

monitoring **IMPACTS** of new gas-drilling technologies

by Faith Zerbe and Candie Wilderman

The hottest environmental topic in Pennsylvania today is the extraction of natural gas from the Marcellus Shale. Although there has been natural gas drilling in Pennsylvania for many years, Marcellus Shale extraction relies on new technologies that pose significant and numerous threats to water quantity and water quality. Volunteer monitoring groups in the region are developing protocols to watchdog the industry and are calling for strong government regulation, cumulative impact studies, and moratoriums on drilling in special places.

Until just a few years ago, it was considered economically infeasible to extract gas from the Marcellus Shale. Most of the shale is a mile or more below the surface, and the gas is trapped in tiny pore spaces in the rock. In 2005, oil and gas companies were offering property owners signing bonuses of only a few dollars per acre to lease their land for drilling. But by 2009, leasing bonuses had gone as high as \$5,500 an acre.

New technologies

This dramatic interest in the Marcellus Shale is due largely to two technological advances—horizontal drilling and hydraulic fracturing—that were developed a few years ago for extracting gas from a similar shale formation in Texas called the Barnett Shale.

Hydraulic fracturing (“fracking”) is a process that releases gas that is tightly trapped in small pores. A mixture of water, chemicals, and a particulate material (usually sand) is pumped into the well at high pressure to create fractures in the rock.

ISSUE TOPIC

Emerging Issues & New Technologies

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The Marcellus Shale



Extent of the Marcellus Shale (adapted from <http://geology.com/oil-and-gas/>).

The Marcellus Shale, named for a distinctive outcrop near the village of Marcellus, New York, is a vast black shale deposit formed 390 million years ago under inland seas along much of the Appalachian Basin. As the materials were deposited, they incorporated microscopic organisms which later slowly decayed to form a mixture of gases, most of which is methane. This gas still resides tightly bound within the rock formation.

The area underlain by the Marcellus Shale is estimated to cover about 54,000 square miles in the states of New York, Pennsylvania, Ohio, Maryland, and West Virginia, making it the largest natural gas development region in the country in terms of geographic extent.

These fractures can extend for thousands of feet. The sand holds the fractures open so the gas can escape.

Explosive growth

Leasing land for drilling can be a lucrative temptation for landowners, who receive both signing bonuses and royalties. The drilling issue is causing divisiveness in communities as

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The Volunteer Monitor is a national newsletter, published since 1989, that facilitates the exchange of ideas, monitoring methods, and practical advice among volunteer monitoring groups.

Subscriptions & address changes

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The Volunteer Monitor online

The newsletter website, www.epa.gov/owow/volunteer/vm_index.html, contains back issues from Spring 1993 and a comprehensive subject index of newsletter articles.

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Upcoming Hiatus in Newsletter Publication

From the first issue, published in 1989, *The Volunteer Monitor* newsletter has been funded under cooperative agreements with the U.S. Environmental Protection Agency (EPA) Office of Water. *The Volunteer Monitor* editorial board is deeply appreciative of this long-standing support. However, this issue is the last one covered by the most recent cooperative agreement.

EPA remains strongly committed to supporting this newsletter and is exploring options for its continued publication. Notification about any future Requests for Proposals for newsletter production will be posted on EPA's volunteer monitoring listserv (volmonitor-subscribe@lists.epa.gov) and EPA's volunteer monitoring website (www.epa.gov/owow/monitoring/volunteer). Please contact the EPA project officer, Alice Mayo (mayio.alice@epa.gov), with any questions.

Networking Resources

Volunteer monitoring listserv

The volunteer monitoring listserv, sponsored by the U.S. Environmental Protection Agency (EPA), is the perfect place to get answers to all your monitoring questions. For example, a listserv subscriber recently asked for advice on preventing theft of continuous monitoring devices. One respondent wrote that his program places such equipment inside PVC pipe housing covered with a plastic lid marked "sewer." He added, "Haven't had one stolen yet!"

In another listserv discussion, people shared ideas for providing volunteers with official identification, such as business cards reading "Volunteer" plus the program name; laminated ID cards to place on a car dashboard; and ID badges on lanyards that can be worn around the neck.

Many exchanges deal with methods and equipment. Where else but on the volunteer monitoring listserv can you learn about the real-world experiences of various programs with specific equipment, test kits, and methods?

To join the listserv, send a blank message to volmonitor-subscribe@lists.epa.gov. And to catch up on past discussions you may have missed, see selected archives at www.usawaterquality.org/volunteer/Special/EPAListserv/index.html.

Volunteer monitoring websites

EPA's volunteer monitoring website (www.epa.gov/volunteer/) includes a searchable national directory of volunteer water monitoring programs, as well as back issues of *The Volunteer*

Monitor newsletter, volunteer monitoring methods manuals and conference proceedings, and guidance for quality assurance plans.

Visit the Volunteer Water Quality Monitoring National Facilitation Project website at www.usawaterquality.org/volunteer/ to find useful fact sheets on many aspects of volunteer monitoring, links to dozens of volunteer monitoring publications, summaries of volunteer monitoring-related research, and an archive of discussions from the volunteer monitoring listserv.

Citizen science websites

Science for Citizens (<http://scienceforcitizens.net/>) is a new website to support volunteers who participate in scientific projects in many different subject areas. The site features a Project Finder (searchable database) and Member Blogs which give citizen scientists the opportunity to interact easily with each other and build a sense of community.

The Citizen Science Central website (www.birds.cornell.edu/citscitoolkit) has a searchable international listing of projects, organized by such categories as water quality, invasive species, astronomy, and climate change. The site also provides many resources and links to help with every step of designing and implementing a citizen science project.

MARCELLUS SHALE, continued from page 1

some landowners decline to sign leases because of their concerns about environmental damage.

It's not just private landowners who are cashing in.

In Pennsylvania, 1.5 million acres of state forest land is underlain by the Marcellus Shale. To date, nearly half of those acres have

Marcellus Shale drilling and extraction activities use a tremendous volume of water and a number of dangerous chemicals.

been leased to drilling companies. A bill to put a moratorium on leasing state lands for drilling was introduced to the state legislature in February 2010.

Extraction activity is increasing at a galloping rate. In Pennsylvania, 768 Marcellus Shale wells were drilled in 2009—up from 195 in 2008—and the industry estimates that up to 1,750 wells will be drilled in 2010.

Water quantity and quality concerns

Marcellus Shale drilling and extraction activities use a tremendous volume of water and a number of dangerous chemicals. Chemicals used in fracking may include friction reducers, biocides (to control microorganism growth), and surfactants, among others.

Drilling requires about 300,000 gallons of water per day per well, and fracking a well uses 2 to 9 million gallons of water. This water is typically pumped from nearby surface waters, potentially causing water depletion, especially in small, remote, forested streams that are often home to wild trout and other sensitive species.

If gas well casings are inadequate or become cracked, fracking water can leak out and contaminate drinking water wells. Groundwater and surface water can also be contaminated by leakage and spillage from the drilling site and operations.

The wastewater that is drawn to the surface (called flowback water) consists of the fracking water along with heavy brines that are found in the rock itself. This wastewater is initially stored in open, lined storage pits, then eventually trucked to a water treatment facility. The quantity of flowback water varies greatly

from location to location, containing from 10 to 90 percent of the fracking fluid initially injected.

Disposal of flowback water poses big treatment challenges. The projected volume is well beyond the capacity of existing treatment plants. Moreover, wastewater treatment plants are not equipped to remove many of the contaminants.

What exactly is in the wastewater? It is difficult to obtain complete information because companies guard the formulas of their proprietary mixtures. A 2009 draft Environmental Impact Statement from the New York Department of Environmental Conservation lists more than 100 different chemicals found in flowback water. Many are known hazardous materials—for example, benzene, acetone, arsenic, heavy metals, bromide, sulfate, toluene, xylenes, and naturally occurring radioactive materials (NORMs), including radium 226.

Typically, flowback water is characterized by very high concentrations (often greater than 30 percent) of total dissolved solids. In 2008 and 2009 the Pennsylvania Department of Environmental Protection (DEP) investigated unusually high levels of total dissolved solids in the Monongahela River and traced much of the contamination back to improperly treated flowback water. At least 11 public water supplies were affected and 325,000 people were advised to use bottled water.

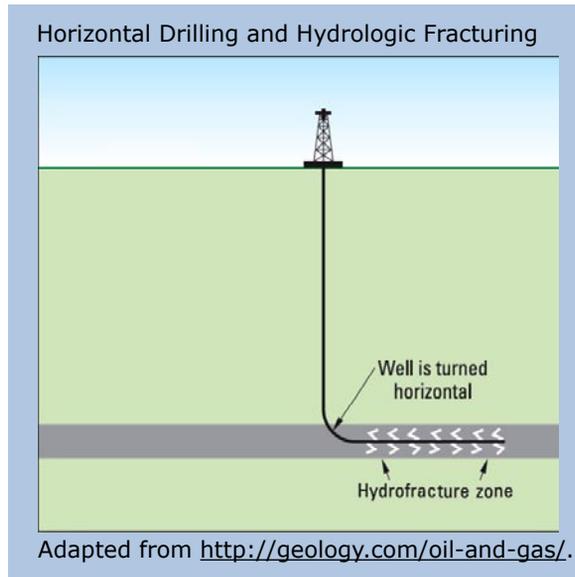
What volunteer monitors can do

Concerned citizens in the Marcellus Shale region are asking how they can best act as watchdogs of drilling activities. For many, the goals are early detection and prevention of serious environmental pollution impacts.

