THE
Volunteer Monitor

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metadata
helping data live longer, go farther

by Eleanor Ely

Suddenly, everybody seems to be interested in metadata, or "data about data." Metadata are data descriptors or qualifiers that document the when, where, what, why, how, and "how good" of sample collection and analysis.

The concept of metadata is not new—after all, data documentation has always been important. So why the recent upsurge in interest? When I raised this question with several members of the National Water Quality Monitoring Council (NWQMC), the first thing they mentioned was data sharing. Tight budgets provide strong motivation to find and use existing data whenever possible, and geographic information systems (GIS) are data-hungry. At the same time, sharing data is easier than ever, thanks to email and the Web. Today's data are on the move, and like humans they need documentation to travel.

TODAY'S DATA ARE ON THE MOVE, AND LIKE HUMANS THEY NEED DOCUMENTATION TO TRAVEL.

Good documentation also extends the lifespan of monitoring data. Sometimes programs are unable to use their own old data because no one can find the records explaining why and how the data were collected. And while no one wants to believe their program will end, it is some consolation to realize that even if a program succumbs the data can live on.

Traditionally, volunteer monitoring programs have been advised to first identify intended uses and users of their data and then decide what kinds of documentation are needed for these uses and users. This is good advice, but it can be taken a step further to also consider *unintended* uses. Rivers of Colorado Water Watch Network coordinator Barb Horn says, "We all get trapped into thinking, 'I'm generating data for this use and that's it.' In fact, our data almost always potentially can be used for something else—but only if we can provide the metadata."

To decide whether someone else's data—or, for that matter, "legacy" data collected in the past by your own program—is suitable for any given purpose, you need answers to a host of questions. Were the data collected to characterize baseline conditions, capture a "worst case" scenario, or some other reason? Was phosphorus measured as total phosphorus or dissolved orthophosphate? What was the detection limit of the method? What is the quality of the data?

Inevitably, metadata documentation takes effort. As NWQMC member Valerie Connor says, "We have to accept the reality that we have to do more because we want our data to live. But how much more?" Volunteer monitoring program coordinators are rightly concerned with finding a balance among multiple program goals. The challenge is to find a reasonable level of documentation that enhances the data's present and future value without overburdening volunteers or staff.

Fortunately, when it comes to data documentation, volunteer monitoring groups are probably a step ahead of many professional monitoring programs. Knowing that their data will be subjected to extra skepticism and scrutiny, volunteer programs have long been accustomed to documenting the validity of their methods, the performance of their volunteers, and the measures taken to assure the quality of their data.

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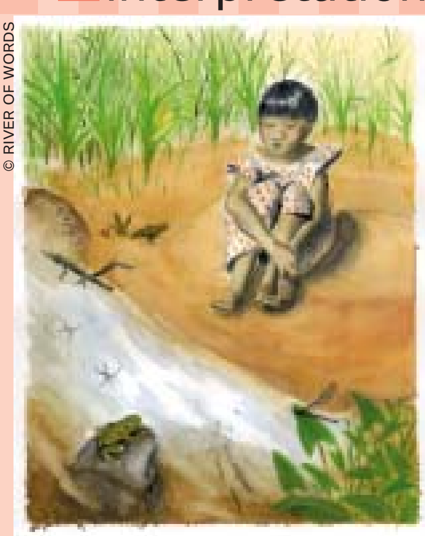
data documentation & interpretation



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THE
Volunteer Monitor

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COVER ART: WATCH, BUT DON'T TOUCH
AYA R., AGE 16
ATLANTA, GEORGIA

Next issue: Bioassessment

The theme for the Summer 2005 issue will be bioassessment, with a particular focus on benthic macroinvertebrate monitoring. Please send ideas for articles to the editor (contact information at left). Stories about use of bioassessment data are especially welcome.

Justifying long-term monitoring

Last May, Gene Williams wrote to the volunteer monitoring listserv, "I am looking for good arguments justifying the continuation of a monitoring program." Each budget cycle, Williams is asked to justify anew the benefits of Snohomish County Surface Water Management's volunteer lake monitoring program. In his posting, Williams asked for help in answering questions like "Haven't you collected enough data yet?" and "Don't you have a good understanding of the lakes already?"

Williams's query elicited many thoughtful replies. Respondents pointed out that long-term monitoring helps resource managers to:

• *Detect problems early*. Like a periodic physical exam, regular monitoring can catch problems before they become more serious and costly.

• *Identify trends*. Monitoring datasets grow more valuable over time, continually improving their ability to distinguish trends from natural variability.

• *Stay up-to-date*. As land-use patterns change and new water quality concerns arise, managers need current, valid data.

• *Target remediation efforts*. Millions of dollars are spent annually on remediation and restoration. Long-term datasets can direct remediation efforts efficiently for maximum return on the investment.

• *Assess remediation outcomes*. Post-project monitoring documents project effectiveness and shows whether modifications are needed.

• *Support regulatory action*. Ongoing monitoring ensures that relevant data will be available to support regulatory or legal action.

The listserv discussion also touched on several special and unique benefits of *volunteer* monitoring. It is cost-effective (although not free). It often reaches smaller water bodies not covered by professional monitoring programs. Since most volunteers are local residents who can visit their sites frequently, they are more likely than agency staff to catch problems like fish kills, dumping, intermittent discharges, vegetation clearing, and leaking sewage lines. Finally, volunteer monitoring expands the knowledge base of the community, focuses public attention on environmental problems, and builds support for protecting water resources.

Where's the "news"?

Williams's listserv posting reminded me of a question journalists typically ask about volunteer monitoring: "What's new?" Lately I've come to realize that the value of monitoring often lies precisely in what is *not* new. The fact that a number of volunteer monitoring programs celebrated their 10th, 20th, or even 30th anniversary last year is probably more significant than whether any of them did something new or different that year. Similarly, the strength of a volunteer program is better measured by the number of veteran monitors marking milestone anniversaries than by the number of new recruits.

In monitoring, sometimes what you really want to see is the "same old same old"—the same volunteers, the same methods, and maybe even (if your water body is healthy) the same monitoring results. As valuable as it is, a consistent long-term dataset is not exactly "news"—and that can make monitoring a hard sell to reporters and funders alike. The points raised in the listserv discussion should provide good fodder for volunteer monitoring groups to use in building their case.

(Note: In case you haven't discovered the EPA's national volunteer monitoring listserv, it's a wonderful place to exchange ideas and raise questions. To join, send a blank message to volmonitor-subscribe@lists.epa.gov.)

Data elements

The NWQMC, a multiagency federal advisory committee formed in 1997, is charged with developing water quality monitoring approaches to facilitate collaboration and data sharing among different monitoring entities. Recognizing inconsistency in metadata as one major barrier to collaboration, the Council went to work on defining a set of standard "data elements" for characterizing water quality data. The NWQMC list of data elements is now available at http://wi.water.usgs.gov/methods/tools/. The Council hopes that widespread adoption of these data elements will promote data sharing among multiple users for multiple purposes. The length of the Council's list is daunting, but remember that these are *potential* data elements; not all will be applicable to any given project.

The summary of important data elements shown at right is roughly based on the NWQMC list, but it is much less comprehensive and is organized somewhat differently.

Documenting and communicating metadata

Many of the elements in the first four categories—Who, Where, When, and What—are typically included on volunteer monitors' field data sheets and entered into program databases. When the dataset is provided to other users, it's likely that these kinds of metadata will accompany it.

The last three categories—Why, How, and How good—represent more complex information that is less likely to be routinely kept with the data and communicated to data users. Most monitoring program spreadsheets are not set up with a neat column or cell for entering the intent of the study, the rationale behind site selection, or the side-by-side studies performed to validate a nontraditional monitoring method. Yet all of this information is critical to potential data users. For volunteer monitoring programs, it's often especially important to document the steps that were taken to assure data quality.

So, how do volunteer monitoring groups communicate this kind of information to data users? One way is by providing users with a copy of the program's quality assurance (QA) plan, which describes in detail most of the why's and how's of their monitoring activities—the intent, study design, monitoring methods, and so forth. The plan also contains QA-related information such as volunteer training requirements, data quality objectives (target levels of accuracy and precision), and specific quality control (QC) protocols (e.g., instrument calibration, replicate sampling) that will be followed.

Certain quality assurance information related to laboratory analysis, like instrument calibration records and QC sample results, is often kept in a handwritten logbook. If data users want to

continued on next page

Data Elements Summary

Who
- Contact information for monitors, organizations, laboratories

Where
- Water body name
- Site number or name
- Sampling station type (stream, lake, estuary, storm sewer, etc.)
- Geographical coordinates (e.g., latitude/longitude)

When
- Date and time of sample collection, delivery to lab, extraction, analysis

What (Results)
- Characteristic name—for example:
  - a chemical analyte; e.g., ammonia
  - a metric; e.g., species richness
  - a field observation; e.g., cloud cover
- Result value
- Result units
- Result type (measurement, observation, calculated endpoint)

Why
- Reasons for sampling—for example:
  - assess general status
  - analyze trends
  - evaluate success of management practices and restoration projects
  - characterize storm runoff
  - identify problems
  - assess impacts of human activities
  - determine whether water quality standards are being met

How
- a. Sampling design
  - approach (random versus "targeted")
  - where, when, and how often samples are collected
- b. Sample collection
  - type of sample (e.g., surface, subsurface, composite, continuous)
  - collection gear
  - storage time; method of preservation
- c. Sample analysis
  - description of method, including method number if applicable
  - modifications to method

How good
- Existence of QA plan and who approved it
- Data quality objectives that data met
- Method detection limit and resolution
- Training level and/or certification of volunteers
- Validation studies for methods and/or for volunteer performance
- Results of quality control samples (blanks, replicates, etc.)
- Instrument calibration records

METADATA, continued

see this information, a photocopy of the logbook may be provided.

Another way to communicate critical metadata about your monitoring efforts is through a written report. Many volunteer programs already publish data summaries in an annual report or create special publications analyzing the findings for particular water bodies. Such reports could be made even more valuable if they were prepared with an eye to documenting metadata for potential future data users. Barb Horn recommends preparing a basic "fact sheet" with this type of information for each project.

Florida Lakewatch receives requests for data from researchers all over the world. According to Lakewatch Assistant Director Mark Hoyer, when the data files are sent out they are accompanied by the Lakewatch annual report (in pdf format), which contains extensive information on study design and methods. Florida Lakewatch (unlike most volunteer monitoring programs) is in the fortunate position of having its data published in scientific journal articles, which are also sent to potential data users.

Capturing metadata electronically

Ten years from now, when key people may have moved on, how easy will it be to locate old laboratory logbooks, volunteer training records, or field data sheets and connect these documents with the appropriate monitoring results in your database? Incorporating as much metadata as possible into your electronic database is the best way to ensure that the metadata stays with the data.

A number of volunteer monitoring programs are already moving in this direction—for example, storing detailed site location information such as verbal descriptions, site codes, and latitude/longitude coordinates in tables that are linked to results tables in the database. Some programs' databases contain a field or table for documenting each volunteer's training level. Replicate results for field tests (an indicator of precision) may also be recorded in volunteer monitoring databases.

Missouri Stream Team posts all its volunteer monitoring data on the Web, along with several types of QA metadata. The results tables include a column identifying the training level of the volunteer who collected the data, and a separate table lists the detection limit and data quality objectives for each parameter.

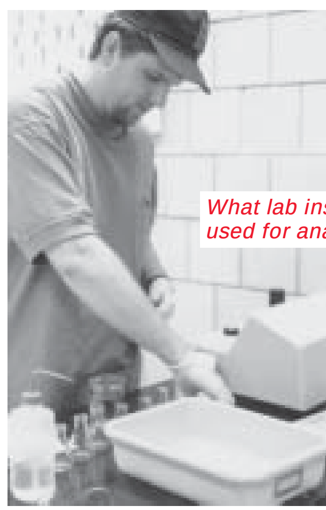
Electronically "flagging" questionable data is another tool to help document data quality. In a well-run monitoring program, the data manager is constantly on the lookout for irregularities. Anything that suggests a problem—a holding time exceeded, a result that's very different from past results at the same site—is flagged in the database, usually with an accompanying comment explaining the reason for the flag. These flags and comments constitute a type of metadata—essentially, the data manager's professional judgment that there is some question about the validity of a particular result. At the data manager's discretion, some or all of the flagged data may be withheld from certain data uses.

"The ultimate"

Revital Katznelson, a scientist at the California State Water Resources Control Board, has designed a data manage-

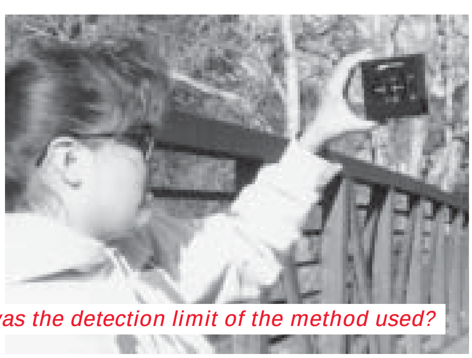
The more background information (metadata) you can provide, the more valuable your data will be for multiple purposes and users.

How were volunteers trained and tested?

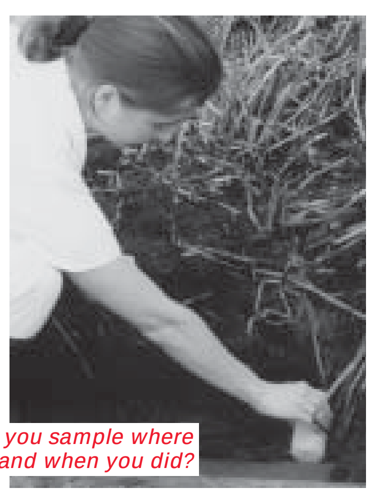


What lab instruments were used for analysis?

What type of net was used to collect macroinvertebrates?



What was the detection limit of the method used?



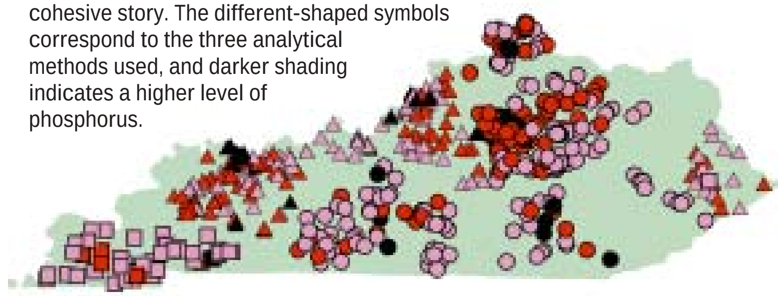
Why did you sample where and when you did?

PHOTOS BY ELEANOR ELY

ment system for volunteer monitoring data that can electronically store and manage a very large amount of metadata—potentially, even more data elements than are included in the NWQMC list, although in practice only a fraction are used in any given dataset. By Katznelson's own description, the system is "the ultimate in comprehensiveness." She explains, "The goal is scientifically defensible data of known quality—data that will be good enough for regulatory purposes—data that can be used for anything." Most volunteer monitoring groups will not need such a comprehensive system, but Katznelson has incorporated several interesting features that other groups may find useful.

Combining Data in GIS

This GIS map brings together data from different volunteer monitoring groups, analyzed by different methods, into a single image that tells a cohesive story. The different-shaped symbols correspond to the three analytical methods used, and darker shading indicates a higher level of phosphorus.



Kentucky Watershed Watch September 2004 Phosphorus Values

Katznelson created her data management system in Excel (a spreadsheet program) rather than a relational database because she wanted a system that would be transparent and accessible for small community volunteer monitoring groups without specialized information technology (IT) expertise.

To make it easier to manage the metadata, Katznelson organized her spreadsheets in a "normalized" format, which gives each individual result point its own row, as shown below:

Monitor	Date	Time	Instrument ID	Sampling depth	Parameter	Units	Result	Replicate	RPD(%)
Jane	10/6/04	9:20	EC-STB3	surf.	conductivity	µS/cm	758.7	759.2	6.6
Jane	10/6/04	9:20	DOW-RK2	surf.	diss. oxygen	mg/L	6.6	7.3	10
Jane	10/6/04	9:20	TTP-STB2	surf.	temperature	˚C	23	—	—

In contrast, most volunteer monitoring programs would format the same results in the following way, sometimes referred to as a "tabular" format, in which each row contains multiple results from the same site visit:

Monitor	Date	Time	DO 1 mg/L	DO 2 mg/L	Cond 1 µS/cm	Cond 2 µS/cm	Temp ˚C
Jane	10/6/04	9:20	6.6	7.3	758.7	759.2	23

The normalized table is less reader-friendly and looks repetitive (since identical information about name, date, and time is repeated in every row). For reporting purposes, Katznelson converts her tables to the tabular format, which shows at a glance all the results from one site visit.

However, for storage and management the normalized format is preferable. Because each row contains information about just one result, it's possible to attach a large amount of metadata to each individual result point. (In theory this could be done with the second format as well, by adding in additional columns such as "DO instrument ID," "DO sampling depth," etc.; but the row would become extremely long and data manipulation would be extremely cumbersome.) Another reason Katznelson chose the normalized format was to facilitate uploading the data to EPA's national database, STORET, which is formatted the same way.

Katznelson's actual results table documents many more pieces of metadata besides those shown in the example, but for the purposes of this article let's just consider two fields, "RPD," and "Instrument ID." The RPD field calculates the relative percent difference of replicate measurements, which is a measure of the precision of the data. One unusual feature of Katznelson's system is that it allows you to document each individual data point's RPD. More commonly, volunteer monitoring programs simply report the data quality objectives that the data met.

The Instrument ID field contains a unique identifier code for each piece of equipment. The code encapsulates information about the parameter and method (e.g., DOE = dissolved oxygen electrode; DOW = dissolved oxygen Winkler) and equipment owner (e.g., STB = State Board). The Instrument ID also links to another spreadsheet that contains detailed information for each instrument (manufacturer, model number, detection limit and range, etc.). Using instrument ID codes is especially convenient in situations where monitoring equipment is kept at a central location and loaned out to different volunteers at different times.

Katznelson stresses that not all the metadata a program documents is provided to data users; some is for internal program use only. "It's all there," she says, "but you never need all of it. You select the relevant metadata needed for each use."

"Watch this space"

This basic overview has only scratched the surface. Any one of the metadata categories—except, probably, "who"—could easily be the subject of its own in-depth article. The "where" category, which I decided to tackle first because I thought it would be simple, quickly ballooned into a 3-page article (see page 8). The topic of "how good" might well fill up an entire issue. Stay tuned! Meanwhile, I hope the information presented here may help set volunteer monitoring data on the path to a longer and more productive life.

The invaluable assistance of Revital Katznelson, Jerry Diamond, LeAnne Astin, Linda Green, Jeff Schloss, Jason Pinchback, and Elizabeth Herron in the preparation of this article is gratefully acknowledged.

Volunteer Certification—and Recertification

by Eleanor Ely

Right from its beginning, in 1993, Alabama Water Watch (AWW) put a premium on data quality. In preparing the program's first QA Plan (which was approved by EPA in 1994), staff spent hundreds of hours documenting the precision and accuracy of each method volunteers would use. They also wrote into the QA Plan a commitment not only to certify every volunteer monitor but to recertify monitors annually.

"You start out starry-eyed," explains Bill Deutsch, who cofounded AWW and still coordinates the program from Auburn University. "You promise the moon. Then that sinking feeling begins."

The sinking feeling intensified as AWW grew. By the end of the program's first year, Deutsch and AWW cofounder Bill Davies were spending nearly half their weekends on the road, training and certifying hundreds of volunteers all over the state to conduct chemical water quality monitoring (including testing for temperature, dissolved oxygen, alkalinity, turbidity, pH, and hardness). When recertification kicked in the following year, a new staff member was hired to manage data and conduct recertification sessions—but still annual recertification was fast becoming, in Deutsch's words, "an unbearable burden—and it was a growing problem because we kept training and certifying new volunteers. We'd created a monster!"

Yet the program remained committed to certification and recertification as indispensable elements of ensuring data quality. As Deutsch says, "It's important to know not just what your protocols are on paper, but what your monitors are really doing."

Training of trainers

To resolve the situation, AWW decided to train a corps of volunteer trainers and QA officers to take the burden off AWW staff. Trainers provide initial training and certification for new monitors, while QA officers are in charge of recertification. To date, about 35 people have been trained as trainers and 15 as QA officers. Ideally every one of the 80-odd groups that currently participate in AWW would have at least one member trained as a trainer or QA officer, but since some groups are very small that isn't practical. Fortunately most of the trainers and QA officers are willing to travel. The "Find a Trainer" section of the AWW website lists all trainers and QA officers along with their travel distance.

Recertification may take place at a stream site, in the home of a volunteer QA officer, or in a public building, and the session can be either one-on-one or in a small group. As a minimum requirement, the QA officer carefully watches the volunteers' technique and makes sure their kits are properly maintained. In addition, QA officers may require monitors to test water of known quality such as previously tested water, buffers, or spiked samples. Currently, recertification is required only for chemical water quality monitoring, which was AWW's original focus and still makes up 80-90% of the program's monitoring activity. Some AWW volunteers conduct bacterial or biological monitoring, for which only initial certification is required.

