rivers, and, for certain applications, enable the investigator to sort out habitat effects from water quality effects. I tend to avoid artificial substrates unless they are the only practical sampling method or are being used specifically to assess the impact of habitat degradation.

Most sampling devices are geared to rocky bottoms. However, a relatively new technique for sampling wadeable streams with sand or mud bottoms consists of using a net to "jab" the bottom or habitats such as large woody debris, bank root wads, or submerged aquatic vegetation.

Sampling non-wadeable streams remains a challenge as all the above devices are designed mostly for use in wadeable streams. Artificial substrates are sometimes used to sample non-wadeable rivers, as are dredges (which grab a sample in their jaws). In either case, the samplers are used from a boat and lowered to their location in the water column or placed on the bottom.

Hess sampler. The operator reaches down and disturbs the streambed within the round open bottom of the sampler. Water flowing through the front of the sampler carries the critters into the net.

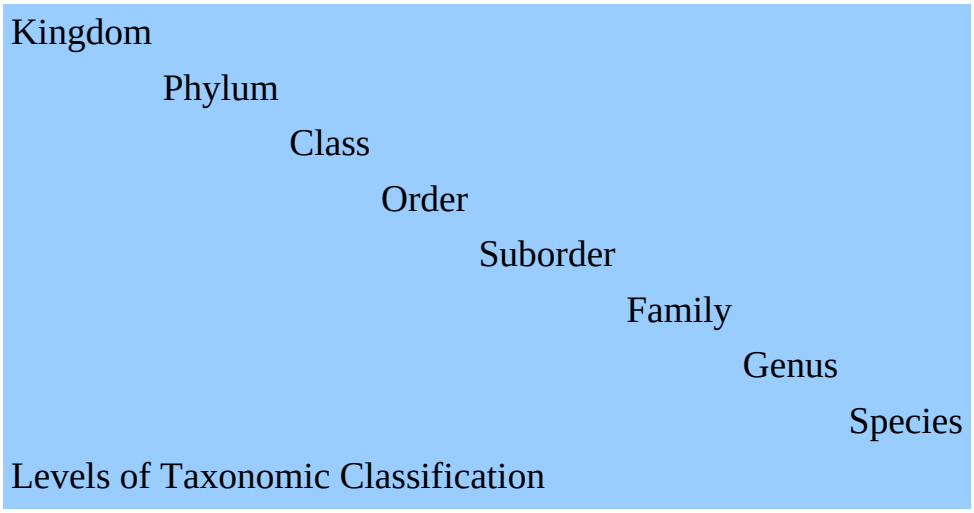
Frequently a stream reach contains multiple habitat types. Should you sample one, some, or all of them? Not surprisingly, biologists argue about this too. Some argue for the "most productive habitat" (usually cobble in riffles). Others believe that sampling all habitats better reflects the true condition of the biological community. Should you combine all the samples from the same reach? Some say yes; others maintain that samples from different habitats should be kept separate. I side with the latter, thinking that at least then you have the option of combining the data or keeping it separate.

Sample processing

There are two issues here: (1) field versus lab processing, and (2) whether to subsample or not. Most rigorous programs preserve field samples and bring them back to a lab for subsampling and identification. Field identification of any taxa lower than order is very difficult, especially for certain stoneflies and caddisflies.

Much has been written and discussed about the merits of identifying only a part of the sample (subsampling). The basic idea is to maintain representativeness while avoiding the time-consuming process of identifying as many as several thousand organisms per sample. Some advocate strongly for processing the whole sample to avoid missing rare critters and to maximize representativeness. Others recommend subsampling a fixed number of critters (100, 200, 500, etc.) or a percentage of the sample. Again, there's no "right" way. In general, though, the more of the sample you identify, the more representativeness you gain.

Identification level



There seems to be consensus that identification of samples to the lowest possible taxonomic level (genus or species) in the lab provides the most information. However, that level of effort may not always be warranted in every situation. The key lies in how the data will be summarized and used to discriminate among different levels of biological condition. Genus/species level information will usually allow the calculation of more metrics (see sidebar) and subtler discrimination of conditions (e.g., slightly versus moderately impaired). But subtlety is not likely to be needed to discriminate severely impaired sites where whole orders of insects are missing. Again, the trade-off is between information and the time it takes. When identification is done in a lab, volunteer groups are usually reliable at family identification, and even at some sub-family groups.

Data summary and interpretation

Now we come to the heart of the matter. As stated earlier, the final analysis is a comparison of the community found at the test site with some actual (reference site) or theoretical (biocriteria) endpoint. But each sample is not just a single number. The results are a list of numbers of critters in each taxon. These must be summarized using metrics.

A

Rivers Project students in Illinois use a D-Frame net to "jab" root wads along the streambank.

gain, if you're lucky, your state may have standardized metrics in its bioassessment or in biocriteria. If not, someone will need to help you decide which to use. There are literally hundreds of possible metrics. How do you decide which to use? Well, agencies and researchers can help you test the metrics to see which work. The key point here is that individual metrics must be tested to see if they respond in a predictable way to human impacts and in their ability to discriminate among different degrees of impairment. Those that do are used. Those that don't are rejected. One good way to test a metric is by making a graph that plots results for that metric against some measure of human impacts (e.g., percent impervious surfaces) and seeing if the metric responds as predicted. Metrics can also be tested using various sophisticated statistical techniques that reveal the level of response to various environmental stressors.

There are three basic approaches to managing and interpreting the resulting data:

1. Metrics are analyzed separately: In this approach, one or more individual metrics is used to assess the biological condition. Results for these metrics are compared with those at an actual reference site or to expected results based on a reference site database. Examples: Vermont biocriteria, various volunteer or school program indexes.

2. Metrics are analyzed as a single score (multimetric index): A set of metrics is selected which responds in a predictable way to impairment. Results for each metric are scored and aggregated into a single score (or index). This score is compared with scores for an actual reference site or to a theoretical score (as in biocriteria). Examples: EPA's Rapid Bioassessment Protocol, Karr's Benthic Index of Biotic Integrity (for more on these two methods, see page 16).

3. Metrics are analyzed using multivariate statistics: Various statistical models are used to predict the results that would be expected at a test site in the absence of environmental stress. These predictions are based on results from a long-term database of reference sites. Impairment is determined by comparing the actual metrics calculated with the predicted metrics. The power of this approach is that it allows you to look at a number of variables at the same time to determine which stressors seem to be having the greatest effect on the community. To find out more about this approach, visit the Australian Rivers Assessment System (AusRivAS) Website (http://ausrivas.canberra.edu.au/ausrivas).

Where is all this going?

Now, a few observations about where the "professional" world of benthic macroinvertebrate monitoring seems to be going:

- **Benthic macroinvertebrate monitoring is becoming more rigorous.** Sampling is becoming more quantitative, subsamples are becoming larger, identification is moving toward genus and species, and metrics are being more systematically tested.

- **Benthic macroinvertebrate monitoring is becoming regionalized.** States and university researchers are finding that different metrics seem to respond differently to the same stressors in different regions. So site selection, sampling frequency and time of year, collection and analysis methods, data summary and interpretation, and the definition of impairment are all being adapted to the unique issues, conditions, and needs in different regions.

- **EPA's national guidance tends to focus on study design rather than prescribing methods.** Largely because of the recognition of regional variation, the new revised edition of EPA's Rapid Bioassessment Protocols tends to describe options and how to choose among them rather than describing the "right" way to monitor. This means that you should check with your state biologist to see how benthic macroinvertebrate monitoring is being done in your region and how you might fit in.

- **The use of multivariate statistics is increasing.** More and more biologists are using complex statistical models to assess how actual results differ from biological expectations. This means that assessing impairment under the Clean Water Act is becoming more complex, automated, and beyond the capabilities of most volunteer groups. There are effective critiques of these models and their potential misuse, but they will likely be the reality in your area. Don't despair, though-I believe there will always be a role for common-sense biology. But the reality is that you may need to find a friendly biologist to be your interpreter.

So, what does all this mean for you? If you live in a state or region that has been monitoring benthic macroinvertebrates for a long time (over 10 years), you may be in luck. At the very least, these areas will have a sense of what works there and what doesn't. At best, you may be handed protocols, metrics that work, and maybe even biocriteria. If you live in a region with little or no history of this type of monitoring, you can usually find someone who has some experience. Or you may need to test methods, find sites, and test metrics yourself.

Regardless, one thing is for sure. Benthic macroinvertebrate monitoring will continue to evolve. Volunteer monitoring needs to evolve too.

Geoff Dates *is River Watch Program Director for River Network, 153 State St., Montpelier, VT 05602; gdates@rivernetwork.org; 802-436-2544.*

Benthic Macroinvertebrate Metrics

Metrics are characteristics of a living community that are used to summarize taxonomic data. Useful metrics are those that respond in some predictable way to increased human impacts. Following are five general categories of metrics commonly used for benthic macroinvertebrates:

- *Richness*: Based on the number of distinct taxa (at a level you've chosen to identify, e.g., order, family, species). Can be the total number of taxa, or the number in an identified groups (e.g., number of mayfly taxa). This is a measure of diversity, which usually decreases with impairment.

- *Composition*: Based on the relative abundance (usually a percentage) of all taxa or certain key taxa (e.g., % in each major group, % stoneflies). A healthy and stable community will have a composition similar to a reference site or biocriterion.

- *Tolerance*: Based on the relative proportion of taxa which are sensitive or tolerant to impairment (e.g., % tolerant organisms). As impairment increases, pollution-tolerant organisms become more abundant.

- *Feeding*: Based on the relative proportion of critters with different feeding strategies (e.g., % functional feeding groups, % specialized feeders). As impairment increases, the percentage of specialized feeders is expected to decrease.

- *Habit*: Based on the relative proportion of critters with different

behaviors (e.g. % clingers). As impairment increases, critters with habits requiring clean cobbles, for example, are expected to decrease.

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New Books on B-IBI and RBPs

by Geoff Dates

Only a "bio-geek" would get fired up by a header like this. But if you are involved in monitoring benthic macroinvertebrates, you may want to add these two new books to your reference library.

A Benthic Index of Biological Integrity (B-IBI)

Restoring Life in Running Waters: Better Biological Monitoring, by James Karr and Ellen Chu (Island Press, 1999), is not a "how-to" manual. It is, in part, an impassioned plea for using biology to assess our waters. Its also the latest salvo in an ongoing debate about the usefulness of biological monitoring and the "best" approach to use. The book argues the case for biology over water chemistry, multimetric indexes over multivariate statistics, and biological judgment over statistical decision rules. In fact, the book is essentially Karr's response to criticisms or opinions expressed by other biologists and skeptics. If you haven't been following these debates, reading this book will likely make you feel as though you have walked in on one side of a jargon-filled conversation!

The book is organized according to 37 "premises" (e.g., "Only a few biological attributes provide reliable signals about biological condition") and 7 "myths" (e.g., "Biology is too variable to monitor") about biological monitoring.

Karr, a professor of fisheries and zoology (among other things) at the University of Washington, developed a multimetric index of biological integrity (IBI) using fish in the early 1980s. He developed the benthic index of biological integrity (B-IBI) in the last few years, in part due to his dissatisfaction with the procedures and metrics in EPA's

original Rapid Bioassessment Protocols (RBPs), which he feels were not adequately tested and some of which didn't work when he tested them.

As described in the book, the B-IBI is not a rigorously prescribed set of instructions but rather a process in which the practitioner selects sites, metrics, and sampling protocols appropriate to the geographical region and the type of aquatic environment being studied, then integrates the individual metrics to arrive at the B-IBI. But Karr does make some specific recommendations about methodology-for example, he favors sampling riffles, collecting three samples using a Surber sampler, identifying the whole sample rather than a subset, and carrying identification to the lowest practical taxon.

B-IBI Videos

The rationale and basic approach of the B-IBI are illustrated in two videos: Fresh Waters Flowing and Biological Monitoring Protocol (Cedar Films, 1998). Both are beautifully filmed with stunning underwater videography of critters and their collection. The former makes the case for assessing biological integrity, while the latter shows the sampling and lab procedures.

Rapid Bioassessment Protocols (RBPs)

Rapid Bioassessment Protocols for Use In Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish (second edition), by Michael Barbour and others (EPA, 1999), is a large technical manual. This is a revision of the 1989 document, which was a set of sampling procedures, recommended metrics, and multimetric indexes for habitat, fish, and benthic macroinvertebrates. The new version is a substantial change:

- Protocols for assessing periphyton (benthic algae) have been added.
- For benthic macroinvertebrates, the original protocols II and III have been combined and lab identification to the lowest practical taxon is recommended (the original RBP II recommended field identification to family).
- Rather than prescribing specific metrics, the new document describes the process for testing and selecting metrics.

The revised Rapid Bioassessment Protocols contains detailed step-by-step instructions for assessing habitat and for collecting and analyzing periphyton, benthic invertebrate, and fish samples. Volunteer monitors will be most interested in the two invertebrate protocols (especially the relatively easy "Biological Reconnaissance Survey"), the habitat assessment, and the "Field-Based Rapid Periphyton Survey." Though developed for professionals, most of these protocols can, in my opinion, be adapted for use by volunteer monitors.

Despite their differences, Restoring Life In Running Waters and the Rapid Bioassessment Protocols actually closely resemble each other in their basic approach to biological monitoring. Neither is exactly easy reading for those new to the world of biological monitoring, nor will they serve as "cookbooks" to tell volunteer monitors which sampling procedures, metrics, etc., they should use. But for those who are interested in staying abreast of the latest thinking in how to use multimetric indexes to assess biological health, I highly recommend both books.

Stonefly (family Chloroperlidae)

Ordering Information:

Restoring Life in Running Waters may be purchased from Island Press for $29.95 (paper); call 800-828-1302, or visit http://www.islandpress.org/.

The two videos, Fresh Waters Flowing and Biological Monitoring Protocol, are both available from the Adopt-A-Stream Foundation (AASF) for $16 each ($30 for both). (Note: AASF also distributes Restoring Life in Running Waters.) Call 425-316-8592, or visit http://www.streamkeeper.org/.

Rapid Bioassessment Protocols for Use In Wadeable Streams and Rivers may be ordered at no charge from EPA's NSCEP (National Service Center for Environmental Publications), 800-490-9198. Order by title and publication number (EPA 841-B-99-002).

Geoff Dates *is River Watch Program Director for River Network; gdates@rivernetwork.org.*

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Putting Wildlife on the Map

by Eleanor Ely

For broadness of scope, it's hard to beat the NatureMapping Program, started in Washington State in 1992.

"We take a holistic approach," explains NatureMapping co-founder Karen Dvornich. "The idea is to look everywhere and get a general picture."

The program aims to enlist the help of as many people as possible-farmers, urbanites, suburbanites, students, teachers, birders, hikers-and get them to send in data about all the wildlife they see, whether it's a robin outside their window or a snake along their hiking trail or a roadkill spotted from their car. Part of NatureMapping's philosophy is that a dataset of lower quality but high quantity (e.g., a lot of volunteers making observations all over the state) is just as important as a higher-quality but low-quantity dataset (e.g., a few researchers doing an intensive study at one spot).

Joining up as a NatureMapper is easy-just register at the Website (http://www.fish.washington.edu/naturemapping/ EXIT EPA). The Website also contains data-reporting forms, guidance manuals, and other useful information. Training sessions are available but not required. "We've made it as simple as 'Tell us what you see,'" says Margaret Tudor, NatureMapping's other co-founder.

Participants send their reports to the NatureMapping central office at the University of Washington, where the volunteers' observations are laid over existing maps showing scientists' models for each animal's range.

"There's no one way to NatureMap," says Dvornich. "People can look in different ways as long as they report in a consistent fashion."

Standardized data reporting is critical for accurate maps. The NatureMapping data form ensures consistency by specifying the information-such as date, location, species, number seen, and habitat description-that must accompany each observation.

To date, participants have reported 160,000 observations. As would be expected from the way the program is structured, most of the observations are of common species-and that's the idea. In fact, "keeping common species common" is one of NatureMapping's slogans.

"Scientists know their specialty but not the common species," says Tudor. Dvornich adds, "Who else is reporting crows? Who's reporting starlings? Yet these can have significant impacts on urban environments. People are telling us what's going on in their backyards, in cities and in sprawl areas. If you see a rat in the supermarket, that's a sighting."

The basic use for NatureMapping data is to learn more about range and distribution-as Dvornich says, "We want to know, Where are the animals? and at what time of year?" But the data can also help answer other questions, such as How are animals' ranges expanding or shrinking? or Where are nonnatives showing up, and what habitats are they using?

Dvornich's long-range goal is to expand NatureMapping all across the U.S., and to other countries as well. So far programs have been started in Norway, British Columbia, Idaho, Iowa, and Virginia, and Dvornich says 13 more states are interested.

Virginia was the first East Coast state to get involved. Virginia's program, which is called WildlifeMapping, was started in 1996 by the state Department of Game and Inland Fisheries.

"Wildlife watching has become one of the most popular outdoor activities in the United States," says Jeff Trollinger, the WildlifeMapping Coordinator. "Everyone who watches wildlife is really collecting valuable data. But usually they don't write the information down." WildlifeMapping provides a way to capture those observations and put them to use.

All WildlifeMappers attend a training workshop where they learn to use field guides, classify habitat, and find latitude and longitude. Data that volunteers submit includes species observed, species heard, tracks, and scat (if it can be positively identified).

According to Trollinger, "Wildlife Mapping is giving us data on species that agencies and scientists don't usually track. Before, we only had five data points for gray squirrels. The WildlifeMappers have already added about 30 more."

Bainbridge Island students learn NatureMapping techniques.

Trollinger says that WildlifeMapping works particularly well in classrooms because "it allows students to collect real data, and it can be integrated into science, math, geography, and English."

"The sheer volume is what makes the program good," says Trollinger. "The volume of data makes up for the lack of expertise. You get the oddball observation-but when you get four or five of those oddball observations, it's time to go and check it out, because everyone isn't making the same mistake."

For more information on NatureMapping, contact Karen Dvornich at kgap@fish.washington.edu; ph. 206-616-2031; or visit http://www.fish.washington.edu/naturemapping/". EXIT EPA *For more information on WildlifeMapping, contact Jeff Trollinger at jtrollinger@dgif.state.va.us; ph. 804-367-8747; or visit http://www.dgif.state.va.us/wildlifemapping/".* EXIT EPA

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Volunteers Track Bird Use of Restored Sites

by Alvaro Jaramillo

If we plant it, will they come? That's the big question for restorationists: whether native wildlife will use restored areas.

At Coyote Creek in Santa Clara, California, a decade of bird banding data-mostly collected by volunteers-is yielding some surprising results about bird use of revegetated riparian sites. Not only are birds using restored areas along the creek, but many species actually seem to like the restoration sites better than the pre-existing riparian forest.

The vision

The story begins in the 1980s, when massive development in our region-best known to the world as Silicon Valley-led to the need for flood control on local creeks. The Santa Clara Valley Water District embarked on an ambitious flood control project, which included creating an overflow channel for Coyote Creek. The channel's construction involved the removal of some riparian vegetation. To mitigate for this loss, the District undertook restoration of two sites adjoining a pre-existing patch of riparian forest. One site was planted in 1986, and the second in 1994.

The Willow Flycatcher, listed as an endangered species in

As part of the restoration process, the Water District had the foresight to include plans for a decade of wildlife

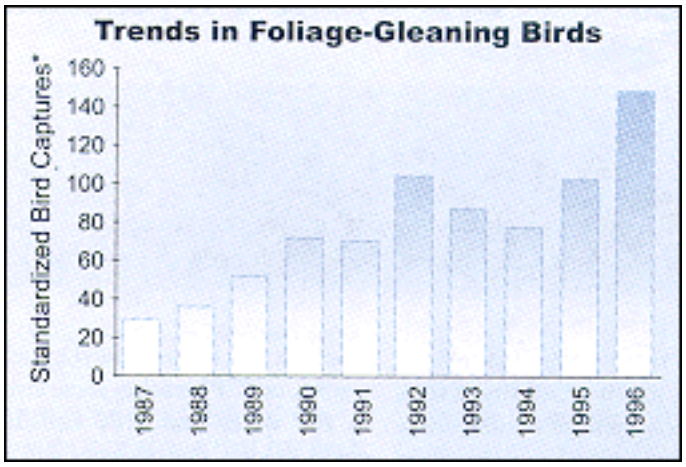
monitoring, with a focus on bird use of the restored sites. Monitoring began soon after the first site was planted, and was conducted by the Coyote Creek Riparian Station (CCRS), largely through the hard work of volunteers. Although CCRS closed its doors in 1999, the bird monitoring will continue under the auspices of the San Francisco Bay Bird Observatory.

California, has been seen in increasing numbers at Coyote Creek since the restoration.

The monitoring

Birds were monitored using a variety of methods, from breeding birds censuses and point counts to standardized bird banding. I will be focusing on the bird banding data, the "gem" of our datasets. Whereas observational methods like censuses and point counts provide only bird species and location, with banding the birds are captured and examined for age, sex, weight, fat level, and other characteristics.

Birds were captured in mist nets (nets so fine-meshed that they resemble mist) and individually marked with US Fish and Wildlife Service bands. We standardized our banding by maintaining net locations fixed during the 10 years and by opening nets for a total of 5 hours on one day every week, unless poor weather prevented us from doing so.



Since restoration began in 1986, foliage-gleaning birds have increased dramatically in abundance at Coyote Creek.
** Standardized bird captures = Birds captured per 1,000 hours of mist net usage*

The grand majority of the mist netting was conducted by trained volunteers. These are folks with a keen interest in birds who wanted to take part in something a little more challenging, educational, and science-oriented than simple birdwatching. Our hard-working team is not dissuaded by the fact that nets have to be opened before sunrise-it's all part of the fun!

Three elements of our program are unusual in riparian restoration monitoring: the year-round mist-netting, the long-term nature of the study, and the use of volunteers as banders. Without volunteers, this research would have been much too costly and would have never been done. Their dedication has been amazing; some have been with the project since its inception.

The sites

The restoration sites have grown over the years, until some of the trees are now tall enough to rival those in the pre-existing riparian forest. The arrangement and diversity of sites at Coyote Creek provides us with a nice "laboratory" for observing and comparing bird use of different habitats. In addition to the two restored areas and the original forest, the overflow channel-which is dry most of the time, and is mowed every few years-provides an open habitat for bird species that are not entirely forest-based.

The results

We have now finished over 10 years of data collection, with thousands of birds banded, and thousands of volunteer hours worked, and it was all worth it. The most basic question one can ask is, Did the restoration work? Of course this depends on how you measure success. What was once a parcel of nonvegetated ground is now a forest, and that alone is success. However, the question that interests us is, Did it work for the birds? The answer is a resounding yes!

Somewhat to our surprise, we found that in general we caught more birds-for certain species, a lot more-in the restored areas than in the original riparian forest. For a few species it was the opposite-we found more in the pre-existing forest-but in general the restored areas have had a greater density of birds. We are not sure why this is, but one hypothesis is that younger, more actively growing trees provide more food for insects than older trees.

Wilson's Warbler is one of several Neotropical migrants that stops at Coyote Creek.

Bird species that have increased in abundance over the time of the study include resident, breeding, wintering, and migratory species, suggesting that it is not only specific types of birds that are benefiting, but a wide variety.

Looking at ecological "guilds" (species that share general foraging habits or behavior), we see that some guilds have responded more dramatically than others. Foliage gleaners-birds that forage on insects they catch on leaves and twigs-seem to have benefited most, showing a gradual but steady increase in numbers (see graph). Annual fluctuations occur, but the pattern is clearly increasing. (Note: The graph shows combined data from all four sites, but almost all the increase was seen in the restored sites.)

Rare and threatened species

We've been especially pleased to see increases in several rare or threatened species. One

is the Salt Marsh Common Yellowthroat, a subspecies endemic to the San Francisco Bay (which is misnamed as it is more properly a bird of younger successional riparian habitats). This riparian specialist has a very small worldwide distribution and is listed by the California Department of Fish and Game as a "Species of Special Concern." Since the restoration, this species has done excellently. Mist-netting, point counts, and the breeding bird census all show that it has become more common on site over the 10 years of monitoring. Similarly, the state listed Willow Flycatcher, which bred in this watershed a century ago but is now extirpated and relegated to being a rare migrant, has increased noticeably over the years.

Migratory species

A good number of the birds that show up at Coyote Creek are migrants on their way to somewhere else. They stop here for a day or two, or maybe a week, to rest and refuel; then they fly on.

Since the restoration, we've seen increased numbers of several migratory species. For example, the Orange-crowned Warbler, a Neotropical migrant foliage-gleaning species, showed significant increases as the vegetation matured. Warblers resting on our site, in greater and greater numbers during each year's migration, could be coming from as far away as Alaska and be on their way to Mexico.

Does this mean that habitat enhancement on our site could in its own little way be having a global impact? It's possible; but we can't be sure because research is lacking. While a great deal of research has gone into understanding the conservation value of birds' breeding and wintering habitats, migratory habitat has been largely overlooked. The population-level effect of these stopover places is unknown. What is known is that over the last 100 years migratory habitat has been drastically reduced. Quite possibly this is one reason that some Neotropical species are in decline. Our project is one small step toward understanding how restoring stopover habitat impacts overall populations.

Alvaro Jaramillo *is the Senior Landbird Biologist at the San Francisco Bay Bird Observatory, P.O. Box 247, Alviso, CA 95002; 408-946-6548; alvaro@sfbbo.org.*

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UPDATE: Toxic Phytoplankton Monitoring

by Eleanor Ely

The Fall 1998 issue of The Volunteer Monitor reported on toxic phytoplankton monitoring by volunteers in California, Maine, and Massachusetts. Since then a new state has joined in: volunteers with New Hampshire's Great Bay Coast Watch began casting their plankton nets in July 1999. And there's exciting news from Maine's ever-active monitors. They're piloting two new techniques: quantitative cell counts, and a protocol for monitoring Prorocentrum lima (another toxic alga). Plus, their findings helped spark a professional research study, which had a very interesting result (see below).

Cell counts

The idea behind monitoring phytoplankton (microscopic free-floating algae) is to try to get a jump on shellfish toxicity incidents. Shellfish become toxic when they ingest toxin-producing algae, and humans come down with shellfish poisoning when they eat those shellfish. Shellfish agencies protect the public health by regularly testing shellfish for toxin and halting shellfish harvesting before toxicity reaches dangerous levels. By monitoring the water column for toxic algae, volunteers can give agencies an early warning and help them focus their shellfish-sampling efforts.

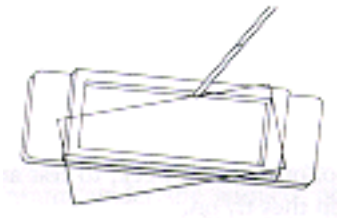
Up to now, Maine's volunteers (like those in the other states) have reported the toxic algae in terms of a rough estimate-"rare," "common," or "abundant." The program is

working very well; the volunteers have indeed been able to "catch" several toxic algal blooms before shellfish became toxic. But quantitative counts would be even better. So, during the 2000 sampling season (April to October), a few of Maine's volunteer groups will pilot-test a technique that will give them an actual count (number of algal cells per liter) for each species they monitor.

"The current qualitative method has both a benefit and a drawback," says Riley Young Morse, the Phytoplankton Monitoring Coordinator for Maine. "The benefit is, it's fast. The drawback is you only get a relative abundance."

Having actual counts will make the volunteers' data more useful to researchers. Quantitative cell counts would allow researchers to run statistical analyses and look for correlations between algal cell concentrations and shellfish toxicity. For example, it could be that when Alexandrium (the alga that causes paralytic shellfish poisoning, or PSP) reaches some critical level in the water-say, 100 cells/liter-you could predict that mussels will test positive in PSP toxicity tests. Such a relationship, if it exists, would be very useful to know about.

To obtain cell counts, volunteers collect a water sample in a sampler or bucket (instead of a plankton net, which is used for the qualitative procedure). They pour off 1 liter into a graduated cylinder and add Lugol's iodine solution to preserve and stain the cells. Now comes the inconvenient part: the sample must stand for 1 to 3 days to allow the phytoplankton cells to settle. After that, 1 ml of the concentrated bottom layer is pipetted off and placed in a special microscopic slide (see illustration) for counting under a microscope. Volunteers don't count every algal cell (which could take hours); instead they focus on a handful of target species known to be potential toxin producers in Maine.



Sedgwick-Rafter counting slide

P. Lima: A new threat in Maine?

Now here's an impressive example of how volunteer data can make a difference: Maine volunteers' phytoplankton results helped set in motion a chain of events which ultimately led to the discovery by researchers that the alga Prorocentrum lima-a toxic species which causes diarrhetic shellfish poisoning (DSP) in many parts of the world-occurs along the coast of Maine.

The story began with the volunteers reporting another alga-Dinophysis-that can also cause DSP. In 1998, the volunteers frequently reported seeing this alga, often in high levels. That in itself was surprising, because until then no one had suspected that Dinophysis was so widespread in Maine's waters. "The volunteer results were sending

up red flags that we might have a potential DSP problem in Maine, if the species of Dinophysis were toxic," says Morse. Maine's Department of Marine Resources (DMR) followed up by testing mussel tissue, and found low levels of DSP toxin in some mussels.

Dinophysis

To further investigate the possible DSP threat, a special team of researchers from the National Ocean and Atmospheric Administration (NOAA) lab in South Carolina came up to Maine in the summer of 1999. Volunteer data on Dinophysis helped them decide where and when to look, and sure enough, they saw lots of Dinophysis.

However, the Dinophysis cells weren't producing any toxin. But the scientists did find some toxicity in mussels, so they looked around for another alga as the possible culprit. Their search led to Prorocentrum lima-another surprise, because *P. Lima* was previously unknown in Maine coastal waters. And when they assayed the *P. Lima* cells for DSP toxin they did find low levels.

A positive link between the *P. Lima* and the mussel toxicity is as yet unestablished, but this study was the first to document *P. Lima*, and the possibility of DSP, in Maine coastal waters. The study was published in 1999 in the Journal of Shellfish Research, Vol. 18, No. 2 (Morton et al., "Evidence of Diarrhetic Shellfish Poisoning Along the Coast of Maine").

Looking for *P. Lima*

To follow up on this very interesting discovery, the volunteers will begin to monitor for *P. Lima*-a task that will be complicated by the fact that *P. Lima* is an epiphyte, meaning that it lives on other plants. Therefore it won't be caught in the plankton nets the volunteer monitors use to catch the other algal species. Instead, the monitors will collect macroalgae by hand at low tide, shake them in water to dislodge *P. Lima* cells, then examine this water under a microscope.

For more information, contact Riley Young Morse, Maine's Phytoplankton Monitoring Coordinator, at 207-832-0343; rmorse@umext.maine.edu.

Resource

"The Plankton Net: Maine's Phytoplankton Newsletter" is filled with useful news, scientific information, and reports about toxic phytoplankton, not just in Maine but from all over. For a free subscription contact Riley Young Morse (see above)

Volunteer Data in Scientific Literature

When research published in a peer-reviewed journal is based, in part or in whole, on volunteer monitors' data, that's an endorsement of the data's value and reliability. So Florida LAKEWATCH volunteers were justifiably proud when, in 1999, their data showed up in articles in three different journals: *Transactions of the American Fisheries Society, Journal of Aquatic Plant Management,* and *Journal of Lake and Reservoir Management.*

Mark Hoyer, who co-authored two of the articles, says the long-term nature of the LAKEWATCH dataset is what makes it so valuable. "Very, very few places have monthly water chemistry data on over 1,000 lakes, some going back to 1986," he says. Hoyer notes that most research study projects are short-term, which means researchers may think they are seeing a significant trend when actually it's just natural fluctuation. "Now," he says, "with the data collected by LAKEWATCH volunteers, we can get a handle on long-term variance."

Meanwhile, volunteer lake monitors in Minnesota and Vermont have also seen their data used in published research. The volunteers' Secchi data, along with the results of volunteer-administered surveys about lake user perceptions, were the basis for several articles published in the 1990s.

Of course, when it comes to getting volunteer data into the pages of scientific journals, birders are light-years ahead of other monitors. Keith Pardieck, Coordinator of the U.S. Breeding Bird Survey (BBS), says that "over 270 peer-reviewed and state journal articles have appeared where the authors relied heavily, if not entirely, on BBS data." And that is just one survey, albeit a very large one.

Attention readers: *The Volunteer Monitor* newsletter would like to hear about more examples of volunteer-collected lake, stream, wetland, or coastal monitoring data being used in published research. Please contact the editor at ellieely@earthlink.net; 401-723-5151.

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New Publications for Volunteer Monitors

Tips on Presenting Data

What are two things to watch out for when creating color-coded charts or maps?

The answer-along with numerous other useful tips-can be found in *Ready, Set, Present! A Data Presentation Manual for Volunteer Water Quality Monitoring Groups*, a new publication from Massachusetts Water Watch Partnership. The manual covers basic principles of data presentation and shows how to create effective and persuasive graphs, charts, brochures, exhibits, and presentations.

To gather ideas for the manual, the authors canvassed the volunteer monitoring community and came up with dozens of real-life examples of ways different groups have brought their data to life. For example, the Charles River Watershed Association brings their bacteria counts to the public's attention by posting flags indicating current water quality: a blue flag if counts meet the boating standard, and a red flag if counts violate the standard. The information is also posted on the Web (www.crwa. org) by using blue and red flag icons.

This blue flag signals good water quality. Flags are posted at nine boathouses in the Charles River basin.

In answer to the above question about color-coding: (1) remember that 8% of the U.S. population is color-blind, so don't use red and green on the same graphic; (2) for a printed report, check to see if the colors are still

distinguishable when photocopied in black and white.

The manual is available for $5; contact Marie-Françoise Walk, Outreach Coordinator, Massachusetts Water Watch Partnership, Blaisdell House, UMass, Amherst, MA 01003-0820; ph. 413-545-5531; mfwalk@tei.umass.edu.

Displaying Data: Three Examples

Recently, several volunteer monitoring groups have created publications that do a nice job of presenting volunteer monitoring data. In a large colorful poster produced by the Coalition for Buzzards Bay, different-colored fish logos placed on a map of the watershed indicate water quality in various locations. (For a copy, call Tony Williams at 508-999-6363, ext. 203.)

Meanwhile, Alabama Water Watch has just completed the first two of a planned series of reports on volunteer-monitored lakes, rivers, and estuaries. These colorful booklets are filled with maps, graphs, and photos, plus text explaining what the findings mean. (For a copy, call 334-844-4785.)

And in Michigan, the Huron River Watershed Council has prepared informative and engaging Creek Reports that include monitoring data along with creek history, features, and suggested activities that the reader can do to help the creek. (For more information, contact Joan Martin, 734-769-5971; jmartin@hrwc.org.)

Wetland Stewardship Video

"Wetlands Stewardship: A Call to Action" is a 28-minute educational and motivational video about wetland conservation. The video explains wetland ecology, functions, and values, and highlights stewardship projects ranging from land acquisition and legislative advocacy to education, mitigation, monitoring, and restoration.

The video was produced by the Izaak Walton League of America's (IWLA) Save Our Streams Program as a companion to the Handbook for Wetlands Conservation and Sustainability. The video costs $20 plus $5 S&H, and the Handbook costs $38.50 plus $6.50 S&H. Quantity discounts are available. For more information, see www.iwla.org/sos/ EXIT EPA (click on catalog) or call 800-BUG-IWLA (800-284-4952).

Revised Estuary Manual from EPA

The Environmental Protection Agency's new *Volunteer Estuary Monitoring: A Methods Manual*, 2nd edition, has been completed and is currently in production. It will soon be available in html format on the EPA's National Estuary Program Web page (www.epa.gov/owow/estuary/nep.html). The manual is more extensive than the previous version and includes new information about monitoring submerged aquatic vegetation (SAV) and toxics and using GIS. It will be available in hard copy in the fall (ordering information will be published in the next issue of *The Volunteer Monitor*). The document was developed by the Center for Marine Conservation under a cooperative agreement with the EPA.

Wetland Resource Guide

The Wetlands Division of EPA's Office of Wetlands, Oceans, and Watersheds (OWOW) is pleased to announce the release of its newest publication, *Volunteer Wetland Monitoring: An Introduction and Resource Guide* (EPA 843-B-00-001). This booklet provides an introduction to why and how people monitor wetlands and includes a 13-page resource guide to handbooks and manuals that offer detailed information on wetland monitoring for the layperson. While it is not a methods manual, the guide also offers advice on approaching wetland monitoring, most of which is a synthesis of comments received from organizers of wetland monitoring programs across the United States.

Copies may be obtained from the Wetlands Helpline at 800-832-7828 (fax 703-748-1308). Also, the publication will soon be posted at http://www.epa.gov/owow/wetlands/.

More New Publications for Volunteer Monitors are at http://www.epa.gov/owow/monitoring/volunteer/spring00/23pubs.html.

The Volunteer Monitor

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Volume 12, No. 1, Spring 2000

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New Publications for Volunteer Monitors (cont.)

"Beginner's Guides" from Florida LAKEWATCH

Florida LAKEWATCH has recently published two Information Circulars for their volunteer monitors. *A Beginner's Guide to Water Management-The ABCs* (39 pages) goes from algae to alkalinity to aquatic macrophytes, and on through the alphabet, discussing common water management terms in clear, nontechnical language. *A Beginner's Guide to Water Management-Nutrients* (32 pages) focuses on phosphorus, nitrogen, and the concept of limiting nutrients. Though designed for Florida volunteers, the booklets contain much useful information for any lake monitoring program.

The circulars may be viewed and downloaded from http://www.ifas.ufl.edu/~lakewatch/LWcirc.html. EXIT EPA A limited supply of printed booklets is also available; for information, call Amy Richard at 352-392-9617, ext. 228.

GIS Grants Available

Conservation and environmental nonprofit organizations seeking to use computer mapping technology can apply for Conservation Technology Support Program (CTSP) grants of computers, software, and training. CTSP is one of the few technology granting programs in the U.S. to offer training and support along with equipment and software. Computers and printers are donated by Hewlett Packard Company, and Geographic Information Systems (GIS) software by Environmental Systems Research Institute, Inc. (ESRI) and Clark Labs.

Application guidelines may be downloaded from http://www.ctsp.org/ (guidelines for the next granting cycle will be posted October 1, 2000).

River Voices Features Volunteer Monitoring

The Fall 1999/Winter 2000 issue of *River Voices,* River Network's quarterly publication, is a special double issue focusing on volunteer monitoring. Articles discuss why monitoring is necessary, how we can measure watershed health, how to locate existing information about your watershed, and moving from information to action. Case studies and a listing of references and resources make this issue a good overview of the principles and practices of volunteer monitoring. Special offer copy is free; contact River Network to purchase multiple copies. Send email to jhamilla@ rivernetwork.org or call 503-241-3506.

Watershed Assistance Grants

Watershed Assistance Grants ranging from $1,500 to $30,000 are available to support local watershed partnerships in the United States. For criteria and guidelines, see River Network's Website at http://www.rivernetwork.org/wag2000.htm. Applications must be postmarked not later than August 15, 2000.

Print Your Own Topo Maps

The TopoZone Website (http://www.topozone.com/) allows users to view a USGS topographic map of any location in the U.S. at different zoom levels. If you have a color printer with good resolution, you can print your own maps for free. Note, however, that the maps are "for personal use only" so you would need to obtain permission to use them in a publication.

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Success Stories from Alabama Bacteria Monitors

Last December, Alabama Water Watch (AWW) became the first volunteer monitoring group in EPA Region 4 to have an EPA-approved QAPP (Quality Assurance Project Plan) for bacteria testing. AWW volunteers use Easygel, a rapid screening method that detects *E. coli* in water samples. They incubate the plates in simple homemade incubators consisting of a styrofoam cooler warmed by a light bulb. (Note: For more on Easygel, as well as other bacteria testing methods, see *The Volunteer Monitor* Fall 1998 issue.)

The Easygel method is used as a first-alert screening test. Volunteers are instructed to follow up high counts by retesting the site, and, if counts remain high, to send a sample to the health department for verification.

"Maintaining data credibility has always been a crucial aspect of our program," says Allison Busby, AWW's Data Quality Coordinator. "We've gotten a lot of pats on the back from EPA, ADEM (Alabama Department of Environmental Management), and the health department for our strong QA program. Having the approved QAPP shows agencies that we're holding our volunteers to some pretty rigid standards."

Among other QA elements, AWW's bacteria-testing QAPP specifies that volunteers test three replicate samples at each site and calls for periodic side-by-side comparison with standard methods.

"We've had lots of success stories from our bacteria monitors," says Busby. In one case, a group of volunteers with RSVP (Retired Senior Volunteer Program) found high counts at a swimming beach on a lake. After the problem was traced to a large Canada goose

population, the city passed an ordinance against feeding the geese.

Another story Busby likes to tell is about the time citizens "took the smelly petri dishes of bacteria straight to the Mayor's office. This was done on a Friday and the city had dozers out Monday morning repairing a broken sewer line."

Of course getting results isn't always quite that simple. Another AWW volunteer found serious bacterial contamination half a mile downstream from a wastewater treatment plant. "The plant was not going to do anything to remediate based just on his findings," says Busby. The volunteer had to contact the state regulatory agency, Alabama Department of Environmental Management (ADEM), several times before an inspector was sent to investigate the site. ADEM confirmed the volunteer's results and concluded that hurricane damage was the problem with the out-of compliance treatment plant. The plant made repairs, and the volunteer continues to check the site; so far, results have been good.

For more information, contact AWW at 1-888-844-4785; aww@acesag.auburn.edu. For guidance on preparing a QAPP, see the EPA publication *The Volunteer Monitor's Guide to Quality Assurance Project Plans* (available online at http://www.epa.gov/owow/monitoring/vol.html; or order EPA 841-B-96-003 from NSCEP, 800-490-9198).