The Alliance for Aquatic Resource Monitoring (ALLARM), a project of the Environmental Studies Department at

Dickinson College in Carlisle, Pennsylvania, has developed a protocol designed to detect flowback water contamination in small streams. The protocol uses total dissolved solids (TDS) and/or conductivity as “red flag” parameters that indicate possible contamination. An increase in the red flag parameters triggers the collection of samples for testing “signature chemicals” whose presence can identify flowback water as the source of contamination. ALLARM has chosen barium, strontium, and total alpha (an indicator of the presence of radioactive materials) as robust signature chemicals.

First, volunteers will be trained to identify potential drilling sites by accessing permit applications, which are public information and available online. Ideally, they will then collect baseline data at their sites for three months to a year before drilling begins. In addition to weekly measurements of the red flag parameters and occasional (two to four



times a year) water sample collection for testing of signature chemicals, volunteers will record stream stage as an indication of flow. (Establishing a relationship between flow and conductivity is necessary for interpreting changes in conductivity.) Once drilling begins, volunteers will continue weekly monitoring of TDS and conductivity. If an increase is seen, volunteers will send water samples to ALLARM for immediate analysis of

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MARCELLUS SHALE, *continued*

signature chemicals. If these are above baseline levels, volunteers will report their findings to the Pennsylvania DEP. We are currently working with DEP to ensure that they will consider the data presented as sufficient to warrant site inspections.

In addition to chemical monitoring, observational monitoring is a powerful and cost-effective way for volunteers to help provide needed oversight of drilling activities. Volunteers are currently recording observations on erosion rills or washouts due to land disturbance on drilling pads, access roadways, and connecting pipelines. They are also being trained to monitor such problems as leaks from storage tanks, gas bubbling from pools or puddles, oily film on water surfaces, water hoses in or adjacent to streams, pipeline breaks, and illegal dumping. Volunteers are being taught the proper protocol for recording observations, taking samples if appropriate, locating sources of problems, documenting observations through photos, and reporting to the appropriate agencies.

In the Upper Delaware (the Pocono region of Pennsylvania and Catskill region of New York), 25 trained volunteers with the Delaware Riverkeeper Network (DRN) are already collecting twice-monthly baseline information on small tributary streams where gas drilling is projected to begin in summer 2010. The volunteers are sampling at 30 stations, using a handheld meter to measure TDS, salinity, temperature, and conductivity,

and a field kit to measure chloride. Two automatic data loggers will be installed with help from the U.S. Geological Survey (USGS), and periodic lab testing of signature chemicals will occur at priority stations.

With this first tier of citizen monitoring under way, DRN and its local agency partners are now planning macroinvertebrate monitoring. Macroinvertebrates,

Volunteer monitors have begun using the data they have collected in public testimony regarding pending natural gas permits.

especially mayflies, are particularly vulnerable to shifts in TDS because dissolved solids affect their ability to osmoregulate (regulate and balance the fluids in their body). If wastewater from fracking finds its way to high-quality streams, the results would be devastating. Volunteers will use Pennsylvania DEP Modified Rapid Bioassessment methodologies for macroinvertebrate monitoring. At sites where the industry is planning the most drilling, samples will be preserved and analyzed by an agency-approved laboratory, while at the remaining stations volunteers will conduct streamside identification.

DRN volunteer monitors have begun using the data they have collected in public testimony regarding pending natural gas permits. In one case where a company proposed withdrawing large amounts of water from the West Branch

Lackawaxen River to use in fracking operations, volunteers testified and presented photo-documentation, USGS flow data, and macroinvertebrate data in support of measures to protect adequate flow.

Volunteer monitoring groups throughout the Marcellus Shale region are working to develop a set of standard protocols, a shared database, and common training materials. We believe that if drilling companies are aware that there are many eyes watching them and evaluating their activities, they will be more likely to implement best manage-

ment practices and avoid contamination of environmental resources. Our presence in the field and the companies' knowledge of our activities are the best deterrents to poor management and illegal practices that can go unnoticed if no one is watching.

Faith Zerbe is Director of Delaware Riverkeeper Network's Water Watch Program. For more information: faith@delawareriverkeeper.org; 215-369-1188; www.delawareriverkeeper.org.

Candie Wilderman is Founder and Science Director of the Alliance for Aquatic Resource Monitoring (ALLARM) at Dickinson College. For more information: wilderma@dickinson.edu; 717-245-1565; www2.dickinson.edu/storg/allarm/.

Resources

Geology.com website. <http://geology.com/oil-and-gas/>.

ProPublica: Journalism in the Public Interest website. Gas drilling link: www.propublica.org/series/buried-secrets-gas-drillings-environmental-threat.

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Pennsylvania Department of Environmental Protection website, Marcellus Shale pages. www.dep.state.pa.us/dep/deputate/minres/oilgas/newforms/marcellus/marcellus.htm.

ALLARM student staff member Atandi Anyona demonstrates the use of a TDS/conductivity meter.



BREANA HASHMAN

FRESHWATER ALGAE BLOOMS: a newly recognized health threat

by Eleanor Ely

It's been nearly two decades since volunteers first started monitoring marine waters for harmful algal blooms (HABs). Now there's a new kid on the block: freshwater HAB monitoring.

For marine waters, the main human health concern is toxic seafood poisoning, a serious and sometimes fatal condition that results from eating shellfish or fish that have fed on toxin-producing algae, usually dinoflagellates.

In freshwater HABs, the culprit organisms are certain toxin-producing members of the cyanobacteria, also called blue-green algae. Cyanobacterial blooms can turn the water a bright green or blue-green color and often produce scums or films on the water surface. However, sometimes there are no obvious signs. Animals and humans encounter the toxins through direct contact (e.g., by



JIM HANEY

Cyanobacteria bloom at Willand Pond in New Hampshire.

Cyanobacteria Facts

Cyanobacteria are classified as bacteria because of their cell structure, but functionally they resemble algae because they contain chlorophyll and are photosynthetic.

Cyanobacteria occur in both fresh and marine waters, but the marine species are not known to produce toxins. (A few brackish-water species do.)

Some freshwater cyanobacteria produce potent toxins, including hepatotoxins (toxic to the liver) and neurotoxins (toxic to nerves).

Some common genera that contain toxin-producing strains are *Microcystis*, *Anabaena*, *Aphanizomenon*, and *Oscillatoria*. A toxin-producing strain often produces several different toxins.

Toxin production is strain-dependent, not species-dependent, so species identification is not sufficient to determine whether toxins are present.

Blooms are most likely to occur in warm, slow-moving waters with high levels of nutrients.

swimming or ingestion) with waters where blooms are occurring.

While toxic seafood poisoning has long been recognized as an important public health problem, the health threat from cyanobacterial toxins has only recently become a focus of research and management. One reason the human health risks of cyanobacterial blooms

Cyanobacteria-related illness and death are more common in pets and livestock than in humans, probably because a dog or a cow is much more likely than a human to drink green scummy water.

were not recognized earlier is that cyanobacteria-related illness and death are more common in pets and livestock than in humans, probably because a dog or a cow is much more likely than a human to drink green scummy water. But public health agencies are increasingly concerned about the threats to humans, especially children, who swim in or drink from lakes or rivers experiencing HABs. The toxins can cause symptoms ranging

from dermatitis and gastroenteritis to liver and nerve damage.

As yet there are no federal standards for cyanobacteria in recreational waters. Some states have set provisional guidelines, and a number have initiated cyanobacteria monitoring efforts.

Monitoring methods

Three methods are commonly used for monitoring cyanobacteria:

Phycocyanin testing. The presence of phycocyanin (a light-harvesting blue-green pigment associated with cyanobacteria) in a water sample indicates that cyanobacteria are present and can give some idea of the concentration, but provides no information as to species or toxicity.

Tests for phycocyanin are based on shooting a beam of light through the water at a specific wavelength that excites the pigment and causes it to fluoresce. The equipment can either be a phycocyanin fluorescence sensor that attaches to a multiprobe instrument such as a Hydrolab or YSI meter, or a handheld

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CYANOBACTERIA, continued

fluorometer unit such as the Aquafluor (Turner Designs).

Microscopic examination. Counting and identifying algal cells microscopically provides information about what species are present and in what concentration, but doesn't detect toxicity.

Toxicity testing. Laboratory tests (using ELISA or HPLC) are available for several cyanobacterial toxins, but are quite expensive. Less expensive test kits have so far been developed for only one cyanobacterial toxin, microcystin.

The above three methods can be performed sequentially – first phycocyanin testing as a screen to see whether cyanobacteria are present, followed by a microscopic examination to determine which algal species are present, and finally toxicity testing to quantify the public health threat.

Information needed

Management of cyanobacterial blooms is impeded by a lack of scientific information. As Beth Cullen, a water quality planner for King County in Washington State, puts it, "How can we manage something we don't truly understand yet?"