No free lunch

For the first few years, recertification automatically included free replacement chemicals for test kits. As the program grew, this became quite expensive. "We couldn't afford to give $70 worth of chemicals to monitors who were only sampling once or twice a year," says Deutsch. "So we decided to raise the bar. To be eligible for free chemicals, a volunteer had to qualify as an 'active monitor,' meaning that they needed to monitor at least six different months during the year. When money got a little tighter, we changed it to nine months."

More recently, the program adopted an even more cost-effective system for replacing chemicals. After learning from their kit manufacturer, LaMotte Company, that most of the reagents last more than one year (some as long as three years), AWW switched to bottle-by-bottle replacement. Before sending reagents to QA officers or individual monitors, AWW program staff write the expiration date on each bottle label (unfortunately the expiration date is not provided and must be calculated—see box for example).

Biennial recertification

Even with the volunteer trainers and QA officers, recertifying volunteers every year remained a big job. Moreover, experienced monitors complained that it was unnecessary, and AWW staff agreed. So when the program revised its QA Plan in 2004, the policy was modified. Every volunteer still has to get recertified after their first year of monitoring, but after that volunteers who monitor at least six months a year only need recertification every other year.

Calculating reagent expiration date

AWW follows these steps to calculate expiration dates for LaMotte chemical reagents:

1. Figure out the manufacture date. The first two digits of the lot number specify the week the reagent was made, and the third specifies the year. For example, lot 322825 was manufactured in week 32 (first week of August) of the year 2002.

2. Add the shelf life for that reagent (available from the manufacturer) to the manufacture date to get the expiration date. For example, in the LaMotte dissolved oxygen kit, the manganous sulfate solution has a 3-year shelf life so it expires three years from the manufacture date.

(Monitors who sample less than six months per year for two years need to go back and take the initial training workshop again.)

More help from the computer

The various modifications AWW has made to its recertification and reagent policies are saving time and money, and the current system is also motivational because it rewards volunteers for being more active. The downside, until recently, was that AWW staff needed to keep track of when each volunteer was due for recertification, which volunteers had been active enough to skip a year, and which ones met the even more stringent requirements for getting free chemical replacements; and they had to remind monitors by phone, email, or mail when it was time to get recertified.

ALABAMA WATER WATCH

Volunteer trainers like Xing Long, shown here assisting a new monitor at a training workshop, enable Alabama Water Watch to offer statewide training opportunities without overburdening the small program staff.

Fortunately the ever-resourceful AWW staff devised yet another creative solution: programming the computer to keep track of volunteers' certification status. AWW already had online data entry capabilities, and more than half of the 300 currently active monitors submit their data online. Now when monitors log on to enter data they see a status report telling them when they were certified, when they're due for recertification, and whether they're eligible for free chemicals. It is the monitor's responsibility to arrange for recertification. The computer is programmed to allow volunteers a three-month grace period, and after that deadline passes, it won't let them enter data. For those volunteers who don't submit their data online, the system is semiautomated—staff can obtain a list of soon-to-expire certifications from the computer, but they still have to mail out reminders.

ALABAMA WATER WATCH

Volunteer QA officer Mary Ann Bronson (seated, left) conducts a recertification session for "veteran" volunteers.

The reward: Useful data

Ensuring that every piece of data in the database has been collected by a certified monitor is a priority for AWW. The program briefly considered implementing a tiered system in which uncertified monitors could submit data that would be identified in the database with a special flag or marker, but decided against it. Deutsch says, "We want our volunteers to know that their conscientious efforts are being matched by all the other monitors, and that they're contributing to a database that can be taken seriously on a watershed or state level."

Perhaps even more important is the ability to assure data users that all the data have met the same high standard. "Alabama Department of Environmental Management has used our data to delist sites for 303(d)," says Deutsch. "Our database has been used by consultants, it's been used for developing watershed management plans and TMDLs, it's used by a lot of different people. We don't even know who they all are because anyone can log on to our website [www.alabama waterwatch.org] and access our data."

For more information please contact Bill Deutsch, Department of Fisheries and Allied Aquacultures, Auburn University, AL; wdeutsch@acesag.auburn.edu; 888-844-4785.

documenting sampling location

by Eleanor Ely

The most carefully collected and analyzed data will be useless without reliable information about sampling site location (the "where" part of metadata). Yet documenting location accurately and unambiguously is not always easy. Secchi Dip-In founder Bob Carlson, who receives annual water clarity data from thousands of sites around the world, can attest to the many sources of confusion—starting with something as apparently straightforward as water body name. Minnesota alone, he points out, has 38 lakes called Clear Lake and 185 called Mud Lake. Systems for assigning site codes differ from state to state and program to program. Even latitude and longitude are sometimes garbled. For example, Carlson notes, Dip-In volunteers occasionally mistake the minute and second symbols for feet and inches (e.g., reporting 47°39'10" as 47° 39 ft. 10 in.).

Systems for documenting site location tend to evolve as a volunteer monitoring program grows. At a minimum you need a clear verbal description like "Bear Creek 20 yards upstream from Highway 46 overpass" (just be sure that half the people in the watershed don't call the same stream "Bobcat Brook"). The description should include driving instructions if needed and be complete enough that anyone could use it to find the site. Sketches and photos are also very helpful. A program with more than just a few sites will undoubtedly want to devise a site code system to make data management easier. Once a volunteer group begins sharing their data with a local or state agency, they will probably need to identify the water body and site according to that agency's specific coding system.

These days, it is becoming more and more important to also identify monitoring sites by a geographic coordinate system such as latitude/longitude or the UTM (Universal Transverse Mercator) grid (see sidebar box on next page). The EPA's nationwide monitoring database, STORET, requires site coordinates, as do many state databases. Perhaps the most compelling reason for determining your monitoring site coordinates is to make it possible for your monitoring data to be used in a geographic information system (GIS). A GIS map layer displaying your data graphically can be combined with other map layers showing, for example, geology, land use, or other monitoring data. GIS is an extremely powerful tool for visualizing and analyzing data, making it well worth the effort to collect the site location information that GIS requires.

(One caveat: Geographic coordinates are not a substitute for a verbal description of site location. You need both!)

So, how can volunteer monitors find the coordinates of their sites? There are three main tools: GPS, interactive online maps, and paper topographic maps.

GPS

Usually the most accurate way to determine your site coordinates is to take a handheld GPS (global positioning system) receiver to the exact location. A GPS receiver calculates position based on signals it receives from GPS satellites. GPS receivers capable of determining location to within 5-15 meters are currently available for under $200. Accuracy depends on both the equipment and site conditions. Interference with satellite signal reception—for example, from tree cover, nearby buildings, mountains, and atmospheric conditions—can create errors of up to 30 meters, or even make it impossible to obtain a reading. In forested locations, it may help to make your GPS determinations in the winter.

The great advantage of GPS is the "you are there" factor. You're not puzzling over a map wondering where your site is; you know that you're standing in the right spot. However, the expense can be a barrier. Some programs purchase a limited number of units which volunteers can borrow.

GARMIN INTERNATIONAL

Palm-size GPS receivers weighing just a few ounces can quickly determine latitude and longitude and/or UTM coordinates. Popular brands among volunteer monitoring programs are Garmin (www.garmin.com) and Magellan (www.magellangps.com). The Garmin eTrex Legend is pictured here.

Interactive online maps

Increasingly, volunteer monitoring groups are determining monitoring site coordinates with the help of interactive online maps, such as those at www.topozone.com, that allow users to view a map of their state, zoom in on a location, then point to or click on their monitoring site to display its latitude/longitude or UTM coordinates.

Some state environmental agencies have created interactive maps for the state. Often these contain additional useful features for volunteer monitors. For example, IOWATER volunteers use the Iowa Water Monitoring Atlas to get UTM coordinates for their monitoring sites. (Go to www.iowater.net, click on "Database" and select "Iowa Water Monitoring Atlas.") This interactive map has a number of useful layers that viewers can turn on or off, including IOWATER monitoring site locations, professional monitoring site locations, watershed boundaries, and sewage treatment plant locations. Once volunteers have zoomed to their general site location, they can switch to the aerial photography layer to find landmarks that will help pinpoint the site exactly.

Determining site location from an interactive map is usually not quite as accurate as using GPS because there is some imprecision in the map itself, and additional imprecision in locating your site. The maps tend to work well for sites that are near an easily identifiable landmark like a building, bridge, or highway intersection. It is harder to find a monitoring site on a small stream in an undeveloped area where the aerial photograph shows mainly treetops. Intermittent streams, drainage ditches, and outfalls may not be on the map at all.

USGS topographical maps

The time-honored, low-tech approach is to determine site coordinates manually from a U.S. Geological Survey (USGS) 7.5' topographical map (scale 1:24,000). The EPA's *Volunteer Stream Monitoring: A Methods Manual* (www.epa.gov/owow/monitoring/volunteer/stream/) includes an appendix with a simple worksheet for calculating latitude and longitude from topographical maps. The more recent USGS maps show grids or tick marks for UTM coordinates in addition to the traditional latitude/longitude grid.

The advantage of using a paper map is that it requires no equipment, not even a computer. The biggest drawback is the potential for error in finding the site or performing the calculations. Also, some USGS topographic maps, particularly for remote locations, may be out of date.

Watch out for datums

Pity the mapmaker. Representing the Earth on a flat two-dimensional map would be challenging enough if the planet were perfectly spherical and smooth, but it is neither. It has a slightly

continued on next page

Geographic Coordinate Systems

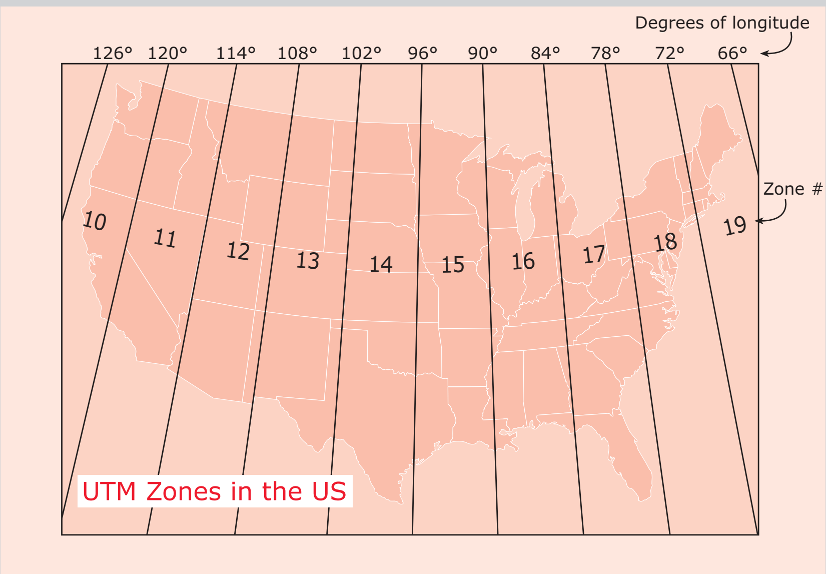
Latitude and longitude

Latitude and longitude have traditionally been expressed as degrees-minutes-seconds. A minute is 1/60 of a degree and a second is 1/60 of a minute (or 1/3600 of a degree). At any point on the Earth, one degree of latitude covers about 111 km (69 miles) and one second covers about 30 m (100 feet). However, the ground distance equivalent to a degree of longitude depends on where you are, ranging from 111 km (same as a degree of latitude) at the equator to zero at the poles.

For GIS applications, it's more convenient to use a decimal-degree format or a hybrid format of degrees and decimal minutes. The following example shows the same coordinate expressed in these three different formats:

degrees-minutes-seconds: 40°39'11"
degrees and decimal minutes: 40° 39.183"
decimal degrees: 40.65302°

When reporting latitude and longitude in any of the above formats, use N or S to indicate whether the latitude is north or south of the equator, and W or E to indicate whether the longitude is west or east of the prime meridian in Greenwich, England (e.g., 37°44'01"N, 122°25'29"W).



UTM Zones in the US

UTM coordinate system

The Universal Transverse Mercator (UTM) system, which is widely used with GIS, divides the Earth (excluding the polar regions) into 60 long, narrow strips, or zones. Each zone is 6° of longitude in width and extends all the way from latitude 84°N (north of Greenland) to 80°S (Antarctica). The United States is covered by zones 10 (West Coast) through 19 (New England). Within each zone, a location is defined by an x ("easting") and y ("northing") coordinate. For example, here are the UTM coordinates for a point in San Francisco: x = 550712, y = 4176323 (UTM Zone 10). Another way to write this is UTM 10, 550712E, 4176323N. Recording the UTM zone as well as the coordinates is essential because there is a point in each of the 60 zones with the exact same coordinates.

The meaning of the y value is straightforward—it is simply the number of meters from the equator. The x value, which is also in meters, is a bit less intuitive. Basically the central meridian (line of longitude) of each zone is assigned the value of 500,000 meters. For points west of the line the easting, or x coordinate, will be below 500000 (for example, at 10,000 meters west of the line it is 490000) and for points east of the line it will be above 500000.

As a rule of thumb, anywhere in the United States (including Alaska and Hawaii) the x coordinate will have 6 digits and the y coordinate will have 7 digits.

Conversion

Fortunately latitude/longitude and UTM coordinates are readily interconvertible. The calculation is complicated and involves a lot of trigonometry, but easy enough with the appropriate software. So you can use either system, as long as you record the coordinates in a correct format.

Resource
The Universal Transverse Mercator (UTM) Grid. USGS Fact Sheet 077-01. http://erg.usgs.gov/isb/pubs/factsheets/fs07701.html.

LOCATION, continued

squashed shape (bulging just a bit at the equator) and an irregular and ever-changing topography. Different maps are based on different mathematical models of the Earth's shape. These models are called datums (no, that's not a mistake—for this meaning of *datum* the plural is *datums*, not *data*).

Many different datums have been used over the years, but we only need to be concerned with the three major ones currently used in the United States: the North American Datum 1927 (NAD27), North American Datum 1983 (NAD83), and World Geodetic System 1984 (WGS-84). NAD83 and WGS-84 are so similar to each other that for many purposes they are virtually interchangeable. These more recent datums are based on satellite information and are more accurate than NAD27. Most currently available USGS topographical maps are based on NAD27, although revised and new maps will use NAD83.

Look in the margins of a map to find information on the datum. It's OK to get your site coordinates from a map based on any of these datums, but you must record the datum used. If site coordinates obtained from a NAD27 topographic map are later used in a GIS based on NAD83, a conversion factor will need to be applied. Otherwise the site will show up in the wrong location on the GIS map.

A plethora of choices

All of the above-described methods for finding geographical coordinates can yield excellent results—if used correctly. All of them can also yield erroneous results, if volunteers are not properly trained. Many possibilities for mistakes and confusion lurk in the variety of coordinate systems, datums, and reporting formats. The chance of error is especially high with GPS receivers because they offer such a wide array of different settings.

For example, volunteer monitors with the Water Action Volunteers program in Wisconsin were given GPS units set to display latitude/longitude readings in degrees and decimal minutes. However, the program's online data entry forms provided three boxes (corresponding to degrees, minutes, and seconds) for entering coordinates. So a volunteer who recorded a readout of, say, 42° 39.603 (degrees and decimal minutes) would enter 42, 39, and 60, respectively, in the three boxes. The problem is that 0.603 decimal minutes doesn't correspond to 60 seconds. As with clock time, you multiply minutes by 60 to get seconds, so 0.603 minutes is equal to 36 seconds. Since one second of latitude covers about 30 meters on the ground, the error in site location was significant. Fortunately, once program coordinator Kris Stepenuck realized what was happening, the problem was easily resolved. Volunteers were given instructions for setting their units to display the degree-minute-second format, and erroneous entries in the database were converted.

Latitude/longitude or UTM coordinates should always be double-checked against a map to be sure the location matches the verbal description. (IOWATER staff plot the volunteers' reported UTM coordinates in ArcView to check the location.) A small transcription error in recording coordinates can bump a site into the next state, or the middle of the ocean.

Finally, be sure to document everything—the method used to determine coordinates (including details about the particular GPS equipment or map), the date on which a GPS determination was made, the reporting format for latitude/longitude (degrees, decimal degrees, etc.), and the datum used.

TAMARA STEINER

GPS Creek Surveys

GPS receivers can do much more than simply document sampling site locations. In the San Francisco Bay area, volunteers with the Contra Costa Watershed Forum use sophisticated GPS units to map the exact location of riparian conditions (substrate, canopy cover, bank slope), vegetation characteristics (type, density, non-native plants), and human disturbances (outfalls, dams). This information helps target restoration and pollution reduction efforts.

The receivers used for the creek surveys, which cost several thousand dollars, are more accurate than the small palm-sized models and are capable of holding up to 1 MB of data. The tall pole shown in the photo is an antenna that improves satellite signal reception.

—Aspen Madrone
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BREAKING THE CODE: Data Analysis Workshops

by Candie C. Wilderman and Julie D. Vastine

As the volunteer monitoring movement continues to move forward, the issue of data analysis is emerging as the new frontier. Volunteer monitoring groups have learned to define their goals, design their studies, and collect and measure a wide array of indicators. But then, how are the data to be analyzed? Who can interpret the maze of numbers, pulling useful information from the data—information that can inform action decisions? Is it feasible for volunteers to engage in data analysis, or must this step be shipped off to professional consultants?

Not every volunteer monitoring project creates the need or opportunity for volunteers to engage in data analysis. In cases where volunteer monitors are answering the call of professional scientists at agencies or other institutions for help in collecting data, it is appropriate for the scientists to do the analysis and interpretation.

However, the need for volunteers to interpret their data arises when watershed groups define their own agendas and design their own studies to address these goals. If these groups' data are to be used effectively, the volunteers must learn to find the "story" in the data themselves.

In the past few years, the Alliance for Aquatic Resource Monitoring (ALLARM) has been exploring ways to help watershed groups we work with climb the learning curve of data analysis. We are finding this process to be the most challenging of volunteer monitoring activities, requiring intensive mentoring by ALLARM staff and a high level of commitment on the part of the volunteers. But the payoff is well worth the effort. Empowered with the ability to use their own data, these volunteers will not be concerned that state and federal agencies will not "accept" their data, since they will be too busy using their own data to notice!

Our journey

ALLARM, a project of the Environmental Studies Department at Dickinson College, started out 20 years ago as a "top-down" program whose agenda was set by program staff. Over the years, we progressed by stages toward a "community-centered" approach in which ALLARM works with citizen watershed groups to help them define their own goals, develop a study design, and collect and analyze samples. [*Note:* For more on the evolution of ALLARM, see *The Volunteer Monitor* Winter 2003.] Yet until recently data analysis and interpretation remained in ALLARM's hands. After a watershed group collected data for at least a year, we analyzed their data for them and presented the results of their studies to them in oral and written formats.

But the outcomes were not satisfying. After our presentations, excited volunteers typically praised our efforts and asked if we could please talk with local reporters or municipal officials about the results of their study. In other words, the volunteers who had invested hours in study design and data collection had little sense of the implications of their study and therefore did not have the tools to engage in discussions regarding action that could be taken based on their findings. It became very clear to us that without a meaningful understanding of the story in the data, there would not be meaningful use of the data by citizen scientists.

continued on next page

ALLARM

THE OLD WAY

ALLARM Science Director Candie Wilderman presents ALLARM's interpretation of a watershed group's data to the volunteers.

ALLARM

Volunteers interpret their data themselves and discover their own story.

Generic "train the trainer" workshops

As service providers, we were not alone in these perceptions. In the late 1990s, ALLARM was part of a consortium of service providers in Pennsylvania engaged in developing and presenting study design workshops for volunteer monitoring groups. Other consortium members were the Pennsylvania Department of Environmental Protection (PA DEP), River Network, the Stroud Water Research Center, the Delaware Riverkeeper Network, and the Canaan Valley Institute. More or less simultaneously, all of us came to the realization that while our study design workshops were very valuable in getting monitoring programs started on the right foot, volunteer groups also needed help and support at the other end of the process. They needed guidance in what to do *after* they had collected a body of data.

So, with funding support from PA DEP, the consortium designed materials for a "train the trainer" workshop in data analysis and interpretation. To illustrate the concepts and techniques, we created a virtual watershed complete with maps showing land uses, monitoring sites, geology, and dischargers, as well as monitoring data organized into tables and graphs. These data-to-information workshops were offered in several regions around the state and attended by representatives from a variety of watershed groups. But although the workshops were well received, we ultimately found that this workshop format was not giving attendees enough experience and confidence to bring the message back to their groups and interpret their own data.

Individualized, tailored workshops

ALLARM then decided to modify and expand the workshop into a customizable version that we could offer to individual watershed groups. We reasoned that by working with one group at a time we could (a) involve most or all of the volunteers, rather than just one or two representatives; and (b) extend the mentoring process to interpreting the group's own actual data. Besides gaining data interpretation skills, participants would be able to identify specific problems in their watershed.

Our new data-to-information workshop model consists of two 3-hour workshops. In the first we introduce the basic concepts, using the virtual watershed, and in the second we apply those concepts to analyzing the volunteers' own real data. So far we have used this model (which we are still revising) with four local watershed groups.

Workshop #1: The basics

Like the earlier workshops discussed above, the first workshop is based on a virtual watershed. This allows us to create simple datasets that clearly demonstrate expected relationships between the indicators and land use, geology, and seasonal variation. We also add outliers and impossible values (e.g., a pH of 16) for the volunteers to discover and discuss.

Each participant receives a notebook of materials including:

- raw data tables, summary statistics, and box-and-whisker plots for the virtual data
- several GIS maps of the virtual watershed (showing land uses, point dischargers, and geology)
- a monitoring site location map on a transparency which can be overlaid on the other maps
- questions to guide participants through the data analysis process

The workshop is divided into three parts—a statistics presentation, small group sessions, and a wrap-up discussion that puts everything together.

"Statistics 101"

Our presentation introduces basic concepts like mean, median, and range, then focuses on the use of box-and-whisker plots as the most useful tool for visualizing the data.

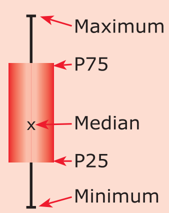
ALLARM was first introduced to box-and-whisker plots by River Network, who had chosen them as the basic data analysis tool for our early collaborative data-to-information workshops. Box-and-whisker plots capture the entire distribution of the data in an intuitively appealing visual snapshot. At a glance, they show the maximum and minimum points, the central point, and the relative variability of the data (represented by the size of the box, which contains the central 50% of the data).

Unfortunately, Microsoft Excel does not include box-and-whisker plots among its bag of tricks. However, we would be happy to share with newsletter readers a small macro (written by River Network) that produces box-and-whisker plots in Excel with a couple of keystrokes.

Small groups: Finding the pieces

After some practice with box-and-whisker plots, the volunteers divide into small groups to analyze the data from the virtual watershed. Each group focuses on one or two indicators, answering the questions provided in their notebooks (for example, What is the highest concentration recorded at any site? What is

Constructing a Box-and-Whisker Plot



To calculate the needed statistics for a box-and-whisker plot, first sort all values in the dataset from lowest to highest.

The median is the middle value (as distinct from the arithmetic mean, or average). For datasets that include outliers or are skewed from the "normal" distribution, the median is the preferred indicator of central tendency.

The minimum value forms the bottom of the whisker, and the maximum value forms the top of the whisker.

The 75th percentile ("P75") is the value below which 75% of the data lie, and the 25th percentile is the value below which 25% of the data lie. The box contains all the data between the 25th and 75th percentiles—in other words, the middle 50% of the data.

the predominant land use at that site? Which month has consistently high concentrations?). Volunteers look for spatial and seasonal patterns in the data, and consult the maps for clues about natural and anthropogenic sources that could affect the level of their indicator in the stream.

As an example, let's take one of the summary graphs used in the workshop (see figure at right). Volunteers can immediately see that for the two forested sites turbidity is low with little variability over the year. Volunteers also discover that the two agricultural sites are quite different from each other. We designed the data this way to illustrate that runoff from agriculture varies depending on management practices. Turbidity at the urban site is also high, which might surprise some participants because people often assume that turbidity comes primarily from agricultural sites. The value of 175 NTU is an outlier. It most likely represents a true value—a very high amount of suspended solids going into the creek on that particular date—but the possibility of a data error must also be considered.

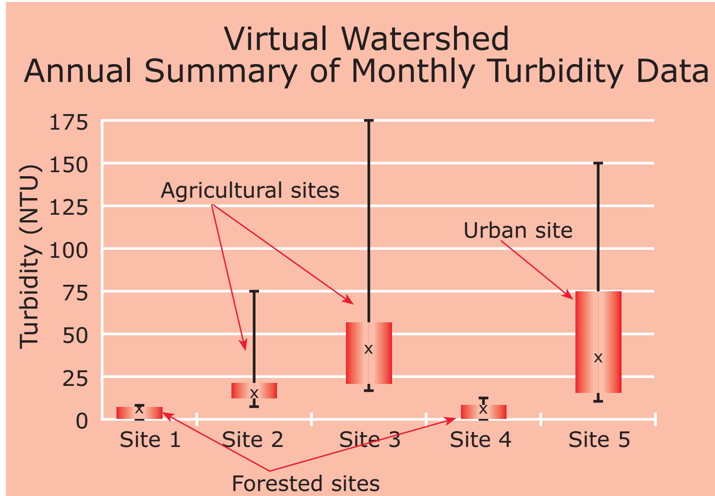
Lightbulbs start going off as the volunteers study the various tables, graphs, and maps and discover patterns—that oxygen varies inversely with temperature; that nitrates are higher in agricultural areas; that if the concentration of an indicator increases with increasing rainfall you should suspect a nonpoint source.

The big picture

The final portion of the first workshop is devoted to identifying the big picture. The small groups report their findings back to the larger group and the pooled results are used to answer questions such as: How are the different indicators related to one another? How do they appear to affect one another? Do flow, geology, land use, or point dischargers have an effect on water quality indicators? Where are the problem sites?

Our teaching philosophy

Our data-to-information workshops are purposely designed to encourage learning through "self-discovery." We do not lecture on expected spatial and seasonal



relationships, nor do we provide lists of water quality standards. Volunteers delight in discovering the patterns themselves and in generating hypotheses to explain the data in the virtual case study.

Soon participants begin to seek some "yardstick" to evaluate the data. They want to know, Is this a typical value? Is it too high or too low? Does it indicate a problem? We are happy to discuss these questions, but by withholding formal information on water quality standards, we shift the focus from violation of standards to overall indications of ecological health and system dynamics.

At the end of the first workshop volunteers have gained:

- a basic understanding of statistical and graphical concepts
- a feel for typical concentrations of indicators and the range of variation
- a sense of how indicators vary with seasons, land use, and geology
- an understanding of the need for criteria with which to compare data
- a sense of empowerment and an eagerness to move on to analyze the real data

Workshop #2: Interpreting real data

For the second workshop ALLARM again provides data tables and summaries, box-and-whisker plots, GIS maps, and a transparency showing monitoring sites—but with a crucial difference. This time the data tables and plots show the volunteers' own real data and the maps depict their own watershed.

We begin by presenting those ecological and state-based criteria that volunteers were seeking in the earlier workshop. We have found that when we present this information to a group that has not yet discovered the need for it, the numbers have little meaning. But by the second workshop, our volunteers are hungry for these numbers, and have a clear context for using them.

The workshop follows the same general structure as the first one, with small groups focusing on one or two indicators and then making presentations to the larger group. Finally the whole group works together to create a large master worksheet listing all problem sites along with the year of the problem, the indicators of the problem, and probable causes of the problem.

Case study

In the winter of 2004, we held data-to-information workshops for about 20 members of the Shermans Creek Conservation Association (SCCA). These volunteers had collected three years of data (pH, alkalinity, dissolved oxygen, temperature, nitrates, macroinvertebrates, and bacteria) on Shermans Creek, a fairly pristine watershed in rural Pennsylvania. Before the workshop, ALLARM staff prepared tables and graphs for all parameters for all three years.

The workshop participants' major conclusions were:

• Shermans Creek is generally in good health. Most of the variation among sites

continued on next page

WORKSHOPS, continued

and over time can be attributed to natural factors such as rainfall, temperature, and underlying geology and soils.

- Some forested headwater stream segments are impacted from acid deposition.
- Some limestone tributaries are impacted by agricultural activities, as indicated by high nitrate concentrations.
- There are numerous bacterial violations, requiring further study.

ALLARM compiled the results into a draft report which was distributed to workshop participants for input and comments. The volunteers are now using the final report in an application to the state to upgrade the creek to "exceptional value." If they are successful, this will be one of the few warm-water fisheries to obtain that status in the state. The report is also helping SCCA make their case to municipal officials regarding the need to incorporate stream protection into land-use plans. Finally, data from the report are being used extensively in a Rivers Conservation Grant application to the Pennsylvania Department of Conservation and Natural Resources.

Moving toward independence

Although the workshop model described above gives volunteers an active role in data interpretation, it still depends heavily on support from a service provider. Preparing the necessary tables, summary statistics, and graphs of the volunteers' data is very time-consuming for ALLARM staff. Our most recent efforts are focusing on training volunteer groups to perform these tasks themselves, moving them a step further toward independence.

Our first "success story" was training Watershed Alliance of York volunteer coordinator Gary Peacock to organize and graph the data collected by three watershed associations in York County, Pennsylvania. ALLARM then used Peacock's data tables, statistics, and graphs as the basis for a data-to-information workshop. After the workshop, Peacock even took upon himself the final step of writing up the workshop findings in a report.

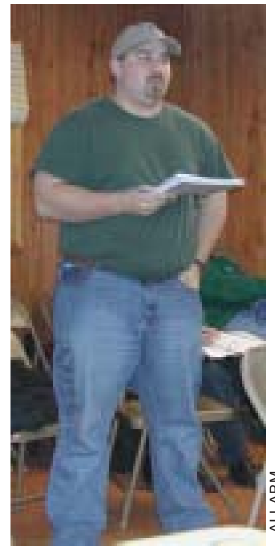
We have also begun advising groups who are starting a monitoring program to plan for data management needs up front. So, when the Antietam Watershed Association (AWA) was designing its monitoring program, volunteer coordinator Melodie Anderson-Smith followed ALLARM's advice and recruited volunteer Frank Conway to be the database manager. Conway, originally a novice with Excel and database management, proceeded to work with ALLARM and independently came up with an improvement to ALLARM's data-entry template. We look forward to the day when the AWA volunteers, having completed their first year of data collection, show up for their data-to-information workshop with all the needed statistics and graphs in hand.

Knowledge is power

There is no denying that training citizen scientists to interpret monitoring data requires a large upfront investment by service providers. Indeed, in most cases such training initially costs more in both time and money than if the data analysis is done by the service provider or a consultant. But the investment pays off in the long run, as groups continue to analyze and use data independently and competently.

Another important benefit of involving community members in data interpretation is that local residents bring to the process their store of knowledge about historical land uses and agricultural practices in the watershed. For example, knowing where old dumps were located can help explain anomalous data. Residents' understanding of community dynamics is also critical when it comes to planning action projects that will be acceptable to the community.

But for ALLARM, the ultimate goal of the data-to-information workshops is to open the door to data use. Simply put, knowledge is power, and the ability of volunteers to understand their own data is critical to their meaningful participation in the discussion of problems that the data identify. The process of involving volunteers in every step of the study—from identifying goals to interpreting data to utilizing the information for action plans—democratizes science and removes information from the sole control of the traditional scientific community. The data story belongs to those who understand it.



SCCA member Vince Humenay presents small group findings at the data-to-information workshop.

Candie Wilderman is the Founder and Science Director and Julie Vastine is the Assistant Director of the Alliance for Aquatic Resource Monitoring (ALLARM), Environmental Studies Department, Dickinson College, Carlisle, PA 17013.

For more information, contact ALLARM at 717-245-1565; allarm@ dickinson.edu; or visit www.dickinson.edu/allarm. A copy of the materials provided at ALLARM data-to-information workshops is available from the authors upon request.

Resources

Dates, G. and J. Schloss. 1998. *Data to Information: A Guidebook for Coastal Volunteer Water Quality Monitoring Groups in New Hampshire and Maine*. Topics include simple statistics, graphing, data interpretation, and reports. Available for $10 from Esperanza Stancioff, University of Maine Cooperative Extension, 207-832-0343.

Rector, Julie. 1995. "Variability Happens": Basic Descriptive Statistics for Volunteer Programs. *The Volunteer Monitor* 7(1):14-17 (Spring 1995).

Going NATIONAL: Volunteer Data in STORET

by Alice Mayio

The US Environmental Protection Agency's (EPA) STORET database offers a way to "go national" with your water quality and biological data. However, not many volunteer monitoring groups use STORET right now—and most of the groups that do are larger organizations with state agency connections. I spoke with some of these groups to find out how they'd made the link between their day-to-day data management needs and STORET.

First, some background. STORET is a national database implemented on local personal computers. It's designed to:

- **Facilitate data sharing nationwide** – STORET users upload their data to a national Data Warehouse that can be accessed by agencies or the public using just a Web browser.
- **Ensure that data are of documented quality** – STORET can store a great deal of metadata (background data about the data, such as project name and purpose, site locations, sampling methods and equipment, QA/QC protocols, and so forth), which is available to anyone who downloads the data.
- **Maintain continuity in data management** – Once your data are in the national STORET Data Warehouse, you'll always have access to them even if your computer dies or your computer-savvy staff member leaves town to go work for Bill Gates.
- **Allow users to have local control of their own data** – You own your data at all times, and you alone can write over, delete, or update what you've loaded into the national Data Warehouse.

STORET can handle all kinds of data, including biological information for benthic macroinvertebrates, fish, and periphyton; thousands of chemical parameters; physical characteristics such as stream substrate and riparian habitat measurements; field sampling and lab analytical methods; and graphics and text documents such as jpegs and pdfs.

To run a local version of STORET, you need a fairly burly PC with enough free hard disk space to handle the software and the database (about 2 GB), a free copy of the STORET System v.2.0 CD-ROM, and Personal Oracle v8.1.7. Oracle is scalable (infinitely expandable) relational database software that serves as a platform for STORET.

While you can enter all your data directly into STORET and use it as your primary data management system, most monitoring entities maintain their data in their own spreadsheet or relational database and periodically upload the data to STORET. They do so using the STORET Import Module (SIM), which "migrates" data from programs like Excel, Access, or Lotus 1-2-3 into STORET. SIM can be downloaded for free by STORET users from the STORET website. However, before you can use SIM you need to get your data into SIM-acceptable format, a task that requires considerable data-management expertise. Once you have your data in your local STORET, it's relatively straightforward to upload it to the STORET national Data Warehouse.

> "If I get run over by a truck, people will still be able to see all our data because it's in STORET."

If you manage large amounts of data which could overwhelm the PC version of STORET, you can also transfer your data from your personal copy of STORET to an Oracle server maintained by another organization (such as a college, service provider, or state water quality agency), which then sends the data to the national Data Warehouse.

Florida Lakewatch

There's a lot of work involved in getting volunteer data into STORET. For example, data from Florida's Lakewatch program *does* end up in STORET, but to get it there, Lakewatch contracts with the University of South Florida to have the data converted from Excel spreadsheets to the Florida Department of Environmental Protection's version of STORET. For Mark Hoyer, Assistant Director of Lakewatch, this process is expensive and time-consuming. He prefers the system he has in place for local management of his data: if someone calls him for information on a particular basin or waterbody, he quickly runs out an Excel spreadsheet that virtually anyone can use. Along with the data he sends a report on Lakewatch's sampling methods.

However, Hoyer acknowledges that there's an upside to Lakewatch's use of STORET. The Florida Department of Environmental Protection—and, for that matter, anyone else who can browse their way to the national Data Warehouse—now has access to water quality data for Lakewatch's 1,200 sampled lakes. "If I get run over by a truck," he says, "people will still be able to see all our data because it's in STORET."

Iowa's solution

Iowa's statewide volunteer monitoring program, IOWATER, is run by the Department of Natural Resources and relies on DNR programmers and a DNR server to make its STORET connection. According to Lynette Seigley, a research geologist with the program, "IOWATER had the advantage of coming along fairly late in the volunteer monitoring game. Our founders knew we didn't have the staff to enter each volunteer's data into STORET, but they also knew STORET was an important part of the data management puzzle." The IOWATER solution? An online database into which volunteers enter their data directly, and a skilled DNR programmer, Joost Korpel, who translates the data from the online database into STORET. Korpel admits that it would be a challenge for volunteers to work directly with STORET; being an Oracle database administrator, he notes, "gives me an edge."

continued on next page

STORET, continued

Korpel says that it's easy to be intimidated by the complexity of STORET, but adds, "Don't let it keep you from developing your own database. Just be sure your system has the kind of metadata STORET wants you to have, because then, when you're ready to get your data into STORET, you can use SIM to move it to the big boy." Korpel recommends beginning with a web-enabled database. IOWATER uses Microsoft SQL-Server (Microsoft's competitor to Oracle) and from there files are regularly loaded into STORET using SIM.

Use that talent

You don't have to be a large state-managed program to use STORET, though clearly it helps. The Alliance for a Living Ocean (ALO)—a New Jersey environmental organization that runs a small volunteer monitoring program on Barnegat Bay—has been getting its data into STORET for several years, with the help of some talented volunteers. Sheila Schultz, a retired software engineer, manages the program's data in Excel (her husband helps with data entry). In 2000, Schultz installed STORET on the ALO computer and began entering the metadata (personnel information, station site locations, methods, equipment). "That was the hardest part," she says. "I worked on it off and on all winter. When I got stuck, I called the experts at STORET tech support." When it finally came time to enter the actual monitoring results, Schultz enlisted the help of fellow ALO volunteer Tom Beaty. Beaty, a software engineer and consultant, spent about 40 hours of his spare time writing a Visual Basic program to convert the spreadsheets into text files that SIM can load into STORET. Now each year Beaty converts the data and puts it on a CD for Schultz, who uploads the reformatted data into ALO's local copy of STORET, and from there e-mails it to the national STORET Data Warehouse.

Schultz says, "When people call us for the data and I tell them it's in STORET, they still ask for our Excel spreadsheets because it's not easy for a novice to retrieve the data from STORET. But we think it's important to have our data in STORET anyway, so that potential users who don't already know about us might find it. Also, it's reassuring to know that if our program ends, the data is permanently archived in STORET."

To go (or not to go) to STORET

Barb Horn of Colorado River Watch and the Colorado Division of Wildlife urges potential users to think through their needs before making a decision about STORET. "Is what you're doing with your data right now serving your needs?" she asks. "Is it serving the needs of your decision makers? Then you probably don't need STORET. But if the answer is no, and if data management is a problem, look at STORET. If you want decision makers—including those you may not have identified yet—to use your data, consider STORET."

Horn chose STORET because her data outgrew her old data management system. "There comes a time when you have to take a leap," says Horn. "It's an investment you make when your program is ready, like moving from litmus paper to a pH pen."

Horn is currently working on a Section 319 grant-supported effort in which the Colorado Water Quality Monitoring Council will act as a STORET service provider for small monitoring organizations in Colorado, especially those collecting nonpoint source monitoring information. Services include paying a contractor to host the STORET Oracle server, managing input and output of data, training and supporting watershed organizations, and developing an approach to sustain the effort into the future. This model could be adopted by other monitoring councils, universities, or water research centers with proper technological skills and interest.

Horn's effort will rely on WebSIM, a new product developed collaboratively by a group of state, tribal, and federal STORET users working with Gold Systems, the contractor who also developed SIM. WebSIM is a hosting tool that allows properly formatted data to be translated from non-STORET data management systems into STORET using a simplified Internet interface. WebSIM offers a promising approach for smaller organizations interested in STORET who can work with a hosting partner—to enter your data, you don't need to know anything about STORET or Oracle or even have them installed on your computer, although WebSIM does need to be set up, supported, and managed by someone who does.

If you're about to upgrade your data system or set up a new one, think of STORET as a sort of template for the proper use and reporting of monitoring data and metadata. STORET *requires* certain basic metadata—you must identify what parameters you are monitoring (by choosing from a pick-list of standard parameter names), where you are monitoring (latitude/longitude coordinates and how they were derived), and when you are monitoring. It *allows* you to enter as much additional metadata as you have on how you are monitoring (e.g., methods and equipment, quality assurance protocols), who is doing the monitoring, and why the monitoring is taking place. These are all questions for which your potential data users—now or in the future—will surely want answers.

Alice Mayio is with US EPA's Office of Wetlands, Oceans and Watersheds. She may be reached at mayio.alice@epa.gov; 202-566-1184.

For more information on STORET, check out the website at www.epa.gov/STORET. You can also access STORET data using a map-based query tool, Window to My Environment, at www.epa.gov/enviro/wme.

I Got the Blues
Gerald A., age 13
Baton Rouge, Louisiana

Environmental art: A Work in Progress

by Steven Hubbell

Let me say at the outset, it was all my fault.

If I had rounded up participants in advance, if I seen the schedule, if I had stepped up to the microphone to announce the start of the poetry reading, if I had brought with me the porta-potty company's phone number ... But I didn't.

The Stream Savers Festival in Austin, Texas, celebrated 2003 World Water Monitoring Day with recorded and live music, earth-friendly concessions, chemical and biological monitoring demonstrations, and monitor recognition. One of the planners (OK, it was me) had had the bright idea of reserving an area for sharing environmental art and poetry.

We selected the shade of an enormous live oak to serve as the "Natural Arts" display and reading area. Three or four people brought and displayed a couple dozen pieces of art depicting natural subjects—landscapes, seascapes, fields, rivers. Someone posted a schedule listing a 2 p.m. start time for the poetry reading—but unfortunately I was so busy helping set up that I failed to notice it.

In addition to providing monitoring demonstrations, the organization I was working for, the Lower Colorado River Authority, had accepted the unglamorous role of ensuring that adequate toilet facilities were available. It was because of this responsibility that, at 2 o'clock, I found myself checking a phone book at a nearby store. An ADA-accessible potty had not arrived, and I had neglected to bring the phone number or even the name of the portable toilet company.

It was 2:30 by the time I returned to the art/poetry tree with my stack of poems. Although I didn't realize it immediately, the moment of opportunity had come and gone. The setting had an inviting, Old World feel to it, and would have provided an intriguing backdrop for an open-air poetry reading. But anyone who had shown up to read or hear poetry had drifted away, and the PA system was generating a steady stream of recorded music.

Despite our disappointing outcome, I still say the idea is a good one. Research suggests that people are motivated more by values than by facts. And many people involved in volunteer monitoring are writers and artists who at times turn their creative attention to the beauty, value, and potential for loss that exist in the natural environment. I've already started a list of tips to ensure the success of the art and poetry event at the next watershed festival.

- Well ahead of time, broadly announce the open reading/art component. Also invite individual writers and artists whom you know.
- At the art display area, prepare adequate space, means of display, and protection from the elements. A sudden downpour should not be a disaster.
- Don't allow the PA system to interfere with the poetry reading. Instead, use the system to full advantage. Perhaps the poetry reading itself could take center stage.
- Acknowledge and openly thank participants. List their names in a program.

I welcome suggestions and ideas from anyone else out there who has considered integrating the arts with watershed education.

Steven Hubbell was formerly the Program Coordinator for the Lower Colorado River Authority's Colorado River Watch Network in Austin, Texas. He may be reached at bsr1508@ccsi.com.

What Are You Looking For?
Mamedov R.G., age 8
Baku, Azerbaijan

Reflections

Sometimes,
when the mountains
reflect on rivers,
you can find out things
you never knew before.
There are flowers up there,
rocks like clouds,
a little snow becomes a creek
and grows into a river.

Lindsay R., age 11
Bend, Oregon

Treat by the River
Catherine R., age 14
Arlington, Minnesota

River of Words

by Mary Pardee

Mamedbeyli L., age 10
Baku, Azerbaijan

If you're an educator and you're reading this newsletter, chances are you work with kids on water quality monitoring projects. Do you want to take that activity a step further and engage your students' hearts? Are you looking for a way to intertwine environmental science with poetry and art? River of Words can help K-12 educators do just that.

Robert Hass (U.S. Poet Laureate 1995-1997) and writer Pamela Michael created River of Words in 1995 to cultivate appreciation for the varieties of human expression and help children develop an understanding of the natural world and a sense of belonging to a particular place. In affiliation with the Library of Congress, River of Words conducts an annual children's art and poetry contest on the theme of watersheds. River of Words also supports educators with training workshops and a multidisciplinary curriculum.

Thousands of children aged 5 through 19 participate in the contest (in 2004 River of Words received over 20,000 entries from all over the world). Generally about two-thirds of entries are poems and the rest are drawings and paintings in a variety of media. In each grade category (kindergarten-2nd, 3rd-6th, 7th-9th, and 10th-12th) one poem and one work of art is selected for a Grand Prize. In addition, about 100 other poems and artworks are selected as finalists.

The Heron

I want to paint its slender legs
As they move with grace
Slowly Oh so slowly
I want to dance its Arabian dance
moving with the water
Water rippling legs lifting
Slowly Oh so slowly
I want to fly like the heron flies
with an "Ark Ark,"
and a flutter of wings;
to fly away.
Swiftly very swiftly.

Leslie B.H., age 11
Chestertown, Maryland

Poetry and art have the ability to make science relevant by giving it a human dimension. In fact, science and the arts have a lot in common. They both aim to explore the unknown, to extend connections and relationships using observation and sense perception. In science as in poetry, models and metaphors are used to envision, understand, describe, explain, and predict. Paradox, creative thinking, attention to detail, and discovery are all critical to both scientific inquiry and the arts.

The children's artworks and poems are themselves really the strongest evidence of the value of mixing art and science. They are much more powerful persuaders than anything I can tell you here. You can find many examples posted at www.riverofwords.org, as well as in several books of River of Words art and poetry that can be ordered from the website.

Dale Cox is a poet and a National Park Service Interpretive Ranger on the St. Croix Scenic Riverway who uses River of Words to help share his love of poetry and rivers with local schoolchildren. The kids' poetry, he says, can "stop you in your tracks." One student Cox worked with, a scruffy-haired 11-year-old boy decked out in Green Bay Packer logos, described a spider's web as "dawn's reflection / honeycomb of light / bound by diamonds / caught overnight."

Ode to a River Evening

After the rain, the river is still easy.
Hundreds of mosquitoes
Cover the banks like draped blankets.
Trees try to overlook the moon.
It darkens. The mosquitoes thin out.
They have had their share of water.
Moonlight seeps through leaves.
Ripples shimmer. Near the water
Mosquitoes tease a fish.
They follow its silver waves.
Full and content, the fish fades.
The water now murky,
No more light or movement,
Just the sound of water, still.

Jamie T., age 15
Vicksburg, Mississippi

Over 30 states have their own River of Words coordinators. I became the Wisconsin coordinator after I "discovered" River of Words at a nationwide water education conference and immediately knew it would be a good fit with my work as a lake education specialist for the Wisconsin Lakes Program. Different state programs offer different River of Words activities. Wisconsin offers a local educator's guide, training workshops, watershed maps, and a statewide contest held after the national contest.

The River

Ducks swim under the bridge,
playing tag
Squirrel peeks at me,
runs away
Deer tracks in dry mud
Grasses bent in a soft, secret bed.

Rokendy J., age 7
Aztec, New Mexico

Prayer

Often have I come to you
In the fitful light of evening
Or the constant sheen of morning
And often have I sought your solace,
River.
Show me the secret of your solitude
That thing, that unknown certain thing
Which has brought you through a hundred shifting seasons
And will bring you through at least a thousand more.
Teach me to be alone through summer, autumn, winter, spring
And still to catch the gleaming sunset
And dance in golden eddies in the shadow of the islands.
Tell me all the secrets of those silent seasons
Or one thing only—
When spring comes, show me how to break the ice.

Alexandra P., Age 14
Washington, DC

The Night
Alex S., age 7
Issaquah, Washington

The Storm Is Coming

Wind whistles through
The pine needles twirl
Sawgrass sways
While clouds dash by

Little creatures hide
The pond waters splash
Rain gushes down
And tickles my toes

Kevin B., age 5
Lake Park, Florida

Wishes of Ant
Zakria R., age 12
Winnipeg, Canada

State coordinators are listed on the River of Words website. If you find that your state has no coordinator, you may want to consider taking on the job yourself. (Note that the national office cannot support state coordinators monetarily so most of them have some sort of institutional backing.) River of Words enhances the knowledge gained through other activities like ecological studies and environmental monitoring. Maybe best of all, it provides a link to the hearts of community members when the resulting art and poetry is shared.

Knowledge alone will not create a change in behavior and knowledge alone will not result in stewardship of our watersheds. But knowledge combined with emotional connection has the power to move students. In her acceptance speech as Teacher of the Year 2003, Alicia Hokansen asked, "Why do I teach poetry?" Her answer: "Because I want poets running my neighborhood council, my city, my country. I want poets ... who know the names of all the birds and will notice if fewer of them return in spring."

Mary Pardee is Wisconsin's River of Words Coordinator and a Lake Education Specialist with Wisconsin Lakes Program, University of Wisconsin-Stevens Point. She may be reached at mpardee@ uwsp.edu; 715-346-4978.

For more information visit the River of Words website at www.riverofwords.org or contact the national office in Berkeley, California; info@riverofwords.org; 510-548-7636. The website includes details about the annual contest; ordering information for the *Watershed Explorer Curriculum* and other River of Words publications; and examples of children's poetry and artworks.

The Millionth Circle

Rippling outward
In
twinkling vibrations
Flickering under the silent
Orb of the moon
The stars giddy
With the sight of countless circles
The fish smile
A mere kiss can cause
a million circles

Leia S., age 12
Mill Valley, California

Pebble Counts and Gravelometers

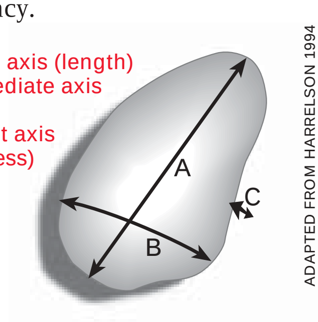
by Richard Albert

I must have been in the river business—watershed management and stream restoration—almost 25 years before I really appreciated stream morphology. A workshop by David Rosgen in 1995 finally persuaded me that understanding a stream requires not just chemistry and biology but also physics.

To see beyond the water and bugs, a person needs to make geomorphological measurements like stream channel cross sections, longitudinal profiles, and pebble counts. The Wolman Pebble Count method developed by Dr. M. Gordon Wolman in 1954 characterizes streambed composition by classifying stream bottom particles according to size.

Pebble count data give information about aquatic habitat characteristics, local stream energy, and upstream inputs of sediment. They can be used to measure differences between locations and trends over time. They can also indicate problems—for example, if data for a gravel stream show a spike in the smaller size classes, a good chance exists that "fines" (sand and fine gravels) are filling in the stream bottom.

To do a pebble count, a sampling team picks up and measures particles along a cross section of the stream. One partner measures the particle's intermediate or "B" axis (see drawing) and the other partner records it. Particles are tallied according to size class—for example, < 2 mm is classified as sand, 2-4 mm as very fine gravel, and so on up through several size categories of gravel, cobble, and boulder. The data are plotted by size class and frequency.



ADAPTED FROM HARRELSON 1994

In practice, I found it time-consuming to find the "B" axis of many rocks and then measure it with a straight ruler. Being the data recorder wasn't any better. It was difficult to hear the sizes being called out by a sampler who was bent over a noisy stream.

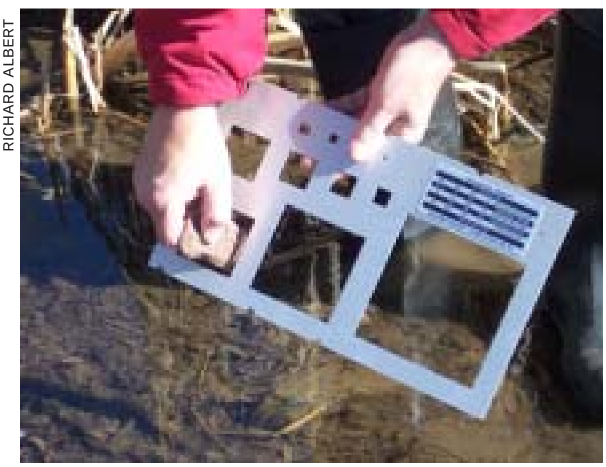
Then I found a 1983 scientific article by Colin Thorne and Richard Hey of Great Britain, describing a gravelometer they had built. Gravelometers are really sieves with each hole duplicating the function of a mesh sieve. In other words, each square hole on a gravelometer is essentially a one-holed sieve. Studies published since Thorne and Hey's paper have shown gravelometers to be superior to rulers in terms of accuracy and reproducibility.

In 1999, I decided to manufacture my own version of a gravelometer. At the time the only U.S. gravelometer was a government-manufactured model for federal agency use which was not commercially available. In any case, I had my own concept for improving the design. My goal was a gravelometer that eliminated the need for a two-person team.

I tested my first prototype while working on a large watershed study for Delaware Riverkeeper Network. My only staff was a volunteer, a high school science teacher with a real enthusiasm for river science. The testing resulted in some design changes, particularly in the placement of the holes, which were moved for better balance and grip. I also switched to aluminum after the tests showed that my original material of choice, cast plastic, was prone to warping in a hot car.

When all my research finally came together, I was able to produce a high-quality product, each gravelometer individually cut out with computer-driven lasers. The AL-SCI Field Sieve/Gravelometer can measure 14 size categories, ranging from <2 mm to 362 mm, using a combination of square holes and notches. The notches along the top and bottom serve as rulers for larger rocks, including those that are too deeply embedded and/or too heavy to be lifted. Particles in the <2 mm size class are measured by holding them against the gravelometer's edge, which is 2 mm thick.

To solve the two-person-team problem, the gravelometers are anodized. This chemical coating allows pencil marks to be made on the gravelometer and then erased later after the data are transferred



RICHARD ALBERT

Measuring a stream particle with the AL-SCI Field Sieve/Gravelometer designed by Richard Albert.

to paper or a computer. As each measurement is made, the sampler places a tick mark next to the appropriate square. I have found that one person using my gravelometer is faster than most two-person "ruler" teams. For safety reasons, I don't endorse one-person field work; but using my gravelometer frees up the partner to do other testing and observations.

At the Delaware Riverkeeper Network, where I currently serve as Science and Restoration Director, we use my gravelometers to take before-and-after measurements for our stream restoration

continued on page 22

Comparing Four Salinity Methods

by Peter Bergstrom

In previous articles in this newsletter I have reported on studies comparing salinity measured by conductivity meter (the reference method) to salinity measured by hydrometer or refractometer (Bergstrom 1997, 2002). Over the past three years, I extended my investigations to include a chloride titration kit. I am now able to provide comparison data for all four of the commonly used salinity methods. Only 2002-2004 data are reported here, since those are the only years when I collected data on all four methods.

Conductivity was used as the standard against which the other three alternatives were evaluated, because salinity is defined by conductivity measurements. The other methods do not measure conductivity directly but rather measure other properties that are related to salinity and thus to conductivity. The chloride kit measures chloride ion concentrations, a refractometer measures light refraction, and a hydrometer measures specific gravity.

I used the following equipment in my comparison studies:

Conductivity meter: YSI 600 QS meter. (Also measures dissolved oxygen, pH, and temperature.)

Chloride kit: LaMotte 3468 direct reading titrator, range 0-50 ppt.

Refractometer: Vista A366ATC.

Hydrometer: LaMotte 60/60F with 500-ml plastic cylinder.

The studies were conducted in the Magothy River, a small sub-estuary of Chesapeake Bay between Baltimore and Annapolis. From April 2002 through October 2004 I measured surface salinity using all four methods in two tidal creeks as well as one site on the mainstem. Samples were collected from piers with a small bucket and the tests were done right after samples were collected. Salinity in the mainstem varies from about 5 to 10 ppt in a "normal" rainfall year, although it can be 2 ppt in a wet spring and over 15 ppt in a dry fall. In the creeks, surface salinity can be less than 1 ppt.

Results of side-by-side testing are typically analyzed using linear regression. The method that is considered more accurate or "standard"—in this case, conductivity—is treated as the independent variable and plotted on the x-axis.

The slope and intercept of the regression line indicate bias, or systematic error. The closer the slope is to 1 and the intercept to zero, the lower the bias. In the graphs below, the solid black line is the regression line. The red dashed line, shown for comparison, is the line of perfect agreement, where y = x. It has a slope of 1 and an intercept of zero.

The regression coefficient (R^2) is a measure of the "scatter" of the data points around the regression line. The lower the value of R^2, the higher the scatter. In a method comparison study, you are looking for a high R^2, indicating that results obtained with one method can reliably predict results from the other. There is no hard and fast rule for the minimum acceptable value of R^2.

Low bias and low scatter are both desirable in order for methods to be considered comparable.

Of the three methods tested in the Magothy River in 2002-2004, the chloride kit measurements had the smallest amount of bias and the smallest scatter in comparison to conductivity. The refractometer data showed the most bias, especially at salinity above 12 ppt, and the hydrometer data showed the greatest scatter. However, all the differences in bias and scatter were relatively minor, so other considerations may be more important in choosing a method.

A conductivity meter is the first choice if budget allows. For data uses that require the highest accuracy and precision, a full range conductivity meter should be used. These start at about $450 (e.g., the YSI EC 300, which also displays salinity and measures temperature); adding dissolved oxygen measurements raises the price to about $1,200 (for the YSI 85). Pocket conductivity meters are available for under $100, but their range (only up to 12 ppt) is too small to be

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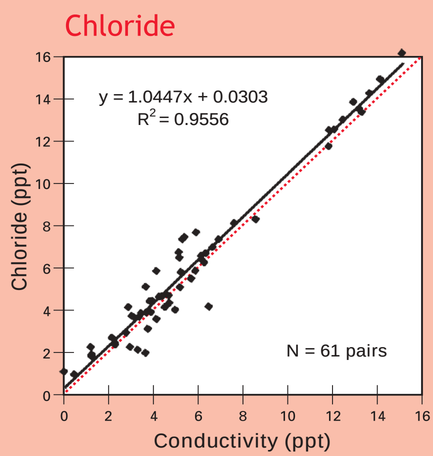

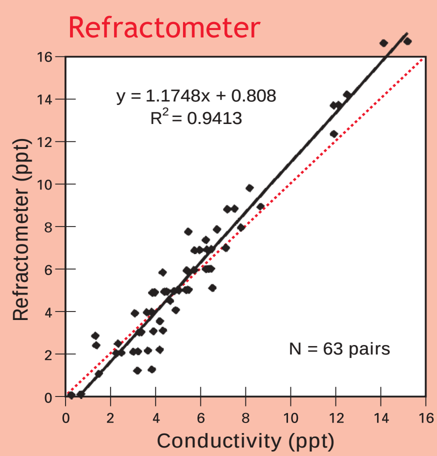

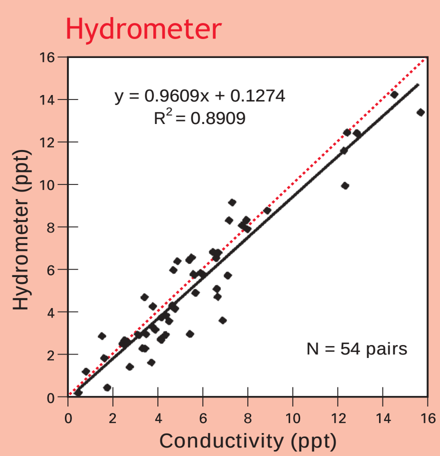

GRAVELOMETERS, continued

projects. Pebble counts are also moving into our volunteer monitoring program as well as other volunteer programs in our region. Numerous agencies, organizations, and universities use the AL-SCI gravelometer, including ones as far away as New Zealand and Brazil.

The AL-SCI Field Sieve/Gravelometer is available from Forestry Suppliers for $46 (www.forestry-suppliers.com; catalog #53250). For additional information, including instructions for using my gravelometer and a downloadable copy of my Excel spreadsheet for analyzing and graphing pebble count data, see www.albertscientific.com.

Richard Albert is the Delaware Riverkeeper Network's Scientist and Restoration Director. He may be reached at ralbert@delawareriverkeeper.org.

Resources

Harrelson, C., C. Rawlins, and J. Potyondy. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique*. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, General Technical Report RM-245. 61 pages. Includes clear instructions and illustrations for performing pebble counts and other basic measurements such as stream cross section, longitudinal profile, and discharge. Available in pdf format at www.stream.fs.fed.us/publication/documentsStream.html. For hard copy contact Rocky Mountain Research Station Headquarters in Fort Collins, Colorado; 970-498-1392; rschneider@fs.fed.us.

Rigney, M. 1996. Monitoring the behavior of streams. *The Volunteer Monitor* 8(2):12-15 (Fall 1996).

SALINITY, continued

useful in estuaries.

In practice, the choice among the other three methods comes down to weighing a variety of factors. The costs are not very different. The chloride kit I used sells for $35, with an ongoing cost of $19 for reagent refills (good for about 50 tests). I paid $150 for my refractometer, but have seen similar models on eBay for about $45. The hydrometer costs $35 for the instrument itself and $25 for the plastic cylinder used with it, and you should factor in ongoing replacement costs for broken hydrometers.

Overall, I would rank a hydrometer as the last choice—it's hard to read, especially on a boat; it's fragile and creates toxic waste when broken; it's less portable than the other choices; and the need to use a table to convert specific gravity to salinity is inconvenient and creates opportunities for error. Moreover, in my comparison study the hydrometer data showed the most scatter.

Data from the chloride kit showed the lowest amount of bias and scatter in my comparison study. On the other hand, the method is messy, hard to use on a boat, and takes longer than a refractometer; and the silver nitrate reagent can stain clothing and surfaces.

My personal preference among the three alternative methods is a refractometer, because it is compact, convenient, and not fragile. However, refractometers can be more expensive than the other alternatives, they need calibration, and they are somewhat hard to read.

The results of similar comparison studies are likely to vary in other estuaries with different water chemistry. In fact, my own salinity comparison studies within the Magothy have yielded variable results in different years and/or with different sites. Monitoring programs planning to measure salinity using one of the alternatives to conductivity should do their own method comparisons with a conductivity meter, to establish data comparability in that water body. Generally, 30-50 paired observations over the normal range of salinities encountered are adequate for this purpose.

Peter Bergstrom is a fishery biologist at NOAA Chesapeake Bay Office; 410-267-5665; peter.bergstrom@noaa.gov.

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Bergstrom, P. 1997. Salinity by Conductivity and Hydrometer: A Method Comparison. *The Volunteer Monitor* 9(1):13-15 (Spring 1997).

Bergstrom, P. 2002. Salinity Methods Comparison: Conductivity, Hydrometer, