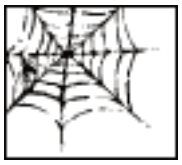
The Volunteer Monitor

The National Newsletter of Volunteer Water Quality Monitoring
Vol. 11, No. 2, Fall 1999



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Issue Topic: Youth Projects

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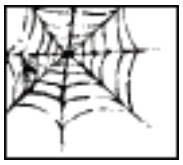

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Next issue

The theme for the Spring 2000 issue of The Volunteer Monitor will be Monitoring Flora and Fauna. Please contact the editor (address below) if you would like to contribute an article.

From the Editor

New Publisher for The Volunteer Monitor

Vermont-based River Watch Network and Oregon-based River Network recently merged under the name River Network (see announcement on page 8). The new River Network has also taken on a new role as publisher of The Volunteer Monitor newsletter, under a grant from the Environmental Protection Agency. Publishing The Volunteer Monitor provides us a chance to learn more about the dedicated work of volunteer monitors and to help build connections among grassroots activists nationwide, says River Network President Ken Margolis.

The Volunteer Monitor will continue to publish the same mix of articles for, by, and about volunteers carrying out a variety of monitoring activities in many types of environments. The biggest change is that newsletter production and distribution are now handled through River Networks national office in Portland, Oregon (see address below).

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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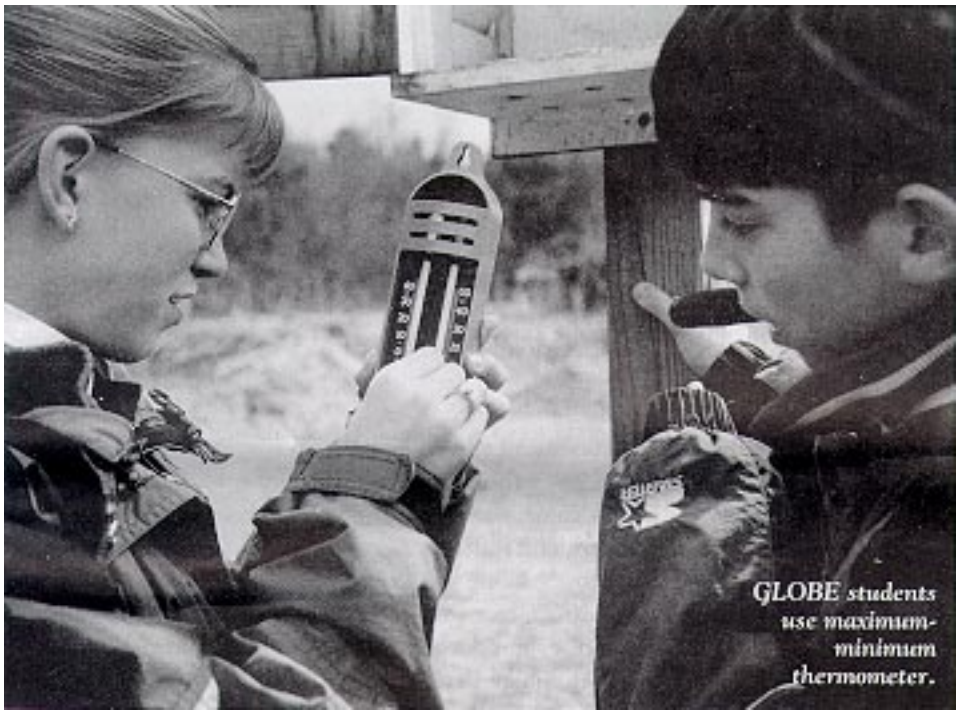
GLOBE Couples Education with Research

by Eleanor Ely



The GLOBE (Global Learning and Observations to Benefit the Environment) program has very ambitious goals. One is to educate K-12 students about the environment and the scientific process by involving them in hands-on data collection. At the same time GLOBE intends the student-collected data to be used by scientists to answer important

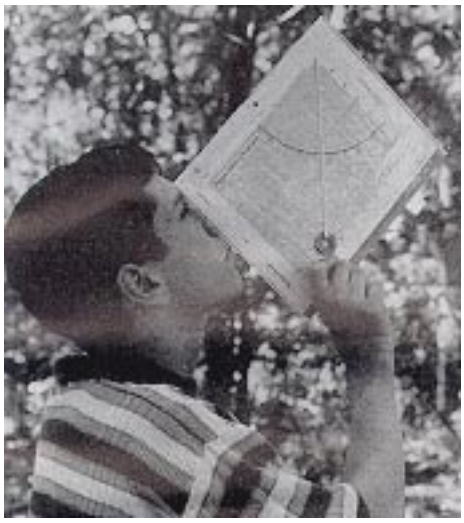
research questions about ecosystems. And finally, GLOBE aims to accomplish these goals on a planetwide scale.

GLOBE, which was originally inspired by Vice President Al Gore's vision of using students and teachers to monitor the whole Earth, officially started on Earth Day 1995. Funding from four U.S. federal agencies, totaling $11 million for the coming fiscal year, pays for the program's infrastructure-the teams of scientists who develop and test the methods, GLOBE's database on the Internet, "train the trainer" workshops, and a 900-page teacher manual available in the six U.N. languages. Schools are responsible for obtaining their own equipment (some of which can be homemade, borrowed, or shared with other schools).

The program has now trained teachers from over 8,000 schools in more than 80 countries and has generated over 4 million environmental measurements, all accessible through GLOBE's Website at www.globe.gov. Because data collection on this scale could not be accomplished in any other way, the potential scientific value of the GLOBE dataset is very exciting-provided, of course, that the information is reliable enough for scientists to use.

GLOBE research domains

GLOBE's investigations are organized under four major research areas or "domains," each focusing on a different part of the Earth system-atmosphere, hydrosphere, pedosphere, and biosphere. (GLOBE uses the terms Atmosphere, Hydrology, Soil, and Land Cover/Biology.) Each domain is coordinated by its own team of scientists, whose job is to design and test protocols that will generate data reliable enough to be truly useful both in their own research and for the scientific community in general.



A student uses a GLOBE homemade clinometer to determine tree height for the Land Cover/Biology Investigation.

The GLOBE teacher's manual contains detailed protocols for collecting data in each domain. For example, the Atmosphere Investigation section includes six protocols: cloud type; cloud cover; rainfall; solid precipitation; precipitation pH; and maximum, minimum, and current temperature. Atmospheric measurements are made daily; hydrology measurements, weekly; and land cover and soil measurements, from weekly to one time only. A school does not need to do every investigation in order to participate, though GLOBE hopes that all schools will eventually implement all the protocols.

GLOBE data use

The strengths of the GLOBE database are its reach (worldwide, though to date the program is most active in the U.S., Europe, and Australia), its size, and its accessibility. Such a database is particularly well suited to tracking environmental changes over large areas and comparing conditions in different parts of the world.

Some current examples of GLOBE data use are:

- Verifying maps made from satellite data. Satellite data are widely used to classify and map land cover. However, ground cover can't always be accurately determined from satellite data alone-for example, what looks like shrubs could in fact be grasses. On-the-ground observations and measurements by GLOBE students are enabling scientists to create more accurate maps-a critical tool for studying how land cover changes in response to climate change, population growth, development, or natural disasters.

- Establishing baseline water quality data. Roger Bales, a scientist with GLOBE's Hydrology team, says, "GLOBE hydrology measurements fill a critical gap because GLOBE schools sample many smaller streams and lakes that are under-represented in the professional monitoring programs run by government agencies."

GLOBE students collect a soil profile sample.

- Documenting the timing of "budburst" (opening of tree leaf buds). Are growing seasons changing in some parts of the world, possibly in response to global warming? Some researchers think they are, but this claim is controversial. According to GLOBE scientist Dave Verbyla, "What is really needed are on-the-ground observations of plant greenup and senescence [death]." GLOBE students are monitoring tree branches near their school to pinpoint the exact date of budburst.

Ensuring data quality

So, how does GLOBE ensure that student measurements are reliable enough for scientists to use? According to Mimi Becker, a member of the Land Cover/Biology team, it's a time-intensive, multi-step process. "The reality of a program like this is that it takes at least five years to create, test, and fully implement the protocols," she says. "First you have to be sure that what you're investigating is a question that's amenable to a student-teacher-scientist partnership." For example, in characterizing land cover, it is reasonable to ask students to identify the dominant tree species but not the dominant

grass species, since it takes a highly trained botanist to identify grasses.

The next step, according to Becker, is to "be sure your protocols are scientifically defensible and that you're providing adequate instructions and training so teachers and students can carry them out." The Land Cover/Biology team does extensive field research with teachers and students to ensure that they can accurately implement the protocols.

Like the other GLOBE scientist teams, the Land Cover/Biology team has done studies comparing student data with professionally collected data from the same site. The results have been encouraging: while students sometimes make mistakes on the details, they generally get the major categories right. (For example, students might accurately classify an area as "closed forest" but then subclassify it as "mixed" when it should be "conifer.")

Attention to data quality is evident throughout the program, from teacher training to data entry. Training sessions and the GLOBE manual both stress the importance of following the protocols exactly. Most of the equipment used in the investigations can be calibrated, and calibration is included in the protocols. And when students enter their data into GLOBE's database, they get immediate feedback-a happy face if the measurement seems reasonable, or a prompt asking them to re-check their results if they enter, say, a tree height of 1 cm or an air temperature of 80°C.

Encouraging wider use of GLOBE data

Finding additional ways to make use of the program's scientific potential is an ongoing project. In a paper presented at GLOBE's 4th annual conference (July 1999) and available at http://www.globe.gov/ EXIT EPA (click on "Special Events"), GLOBE scientist David Brooks writes, "True partnerships develop when scientists define their needs and schools provide high-quality data that are otherwise difficult or impossible to obtain. However, this ideal arrangement is rarely realized in practice even within GLOBE. In order to develop indispensable partnerships, we must actively seek ways to use the resources GLOBE has to offer."

Brooks proposes using GLOBE data to assist with integrated pest management (pest management that minimizes the use of pesticides). Integrated pest management requires knowledge of local air and soil temperature for predicting the time of pest emergence. Existing weather data collection sites are too widely spaced to meet this need. Since GLOBE protocols already call for daily air and soil temperature readings, GLOBE schools have the potential to fill the gap.

However, according to Brooks' article, many GLOBE schools are not currently

reporting temperature data consistently enough to be useful in pest management. In a discussion that will sound familiar to people involved with volunteer monitoring, Brooks argues that students and teachers will be more motivated to collect good data if they feel connected to a real science investigation-in other words, if they know how their data will be used. Brooks writes, "GLOBE protocols are only starting points for doing meaningful science. . . . Just doing the protocols is not science." But once teachers and students understand what scientific questions their data will address, Brooks writes, "following GLOBE protocols [will] be viewed as a necessary part of answering those questions, rather than as an end in itself."

Dixon Butler, GLOBE's chief scientist, adds that student commitment to data quality is also strengthened when students do their own research projects as part of their science classes. "GLOBE data allow students to ask and answer their own questions about the environment," he says.

Volunteer monitors can help

The GLOBE program, with its large number of scientific protocols and its emphasis on data quality, can easily be intimidating for teachers. "Teachers leave the training with a tension between enthusiasm for the project and feeling overwhelmed by the possibilities," says Butler. "Local adult volunteer monitors are a wonderful resource. They can bring their passion and knowledge to help a teacher who may be feeling timid scientifically."

Martha Conklin, a scientist with GLOBE's Hydrology team, says, "We've been in a bit of a vacuum. Teachers from around the country call and ask me if their measurements are good, and I have no way of knowing what values are normal for their stream-but a local volunteer monitoring group could really help."

Conklin recently discovered the online Directory of Volunteer Environmental Monitoring Programs (http://yosemite. epa.gov/water\volmon.nsf) and was delighted with the possibilities it offers. "Now," she says, "when teachers call me I can refer them to a local volunteer group."