Cullen is one of the lead investigators in a three-year monitoring and research project called REHAB (Regional Examination of Harmful Algal Blooms) designed to answer questions about the prevalence, patterns, and health risks of cyanobacteria blooms. Volunteer monitors are assisting REHAB by collecting lake water samples that are sent to state laboratories where they are examined microscopically and analyzed for cyano-

bacterial toxins. "This effort would not be possible without the volunteers," says Cullen. "Thirty lakes are sampled every two weeks from June through October, and even more often if the volunteers notice bloom conditions."

Volunteer lake monitors in several other states, including New York, Florida, Maine, Michigan, and New Hampshire, are also collecting samples that are sent to professional labs for cyanobacteria testing. Generally the volunteers collect samples at regular intervals, with additional sample collection if there are signs of a bloom. In Maine, one trigger for sample collection is a decrease in Secchi disk reading below a threshold level.

A greater role for volunteers?

With few exceptions, volunteer involvement in cyanobacteria monitoring is currently limited to sample collection. One of the exceptions is Roger Frymire, a longtime volunteer monitor in Massachusetts who has been using all three of the above-described analytical methods for about four years. Frymire volunteers with both the Mystic River Watershed Association and the Charles River Watershed Association. These two associations, along with local and state agencies, are part of the Cyanobacteria Working Group, which was started in 2006 after a swimming race on the Charles River was canceled because of a cyanobacteria bloom.

The Cyanobacteria Working Group is especially interested in three genera – *Anabaena*, *Aphanizomenon*, and *Microcystis* – a.k.a. Annie, Fanny, and Mike. During the summer, samples are

collected every two weeks, or weekly if there are signs of a bloom, from various sites in the Charles and Mystic Rivers.

Frymire has his own microscope, which he uses for cell counts. For measuring phycocyanin he uses an Aquafluor fluorometer. To test for the microcystin toxin, Frymire uses the EnviroLogix QuantiTube microcystin test kit. The procedure is somewhat involved, requiring several freezing and thawing steps to lyse the cells and then a couple of hours to prepare and run the assay. If the toxin level is high, samples need to be diluted to obtain a more accurate result. But Frymire, a veteran volunteer monitor with years of experience in water quality testing, has had no difficulty performing the analysis. He even designed his own test tube holder to use with the kit (see photo).

Data from the Cyanobacteria Working Group are used by the Massachusetts Department of Public Health for public advisories, based on the following criteria: cell count $\geq 70,000$ of any potentially toxin-producing cyanobacteria species, or microcystin ≥ 14 parts per billion.

Another example of volunteers doing actual cyanobacteria testing, as opposed to simply collecting water samples, comes from Oklahoma. In 2008 and 2009, Oklahoma Water Watch volunteers participated in a pilot study in which they performed microcystin testing with a quick and simple test strip kit. Although the test strips were easy to use, the program coordinators had concerns about the precision and subjectivity of the method, which relies on visually interpreting a color change.

"How can we manage something we don't truly understand yet?"

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New Hampshire tries new method

The New Hampshire Lakes Lay Monitoring Program is experimenting with a new method for collecting samples for microcystin analysis. The chlorophyll filters that volunteer lake monitors routinely prepare and send to the program laboratory are subsampled at the lab by taking a small hole punch from the filter. The punched-out piece is then analyzed by the highly sensitive ELISA

continued at right

Massachusetts volunteer Roger Frymire glued together six wooden spring-type clothespins to make this test tube holder, which he uses with the EnviroLogix microcystin test.



ROGER FRYMIRE

Internet keeps marine algae network Connected

The Phytoplankton Monitoring Network (PMN) began in 2001 with three volunteer groups in South Carolina. Today the Network, still headquartered in South Carolina at the Center

(see *The Volunteer Monitor* Fall 1998 and Spring 2000). Subsequently, Morton adapted the Maine methodologies for South Carolina and then the larger network. PMN volunteers use plankton nets to collect samples from marine or estuarine waters. They microscopically identify potentially toxic marine algae as well as a number of nontoxic algae. The volunteers' data sheet includes over 50 genera.

New communication technologies make it feasible for PMN staff to train and support the far-flung participants. Staff members travel to each site once per year to offer in-person training sessions in phytoplankton identification, but training can also be conducted over the Internet using the web-based meeting and conference service WebEx (www.webex.com), which allows trainers and trainees to simultaneously view images from the PMN digital microscope. Once volunteers start monitoring, they use the Internet for data entry and to get ongoing assistance with algal identification. Each volunteer has a digital microscope (provided on loan from the program), so whenever they have trouble with identification they can take a digital photo and e-mail it to PMN program staff in Charleston, South Carolina.

The PMN database includes data not only from PMN-initiated programs in multiple states but also from independently founded and managed marine phytoplankton monitoring programs in three additional states (Maine, New Hampshire,

and Washington). This multistate database gives researchers insight into algal species composition and distribution in coastal waters around the nation.

The PMN is about to launch a pilot program for cyanobacteria monitoring in the Great Lakes region. Sample collection will be different than for the marine monitoring (a simple water sample for cyanobacteria versus the plankton net for marine phytoplankton), while most of the other methodology will be the same or very similar.

For more information about the PMN, please see www.chbr.noaa.gov/pmnn/.

NOAA/PMN



A Phytoplankton Monitoring Network volunteer uses a digital microscope to identify marine phytoplankton.

for Coastal Environmental Health and Biomolecular Research, extends to 17 states plus the U.S. Virgin Islands. This broad reach—participating states include Florida, Alaska, and Hawaii—is made possible by creative use of the Internet for volunteer training and support.

PMN founder Steve Morton was involved in the startup, in the early 1990s, of Maine's volunteer-based toxic phytoplankton monitoring program, designed as an early warning system for potential outbreaks of toxic seafood poisoning

CYANOBACTERIA, continued

method. For more information on this method, please contact Jeff Schloss at jeff.schloss@unh.edu.

Resources

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NOAA/PMN

Phytoplankton Monitoring Network volunteers in North Carolina collect a sample using a plankton net.

displaying SITES & DATA with Google "My Maps"

by Elise Torello

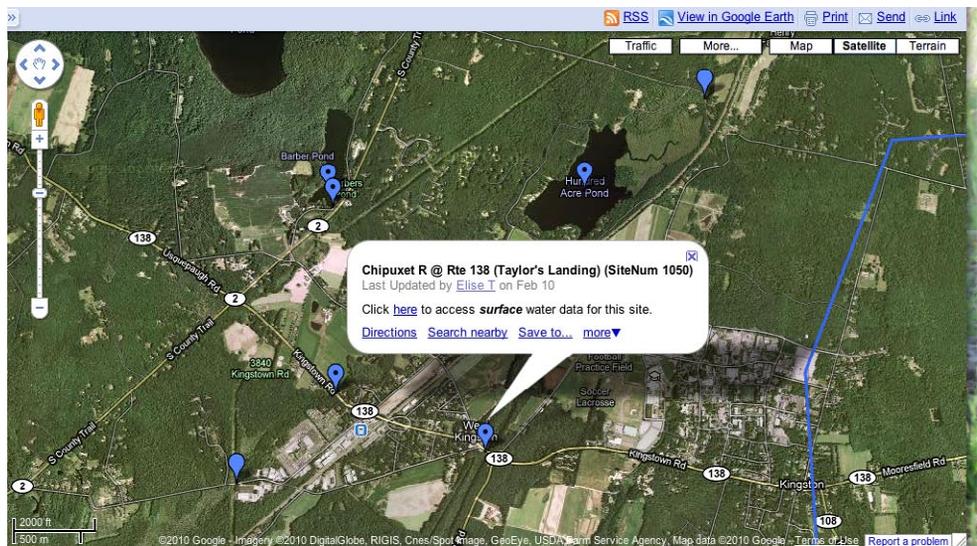
A couple of years ago I was looking for a volunteer opportunity that would make use of both sets of skills from my educational and work backgrounds: wildlife biology and computer science. When I approached the Wood-Pawcatuck Watershed Association (WPWA) and offered to help with data management, they already had 20 years of volunteer-collected water quality data from some 150 sampling sites. These potentially valuable long-term monitoring data were stored in an assortment of separate Excel spreadsheets in various formats and were virtually inaccessible to the public, to managers, and even to the Association itself.

Thus began a project which has snowballed into our current database and online mapping project, which has been funded under a grant from the Forrest & Frances Lattner Foundation since June 2009. The project has three major components: data management, data reporting, and interactive online mapping and data access.

A workable data management system

Our initial goal was to display WPWA's data in multiyear tables and plots in order to look for trends over time. It soon became apparent that this would be extremely difficult and labor-intensive with the existing diverse assortment of Excel spreadsheets. Therefore, my first task was to create a workable data management system. This involved standardizing the sampling site names, assigning every site a unique numeric code, and compiling all the data into a single Microsoft Access database.

Bleary-eyed but forging onward to the



Screen capture of WPWA map in "satellite" view. Placemarks with dots are active sites; those without dots are "legacy" sites.

data reporting phase, I learned to use the powerful forms and reporting features of Access, along with some Visual Basic programming, to automate the production of multiyear reports with a table and bar chart for each station and parameter. With 152 sampling sites and up to 17 water quality parameters, this amounted to the generation of 1,452 PDF-format reports.

Automating the production of these reports was by far the most technically challenging (and at times frustrating) part of the project, but well worth the effort for the amount of future time and effort that will be saved. Now, each time

another year's worth of data is added to the database, updated reports for each sampling site and param-

eter can be generated with the click of a button — much easier than updating 1,452 reports by hand!

The mapping component

The mapping component of the project

will probably prove to be the most valuable and useful to WPWA and to the public. Adding spatial context to monitoring data through the use of interactive web-based maps can greatly enhance data use and visualization. People really appreciate being able to see a sampling site in relation to surrounding land use, their homes, roads, landmarks, and other features. Plus, having an easy and fun way that anyone can access data via the Internet helps a monitoring group gain public recognition and support.

Choosing a mapping option

Because WPWA is a small nonprofit organization with limited financial resources and staff, I knew that any online mapping system I set up would need to be easy for the organization to maintain on their own without the need for ongoing technical support. As part of my research for a Master's thesis in Computer Science, I had already investigated several different options that small nonprofits could use for creating an interactive online map and data portal. Factors I evaluated included cost, ease of use for a diverse audience, widespread browser compatibility, functionality vs.

People really appreciate being able to see a sampling site in relation to surrounding land use, their homes, roads, landmarks, and other features.

complexity, and ease of development and maintenance. Based on this research, I recommended Google's free and very simple "My Maps" to WPWA.

My Maps provides a ready-made package that is unbelievably powerful and easy to use. Users only need to create a Google account to begin building their own maps following the simple instructions provided by Google (<http://maps.google.com/help/maps/mymaps/create.html>). Without needing to purchase or install any software, users get the benefits of highly developed, robust software which a small organization could never create for itself. Google Maps gives you access to frequently updated satellite imagery, aerial photography, and map data, along with many tools for exploring the imagery and data. Built-in automated tools perform a variety of tasks, such as generating driving directions to sampling sites or letting users view the map in Google Earth.

The more sophisticated Google Maps Application Programming Interface (API) is also free, and it offers more opportunities for customization than My Maps. However, once you leave the comfort and ease of My Maps and venture forth into the API, you add much complexity to the development and maintenance of the site. As stated on the Google website, using the API requires familiarity with JavaScript programming and object-oriented programming concepts. Many features that are automatically included with My Maps have to be added manually when using the API—for example, you have to select and place the tools for zooming and panning, choose the size and shape for pop-up balloons, and so forth. While this customization has its advantages, it also means you are doing many tasks that are already done for you in My Maps. Another drawback is the possibility that compatibility issues may arise (e.g., your site may not display properly using other browsers, such as Firefox or Safari). Since WPWA does not have a dedicated techie on staff, I decided that the API was not the best choice for them.

My Maps provides a ready-made package that is unbelievably powerful and easy to use.

Creating placemarks

The first step in creating WPWA's map was marking the site locations. Placemarks can be chosen from those provided by Google or can be custom-created by the user (the default blue upside-down drop looks conveniently like a water drop!). A feature of My Maps is that clicking on a placemark causes an information balloon to pop up. You can put information about the monitoring station, including text, hyperlinks, and photographs, in this balloon.

I color-coded the WPWA station placemarks to indicate which watershed they are in, and I used placemarks with a dot for active sampling sites and placemarks with no dot for "legacy" sites.

WPWA is fortunate in having some GIS capabilities, and many of their sampling sites were already in a GIS shapefile. It is possible to output the shapefile data as a KML (Keyhole Markup Language) file which can then be easily imported into Google Maps, and this is how I initially added WPWA's sampling site placemarks to the map. However, it turned out that some of the markers were in the wrong place, either because volunteers' handheld GPS units were not always accurate enough or because of typographical errors in the database. I found that zooming in as close as possible with the "terrain" view (which shows streams, roads, and topographic lines) allowed me to manually correct the marker positions. Then, sites that were not in the original GIS shapefile were visually located and added manually (just point and click!).

Linking monitoring data to the map

The final step is linking the monitoring data to the map. The map-data combination is an example of what is called a "mashup" in web development lingo. A mashup combines existing content or technology from different sources to create new content.

There are many ways to combine or "mash" water monitoring data with an interactive map (see the following article

for some examples). For the WPWA map, I manually placed hyperlinks in the information balloons that appear when users click on the site placemarks. Clicking on the hyperlink brings up a data portal page for that particular monitoring site. The data portal page (which is a PDF file residing on WPWA's server) displays a list of hyperlinks for individual water quality parameters. Clicking on one of these brings up a PDF file with summary data for that parameter and a colorful bar graph plotting data against time. I chose the PDF format because it displays consistently on different browsers and computing platforms and is convenient to print.

Publishing the map online

Embedding the map in the WPWA website was easy using the automated "Link" button in My Maps. The "Link" window includes an option ("Customize and preview embedded map") that lets you adjust the size of map you want to embed.

Into the future

As new years of sampling data are added, the automated report-genera-

Once you leave the comfort and ease of My Maps and venture forth into the Application Programming Interface, you add much complexity to site development.

tion process I created in MS Access will greatly simplify the production of updated PDF data report files. Automatically generating the new files with the same file names, then putting them in the same location in WPWA's web server, allows the hyperlinks in the PDF data portal pages and in the placemark balloons in WPWA's Google map to successfully link to the new data files. I am also carefully preparing detailed documentation of the database design, automation process, and updating procedures. The documentation step can be tedious and easy to skip, but is critically important to preserving the usefulness of the system in the future. Having this detailed docu-

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Examples of DATA MAPPING

by Eleanor Ely

More and more volunteer monitoring programs are using online maps to display their data, and it seems that every group puts its own individual spin on the project. Elise Torello describes one approach in the preceding article and three more examples are shown below.

Putting the monitoring site locations on a map is usually the easy part; the challenges come with linking the monitoring data to the sites. These challenges multiply the more sites you have, the more data you want to make accessible through the map, and the more “bells and whistles” you want to add.

The simplest option, which is feasible when there are only a few sites and a small amount of data, is to use Google My Maps and directly type the data into the pop-up balloons that appear when users click on a site. The process of getting the data into the balloons can be semi-automated by converting the data to a KML file (as was done for the Rivanna watershed map; see next page).

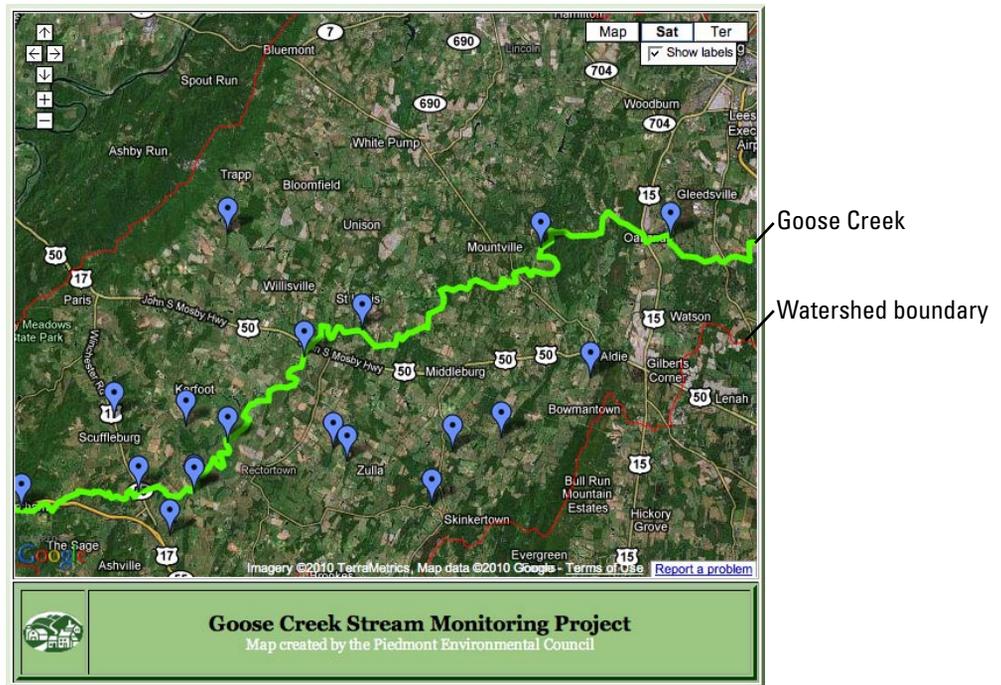
If you want to display more data than can fit into the balloons or provide data in formats such as data tables, graphs, and multiyear data reports, the data will need to be maintained somewhere other than in the map and linked to the map via hyperlinks in the balloons. Options for where to keep the data include:

1. In a static file (e.g., HTML page, PDF file) on a publicly accessible part of the monitoring program’s website. Example: Wood-Pawcatuck Watershed Association; see pages 8-9.
2. In a queryable database on a non-public part of the monitoring program’s web server. Example: Friends of the Shenandoah River, next page.
3. On an external server; for example, a Google Docs spreadsheet or Google Spreadsheet Mapper, maintained on the Google server. Example: Goose Creek, below.

When using a spreadsheet on an external server (option 3), many volunteer monitoring programs want to also maintain their own internal database. This means they either have to double-enter data updates or import updated data from the internal database into the external database.

In options 2 and 3, where the map is dynamically linked to the database, updating the database automatically updates the map. This is not the case when data are typed directly into the map balloons or kept in static files linked to the map.

Example 1: Goose Creek Stream Monitoring Project, Goose Creek Association



Technical Hints

The following tips are from Howard Webb (webb.howard@gmail.com), a professional programmer and a volunteer with the Lakes of Missouri Volunteer Program:

1. GPSBabel (www.gpsbabel.org/) is a simple, free tool that converts many different GIS file formats from one to another (KML/CVS/GPX).
2. Here’s a trick for getting the KML for an existing Google map: (1) Bring up the map in Google Maps. (2) At the end of the URL, add “&output=kml” (without the quotes). (3) Hit enter. A KML file of the map contents will be downloaded. This is a great way to look at other programs’ maps to see how they were constructed.

www.goosecreekassn.org/currentissues.html

The Goose Creek Association map is based on Google My Maps, enhanced with the addition of lines showing the creek (thick green line) and the watershed boundary (thin red line). This was accomplished by exporting GIS shapefiles into KML files, which were then imported into My Maps.

Clicking a link in the placemark balloon dynamically queries a Google Docs spreadsheet in a separate web page and opens a multipage spreadsheet with data graphs and tables for the site. Because there are only 21 sites and just five parameters for each site, data from Goose Creek Association’s existing spreadsheet were simply entered by hand into the Google Docs spreadsheet. As new data are collected they will need to be double-entered into the Association’s spreadsheet and the Google Docs spreadsheet.

For more information, please contact Watson Randolph, Piedmont Environmental Council, wrandolph@pecva.org.

Example 2: StreamWatch, Rivanna watershed

The Rivanna watershed map, created in My Maps, is notable both for the way it quickly and simply conveys basic water quality information and for the well-designed web page layout that complements the embedded map.

The color-coded placemarks, with six colors corresponding to ratings between “very good” and “very poor,” provide an at-a-glance overview of watershed conditions. A key to the color coding is prominently displayed in the column to the right of the map. This is a clever solution to a limitation in My Maps – namely, the lack of a tool for creating a key and displaying it in the map.

Clicking on a placemark brings up a balloon with summary data (biological condition rating and biological index score) for the most recent three years. This summary information will be enough for most users. Those who want more detail can use the “browse database” link in the righthand column to access the entire database.

A new map is created each year. (Maps for prior years are archived on the website.) StreamWatch Director John Murphy says that initially the summary data were hand-entered into each information balloon, but in 2009 he switched to using “Excel To KML” (a free software product from Earth Point, www.earthpoint.us/), which automatically converts an Excel spreadsheet into a KML file.

For more information, please contact John Murphy, johnmurphy@streamwatch.org, 434-242-1145.

<http://streamwatch.org/stream-conditions>

Example 3: Friends of the Shenandoah

The Friends of the Shenandoah River used the Google Maps API to create this sophisticated map, which has seven different layers that users can turn on or off by checking the boxes in the righthand side panel. The layers show such things as impaired stream segments, watershed boundaries, and U.S. Geological Survey (USGS) stream gage sites. Clicking on an

impaired stream segment brings up details about the impairment, and clicking on a USGS stream gage marker brings up a link to a USGS web page with real-time data for the site. The layers are KML files that reside on the Friends of the Shenandoah River website and load quickly when a checkbox is selected. The web page uses JavaScript to coordinate the checkboxes with the map.

The Friends have more than 12 years of volunteer monitoring data from over 100 sites. These data reside in a Microsoft Access database on the program’s web server. Clicking a hyperlink in a placemark balloon on the map brings up a data query page that allows users to specify a start and end date, parameters of interest, and the desired data display format (graph or table). Submitting a request from the data query page launches a dynamic query of the database and generates the requested graphs or tables.

The map was constructed by a paid consultant, Gary Lauben, who is also a volunteer monitor with the Friends of the Shenandoah. In creating the map, Lauben used a number of software tools including Google Earth Pro, Excel (using Visual Basic to produce KML), and ColdFusion (for generating graphs).

For more information, please contact Gary Lauben, fosrweb@fosr.org.

www.fosr.org/

Blue placemarks indicate sampling sites and brown lines show impaired stream segments.

Protecting Lake Hallett: a story of passion and persistence

by Courtney Kowalczak

For many years, the city council in St. Peter, Minnesota, viewed Lake Hallett as little more than a convenient place to dump stormwater. But a group of local citizens saw the 12-acre lake as a jewel worth protecting. In a region where the typical lake water clarity is 0.5 to 5 feet, Lake Hallett's clarity averages 12 feet.

This pipe dumped stormwater and silt into Lake Hallett for decades, until it was finally closed in 2007 after years of citizen effort.

The city first began diverting stormwater to Lake Hallett in the mid-1960s, a time when this was considered a normal practice. A detention basin was constructed adjacent to the lake, with a pipe at the bottom draining directly to



TRUDI OLMANSON

As a city-owned stormwater detention basin, the lake would have no water quality protection.

the lake. By 1996 the city had increased the area of land contributing stormwater runoff to the lake from the original 100 acres to 390 acres. Then in 1996 the city council proposed increasing the area contributing runoff to 700 acres and also moved to officially designate Lake Hallett as a stormwater detention basin. Toward that end, the city purchased the lake itself in 1998. As a city-owned stormwater detention basin, the lake would have no water quality protection.

Alarmed by the city's actions, a group of 10 concerned citizens led by Trudi Olmanson formed the Lake Hallett Association (LHA) in 1999. Their goal was to end the dumping of stormwater and silt into the lake.

Learning more about Lake Hallett's water quality meant becoming informa-

tion detectives. The citizens examined existing data from the city of St. Peter, the Minnesota Pollution Control Agency (MPCA), and Minnesota Department of Natural Resources (MNDNR). From MNDNR historical records they learned that the lake depth had changed from 35 feet in 1968 to 22 feet in 2001, a change

they suspected was directly related to stormwater silt. In addition, they found that the lake had an official Lake ID number assigned by MNDNR, which meant that it was officially a public water of Minnesota and the city's purchase of the lake was invalid.

LHA members also collected their own data. They photographed algal blooms and observed a fish kill. Starting in 1998 Olmanson took Secchi disk readings as part of the MPCA's Citizen Lake Monitoring Program. During one 2005 storm the Secchi depth went from 16 feet to 6 feet in just 11 days as thousands of gallons of runoff from the stormwater detention basin poured into the lake. In 2006, with help from the nonprofit organization Minnesota Waters, the Association created a water quality monitoring plan for Lake Hallett and received funding to start their monitoring program. Because of their specific concerns about stormwater runoff contamination they tested for bacteria, nutrients, volatile organic compounds, diesel and gasoline-related compounds, pH, conductivity,

and temperature.

As the group members educated themselves, they also worked to increase community awareness of Lake Hallett. They hosted informational booths at local fairs, gave media interviews, wrote letters to newspaper editors, and appeared on public access television.

LHA also encouraged use of the lake by local groups. Through LHA's efforts, the lake went from being almost unknown to being regularly used by the community for celebrations such as the Special Olympics Polar Bear Plunge and an annual kids' fishing contest.

It would be nice to say that as LHA members shared their concerns and water quality data with the city council immediate action was taken to stop stormwater runoff. Unfortunately, as has been the experience

with volunteer groups across the nation, knowledge is not always enough to change behavior. Economics, social values, and personal relationships are all part of the dynamics of water quality protection. As more concerns and demands were presented to the city council, communications between the groups at times were contentious.

Knowledge is not always enough to change behavior. Economics, social values, and personal relationships are all part of the dynamics of water quality protection.

Support from state agencies was key to achieving the Association's goals. In response to invitations from concerned citizens, MNDNR staff paddled the lake to see firsthand the lake's amazing water clarity and abundant fish. MNDNR's

continued on next page

One-Day snapshot finds HOTSPOTS

by Lisa Emanuelson

The first Saturday in May is Snapshot Day in central California. On this single day, hundreds of volunteers head out to creeks, rivers, and streams that drain into the Monterey Bay National Marine Sanctuary (MBNMS). Volunteers are assigned three to six sites where they field-test running water for temperature, pH, transparency, dissolved oxygen, and electrical conductivity, and collect samples to be lab-tested for nitrate, phosphate, total coliform, and *E. coli*. These are not your ordinary volunteers – many have participated since the very first Snapshot Day, in 2000. For them, the trek to streamside sites is an annual ritual where they can see, smell, and hear the changes from one year to the next.

A number of programs are available to central California citizens interested in monitoring water quality, but Snapshot

Day is special. Volunteers collect data from an almost 300-mile stretch of coastline, including areas 100 miles upstream of the ocean. The information is used in conjunction with other data to determine whether water quality is improving in watersheds flowing into the MBNMS, and to determine whether creeks and rivers should be included on California’s list of impaired water bodies (303(d) list). All this from volunteer-collected data!

A program of this scope and range would not be possible without partners dedicated to recruiting and training volunteers and making certain that data is reliably collected using the same protocols at all sites. The primary partners in this venture are the Coastal Watershed Council and the Monterey Bay Sanctuary Citizen Watershed Monitoring Network.

continued on next page



A. DEVOGELAERE

Volunteers of any age are encouraged to participate in Snapshot Day. Here a volunteer uses a transparency tube to check water clarity in Big Sur.

LAKE HALLETT, *continued*

Gene Jeseritz (fisheries supervisor) and Leo Getsfried (hydrologist) pushed the city of St. Peter to realize how its stormwater practices were harming Lake Hallett. The city was told that it would be fined if any more stormwater silt was added to the lake. It took months of back-and-forth discussions before the city finally closed the stormwater pipe in 2007. An improved stormwater detention pond has now been built by the city of

St. Peter, as well as a new wastewater treatment plant. The passion of the LHA and local citizens was necessary to keep all the governmental institutions diligent about their responsibilities toward this public resource.

What can other citizen monitoring groups learn from LHA’s experience? Communication, communication, communication! According to LHA president Olmanson, the key to success was “be-

ing persistent, making it public, trying to get other people from all walks of life involved, and letting people know that they have to speak out.”

The LHA has evolved from a group that expected state agencies to be the primary problem solvers to a group that has learned what they themselves can do as committed, empowered citizens. From a group of 10 people who loved a lake to community-wide recognition of a valuable resource, the story of the Lake Hallett Association is an amazing journey, and like all great journeys it is never really over.

Courtney Kowalczak is the Citizen Monitoring Program Director for Minnesota Waters; courtneyk@minnesotawaters.org; 213-343-2180; www.minnesotawaters.org. For more information about Lake Hallett, see www.lakehallett.com.

Participants in the Polar Bear Plunge jump into Lake Hallett’s frigid winter waters to raise money for Special Olympics Minnesota.



TRUDI OLMANSON

Data quality

The first step in ensuring good-quality data is training. Volunteers are usually trained a week or two before the event in a three-hour class. Volunteers get a chance to try out the materials and equipment (CHEMets test kits for dissolved oxygen, Oakton meters for conductivity, and either transparency tubes or turbidimeters for turbidity) and make certain they understand everything and know how to spot any equipment malfunctions. During the training course and after, volunteers are encouraged to ask questions. For many, their last connection to any scientific data gathering may have been years earlier in high school. Being open and available for questions is a way for program staff to make sure the volunteers feel supported in learning new skills. “Anybody can participate, because the training provided prepares you for the sampling tasks,” says water quality volunteer Art Evjen.

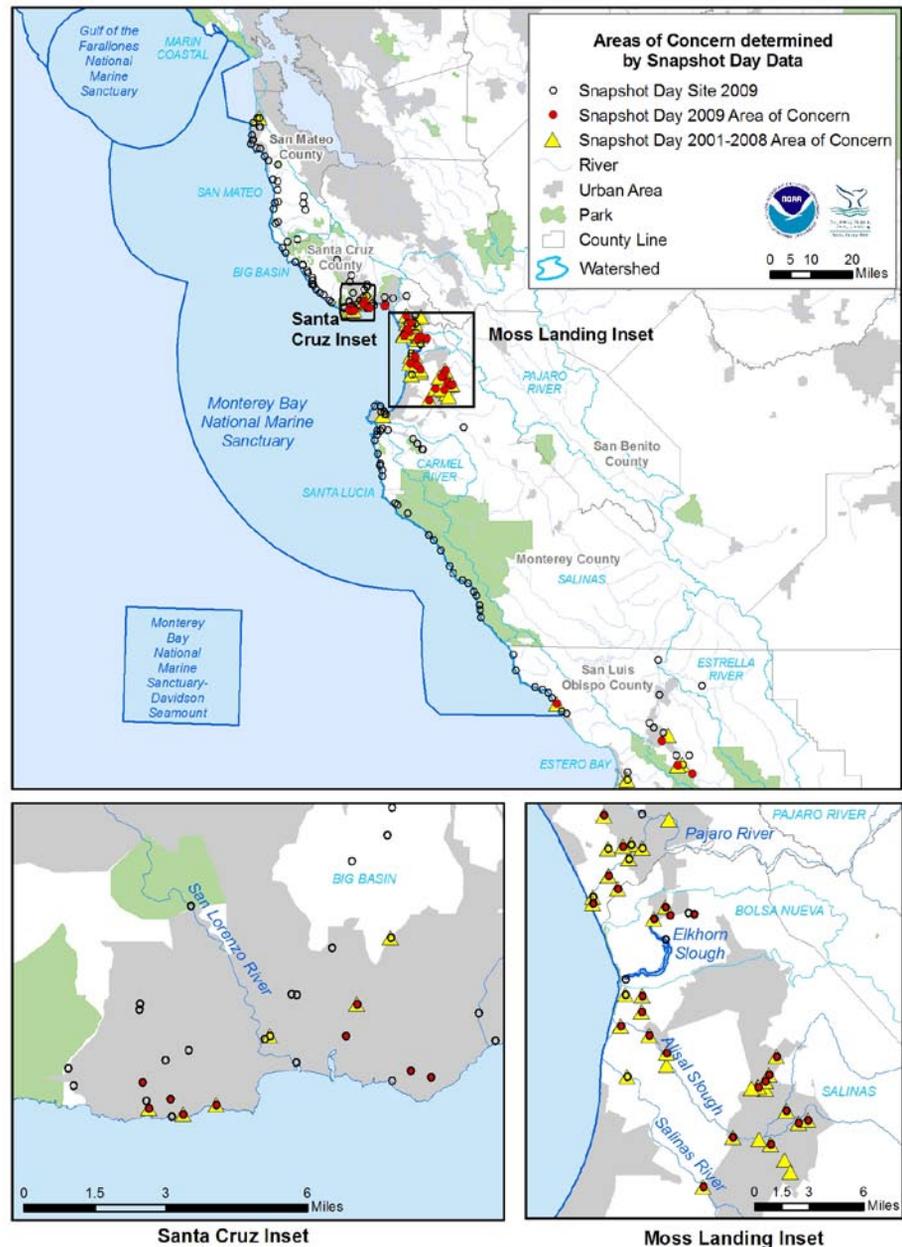
Snapshot Day teams can be as few as two or as great as 10, and usually combine new volunteers with veterans. Each team has its own set of equipment along with a thorough instruction sheet. Replicate measurements are taken at one site monitored by each team, to help assure the quality of the team’s data.

Using the data

“The results really do matter – they are shared and published and used to improve the quality of the watershed,” says Fran Horvath, longtime MBNMS water quality volunteer.

With 10 years of Snapshot Day data, trends are apparent. Snapshot Day measurements are compared to Central Coast Ambient Monitoring Program Water Quality Objectives and the EPA Ambient Water Quality Criteria to determine which sites have exceeded the water quality objectives. A site with exceedances in three or more of the measured parameters is identified as an Area of Concern (see map); sites that continue to be Areas of Concern year after year are considered “hotspots.” Snapshot Day has identified many hotspots that consistently show high levels of nitrates, phosphates, and bacteria. The majority

In 2009, Snapshot Day volunteers monitored 185 sites. Red dots indicate Areas of Concern for 2009, and yellow triangles show areas that have consistently exceeded water quality objectives over the years.



of these areas have a mix of urban and agricultural uses, which contributes to difficulty in source tracking.

One appeal of Snapshot Day is that the commitment is minimal – up to three hours for training and another four to six hours for the actual event. Horvath says, “With just one short day, you get a lot out of it – the fun of meeting new people, the satisfaction of volunteering, knowing that it’s doing some good, and probably seeing parts of the local area you never went to before.” A one-day program like

this gives volunteers an entrée into the world of water monitoring where they can see if they would like to learn and do more.

Lisa Emanuelson is the Coordinator of the Monterey Bay Sanctuary Citizen Watershed Monitoring Network; lisa.emanuelson@noaa.gov; 831-647-4227; www.monitoringnetwork.org.

Dealing with the **DOWN** **TURN**

by Ed Chadd

The worldwide economic crisis has found its way into every nook and cranny, and Clallam County, Washington, is no exception. The county's tax and interest revenues are down about 25 percent since 2007, and in a government that had already trimmed the fat during the previous downturn earlier in the decade, ours had no further easy places to trim.

Streamkeepers of Clallam County is a volunteer program started under Cooperative Extension in 1997 and taken over by county government in 1999, when there was a bit of "fat" for non-essentials. Our mission is to involve citizens in gathering good data, sharing it with

How do you cut expenses when most of your labor is free in the first place?

decision makers and the general public, and promoting watershed stewardship. We don't perform any mandated activity such as TMDL development or NPDES permit monitoring. In other words, Streamkeepers is an "extra" in terms of government function.

In past years, we helped pay our way by pulling in grant money, enough to cover half to three-quarters of our expenses. But recently, with grant resources drying up, the message came from our elected leaders: Bring in revenues, cut expenses, or else. With option 1 unavailable, and option 3 unpalatable, we had no choice but to try option 2.

How do you cut expenses when most of your labor is free in the first place? The only way is to squeeze the turnip a bit harder, and miraculously, that strategy seems to have worked. Thanks largely to heroic efforts on the part of our volunteers—doing what they do best, but even better—we've been able to trim more than 30 percent from our budget, helped our department meet its belt-tightening target, and probably saved our very existence. In the meantime, we have continued to expand the scope of our activities.

What made this seeming miracle almost a slam dunk is that from the very beginning our basic operating principle has been to pass on as much responsibility as possible to our volunteers, for two very good reasons: (1) to free up staff to take on other tasks, and (2) to empower our local citizenry.

From Day One we made it clear that the sky was the limit in terms of volunteer involvement, and that if anyone had a passion in a particular direction, we'd put it to good use. A host of volunteers answered the call, slowly infiltrating into leadership positions, bit by bit and year by year. In our volunteer corps of 200, about 10 percent have become "super volunteers" in fields of their own choosing.

So last year, when the budget crisis hit, volunteers simply ramped up this empowerment process by taking on more chunks of the program:

- A team of volunteers has taken over virtually all monthly maintenance, calibration, and accuracy checking of our equipment (four units each of three different water quality meters and one flow meter). These volunteers have written protocols, trained others, and entered calibration data into our database.
- Others have taken on the intake of new recruits, including interviewing interested people, getting them officially registered in the county's volunteer database, and signing them up with volunteer teams.
- Another group has learned how to give a basic slide presentation about Streamkeepers' work and data findings to community groups, and to demonstrate our tabletop watershed model at community festivals.
- A team has formed to pre-sort our benthic macroinvertebrate samples to speed up (and get a price break on) the work of the taxonomy lab we contract with.
- A new team is gearing up to create an in-house lab to analyze suspended sedi-

ment concentration for our stormwater monitoring.

The trick, of course, is to keep covering new ground without letting the old patches grow weeds. By emphasizing the team concept, we try to keep a cadre of volunteers trained in any task, so that if

We're not shy about asking for help.

we lose a "super volunteer" there are others ready to step up. (We also often beg the river gods to keep our 80-year-old database programmer healthy!)

Finally, we're not shy about asking for help. Our tiny staff's motto is, "If you can pass it off, do!" At the same time, we constantly remind volunteers that they are under no pressure and should back off if they find they're no longer having fun. But it's amazing what they find to be fun!

Ed Chadd is Program Coordinator for Streamkeepers of Clallam County. For more information: 360-417-2281; streamkeepers@co.clallam.wa.us; www.clallam.net/streamkeepers/.



Volunteer Steve Belcher prepares a Winkler titration to use in monthly accuracy checking of dissolved oxygen meters.

BETTER Outreach & Impact

by Eleanor Ely

Kris Stepenuck probably echoes the thoughts of many volunteer monitoring program coordinators when she says, “We do a good job of obtaining quality data, but sometimes it feels like a one-way street: A lot of information is coming in but not as much is going out.”

Fortunately for Stepenuck, the program she coordinates—Wisconsin’s Citizen Stream Monitoring Network—enjoys some special advantages that come with a university affiliation. The Network is jointly sponsored by University of Wisconsin Extension (UWEX) and Wisconsin Department of Natural Resources. Recently, the monitoring program was adopted as the subject of a research

With this information in hand, Shaw and two graduate students collaborated with Stepenuck and her colleague Chris Clayton to find practical ways to meet the volunteers’ needs. Here are some of the products that came out of the project.

Meaningful data display

Shaw and the students recognized the importance of presenting monitoring data in a way that quickly conveys the relationship between the data and water body health. They drafted graphical templates, which were later refined by Stepenuck and a UWEX graphic artist, for displaying a variety of monitoring

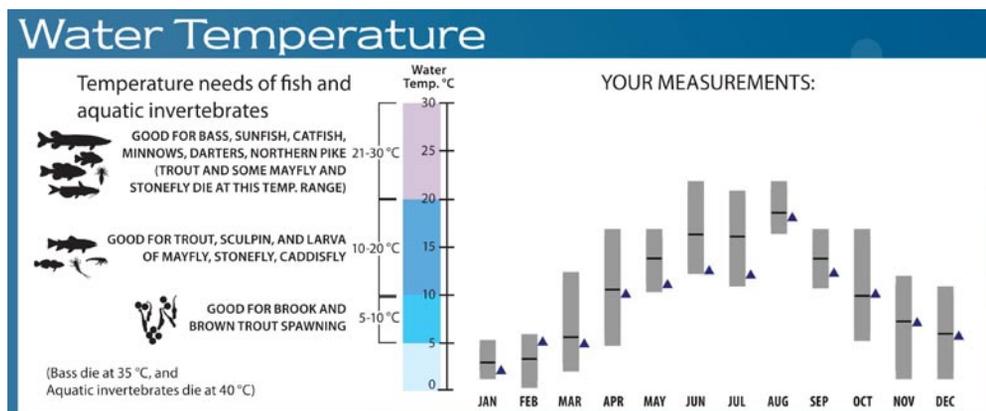
Media coverage

Elizabeth Goers, one of Shaw’s graduate students, interviewed a number of volunteer monitors and wrote articles about their work. Her efforts resulted in six articles published in local media, and a radio story. A website with tips for working with local media was developed for use by the volunteers to develop additional stories.

Brochure

Shaw found that the volunteer monitors wanted to have something to give passersby who saw them in the field and were curious about what they were

One of five graphical templates for displaying Wisconsin Citizen Stream Monitoring Network results in a meaningful way. The bars summarize the range of temperature results from multiple years, the lines indicate the median temperature, and the triangles show results for 2009.



project led by Bret Shaw, a professor in the Department of Life Sciences Communication at the University of Wisconsin and a UWEX environmental communication specialist. Shaw’s project consisted of implementing various strategies for improving outreach and communication and then evaluating the success of those efforts.

Shaw’s first step was to assess the volunteers’ needs. Through an online survey and informal conversations, he learned that the volunteers shared Stepenuck’s view that the program could be doing a better job with outreach. The volunteers wanted more feedback about their own data and more help in publicizing their work and their data to the broader community.

parameters in a meaningful context. For example, the water temperature graphic (above) makes it easy to visually compare temperature data at a particular site with the temperature needs of fish and other aquatic organisms. Similar graphics were designed for dissolved oxygen, transparency, biotic index, and habitat.

The next step will be to use the templates to create individual customized postcards for each of the 185 sampling sites. The cards will be folded, with each panel showing results for one or two parameters, and mailed to volunteers and local coordinators. Even with the prefabricated template, Stepenuck anticipates that a lot of work will be required to create all the individual graphs and integrate them into the template files.

doing. Undergraduate students in a Life Sciences Communication class created a colorful trifold brochure explaining the reasons for monitoring temperature, dissolved oxygen, and water clarity. After a bit of jazzing up by the UWEX graphic arts department, the brochures were printed and have now been distributed to the volunteers.

For more information on the outreach project, contact Kris Stepenuck, kfstepenuck@wisc.edu, 608-265-3887.

Purchase & Care OF ELECTRONIC METERS

by Ann Schenk

Judging from recent postings on the volunteer monitoring listserv, many groups are moving from chemical test kits to electronic meters. Choosing a meter can be daunting to newcomers. Here are some points to keep in mind.

Cost considerations

- All other considerations are moot if you cannot afford what you really want or need in a meter. Decide on a preferred cost per unit and a maximum cost per unit before you even open a catalog, web browser, or phone book.
- For preliminary planning purposes, about \$200 per parameter is a good guesstimate. Some meters, such as pH, can be had for under \$100, while dissolved oxygen (DO) meters tend to run closer to \$500. Optical DO probes are still running in the \$1,000 neighborhood.
- Multiparameter meters start at about \$500 and can easily exceed \$8,000 for a model with all the bells and whistles and a long cable for depth profiling. This is well beyond most volunteer program budgets.
- Don't forget to include maintenance costs in your calculations. Many probes are not user-serviceable, and therefore will need replacement or expert servicing every year or two.

Tips for purchasing

- The intended uses of the meter will help determine what kind of meter to get. Units designed for field use will be awkward to use in a lab setting, and those made for indoor use will not long survive outdoors. "Water resistant" or "splashproof" units will not survive immersion. To determine waterproofness look at the IP code or NEMA rating.
- If your volunteers are mostly bifocal-wearers, get screens big enough to see. If volunteers will be working in bright sun,

check the display to see if you can read it wearing polarized sunglasses. (Just think how hard it is to read some gas pump displays through sunglasses.)

- Make sure the meter provides the levels of precision and accuracy your program requires. You get what you pay for. Cheap pH probes might show two decimal places in the display, but a check of the specifications shows the resolution to be only ± 0.2 pH units. A pH 7.01 solution could read anywhere between 7.21 and 6.81 on such a meter.
- Most volunteer monitoring programs want reported values to be temperature-corrected. Verify that the meter you buy has such correction if you require it. The cheapest meters do not necessarily have temperature corrections.
- The biggest differences among DO probes are in the ruggedness of the probe housing and the temperature and salinity correction options. All DO measurements require concurrent measurements of temperature and (except in freshwater) salinity for correct calibration and use. However, some DO meters perform these measurements and corrections automatically while others require the use of separate equipment to measure salinity and/or temperature.

- Most vendors are more than willing to send you an evaluation unit. Take advantage of this offer. No picture can substitute for actually holding the real thing. Most, if not all, of the information you need to make sure the unit will meet your needs will be in the manual that comes with the unit.

Care of meters

- Chemical test kits can last decades — all you need to do is replace the reagents. This is not the case with electronic meters. Manufacturers come out with new models, replacement parts for old

models become impossible to get, and the meters just plain wear out.

- Improper use or storage can render a meter useless. Storing it nine months of the year with the batteries installed will have the insides looking like that flashlight you put in the glove box a long time ago.
- Many pH probes use a porous glass or ceramic tip that must be kept moist while stored or the reference solution or gel will dry out and the probe will need replacing. Use tap water for storing pH probes; never use distilled or deionized water, as the reference gel or solution will be diluted and the probe will need replacement a lot sooner than expected.
- Most DO probes also require moist storage conditions to prevent the membrane from drying out. For storing DO probes, distilled water is preferred.
- Definitely have a mandatory annual training session for everyone using the meters. People can forget a lot in a year! Make sure at least two people know how to calibrate and troubleshoot the meters. When all else fails, read the manual!

Recordkeeping for posterity

When using a meter, it is vital to record the make and model and keep this information with the dataset. If you switch brands of meters, you might find that a side-by-side comparison gives very different numbers. Ten years later, it helps analysts to know that the jump in numbers is an artifact of the technology, not a real-world change.

Ann Schenk was formerly a biologist with Maryland Department of Natural Resources, where she provided extensive technical support to the Maryland Stream Waders volunteer monitoring program (www.dnr.state.md.us/streams/streamWaders.asp). She may be contacted at aschenk2@mac.com.

An Uncommon Tribute

Naming a Creek for a Volunteer Monitor

by Steven Hubbell

On Saturday, November 7, 2009, at 2 p.m., a few dozen former students, family members, and friends of the late Robert (Bob) A. Furtado gathered beneath the trees at his old monitoring site in Austin, Texas, to honor his memory. The extraordinary element to this event was that these people gathered to christen a new creek name: the stream which was formerly an unnamed tributary to Bull Creek would now officially be Furtado Creek.

Bob Furtado was an Anderson High School teacher who monitored water quality with his students at the tributary. In 1988, he was one of the founding Colorado River Watch Network (CRWN) teachers, and he coauthored the first CRWN biomonitoring manual. Above all, Bob was a dynamic advocate of clean water and an inspiration to his students and peers. For him, teaching was not just a profession—it was a calling. As his son observed quietly, “He *lived* teaching.” He answered questions with

questions, used Monty Python to teach the scientific method, and liked to refer to the “butterfly effect” (“You fail my class, you don’t get accepted at Berkeley”).

After Bob passed away in 2002, some of his former students came to me (as coordinator of the CRWN program) with the idea of getting the creek named for him. We looked into it, and discovered that you have to wait five years after a person has died before submitting your

Bob would have laughed
at the idea of a creek
having his name.

request to the U.S. Geological Survey.

As the five-year waiting period drew to a close, two former students, Jennifer Quereau and Emily Dubin, took the challenge upon themselves to gather and submit the necessary information, including supportive statements from Bob’s colleagues and students. Meanwhile, Dani Apodaca (the new CRWN coordinator) obtained permission from

the park to place a bench and a plaque honoring Bob near the monitoring site.

Bob would have laughed at the idea of a creek having his name, but I believe he would have been deeply moved by the dedication and perseverance of his students, and very proud of their achievement. Sitting on this comfortable bench in the shade, I watch dragonflies flit above the surface of this lovely little creek. I find it immensely satisfying to know that a simple man who sought neither fame nor riches, a dedicated teacher who inspired scholarship and stewardship, should be honored in such a meaningful and enduring way.

Steven Hubbell, former CRWN Program Coordinator (1995-2004), is a volunteer monitor who works as a Site Assistant at Westcave Preserve. He can be contacted at steven_hubbell@sbcglobal.net.

Bug Guide, Flash Cards

Macroinvertebrate monitors may already be familiar with J. Reese Voshell, Jr.’s very popular 2002 book, *A Guide to Common Freshwater Invertebrates of North America*. Now Voshell and McDonald & Woodward Publishing have created four new products incorporating Amy Bartlett Wright’s beautifully detailed illustrations for the book.

“QuickGuide to Major Groups of Freshwater Invertebrates” is a folded 8-panel laminated chart, handy for field use in identifying macroinvertebrates to class or order.

“Flash Cards of Common Freshwater Invertebrates of North America” consists of three different sets of 32 cards each. The 4-by-6-inch waterproof cards display a full-color scientific illustration of an organism on the front, and information about that organism on the back.

For detailed descriptions and ordering information for these products, as well as Voshell’s 2002 guidebook and *The Bug Book* (a new family-level guide that was described in the previous issue of this newsletter), please visit www.mwpubco.com/titles/invertsflashcards.htm or contact McDonald & Woodward at 800-233-8787.



Underwater Video Shows Bugs in Action

“Bugs of the Underworld: The Natural History of Aquatic Insects,” a 35-minute DVD filmed with custom lenses and underwater housings, provides an amazingly clear view of aquatic macroinvertebrates living in their natural habitat. Many different types of aquatic insects are shown at different stages of their life cycles. Close-ups of metamorphosis and emergence are especially fascinating. The narration explains the details of life cycles and behavior. \$29.95 plus shipping. See www.flyline.com/ for more information, including a trailer.

World Water Monitoring Day

In 2009, about 122,000 people from 81 different countries submitted World Water Monitoring Day data from 8,090 sites. Participants use a simple test kit to collect data on water temperature, pH, clarity, and dissolved oxygen. Malaysia had the largest number of participants (over 50,000), and the United States had the most sites monitored (4,155). The event's coordinators, the Water Environment Federation and the International Water Association, have set a goal of one million participants by 2012.

World Water Monitoring Day is officially celebrated each year on September 18, but data may be collected from March 22 through December 31. The 2009 World Water Monitoring Day report is available at www.worldwatermonitoringday.com/About/Annual_Reports.html.

World Water Monitoring Day participants in Indonesia.



ROSEMARY SILVA

Subscriptions

Electronic and hard copy subscriptions are available. Both are free. Send requests to Alice Mayo at mayio.alice@epa.gov; U.S. EPA, 4503T; Office of Wetlands, Oceans, and Watersheds; 1200 Pennsylvania Avenue, NW; Washington, DC 20460.

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Back Issues Online

Issues from Spring 1993 onward are posted at www.epa.gov/owow/volunteer/vm_index.html. (Note that for issues before 2002 the posted version is different from the original layout.)

A subject index for Spring 1993 through the current issue is also available at the website.

Free Resources

Macroinvertebrate identification

The Volunteer Stream Monitoring Interactive Verification Program (VSM-IVP), developed by University of Minnesota entomologists, features photos and descriptions of macroinvertebrates, including close-ups of key identifying structures, to help with family-level identification. The site was designed to be used with the companion manual, *Guide to Aquatic Invertebrates of the Upper Midwest*, but is also valuable on its own. <http://www.entomology.umn.edu/midge/index.htm>.

MORIYA M. RUFER



Water scorpion.

Newsletter

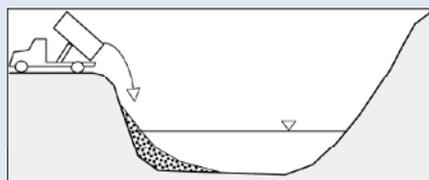
EPA's Nonpoint Source News-Notes covers a wide range of topics related to watershed management and restoration, including environmental education and activities of citizen groups. It also features extensive resource listings. www.epa.gov/owow/info/NewsNotes/.

Managing stormwater

Fundamentals of Urban Runoff Management: Technical and Institutional Issues, 2nd edition (2007), published by the North American Lake Management Society, is detailed and comprehensive yet accessible to nonexperts. 300+ pages. www.nalms.org.

A site for techies

The Stream Systems Technology Center website, maintained by the Forest Service's Rocky Mountain Research Station, offers detailed information, including free online videos and the newsletter "Stream Notes," about monitoring stream morphology and hydrology. www.stream.fs.fed.us/.



From "Stream Notes" Spring 2007.

The Volunteer Monitor
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MAPPING, continued from page 9

mentation on hand will allow WPWA to “pick my brain” about the system in the future, even if I move to Tahiti.

WPWA’s data and online mapping project will be ongoing and evolving. One option we are considering is aggregating or summarizing data for some parameters to yield overall indices or “report cards” of environmental health. Many members of the public are not

interested in data tables and plots but rather want answers to questions like “Can I swim there?” or “Can I fish there?” Generating this type of summary information requires much time and consideration on the part of watershed scientists. However, using such indices in conjunction with our online map would be a powerful and useful tool for scientists and the public to visualize and

utilize WPWA’s data.

Elise Torello has a B.S. in Wildlife Biology and M.S. in Computer Science from the University of Rhode Island and is currently working for WPWA. She can be contacted at elise.torello@gmail.com.

To view the WPWA map, go to www.wpwa.org/waterQuality.htm.

Monitoring Climate Change

Volunteers who are interested in monitoring climate change can participate in several nationwide programs that are collecting various kinds of climate-related data.

IceWatch USA invites citizens to become IceWatchers and report their observations on freeze (ice-on) and thaw (ice-off) dates for lakes and rivers. <http://natureabounds.org/icewatch/>.

CoCoRaHS (Community Collaborative Rain, Hail, & Snow Network) is a network of volunteer weather observers that started in Colorado in 1998 and is now active in all 50 states. Using simple equipment—rain gauges and “hail pads”—participants collect data on rain, snow, and hail. www.cocorahs.org/.

Project BudBurst volunteers collect data on the timing of leafing, flowering, and fruiting of trees, shrubs, flowers, and grasses, especially native species. www.windows.ucar.edu/citizen_science/budburst/.



HENRY REGES

James Cano, a CoCoRaHS volunteer in Texas, with his rain gauge.