So, volunteer monitors: Be ready! The next time your phone rings, it could be a GLOBE teacher from a school down the street.

For more information about GLOBE, visit http://www.globe.gov/.

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

All Photos within this article courtesy of: GLOBE

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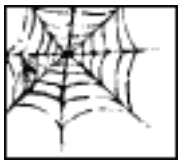

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Bioassays Bring Real Science to the Classroom

by Nancy Trautmann

Over the past decade, Cornell University has carried out summer programs for high school science teachers interested in watershed science. One topic we cover is water quality testing, including simple chemical measurements using test kits, as well as biomonitoring studies based on the numbers and types of invertebrates collected in stream habitats.

Several years ago we introduced bioassays into the program because students were coming up with questions they couldn't answer with chemical and biodiversity monitoring. For example, when students in one school found few invertebrates downstream of their football field they wondered whether a pesticide or other toxic chemical might have drained from the field during storms. Other explanations for the low counts might be that dissolved oxygen in the stream had intermittently dropped too low to support sensitive species, or the pH had become too high after liming of the fields.

Student counts duckweed fronds (leaves) in a bioassay experiment at Ithaca High School.

Chemical test kits can be used to measure dissolved oxygen and pH, but testing for pesticides or other toxic chemicals generally requires equipment and reagents that are too expensive or dangerous for high

school use. Bioassays provide a feasible alternative. A bioassay is a test that uses biological organisms to determine toxicity, which is a measure of the degree to which a chemical or mixture of chemicals will harm living things. All chemicals are potentially toxic, but some are deadly at much lower concentrations than others. Rather than measuring the concentration of a specific chemical, bioassays provide an integrated measure of the toxicity of the mixture of chemicals in a solution.

Types of bioassays

Three popular test organisms for bioassays in the classroom are lettuce seeds, duckweed, and *Daphnia*. (Procedures for all three have been described in previous issues of *The Volunteer Monitor*-lettuce seeds in Spring and Fall '96, duckweed in Fall '96, and *Daphnia* in Spring '93.)

In our teacher programs at Cornell, we started with the lettuce seed bioassay-probably the simplest, since it requires no maintenance of cultures of test organisms. You simply place lettuce seeds in petri dishes along with the water, sediment, or chemical solution you wish to test. Five days later, you count how many seeds have sprouted and measure the lengths of their radicles (the embryonic roots).

We've also used duckweeds-tiny aquatic plants that float at the surface of ponds, lagoons, and slow-moving bodies of water. In duckweed bioassays, you float duckweed plants in your test solutions, then after several days of incubation you count how many new fronds, or leaves, have grown.

This past year we started working with *Daphnia*, tiny freshwater crustaceans that are related to lobsters and crabs but look more like fleas as they hop around in water. In most *Daphnia* bioassays, you look at survival rate. It's also possible to use *Daphnia* heart rate or appetite as an indicator of toxicity.

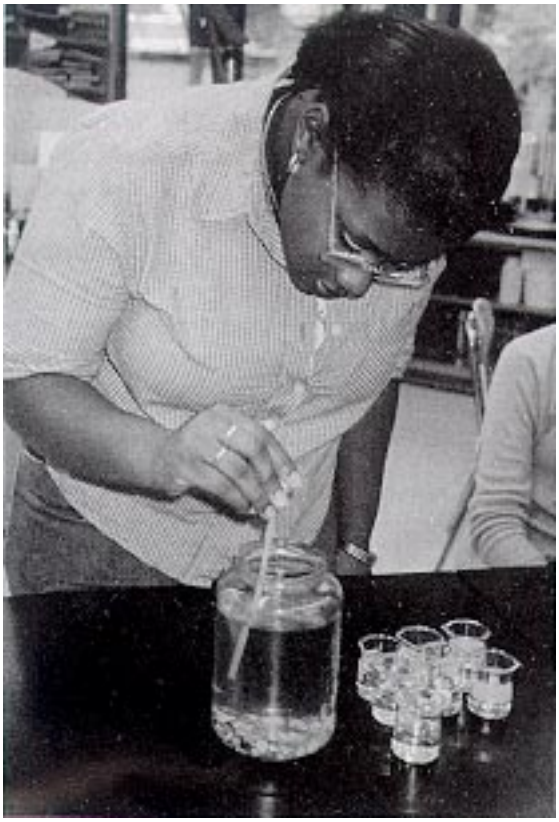
Why bioassays in the classroom?

Traditionally, high school science has been taught as a set of facts, principles, and vocabulary words to be memorized rather than as an ongoing process of inquiry and discovery. Too often, laboratory activities are demonstrations or cookbook-type exercises in which the teacher knows the correct answer and all the students

should get the same results. This gives students no understanding of the processes through which scientific discoveries are made.

National education reform efforts have focused attention on the need for students to engage in authentic research. One of the great challenges for science teachers is to provide students with opportunities for authentic open-ended investigations that are safe and feasible to perform at the high school level.

Bioassays are ideal for this purpose. They are "real science" and can be used to investigate issues of importance to the local community. At the same time, they are simple and inexpensive to carry out.



Using a plastic pipette, an Ithaca High School student transfers Daphnia *to beakers containing water samples for toxicity testing.*

At first, students may think it silly to use lettuce seeds to test for pollution in a lake or stream. They will probably be surprised to learn that this same technique is used by scientists in government and industry. For example, lettuce seed and other bioassays are used to map areas for cleanup of contaminated sites and to determine whether effluent from wastewater treatment plants or industries is clean enough to be discharged into a stream or lake. With very few modifications, students can carry out the same procedures to answer questions of their own design.

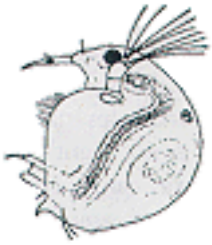
Pros and cons of different bioassays

Each of the three test organisms has its own advantages and disadvantages. Lettuce seeds are the easiest to work with, but duckweed and *Daphnia* have a more obvious connection to water pollution since they naturally grow in ponds. Results are usually quickest with *Daphnia* (in highly toxic solutions, they die immediately). However, both *Daphnia* and duckweed require either long-term maintenance of populations or ordering of new cultures each time bioassays will be carried out.

Interpretation and critical thinking

Precisely because they are real science and not cookbook exercises, bioassays often lead to more questions than they answer. For example, if duckweeds and *Daphnia* thrive in samples of lake water, would it be reasonable to conclude that it is safe for humans to

swim in this water or even to drink it? Of course not, since human physiology is entirely different from that of the bioassay organisms.



Daphnia

Alternatively, suppose that none of the lettuce seeds sprout when exposed to lake water. Does this mean that there must be a poisonous chemical in the lake? Not necessarily. Perhaps the pH is simply too low to support seed germination. (Solutions that are less acidic than lemonade or soda can kill *Daphnia* and inhibit duckweed and lettuce seed growth, yet they obviously are not poisonous to humans.)

If more *Daphnia* survive in your stream samples than in the distilled water control group, does that mean that the stream is not polluted? No-in fact it might be "polluted" with excess nutrients that are disrupting the stream ecology but are not toxic to *Daphnia* under the bioassay conditions.

These kinds of questions help students to think critically. Initially students may jump to conclusions, then realize through classroom discussions that other explanations are more likely.

They may end up deciding that further experiments are necessary before a final conclusion can be reached.

Data analysis

Students can carry their data analysis to different levels, depending on their interest and mathematical background. At a relatively simple level, students can graph their lettuce seed data with bar graphs showing the average radicle lengths in different solutions. Looking at these graphs, students may be tempted to conclude that the treatments with the highest bars are the least toxic to lettuce seeds. But how can you tell if the differences are real or due to random variation in radicle length? One way is to graph individual data points rather than just the means, which gives a visual picture of the large degree of variability commonly found in bioassay data. Students who are ready for a higher level of complexity can also use statistical tests to determine the significance of any differences they have observed.

In lettuce seed bioassays, one question that frequently arises is how to handle the zeros-that is, if a seed doesn't sprout, should you include a zero for that seed when calculating the average radicle length, or should you calculate the average length just of the seeds that do sprout? This makes for interesting classroom discussions and helps students to understand that there is no "right" or "wrong" answer-either way can be correct depending on how you report your results. For comparison with other studies, however, it is important to know which technique was used. (According to Joe Rathbun, the

aquatic biologist/chemist who reported on bioassay techniques in previous issues of The Volunteer Monitor, the usual procedure is to report the number or percentage of germinated seeds, and to calculate the average root length without including the zeros.)

Community connections

Bioassays offer the opportunity to connect classroom science to relevant community issues. Students in Mark Johnson's environmental science classes here in Ithaca used lettuce seed and *Daphnia* bioassays to compare the toxicity of road salt (sodium chloride) with a de-icing alternative. The students found the alternative product to be less toxic than salt to their bioassay organisms, but also less effective in melting ice and snow. The same product was being pilot-tested by the local highway department, and the students sent their results to the department. According to their teacher, "Having this sort of community connection helps students to see that scientific research has real-world applications and is not just something that scientists carry out in isolation in their labs."

Duckweed

An aspect of science that typically is missing in high school classrooms is the opportunity to share findings and discussions with a wider community of scientists. To provide this possibility for high school students engaged in bioassay experiments, the Environmental Inquiry Program at Cornell University has created a Website (http://ei2.education.cornell.edu/) where students and teachers can share questions, ideas, and results with other classes that are carrying out similar types of experiments. The Website also contains protocols for the three types of bioassay discussed above, as well as ideas for student experiments.

Anyone is invited to visit this Website, either as a participating student or teacher, or as a casual observer. If you have a comment to make about your own bioassay experiences, here is a good place to do it!

Nancy Trautmann is Program Leader for Environmental Inquiry, a Cornell program dedicated to supporting research in environmental sciences by high school students and teachers. She may be reached at the Cornell Center for the Environment, 100 Rice Hall, Cornell University, Ithaca, NY 14853; 607-255-9943; nmt2@cornell.edu.

All Photos within this article courtesy of: Nancy Trautmann

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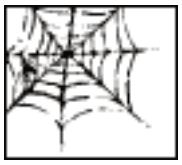

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Mark Your Calendar!

6th National Volunteer Monitoring Conference April 26-29, 2000

Everyone with an interest in volunteer monitoring is invited and encouraged to attend the 6th National Volunteer Monitoring Conference, to be held at the Clarion Suites Hotel in Austin, Texas, April 26-29, 2000.

Focusing on the theme of *Volunteer Monitoring: Moving Into the Mainstream*, the conference will offer new ideas and inspiration to volunteer monitoring newcomers and old hands alike. The conference will offer interactive skill-building workshops, breakout sessions, presentations, field trips, interactive exhibits, and, of course, plenty of time for networking.

To receive registration information, please contact Volunteer Monitoring Conference, c/o Mary Crowe, Tetra Tech, 10306 Eaton Place, Suite 340, Fairfax, VA 22030; ph. 703-385-6000; fax 703-385-6007; crowema@tetratech-ffx.com Conference updates will be posted on the EPA Website at http://www.epa.gov/owow/monitoring/vol.html.

(Note: Those who can come to Austin a little early may want to consider attending all or part of the National Water Quality Monitoring Council

conference, which will take place immediately preceding the volunteer monitoring conference. For more information, visit the Website, http://NWQMC.site.net/">NWQMC.site.net .)

What Do You Mean, Success?

by Steven Hubbell

Because I'm the coordinator of a large volunteer monitoring network, people periodically ask me for success stories about our program. I know what they want to hear. They'd like a clear-cut, headline-grabbing story--maybe something about volunteers who prevented fish kills by first tracking the correlation between elevated water temperatures and low dissolved oxygen levels, then promptly notifying their friends at the industry upstream, who immediately altered their discharge schedule to allow ambient water temperature to cool, reversing the threatening conditions and allowing the fish to survive.

And, yes, we have our variations of those stories. There were the phosphate reduction ordinances of 1991, which came about when a small group of Colorado River Watch Network students, teachers, and staff showed their phosphate results to community leaders in Austin and other towns along the lower Colorado River. The phosphates were considered to be a contributing factor to algae blooms and declining fish populations, and the City of Austin and several downstream communities passed ordinances limiting the retail sale of high-phosphate detergents. A recent analysis by the Lower Colorado River Authority indicates a statistically significant decline in phosphates in the river over the last 10 years.

Then there was the decision to permit swimming at McKinney Falls State Park. After being closed to swimming for twelve years, the parks swimming area was reopened based in part upon consistently low fecal coliform levels detected by volunteer monitor D.W. Brown.

Accomplishments like these are commendable and noteworthy. But to measure success exclusively in terms of volunteers making a quantifiable difference in the health of local waters is to overlook the larger impact of volunteer monitoring. I have come to believe that it is the unsung successes that really make the difference--the environmental ethic infiltrating the lives of new generations, the sense of ownership and personal responsibility that accompanies the monitoring experience, the stewardship model being played out in cities and towns where citizens from every walk of life join the common

purpose of safeguarding precious resources for future enjoyment.

We do not fully appreciate the successes of volunteer monitoring unless we acknowledge the significance of volunteer monitoring as a democratizing movement that makes a qualitative difference in the lives of volunteers and their communities. This is the quiet, immeasurable, cumulative impact of volunteer monitoring upon our society and, if we succeed, across the globe.

Steven Hubbell *is the Program Coordinator for Colorado River Watch Network, Lower Colorado River Authority, Austin, TX 78767; 800-776-5272, ext. 2403; steven.hubbell@lcra.org.*

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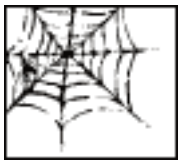

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Bioassay Experiments--One Teacher's Story

Three years ago, Pat Carroll started doing bioassays with her 10th grade Applied Science class at Newark Valley High School, a small rural school in upstate New York. The school's Applied Science program is especially designed for students who are not planning to go to college.

The students carry out an ambitious series of experiments using both lettuce seeds and Daphnia. Carroll explains that she likes to use two test organisms, one plant and one animal, because that's what scientists would do. If you were testing a site that had phosphorus or nitrogen, she says, you could do a lettuce seed assay and the seeds would grow very well. But Daphnia might be killed. Using both assays shows the students that what's toxic to animals is not necessarily toxic to plants.

The students make solutions of heavy metals (lead or zinc) or organic compounds (pentachlorophenol or para-nitrophenol) and test the solutions in the two bioassays to determine their toxicity. Then they do experiments to try to remove the toxic compounds from the water samples.

"The kids are doing open-ended experiments," says Carroll. "I am sincerely excited to see their results because I don't know how it will turn out."

Carroll gives the students a tap water purifier, which they take apart to observe what is inside--small resin beads and activated charcoal. Then they make little columns out of 5- or 10-ml plastic pipettes with the tips cut off, and fill the columns with either activated

charcoal or resin beads. They attempt to purify their toxic solutions by pouring them through the columns.

"The students took a solution that they had shown was toxic to lettuce seeds and dripped it through a column," says Carroll, "and when they took the effluent and used it in the bioassay, the lettuce seeds grew wonderfully. The students proved they could remove the toxic compound."

Through their experiments, the students discover that they can clear the metals--but not the organics--with the resin column. Conversely, the activated charcoal column removes the organic compounds but not the heavy metals. This leads to discussions of how the columns work (the resins absorb charged ions, such as metals, while activated charcoal removes uncharged organic molecules).

"For students who are not used to thinking of themselves as scientists, these experiences can trigger increased motivation and self-esteem. I was thrilled with the way the students reacted to the bioassays," says Carroll.

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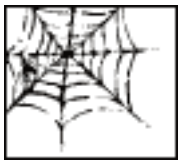

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Visually Impaired Students Monitor Illinois River

by John Moreland

My science students at the Illinois School for the Visually Impaired (ISVI), who are blind or visually impaired, don't let their lack of sight stop them from helping the environment, increasing their knowledge, or having fun. As participants in the Rivers Project, a program that involves 435 schools and thousands of students across the state of Illinois (see sidebar at right), ISVI students monitor the Illinois River for nitrates, dissolved oxygen, phosphate, temperature, velocity, turbidity, plankton, and macroinvertebrates. The students work as a team, with those students who have some vision assisting those who do not have vision.

Because of the visual impairment of our students, we have made some adaptations and modifications to our testing equipment. Most of the equipment is marked with large print and some is marked with Braille. We put Braille dots inside test tubes to indicate how deep the tube should be filled. The students use Braille rulers to measure water depth and large-sized thermometers to read temperature. Microscopes equipped with cameras are connected to a television screen for enhanced viewing of plankton and macroinvertebrates.

The students are also beginning to use a DR/2000 Spectrophotometer, which gives a visual readout of water testing results. We will connect the DR/2000 to a computer for larger viewing and recording, and we will have the procedures and results put into Braille copy for our blind students.

The Rivers Project gets the students out into the community, gives them hands-on experience, and creates challenges that they enjoy. For the past seven years, ISVI students have presented their water testing results at the Illinois State Fair in Springfield. With proper equipment modifications, and lots of patience and hard work, the ISVI students can successfully compete with their sighted peers.

Photo courtesy of: John Moreland

John Moreland *teaches high school science at the Illinois School for the Visually Impaired, 658 E. State St., Jacksonville, IL 62650; 217-479-4400.*

Earth Force Assumes GREEN's Mission

Early in 1999, GREEN (Global Rivers Environmental Education Network) formally dissolved, mainly on account of financial problems. GREENs mission and vision have been taken up by Earth Force, a national nonprofit organization based in Alexandria, Virginia. All the GREEN publications and water monitoring kits are now available through Earth Force. Earth Force will also be offering GREEN training workshops and supporting the international network of schools participating in GREEN.

Earth Force uses the term youth-driven to describe its philosophy and approach. The organization has a national Youth Advisory Board whose 15 members are from 10 to 17 years old, and young people involved in Earth Force projects decide what issues they want to work on and what actions to take. Earth Force programs include Get Out Spoken, a campaign to promote bicycling, and CAPS (Community Action and Problem Solving), through which young people address an environmental issue in their community.

For more information about Earth Force, please visit the program's Website, http://www.earthforce.org/ EXIT EPA, or contact the National Office at 1908 Mount Vernon Avenue, 2nd Floor, Alexandria, VA 22301; 703-299-9400; earthforce@earthforce.org.

The Rivers Project

This summer, the Rivers Project celebrates its 10th anniversary of working with schools across the country. The Rivers Project curriculum can be used in six subject areas--math, biology, chemistry, language arts, geography, and earth science--all designed around the interdisciplinary study of rivers.

Bob Williams, founder and director of the Rivers Project, says, For teachers who want to do river monitoring with their classe's, its relatively easy to perform the tests, but more difficult to explain the whys. Our curriculum provides students with the background they need.

Rivers Project students in Collinsville, Illinois. Photo courtesy of: Bill Brinson

This summer, the Rivers Project will conduct teacher-training workshops in Rhode Island and Illinois. Workshops are one week long and most sessions are taught by Rivers Project teachers. Graduate credit is available. One of the workshops will have a special focus on instrumentation. Participants will get hands-on experience using equipment like the DR/2000 spectrophotometer, graphing calculators, and GPS (global positioning system) receivers.

"Teachers want to include more technology now," says Williams. "It's good job preparation for the students. They can walk into a college or industry lab and see the same instrument they used in high school."

For more information about Rivers Project curriculum materials (available for $23.95 per book) or teacher-training workshops, visit www.siue.edu/OSME/river or contact Bob Williams at rivers@siue.edu; 618-650-3788.

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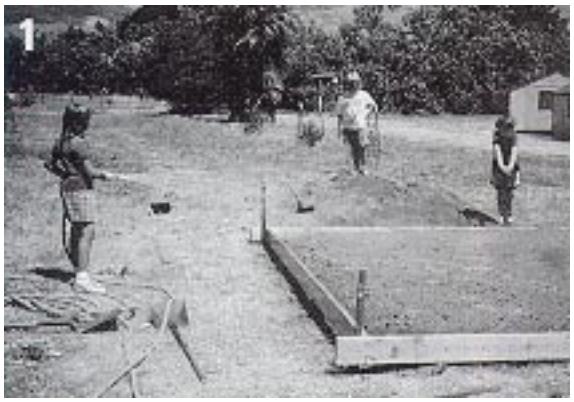
Building Large-Scale Watershed Models

by Judy Neuhauser

In August 1998, I began working with a group of volunteers-mostly kids from my 4-H Science Clubs (see article on page 10)-to construct a large-scale model of the Morro Bay watershed. The accompanying photos show some highlights of the process.

We finished the model in about eight weeks, working mainly on weekends. We were figuring out our construction techniques as we went. The actual model construction materials came



The first step in preparing the foundation was to build a 12-foot square wood frame and fill it with sand.

We photocopied the topographic map of Morro Bay watershed onto clear acetate, then projected it onto 4-by-8-foot, 2-inch-think rigid foam insulation boards. With a marker, we traced the contour lines for different elevations onto different boards.

to only about $1,100. The money came from the Morro Bay National Estuary Program.

This model was so popular and effective at teaching people about runoff pollution that, over the next year, I ended up overseeing the construction of two more. The second model was built by a group of at-risk high school students who came on a field trip to see the Morro Bay model. After working with the model they got pretty excited, telling us, "This is way cool!" I told them that kids had built it and showed them our photo album of the construction. They pushed hard to build one of their own, enthusiastically writing letters to support a small grant that we applied for.

With funding from Pacific Gas and Electric, these students completed a model of their own watershed-Arroyo Grande Creek-in one month. They're very proud of it! One told me, "I can't believe we built this from a couple of bags of concrete and some boards." It was a real, tangible project that they were able to do from start to finish; they learned some good,

We cut the foam along the contour lines using a saber saw, then stacked the pieces like a giant layer cake. It's ver easy to lose track of where a piece goes, so as soon as each piece was cut, it was labeled with its elevation and an arrow pointing north, then immediately put in place and pinned with nails.

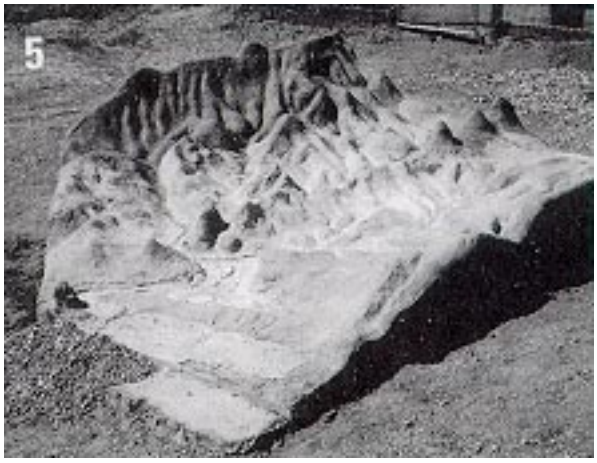
We smoothed out the "stair-stop" effect by covering the whole model roughly with a concrete mixture (gravel, sand, cement, concrete glue, and chopped synthetic fiber). After that, we applied a layer of stucco (similar to the concrete mixture but without gravel), followed by a color coat of cement-cyed stucco: green for chaparral, yellow-tan for grasslands, brown for mudflats, blue for water.

Since cement powder is very alkaline, we protected our skin by greasing with Vaseline up to the elbows and wearing rubber-coated cotton gloves.

basic construction skills along the way; and they've learned and taught others about keeping their creek clean.

We built a third model at an elementary school. Parents helped out a bit, but kids-kindergartners through high school students-did most of the work themselves. Cement is really easy for young kids. You pick it up in your hands and you smear it on. It's like making giant, permanent mud pies! Teachers at the school now use the model to teach about watersheds, and kids from the 4-H Science Clubs give demonstrations about runoff pollution to community groups. It's been a great teaching tool!

For detailed instructions, see Judy Neuhauser's "Watershed Model Construction Manual." The manual can be downloaded from http://www.slo4h.org/ EXIT EPA *. It's also available in hard coppy (20 pages) for $5.50, or on diskette (Mac or PC) as a PDF file for $5. In addition, a video titled "Watershed Project" that shows the at-risk kids building their model is available for $18. Send*



The finished model! Vertical elevation is exaggerated 3:1. Water sprayed from a hose shows where stormwater runoff goes.

All Photos within this article courtesy of: Judy Neuhauser

orders to 4-H, UCCE, 2156 Sierra Way, Suite C, San Luis Obispo, CA 93401.

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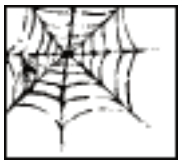

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River Watch Network, River Network Merge

This fall, River Watch Network (based in Montpelier, Vermont) merged with River Network (based in Portland, Oregon). The merged organization, called River Network, offers a combination of monitoring, organizational development, and river protection and restoration services and will operate out of a national office in Portland as well as from field offices in Montpelier; Washington, DC; and Helena, Montana. For more information and to join the River Network Partnership, please contact River Networks National Headquarters at 520 SW 6th Ave., Suite 1130; Portland, OR 97204; 503-241-3506; 800-423-6747; info@rivernetwork.org; http://www.rivernetwork.org/.

New Girl Scout Water Drop Patch

Girl Scouts across the nation can now earn a new Water Drop patch by completing a requisite number of watershed stewardship activities. The Water Drop Patch Program was created through a joint effort of the Girl Scout Council of the Nations Capital and EPAs Office of Wetlands, Oceans, and Watersheds.

Girl Scouts who want to earn the patch can choose from 20 projects and activities. (The number of activities required for the patch depends on the age level; Brownies need to complete only four, while Seniors must do seven.) Activities include stream walks, water quality monitoring, and storm drain stenciling.

The activities are described in a 42-page booklet called Water Drop Patch Program, published by the EPA. The booklet also contains background information on watershed issues and a list of useful resources.

The booklet is available at no charge to anyone working with Girl Scouts. Order from NSCEP, 800-490-9198; ask for EPA-840-B-99-004. The booklet can also be downloaded from http://www.epa.gov/adopt/patch/.

For more information, contact Patty Scott at U.S. EPA, 202-260-1956; scott.patricia@epa.gov.

New Publication Explores Watershed Issues

A new report from River Network explores issues of collaboration and partnerships between nongovernmental watershed organizations and state environmental agencies. The 110-page report is based on a series of meetings of leading watershed practitioners from Florida, Washington, California, and Massachusetts.

Some of the ideas may be surprising. For example, many participants felt that substantial long-term government funding can do a watershed group more harm than good, because it can easily give watershed communities the impression that the group is government-initiated and government-controlled. Another finding was that the charismatic leadership that is so often necessary at a groups beginning can become a major liability if it is not quickly accompanied by the development of an organizational model in which responsibility and authority are shared.

Exploring the Watershed Approach: Critical Dimensions of State-Local Partnerships, by Stephen M. Born and Kenneth D. Genskow, is available for $20 from River

Network, 800-423-6747, jhamilla@rivernetwork.org.

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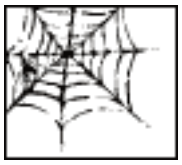

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4-H in the City

by Eleanor Ely

"One thing I think has gone wrong with how we deal with kids is that kids are not needed anymore," says Judy Neuhauser, 4-H Watershed Program Coordinator for the University of California in San Luis Obispo. "On a farm, kids are needed. They have to feed the chickens or the chickens go hungry."

This philosophy shines through in Neuhauser's work. Through the 4-H Youth/Adult Science Clubs that she started, young people not only have fun exploring science and the natural world but also have the chance to do meaningful work. "This is a way for kids to know that they are needed-useful and important," she says.

SLO Scientists measure creek flow.

Kids in the clubs-also known as SLO Scientists ("SLO" for San Luis Obispo)-have banded birds and measured creek flow as part of real scientific studies. They make regular trips on a Coast Guard boat to collect phytoplankton samples for the California Department of Health Services, which is tracking populations of toxic phytoplankton along the California coast. (For more on the phytoplankton project, see The Volunteer Monitor, Fall 1998, pp. 4-7, " 'Early Warning System' for Shellfish Poisoning.")

SLO Scientists also join forces with other community volunteer organizations-for example, they do monitoring, tree planting, and weed removal with a local Adopt a Creek program. "I love getting the kids connected to what's going on in the larger community," says Neuhauser.

Of all the nifty projects Neuhauser does with young people, perhaps the niftiest is building watershed models so big that people can actually walk around on them (see page 8, "Building Large-Scale Watershed Models").

Because the models show local watersheds, they are terrific for bringing the environment home to people. Neuhauser says, "So many topics in environmental education are about somebody else-save the rainforest, save the redwoods. This is us. Kids can point to it and say, 'I live here. There's my school. There's the lake where I swim.' You look at it and realize this is your creek that's being polluted by your car."

Recently a fifth-grade teacher told Neuhauser about all the ways he's planning to use one of the models. "We can demonstrate absorbancy, pollution, and runoff," he said. "We can learn about landforms and maps. We can study the water cycle."

Tips for working with 4-H

Compared to out-of-school programs like 4-H, schools do have one undeniable advantage: they have access to the kids for a big chunk of the day. But Neuhauser points out that working through 4-H gives her much more flexibility and freedom than classroom teachers have. Teachers must follow a prescribed curriculum, and it's hard for them to get the students out of the classroom.

For example, school classes cannot participate in the phytoplankton sam-pling because the school's insurance policy doesn't permit students to go on boats.

In terms of marketing her programs, Neuhauser learned early on that 4-H has a certain image problem. She got little response to the first flyers she sent out, and when she asked people if they'd seen the flyers they would say, "I saw something that said 4-H but I didn't look at it because that's ag."

"Most people still think of 4-H as 'the Farm Bureau's sheep and bunny club,'" says Neuhauser. In fact, 4-H is simply the youth component of the Cooperative Extension program that every land grant university operates. When it started in the early 1900s, 4-

H was farm-oriented because most kids were on farms then. But now, says Neuhauser, 4-H also offers lots of programs for urban kids.

Nowadays when she sends out a news release Neuhauser doesn't mention 4-H by name; instead she calls it "the University of California's nonformal youth science program," which is really what it is.

The ultimate goal of 4-H has always been to help kids develop leadership skills. As Neuhauser puts it, "Our project isn't the watershed or the sheep or the bees-it's the kids."

"This kind of experience has tremendous impact," say Neuhauser. "It's real, it's hands-on, it's kinesthetic-it involves the whole person. If there's one message I'd like to get across to people in government, it's that youth programs like SLO Scientists create a well-informed constituency for creeks and waters. They may not vote now, but they will vote!"

For more information, contact Judy Neuhauser at 4-H Office, UC Cooperative Extension, 2156 Sierra Way, Suite C, San Luis Obispo, CA 93401; 805-781-5944; janeuhauser@ucdavis.edu.

All Photos within this article courtesy of: Judy Neuhauser

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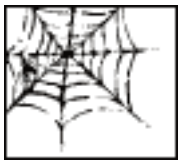

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A Change in Perspective: Using Aerial Photos to Study Watersheds

by Marianne Krasny

How do you see your watershed? That can depend on where you're standing-- your point of view.

If you are monitoring a stream above and below a potential pollution source like a sewage treatment plant, factory, or farm, your perspective is from the ground and your scope is the stretch of water between your monitoring sites. If you find problems you are likely to attribute them to the obvious pollution source. Other activities in the watershed that could affect the stream are outside your range of vision and may be hard for you to see.

You can broaden your view by traveling around and viewing the watershed from different vantage points. But you are still on the ground.

Getting the bird's-eye perspective

What happens if you take a leap upward and look down on the whole watershed in one

sweeping view? Now your scope is dramatically enlarged and the spatial relationships in the watershed are clearly revealed.

One way to achieve such a bird's-eye view is with a large-scale watershed model (see Building Large-Scale Watershed Models). Models are excellent for showing landscape contours in 3-D, and you can spray water on them to simulate stormwater runoff paths. However, models don't show much detail.

Photographs offer a different aerial perspective. Most aerial photos are taken at altitudes low enough to show individual landscape features like shopping malls, highways, airport runways, sewage treatment plants, dairy farms, parks, residential areas, and factories.

At Cornell University's Explorations from an Aerial Perspective program, we teach educators how to use aerial photos and topographic maps to investigate land use and water quality in their watershed. Over the past six years, we have trained some 400 educators, including teachers from 4th grade through community college and educators from nonformal settings like museums, nature centers, or Cooperative Extension. They in turn have worked with approximately 35,000 youth and adults.

Aerial photos in the classroom

We have found that aerial photos generate a lot of excitement in classrooms as students recognize features they know: their school, their houses, local parks, train stations, graveyards, creeks, landfills. The photos also help students sharpen their observational skills. An aerial photo contains a lot of information, but that information doesn't necessarily jump off the page at first glance. Students find that when they pay close attention to the tone, texture, size, and spatial relationships of objects in the photos, more and more features become apparent.

It's useful to study aerial photos in conjunction with topographic maps, since the maps provide useful complementary information like elevations and place names. After students become comfortable with the photos and maps, many teachers go on to introduce studies of satellite imagery and GIS.

From study to action

Aerial Perspectives participants don't limit themselves to classroom study. All kinds of creative activities have come out of the project. For example, at Rondout Valley High School in upstate New York, students in Leanne Avery's basic environmental science course used photos, maps, and field trips to identify potential sources of pollution to Rondout Creek. The pollution source that concerned them most was the Town of

Rosendales salt storage area. The students made a visit to the site and confirmed that salt from this open salt pile was entering Rondout Creek. Based on the students report and recommendations, the town board passed a resolution to construct a salt storage shed.

A student looks through a stereoscope to analyze an aerial photo of Fark Rockaway, with assistance from Cornell Cooperative Extension educator Gail Pasternak.

Getting buy-in from kids

In New York City's Far Rockaway neighborhood, several educators from Cornell Cooperative Extension of New York City incorporated Aerial Perspectives into an after-school program for junior high and high school students at the Reverend Mason Community Center. The challenge was to infuse environmental education into an after-school setting where the kids were not required to participate in any particular activity.

If we had come in with preconceived notions and set ideas of projects the students could do, we would never have been accepted, says Jackie Davis-Manigaulte, one of the Cornell educators. Instead, the educators started by learning about the kids interests--one of which was creating rap music videos. For several weeks Davis-Manigaulte and the other educators watched the kids' videos and led discussions about ways to use video to help the community. We had to build connections and establish trust before we could suggest anything, says Davis-Manigaulte.

The kids formed a 4-H group called Far Rockaway Environmental Youth (FREY) and decided to use their video skills to make a documentary about local land use changes and how those changes have impacted Jamaica Bay (which borders Far Rockaway). As part of the project, FREY youth interviewed historians, politicians, and local residents.

Members of Far Rockaway Environmental Youth meet with Commissioner Joe Miele, Sr., of the New York City Department of Environmental Protection. Jackie Davis-Manigaulte is at right.

The project had many positive spinoffs. One was a conference at the Reverend Mason Community Center, where the students discussed local environmental problems. The following year FREY members organized a beach cleanup, and now they are working on a video about lead contamination in and around the home.

How-to manual

Technical background information, hands-on classroom activities, and case studies are

included in the 200-page *Explorations from an Aerial Perspective Educators Manual*. The accompanying student manual includes shorter background information and worksheets for the activities. Both are available from Cornell Media Services Resource Center, Cornell Business and Technology Park, Building 7 and 8, Cornell University, Ithaca, NY 14853 607-255-2080; publications@cce.cornell.edu; http://www.cce.cornell.edu/publications/catalog.html .

Marianne Krasny *is an Associate Professor in the Department of Natural Resources, Fernow Hall, Cornell University, Ithaca, NY 14853; 607-255-2827; mek2@cornell.edu.*

Sources for Aerial Photos

To obtain aerial photos you must be able to identify your study site on a topographic map or other geographically referenced map, such as a county or state road map. Topographic maps may be obtained from the U.S. Geological Survey (USGS) or at sporting goods stores or bookstores.

Aerial photos may be obtained from all three agencies listed below; it may also be useful to contact local agencies such as planning offices, highway departments, or soil and water conservation agencies. The USGS can conduct a search for a specific location and provide a printout of what photos are available and where they are held. Black-and-white photos range in price from $5 to $50, depending on the vendor and the size of the photo. It's wise to order photos at least two months in advance.

In general, photos from before 1955 are held by the National Archives and Records Administration, and more recent photos by the U.S. Department of Agriculture (USDA) Consolidated Farm Service Agency. (Using older photos in conjunction with recent ones makes for a fascinating study of changing land uses.)

U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57198-0001
605-594-6151 or 1-888-ASK-USGS
Fax: 605-594-6589
http://edc.usgs.gov/

USDA Consolidated Farm Service Agency
Aerial Photography Field Office
2222 West 2300 South
Salt Lake City, UT 84119-2020
801-975-3503
Fax: 801-975-3532

National Archives and Records
Administration
Cartographic and Architectural Branch
8601 Adelphi Road
College Park, MD 20740-6001
301-713-7040
Fax: 301-713-7488

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Cruisin' Culverts

by Tom Youngblood-Petersen

Picture high school students on summer vacation: sleeping till noon, cruisin' the strip, or maybe catching a dollar movie at night, right? Not so for ten students from Big Sky High School in Missoula, Montana, who spent two weeks in late June documenting road impacts in the Lolo National Forest.

Students measure stream velocity to assess the effects

Andrea Stephens, a science teacher at the high school, put this creative project together by combining local resources. When her ecology class was studying road removal, Stephens approached hydrologist Traci Sylte at the Lolo National Forest to find out if students could come and observe a road removal project. As they talked, Stephens learned that the Forest Service was in the process of evaluating the Lolo Creek Watershed with GIS (Geographic

Information System) mapping, but didn't have the funding or staff to field-check the data. Stephens and Sylte came up with the idea of using the ecology students to help with field-checking. The project received tremendous support, both financial and philosophical, from the school district, which encourages student involvement in community projects. Financial support also came from two local volunteer monitoring groups.

of a culvert.

Upper Lolo Creek: Not a pretty picture

The Upper Lolo Creek Watershed was chosen as the site for the students to field-check because of its high road densities and many undersized culverts. With 324 miles of roads in the 71-square-mile watershed, the road density is 4.56 miles per square mile (mi/mi2)-way above the standard wolves, elk, and other species can tolerate. For example, research has shown that wolves fail to survive when road densities exceed 0.93 mi/mi2, and water quality begins to suffer at densities above 1 mi/mi2.

According to Sylte, many of the culverts in the watershed were installed undersized to save money-a decision that has come back to haunt the Forest Service. The combination of high road density, road failures, and undersized culverts has created erosion problems. Large amounts of sediment from roads land directly in streams, to the detriment of fish and aquatic insects. The undersized culverts are also likely barriers to fish migration.

Cruising the culverts

The Big Sky students photodocumented and inventoried Upper Lolo Creek roads and culverts, using a data sheet that Sylte designed especially for them. They recorded such information as culvert size, stream width, stream scouring at the culvert outlet, and whether the culvert was "perched"-that is, how high the culvert was placed above the natural streambed. A culvert perched one foot or more above the streambed could be a barrier to upstream migrating fish.

At one point the students found a 12- to 14-foot stream squeezed into a 4-foot culvert. Kelsey Nielsen, one of the students, says, "The stream had an hourglass shape coming in and out of that

culvert and measured 29 feet wide at one place. The water velocity was way high for a lot of fish species."

"I've never seen students learn so quickly," says Stephens. "It's one thing to read about road impacts, but to be able to teach earth sciences in the field is absolutely the best approach."

The Forest Service will use the students' data to help assign priorities for removing culverts. This is part of an overall road reduction and culvert replacement project in the Lolo National Forest, which calls for decommissioning approximately 64 miles of roads over the next three years. (The term "decommission" is defined in various ways. In the Lolo, the Forest Service will in most cases close the road with an earthen barrier, remove all culverts, and rip up all or part of the roadbed to a depth of 6 to 12 inches then seed and fertilize to natural conditions.)

Big Sky High School students collecting data in Lolo National Forest.

"The students did an excellent job," says Sylte. "I've already been able to utilize their work. They gave us great descriptions and photos of road and stream-crossing conditions in Upper Lolo Creek."

Resource

Bagley, Scott. 1998. The Road-Ripper's Guide to Wildland Road Removal. A 40-page guidebook that gives citizens the technical information they need to understand road removal projects and techniques and influence road removal policy. Order from Wildlands Center for Preventing Roads at the address below. $7.

Tom Youngblood-Petersen *is Development Director for Wildlands Center for Preventing Roads, a national clearinghouse and network that works to protect and restore wildland ecosystems by preventing and removing roads and limiting motorized recreation. He may be reached at Wildlands CPR, P.O. Box 7516, Missoula, MT 59807; 406-543-9551; wildlandsCPR@wildrockies.org; http://www.wildrockies.org/WildCPR/*

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All Photos within this article courtesy of: Andrea Stephens

Note: *A longer version of this article appeared in the Sept/Oct 1999 issue of "The Road-RIPorter," the bimonthly newsletter of the Wildlands Center for Preventing Roads. For a complimentary copy of the newsletter, contact the author at the address above.*

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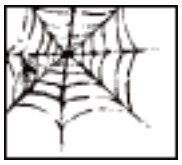

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Dissolved Oxygen and Temperature: The Stories You Can Tell

by Stacy Renfro

Your monitoring project has been offered a booth at a watershed festival. You'll be there all day, right near the water. What can you do to help fair-goers understand more about water quality, stream ecosystems, and monitoring?

The Student Watershed Research Project (SWRP) recently pondered this question when we found ourselves being invited to more and more water festivals and other public outreach events. Of course we were pleased to see that our collaborations with community groups were increasing SWRP's visibility, and we welcomed the chance to tell people about the long-term watershed monitoring projects conducted by SWRP science teachers and students in grades 8 through 12. But we wanted to do more than just sit there and talk about our program-we wanted to involve the public, including kids younger than SWRP's target age, in a dialogue about stream ecology.

So we came up with an idea: Since so many water festivals are held near a stream or river, why not bring our thermometers and dissolved oxygen kits and take measurements throughout the day? This activity lets fair-goers do a little hands-on water quality testing for themselves, and the test results, graphed as we go along, illustrate the relationships between water, sunlight, riparian vegetation, and fish health.

The exercise can be tailored to any age group. Adults are very interested in learning the

relationships between temperature, algae, riparian shading, and dissolved oxygen levels. With little kids, we start by asking, "What do fish breathe?" Invariably they answer, "They come to the surface for air." This leads to a whole discussion about gills, the "fish air" that is dissolved in water, and things that harm the supply of fish air.

Terry Lindbo, SWRP's Technical Coordinator, discusses temperature and dissolved oxygen results with fair-goers.

Here are the procedures we use for the activity:

Location

You will need access to the water. The activity works best on a small stream or wetland and can also be done on a larger river or a pond or lake.

Timing

It's best to start in the morning and continue through the hottest part of the day.

Materials

Two thermometers - One for air temperature and one for water temperature.

Dissolved oxygen test kit - We use Hach's modified Winkler titration method, which allows us to talk about the chemistry behind each step. Meters or other methods will work fine too.

Fresh reagents - Make sure the expiration date has not passed!

Flip chart or large paper or cardboard on which to graph.

Colored markers in at least four different colors.

Process

1. Prepare a large chart for graphing dissolved oxygen and temperature against time. You may want to draw lines corresponding to the state standard for minimum dissolved oxygen or maximum temperature. Since our biggest concern is salmon, we draw the values for salmon spawning on our chart. If you use Celsius thermometers, consider labeling the chart with both °C and the Fahrenheit equivalent.

2. Decide on a sampling interval. We sampled every half-hour when our booth was just 20 feet from the water. At another fair, when we were a good seven minutes' walk from the stream, we sampled every hour.

3. Collect and test the samples. You can either perform the dissolved oxygen test yourself, as a demonstration, or have fair-goers do it.

4. Graph the results.

5. Discuss the results.

Variations

- Test multiple replicates at each sampling time to ensure accuracy (chart the average).
- Sample two or more sites for comparison. Examples: a well-shaded stretch of creek vs. an exposed stretch; a pool vs. a riffle vs. a stagnant area; places with different average depths in a wetland.
- Spread the activity over several days. Make sure you sample the same area at the same time of day, and include weather observations.

Discussion topics

- **How do dissolved oxygen levels affect fish?**

Both a deficit and a surplus of dissolved oxygen can be a problem for fish. The first will smother them (hypoventilation); the second will poison them through oversaturation (hyperventilation).

Terry Lindbo performs dissolved oxygen testing under the watchful eyes of fair-goers.

- **How does temperature affect fish?**

Because fish are cold-blooded, their metabolic rate changes with temperature. Each species of fish has a preferred temperature for growth and for spawning.

- **What factors affect dissolved oxygen levels?**

An interplay of several factors, including photosynthesis, respiration, temperature, and turbulence, determines the amount of oxygen dissolved in the water. As with many natural systems, the relationships are complex and your graph won't necessarily present a clear-cut picture-but it will give you the opportunity to talk about the different factors and hypothesize about why your graph looks the way it does.

Factors that increase the dissolved oxygen level include water turbulence (more air gets mixed in), photosynthesis by algae and aquatic plants (produces oxygen as a byproduct) and low water temperature (cold water can hold more oxygen than warm water).

Factors that lower dissolved oxygen include respiration and decomposition (consume oxygen), high water temperature, and inputs of water with a low dissolved oxygen content, such as groundwater seeps or releases from the bottom of a reservoir.

- **How does dissolved oxygen change over the course of a day?**

A common pattern is for dissolved oxygen to be low early in the morning, before photosynthesis begins, and to rise over the course of the day. But other factors (see above) can complicate this picture.

- **Why is riparian shade important?**

This is the discussion that elicits the most "Aha's" from our audiences. Many of them have heard that the biggest threat to Oregon streams is loss of shading, but they don't really understand why. Once they learn that salmon spawning requires cold water with high dissolved oxygen levels, and they understand that cold water holds more dissolved oxygen, they get it. We hear comments like, "Oh, so that's why everyone is so concerned about water temperature and trees in the riparian zone."

Things to watch for

1. Plan the scale of your graph to reflect the expected diurnal range of temperature and dissolved oxygen. Use data from a local agency or your own monitoring program. If no data are available, make a guess-and be prepared to adjust your scale and redraw your graph halfway through the day.

2. Be aware of water level changes. At one festival we were on a highly regulated stream with several dams. Our dissolved oxygen results showed great variation throughout the day. No patterns emerged except that the stream level was different every time someone went down for a sample. We finally figured out that intermittent

water releases were causing dramatic fluctuations in the amount of water flowing over the rocks directly upstream of the pool we were testing. When turbulence increased, so did dissolved oxygen.

Volunteer training sessions

This activity can also be set up at training sessions for new volunteer monitors, if you will be at streamside most of the day. For your monitors, you can get into some more advanced discussion topics, such as:

- Why is it important to record the time your monitoring samples are taken?
- In a monitoring regime, is it better to try to sample at the same time of day? What effect will time of day have on your results? Is that important in your overall monitoring plan?
- What color is the streambed? Is it absorbing or reflecting heat?

Safety notes

- Gloves and safety glasses should be worn when chemical reagents are used to test dissolved oxygen.
- Use Enviro-Safe metal-armored thermometers. Mercury should not be used in natural systems-an accident could be worse than you'd like to imagine.
- Make sure that you have containers for both liquid and solid waste. DO NOT DUMP WASTE NEAR A STREAM!
- Make sure that you have deionized or distilled water available to clean glassware between tests.

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All Photos within this article courtesy of: Stacy Renfro

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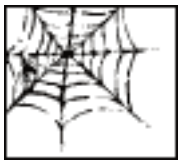

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Youth Corps/Agency Partnerships: Balancing Expectations

by Esther Lev

Replacing contract or staff labor with volunteer labor is becoming increasingly common as federal, state, and local land managers are seeing their workloads increase and budgets decrease. At the same time, education is moving more and more toward "service learning" and "hands-on" participation. But what seems like a match made in heaven can become a train wreck waiting to happen. Student involvement in restoration efforts has numerous educational, community, and stewardship values-but to view it primarily as a cheap labor source or a way to make up for budget shortfalls is to invite disaster.

My experience with teenagers as restoration workers began with an inspiration I had in 1991. In my capacity as scientific director of The Wetlands Conservancy (TWC), I was doing biological assessments and restoration at a 2,000-acre urban wetland surrounded by a garbage dump, industrial development, and the degraded Columbia Slough. Restoration opportunities abounded in the neighborhood. When I found out that the local high school had a 60 percent dropout rate, I naively thought, Restoration is a very hands-on and emerging field-perhaps if these students could be employed to restore natural areas in the neighborhood, they could be engaged in a positive activity and maybe even find themselves at the front of the opportunity line for once, rather than in the very way back.

That was the beginning of what was originally called the North Portland Youth Conservation Corps and is now Corps Restoring the Urban Environment (CRUE). My "simple" idea turned out to be way more complex and multi-faceted than I ever dreamed, but somehow the project survived and is still flourishing today. Along the way I learned a lot about 16- to 19-year-olds, education, restoration, and partnerships.

For its first couple of years, the North Portland Youth Conservation Corps employed youth in basic restoration work like weed removal and planting, but offered participants only limited opportunity for education and growth. That changed in 1993 when Andrew Mason got involved. His passion for education and student opportunity enhanced the program into an alternative high school that continues to grow and change yearly. During the school year, the students take classes in the morning and work on restoration projects in the afternoon. In the summer, they work full-time and are paid minimum wage. Clients pay the CRUE program a daily stipend which goes to cover various expenses, including tools, transportation, clothing, and other program activities.

Case study:
A five-year partnership

Over the years, CRUE has worked on a number of design, site assessment, restoration, and monitoring projects with various agencies, nonprofit organizations, and private businesses. This article will focus on one five-year partnership with the City of Portland Bureau of Environmental Services (BES). The longevity of this partnership allowed time to build trust, work through hard times, and understand the expectations and limitations of each of the partners.

The project began with BES's decision to restore the banks of the Columbia Slough by planting native vegetation. BES hoped that increased shading would improve water quality in the Slough. I became involved with the project through my job at TWC, and quickly recognized a great opportunity for CRUE students to help restore their own watershed while being involved in a city-initiated project. For BES, the appeal of working with CRUE was twofold: outreach to students and assistance with a labor-intensive effort.

A CRUE student in an innter tube retrieves a Hydrolap (a submersible automated sampler) from the Columbia Slough.

CRUE students went to work removing blackberries, planting bare-root trees, collecting native seed, and "tubing" plants (encasing them in wire mesh tubes to protect them from beaver and nutria). At first, their learning curve was high, both for learning restoration techniques and for understanding BES's program goals and infrastructure. This led to

frustration on the part of city staff, who started out comparing the students' productivity and labor quality to that of their paid contractors.

Over time, it became apparent that CRUE and BES had somewhat different approaches and desired outcomes. CRUE staff entered into the partnership with "hands-on learning" as one of the goals. While accountability, quality of work, and productivity are an important part of the CRUE program, CRUE leaders also wanted time to teach students. BES, on the other hand, had gone into the project hoping the students would be an economical and efficient source of labor. The reality was that working with CRUE required more project oversight and yielded lower productivity compared to working with regular contractors.

Because the CRUE program works with a population of youth who have previously dropped out of school, CRUE leaders were not surprised to have some days when attendance and productivity were low. Students got bored quickly if they were asked to do a single task for eight hours. Large sites where it was difficult to see any noticeable change by the end of the day were particularly difficult.

CRUE students work on a restoration site. Newly installed plants are surrounded by mesh tubes for protection from predators.

Staff from CRUE, TWC, and BES met monthly to clarify goals and responsibilities and work out problems. We found that work quality and productivity improved when student crew leaders were in charge of quality control and when students were given financial incentives, such as bonuses for finishing ahead of schedule or doing more work than anticipated. Over time, we learned that assigning CRUE students to their own sites and putting them in charge of all the steps-assessment, design, installation, monitoring, and maintenance-seemed to work best. Moving beyond providing "grunt labor" and taking responsibility for project completion and success has given students a greater sense of ownership and commitment. We also learned that the optimum site size is about 1 to 2 acres, which is small enough for students to quickly see the results of their efforts.

All seemed to be going well until a project that students had designed was planted by someone else. En route to another project, students noticed the site had already been planted-and, to add insult to injury, with a different planting scheme than their own design. In the frenzy of the planting season, BES contractors had planted the site. Lack of respect and the illusion of being asked to do busywork are sensitive issues for teenagers. It took a lot of conversation for BES staff to understand the students' feelings and for students to accept that the mistake was simply an oversight.

Weathering that storm built more trust and understanding between all parties. Two years ago, students requested more responsibility and more academic content. They are currently monitoring plant growth, collecting water quality data, producing GIS maps, and analyzing the relationship between restoration and watershed health. They are also producing a book on how and when to use specific plants for riparian restoration.

One of the initial goals of the partnership between TWC, CRUE, and BES was to test the value of student labor and involvement in restoration projects. For the first two years, the students' involvement had educational value rather than being a labor cost savings to the city. Students were learning about watershed ecology, water quality, and restoration while also defining their own personal responsibilities to the landscape, their community, and their "clients." By the end of year three, CRUE participation was viewed as a benefit to the overall restoration program. Although students' work was still not comparable to the work provided by paid contractors, by that time everyone recognized that it was unrealistic to expect the same level from students. Paying salaries to contractors gives an agency the authority and leverage to demand certain productivity levels and quality, as compared to working with volunteers or students who are more likely to complain if they get hot, cold, wet, or simply bored.

Keys to success

My experience has taught me that people tend to underestimate what it takes to successfully involve students in restoration projects. You will need lots of time, patience, commitment, and communication skills, along with a sound knowledge of restoration techniques. A good rule is to always assume that things will take longer and be more complicated than you expect.

Nine years ago, I never visualized the projects and successes that are the CRUE program today. Programs like CRUE can succeed as long as everyone is clear about their expectations, abilities, and limitations and is committed to dialogue, honesty, and flexibility. Finally, never be afraid to make changes or learn from past choices!

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Youth Corps

The CRUE program described in the accompanying article is one of many youth conservation corps programs across the nation. Some are funded by state or local governments, some by nonprofit organizations. While each youth corps program is independent, they share a commitment to combining community service with education and job training. The type of work varies from corps to corps and may include environmental projects, like restoration and trail-building, or social service projects, such as working with homeless people.

In 1985, the nonprofit National Association of Service and Conservation Corps (NASCC) was formed to provide central coordination for youth corps projects. NASCC serves as a clearinghouse, provides technical assistance and training, organizes conferences, and helps new youth corps programs get started. For more information on youth corps, or to locate a youth corps near you, contact NASCC at 666 11th St., NW, Suite 1000, Washington, DC 20001; 202-737-6272; or visit http://www.nascc.org/  .

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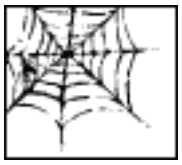

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"But What If the Volunteers Sue Us?" The Missouri Experience

by Sharon Clifford

When the Missouri Stream Team Program began in 1989, volunteer Stream Team activities included litter pickups and a visual inventory of their adopted stream, but no actual monitoring. Then, in 1992, a survey of volunteers indicated that what they really wanted to do was monitor water quality in their stream.

With volunteer monitoring as a new program goal, Stream Team's original two sponsors-the state Department of Conservation and the nonprofit Conservation Federation of Missouri-invited the state regulatory agency, the Missouri Department of Natural Resources (DNR), to join in as the program's third sponsor. DNR would help design the monitoring program and assist with training.

Agency concerns

State regulatory agencies are frequently apprehensive about becoming involved with volunteer monitoring. This was also true in Missouri. At one presentation to DNR about the Stream Team program, the very first question was, "Does this mean we are going to have a bunch of pseudo-experts out there running to the press?"

Concerns expressed by DNR are representative of why many government agencies are

cautious. Questions included:

- Could volunteer monitoring create more problems than it solved because people with limited knowledge would be involved in complex scientific issues?

- Would volunteers use their information to create crises by speaking to local groups or the media?

- Could the Stream Team program result in a heavier workload for agency employees?

- Did the possibility exist that sponsoring such a program could hurt the agency in political circles?

- Would volunteers really be able to gather useful data, given that generating "good" data requires so much time, effort, and expertise?

- If volunteer data wasn't used, would volunteers get frustrated and confrontational?

- Could volunteer monitoring help create an atmosphere of "get your neighbor" and result in adversarial relationships in local communities?

Despite all these concerns, the potential benefits of the program eventually carried the day. In 1993 the volunteer monitoring component of the Stream Team Program was initiated, with Missouri DNR onboard as a sponsor.

What has really happened

So, after six years, have any of the feared outcomes happened in Missouri? The answer is yes. Stream Teams have made their presence felt at city council and county commission meetings, at state legislative hearings, and in the media. Some volunteers are involved in lawsuits (which could have major impacts on DNR) over issues like the 303(d) list and Total Maximum Daily Loads. The number of public comment letters received on NPDES permits and proposed rules has increased dramatically.

And has all this citizen activism hurt the sponsoring agencies? Quite the opposite! During 1998, when DNR was seeking legislative approval for a big staff increase, there was concern that Stream Team participants were gaining such notoriety that the program might become a liability for the agency at the State Capitol. But in fact DNR sponsorship of the Stream Team Program was never raised as an issue, and the legislators allotted the agency 45 new full-time employees out of 48 requested. The newly approved staff positions included planners, support personnel, field staff, GIS and modeling specialists, and data and grant managers. Many people believe that the

increased interest in water quality on the part of the general public is at least partially responsible for the agency's success.

To the question of whether decision-making authorities would be able to use volunteer monitoring data, the answer is that they can and they have. Data from volunteers who have participated in a quality assurance/quality control program is included in the state's 305(b) report to EPA, and volunteer data is also evaluated when developing the 303(d) impaired waters list. In addition, Stream Team data has been used to verify the accuracy of data received from the regulatory community. Bottom line: the more information available for decision-making, the better the resulting decisions.

And what about fears that the program might result in adversarial relationships? In a few instances, this has occurred. The popularity of the Missouri Stream Team Program has led to the formation of over 1,400 teams, representing thousands of volunteers. In a program this large, all ends of the spectrum are represented, including (inevitably) a few people who choose to be confrontational. The program's goal is to provide participants with education and the tools to work on the issue of their choice. No attempt is made to control how volunteers approach advocacy or how they should think on a particular issue.

But adversarial relationships are the exception. For the most part, Stream Team has fostered cooperative, friendly relationships. A case in point has been the formation of Stream Team Watershed Associations that are committed to local cooperative efforts to benefit their streams. Several Associations have received grants for such projects as providing watershed education, installing best management practices, and developing a model for cost-effective urban stormwater management.

Changing hearts

To quote Stream Team volunteer Justin Mutrux, "If you think that a volunteer monitoring workshop just teaches you to test the quality of stream water, you're wrong. Learning to monitor a stream teaches the importance of caring about our world. By monitoring the waters, we change our hearts."

The Missouri Stream Team Program is fortunate that it has been able to make "changing hearts" a major goal. Generation of data is a highly valuable secondary result. To all state agencies concerned about participating in volunteer monitoring, the Missouri experience says that this type of effort may well produce more actual benefits for the resource than all the permit writing and law enforcement currently being done. And isn't that what it is all about?

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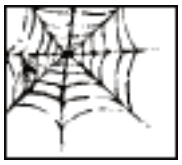

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An Earth Day to Remember: One-Day Basinwide Monitoring

by Steven Hubbell

Last March, my supervisor approached me with a request. The Texas legislature had just designated April 15 May 15 as Water Month, and the Lower Colorado River Authority (LCRA) had been asked if we might conduct some activity during Water Month to help raise public awareness about the importance of a safe, abundant water supply. "Can you think of anything?" she asked me.

It sounded like an interesting concept, and as the program coordinator of LCRAs Colorado River Watch Network Im always looking for a chance to spotlight the monitors. So I suggested, How about if we ask all the volunteer monitors in our basin to go out and test their sites on Earth Day?

"Can we pull that off?" my supervisor asked.

"I dont see why not," I answered.

What started as a quiet conversation bloomed into a bright idea, then exploded into a cascade of enthusiastic commitment.

Immediately I began to appreciate the implications of such an event. It could bridge the

territories of the Lower Colorado River Authority and the Upper Colorado River Authority, strengthen our bond with neighbor volunteer monitoring programs supported by the City of Austin, and unite the entire basin through an event designed to raise public awareness about water as a precious resource.

Upper management was supportive from the beginning: I only needed to ask for help from colleagues and it was sure to come. We decided to have an LCRA staff member visit every participating site to observe, take field notes, give the monitors a token of our appreciation (a certificate for each monitor and a clipboard for each group), and collect data sheets. At a staff meeting, I passed around a sign-up sheet and collected 20 staff signatures in 10 minutes. The River Watch has many friends throughout the LCRA! I knew at once that we would find all the internal support we could use. Now if only the monitors would come through.

We mailed announcements to all the monitors in the basin, and enclosed a letter requesting the support of their employers. This provided a little extra ammunition to monitors who wanted to conduct their testing during work hours. Then we followed up by phone. One by one the LCRA monitors agreed to test their sites on Earth Day. Monitors with the Austin Water Watchdogs, the Austin Youth River Watch, and the Upper Colorado River Authoritys West Texas Watch also said yes.

Soon we had 20 confirmed sites, then 30, then 50, then 60. The number of individual monitors passed 100, then 200, then 300. I had a tiger by the tail and I sincerely hoped I wasnt being taken for a ride.

On April 22, 1999, the volunteers exceeded our expectations at every turn. Across the basin, from dawn to dusk, more than 300 monitors participated. Sixty-three sites were tested for temperature, dissolved oxygen, pH, and total dissolved solids. At 50 of the sites, nitrates were also measured. The testing covered over 1,000 river miles (including sites on tributaries) and we received more data on that one day than we usually get in a month. LCRA managed to have a representative at every site (some drove as much as 200 miles each way).

Reporters talk to students from Westlake High School at a special demonstration site for the Earth Day event. Photo courtesy of: Billy Moore

Dissolved oxygen results were phoned in immediately to LCRA and used to assign a preliminary rating of poor, fair, good, or excellent which was posted live on our Website.

The event generated tremendous excitement and a strong feeling of unity across the basin. It was covered by about 20 local newspapers and three television stations. People talked about it for a long time afterward, and our monitors are ready to do it again in 2000!

Other similar events

When I was planning our Earth Day sampling, I assumed we were walking on the Moon for the first time. Afterward (too late, unfortunately, to benefit from their experience) I learned about other similar events. For example, Kentucky Water Watch holds three one-day events every year, the most ambitious being basinwide fecal coliform samplingwhich is accomplished in a six-hour timeframe (for details see http://water.nr.state.ky.us/watch/fec/). Its like herding flies to organize one of these events, comments Kentucky Water Watch coordinator Ken Cooke.

In the Delaware River basin, the Water Snapshot enlists volunteer monitors from four states to conduct testing during a 2-week period bracketing Earth Day. (For more on the Snapshot, see The Volunteer Monitor, Fall 1997, or visit www.state.nj.us/drbc/snap.htm.) And the Great American Secchi Dip-In, an annual international water transparency monitoring event coordinated by Bob Carlson of Kent State University from mid-June to mid-July, has been conducted every year since 1994.

The hot, the cold, and the lukewarm

So, what really worked and what didnt? Here are some dos and one dont:

- At the beginning, write out a straightforward and inspiring statement that describes your purpose and the process you will follow. We used our written statement in our invitations to monitors and LCRA staff, our requests for support from monitors employers, and our news releases.

- Identify the person who will assume the primary responsibility for making decisions and answering questions. Without an individual who is unflinchingly committed to the event, many loose threads can unravel.

- Enlist all the internal and external support you can. Having the City of Austin and the Upper Colorado River Authority oversee the involvement of their own volunteer monitoring programs eliminated a lot of logistical complications. The involvement of LCRA colleagues reinforced the value of the effort and allowed us to provide onsite support to monitors during the event.

- Make the invitations to monitors as personal as possible, and follow up with a phone

call.

- Publicize the event. We used generic press releases and also sent customized invitations to local media to observe specific volunteer monitoring groups. We also established a special demonstration site where television media could come at noon and 5 p.m.

- Dont throw last-minute brainstorms into the mix. There is always something that can be done a little better. Once you get down to a week before the event, make the most of what you have. You can always add special features or tweak the minute details next time around.

The concept of limiting the event to a single day may or may not be such a great idea. As I have learned more about similar events conducted by other organizations, I can see the rationale behind stretching the effort over a week or a month. This allows more monitors to participate and provides some insurance against bad weather. On the other hand, the one-day event generated a sense of drama, excitement, and unity, and encouraged press coverage. Earth Day is an occasion that just begs for special attention, and the fit between environmental stewardship and Earth Day is perfectly logical and appropriate.

The same-day data reporting on the Web was both good and bad. Data are such sneaky little gremlins that I tend to believe it is smart to carefully review the findings before making them public. On the flipside, posting immediate results allowed each monitor to immediately see their own little piece making its contribution to the whole picturereinforcing the theme that all these people spread across all these miles were involved in a clearly united cause.

A commitment to the future

Thanks to the committed citizens of our river basin, Earth Day 1999 will be a celebration to remember. I envisioned the event as a closing statement on an erathe last Earth Day of the 1900s. The promise to protect the irreplaceable and essential resource of clean water has been issued loud and clear. And even as Earth Day 1999 was a pledge to tomorrow, Earth Day 2000 affords the opportunity to show that dedicated watershed stewards have every intention of fulfilling this commitment.

So, what time will you be monitoring next Earth Day?

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Update Yourself!

Volunteer Monitoring Directory Goes Online

The *National Directory of Volunteer Environmental Monitoring Programs* is now available and updatable online at http://yosemite.epa.gov/water\volmon.nsf. The Directory lists over 770 programs, including contact information, parameters monitored, sources of funding, number of volunteers, data users, and data uses. You can use the online Directory to find out about other monitoring groups, update an existing entry, or add a new program.

Has your program changed recently? Perhaps you have a new name or address, or youve added new monitoring activities, or (horrors) youve fallen victim to a pesky area code change. If so, get online and set the record straight! And if youre a new program, here is your chance to be included in this useful resource.

The printed version is available at no charge from NSCEP, 800-490-9198; order National Directory of Volunteer Environmental Monitoring Programs, 5th Edition; publication number EPA 841-B-98-009.

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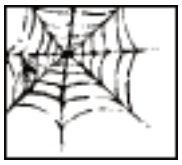

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Monitoring Optical Brighteners
Detergent Ingredient Helps Track Bacteria Sources

by Geoff Dates

Those of us monitoring fecal indicator bacteria to assess the risk of getting sick from swimming have a dirty little secret: we can't tell if the bacteria we find come from humans! The three most commonly used indicator bacteria-fecal coliforms, Escherichia coli (a subset of fecal coliforms), and enterococcus-can all come from both animals and humans. For the purpose of assessing health risk, that's OK, since animals carry diseases harmful to humans. But if our goal is to clean up the sources, we need to know where the bacteria on our petri plates originate! The presence of optical brighteners (OBs) just might give us the clue we need.

What are optical brighteners?

If your clothes are "whiter than white," you use OBs. They are fluorescent blue dyes that are added to almost all laundry detergents so your cotton whites don't come out of the washer looking "drab."

Optical brighteners (also know as "fabric whitening agents") were developed in the 1930s and began to be added to laundry detergents in a big way after World War II. Actually, detergent manufacturers use several different types of OBs. Some work better in hard water (water high in dissolved solids); others work better with bleach. So there may be a number of different OBs in your detergent.

Why are OBs good indicators?

The short answer is that OBs indicate the presence of laundry effluent, which is unique to humans. Since laundry effluent goes down our drains, OBs get mixed with our sewage and can wind up in both septic systems and municipal wastewater treatment plants. What happens there determines whether they get into our ground and surface waters.

Optical brighteners are removed from subsurface wastewater by the process of "adsorption"-the binding of molecules to soil and organic particles. They also decay when exposed to sunlight. Since adsorption of wastes to soil particles is one of the processes that make septic leach fields work, a properly functioning septic system should also remove OBs. If not, they show up in the groundwater and may find their way to a stream or lake where we can detect them. So, detecting OBs in surface water in an area where there are septic systems is an indicator that these systems are failing, especially if you also find high bacteria levels.

Wastewater treatment plants are another story. OBs are theoretically removed from wastewater by the treatment process. However, according to Ron Spong of the Dakota County Environmental Program in Minnesota, OBs are frequently detected in high concentrations even below properly functioning plants. So, detecting OBs below a wastewater treatment plant is not necessarily an indicator of plant failure. In conjunction with high bacteria levels, however, OBs can point to faulty or missing connections (e.g., a home that is not hooked up to the sewer system and is discharging directly to the surface water or into the storm sewer) or to leaky sewer pipes.

How are OBs detected?

If you expose cotton fabric with adsorbed OBs to a long-wave ultraviolet light, the fabric will fluoresce (glow) with intense bluish-white light. This phenomenon forms the basis for a simple method for detecting OBs in surface and subsurface waters. Briefly, a piece of cotton fabric known to be free of OBs is placed in a sampler and immersed in the water to be tested. It's left there for a period of time (typically one week), then retrieved and exposed to an ultraviolet light source. If it fluoresces, the result is positive, indicating that at some point during its immersion the pad probably came in contact with OBs, and therefore human wastewater. If the result is

An OB sampler, consisting of a cotton pad in a vinyl-coated wire cage, is placed in a stream. Photo courtesy of:

negative, you assume the pad did not come in contact with human wastewater.

Dave Sargent

A more sophisticated analysis can be done by using a spectrofluorophotometer. This instrument also uses ultraviolet light, but breaks it up into specific wavelengths. Unlike the simple visual method described above, a spectrofluorophotometer can identify specific OBs and separate natural fluorescence from OB fluorescence. However, before you run out and try to buy a spectrofluorophotometer . . . well, you can't afford it. Besides, the simple visual method can tell you a great deal, if it's done carefully and as part of a more comprehensive monitoring program.

How to monitor OBs

For the past several years, various groups in northern coastal Massachusetts have been successfully using the simple OB method described above to identify faulty septic systems, sewage leaks, and storm drain cross-connections, and to differentiate human from animal waste. Their techniques are described in detail in An Optical Brightener Handbook, by Dave Sargent and Wayne Castonguay, and summarized below. The method can be used to sample small streams, storm drains, pipes, and catch basins. It is not recommended for larger water bodies, such as lakes, rivers, or estuaries, in which OBs would probably be too diluted to be detectable. For this article, we'll assume that you are sampling a small stream. (A different type of sampler is used for testing subsurface waters; see the Optical Brightener Handbook for details.)

Equipment needed

The first challenge is to find untreated cotton pads. One source is VWR Graphics (856-467-2600). Prior to use, check all pads with an ultraviolet light to make sure they do not fluoresce.

Next, you need a rigid plastic or vinyl-coated cage to hold the pads. A source for a 5" x 5" hinged cage that keeps the pads off the stream bottom at a 45-degree angle is Winchester Fishing Co. (978-281-1619).

Finally, you need a long-wave (365 nanometer) 4-6 watt fluorescent ultraviolet light. VWR Scientific (800-932-5000) is a source for these. These materials can cost from $100 to $500, mainly depending on which light you purchase.

Procedure

1. The sampling device (cage) is placed on the bottom and attached to a branch, rock, or spike with monofilament fishing line.

2. Samplers are retrieved after 7 days. The cotton pad is rinsed in the stream water to remove sediment, squeezed to remove excess water, and labeled with the location and date. Pads are dried in a space that is not exposed to direct sunlight.

3. Pads are placed on a table in a darkened room (the darker the better) and viewed with a long-wave ultraviolet fluorescent light. Avoid reading the labels at this time. Each pad is viewed next to a "control" pad that has not been exposed to the stream. If a pad glows compared with the control, the result is positive. If it looks the same as the control pad, it is negative. All other pads are either considered "undetermined" or are re-tested. After all the pads have been read, the labels are read and the results for each site recorded.

Data interpretation

It's important to note that OBs alone cannot give you the whole story. OBs should be monitored as part of a more comprehensive monitoring program that includes sampling fecal bacteria, flow, and rainfall, and making various visual observations. The table at right (adapted from An Optical Brightener Handbook) summarizes how the data can be interpreted.

For all positive samples, follow-up sampling is highly recommended. First repeat the sampling to verify the results, then do additional follow-up sampling to trace and bracket the suspected source during wet and/or dry weather.

Sources of error

There are two main errors: false positives and false negatives. False positive readings can result from naturally occurring fluorescent substances such as humic and fulvic acids, which are common in some waters. Another cause of false positives is using pads that contain fluorescent substances. False negatives can be caused by interferences, such as detritus, sediment, iron oxides, algae, and iron bacteria, that coat the pads and either prevent adsorption of the OBs or prevent the ultraviolet light from reaching the pad during analysis. Finally, you might fail to detect OBs because they break down in sunlight and may never reach your pads.

Sargent and Castonguay, the authors of the OB Handbook, report that they have analyzed over 1,200 samples around the Gloucester and Ipswich areas of coastal Massachusetts and found a positive rate of about 20 percent, yet they have never had a false positive. All positive samples have been traced to a human source-in most cases faulty septic systems, sewer system leaks, or cross-connections with storm drains. On the other hand, false positives are not unusual in Ron Spong's experience in the upper Midwest. Using the sophisticated spectrofluorophotometer method described above

(which actually identifies the OB), he estimates as many as 20 percent of his samples are false positives caused by naturally occurring fluorescent substances. Monitors should be sure to do follow-up testing of all positive results to determine whether they can be traced to a human source.

Study design

Bacteria Counts	Optical Brightener	Weather	Interpretation
high	+	dry	Human wastewater is present.
high	-	dry	Bacteria could be of human or animal origin.
high	-	wet	Inconclusive--many potential sources. Storm runoff or combined sewer overflows.
high	+	wet	Human wastewater is present, likely associated with storm runoff or combined sewer overflows.
low	+	dry	Treated human wastewater is present, likely from a wastewater treatment plant (responably effective bacteria removal).
low	-	dry	No evidence of pollution at this time.
low	-	wet	No evidence of pollution at this time.

Like any other monitoring program, OB monitoring needs a study design. Selection of sampling locations will depend on what your questions are. You may choose sites that are representative of a stream reach, or you may want to isolate problems by bracketing suspected pollution sources. Following are some things to think about when designing the study:

- **Monitor other indicators.** Monitoring the presence or absence of OBs tells you just that. It doesn't tell you anything about the presence or concentration of bacteria, for example. So, other information is essential.

  - *Bacteria levels* provide a quantitative estimate of the severity of the pollution and also give an indication of the relative contribution of various pollution sources, if you bracket sources properly with sampling sites.

  - *Rainfall data* can help establish the relationship between wet-weather pathways and surface-water contamination.

  - *Flow data* can be used along with bacteria counts to calculate bacteria loading

and can indicate high water tables, which can saturate leach fields and cause septic systems to fail.

- *Field observations* might indicate the presence of specific pollution sources, such as drainage ditches, unexpected pipes, or animal or bird activity.

- **Place samplers carefully to avoid some false negatives.**

  - Keep them out of direct sunlight. OBs degrade when exposed to direct sunlight. Place your samplers so that they are in the shade between 11 a.m. and 4 p.m.

  - Keep them away from sediment. Pads should be kept off the bottom, either with a special sampler or by suspending them in the water column.

  - Keep them away from iron. Iron in the water or in bacteria can coat the pads, preventing OB adsorption and emission.

  - - Keep them out of turbulent water. Turbulence can cause the pad fibers to break down.

  - Avoid highly colored waters. Waters with tannins and lignins contain naturally fluorescing materials.

  - Avoid waters with lots of coarse organic matter. As leaves break down, they form naturally fluorescing compounds.

- **Find the right exposure time.** Leave the samplers in the water long enough to be exposed to OBs, but not so long that sediment, algae, or other growth masks the pads. Start with a week, but you may have to experiment to find the right time. Or, you can place several samplers at each site and retrieve them after different intervals.

- **Sample bacteria as often as you can while the samplers are in the water.** Samples for bacteria testing should be collected when samplers are placed and retrieved. If possible, also collect samples at least once while samplers are in the water.

- **Sample during dry and wet weather.** Wet weather has potentially contradictory effects. On the one hand, it may cause septic systems to fail. On the other, it dilutes the OBs. Wet weather also washes natural, fluorescing dissolved organic compounds into the water. So, sample during dry and wet weather to get the whole story.

- **Train monitors to recognize fluorescence.** You can create positive and negative control pads so your analysts know what to look for. Positive controls can be created by

soaking pads in a mixture of detergent and stream water. Negative controls can be created by soaking pads in OB-free stream water.

- **Verify positive results.** Re-test sites with positive results to be sure that you can replicate the result several times.

- **Include quality control.** Quality control consists mainly of having 10-20 percent of pads re-read by other personnel or quantitatively tested by a laboratory with fluorometric capabilities.

The bottom line

Monitoring optical brighteners seems to have great potential to identify human sources of fecal contamination. The most effective use of simple OB monitoring is as a low-cost supplement to a program that includes bacteria, rainfall, flow, and other data. For more information, including procedures, forms, and equipment lists, visit http://www.thecompass.com/8TB/ EXIT EPA .

References

Sargent, Dave, and Castonguay, Wayne. 1998. An Optical Brightener Handbook. Available at http://www.thecompass.com/8TB/ EXIT EPA .

Spong, Ronald C., and others. 1995. "Optical Brightener Screening for Sewage Contamination of Water Table Aquifers in Southeastern Minnesota." International Association of Hydrogeologists, XXVI International Congress, Edmonton, Alberta, Canada. June 1995. Proceedings.

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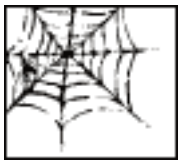

Note: This information is provided for reference purposes only. Although the information provided here was accurate and current when first created, it is now outdated.

RESOURCES

New Watershed Science Manual

Cornell Center for the Environments new 213-page manual, Watershed Science for Educators, is designed for high school and middle school science classes and after-school science clubs. It covers biological, chemical, and physical monitoring and the use of topographic maps and aerial photographs. Each of the 15 activities includes a teachers page with background information and preparation suggestions. Clear instructions and photocopyable data forms make the manual easy to use. Authors Karen Edelstein, Nancy Trautmann, and Marianne Krasny bring to the book many years of experience in developing environmental education materials. (Note: Trautmann and Krasny both contributed articles to this issue of The Volunteer Monitor.)

The manual is available for $39 (includes postage) from the Cornell University Media and Technology Services Resource Center, 6 Business & Technology Park, Ithaca, NY 14850; 607-255-2080; publications@cce.cornell.edu.

EPAs TMDL Website

With the release of its proposed TMDL regulations, EPA has updated its TMDL Website. At http://www.epa.gov/owow/tmdl/ you will find a variety of resources including fact sheets, full-text versions of the new proposed regulations, digitized maps of impaired waters for each state, a TMDL Tracking System database with data from

1998 listed waters, and an update on TMDL lawsuits brought against EPA.

Environmental Education Magazines

Two excellent quarterly publications for teachers are Clearing: Environmental Education in the Pacific Northwest (published in Oregon City, OR) and Green Teacher: Education for Planet Earth (published in Toronto). Both run 40 50 pages per issue and are packed with thought-provoking essays, hands-on activities, news items, and resource reviews. Though each reflects to some degree the region in which it is published, both are very broad in scope and would be useful to environmental educators throughout the U.S and Canada.

To subscribe to Clearing, send $18 (for 4 issues) to Clearing, c/o E.L.C., 19600 S. Molalla Ave., Oregon City, OR 97045; or visit http://www.teleport.com/~clearing/ EXIT EPA .

To subscribe to Green Teacher, send $24 (for 4 issues) to Green Teacher, P.O. Box 1431, Lewiston, NY 14092, or visit http://www.web.net/~greentea/ EXIT EPA .

Curriculum Summaries

Summary descriptions of about 120 water education curricula are available at http://www.uwex.edu/erc/ywc/ EXIT EPA . The site is searchable by grade level or by topic, and each entry also includes information about how to obtain the materials. A less up-to-date printed version, containing 100 entries, is also available for $5; to order, call 800-276-0462 and ask for A Guide to Goals and Resources, 2nd ed.

Give Water a Hand

The Give Water a Hand materials consist of two guidesone for youth ages 914 (the Give Water a Hand Youth Action Guide, 65 pages) and one for adult leaders (the Give Water a Hand Leader Guidebook, 35 pages). The youth handbook, which is also available in Spanish, contains a series of exercises to help young people identify local water issues, then plan and carry out service projects to address problems. The leader guidebook includes background information, guidelines for preparation, resources, and ideas for additional activities. Both may be downloaded from http://www.uwex.edu/erc/ EXIT EPA , or call 1-800-WATER-20 to order printed copies ($5 each).

Teacher and Student Resources from IWLA

Hands On Save Our Streams: The Save Our Streams Teachers Manual is a 215-page curriculum for grades 112. It contains classroom and field activities relating to watersheds, pollution sources, stream monitoring, and the relationship between land use and water quality. Also included is a science project guide with ideas for turning stream study into a science fair or community project. The teachers manual costs $30+S&H; the science project guide (recommended for grades 612) is also available as a separate booklet, for $5+S&H. Both are published by the Izaak Walton League of America Save Our Streams Program. To order, call 1-800-BUG-IWLA; or visit http://www.iwla.org/  for more information.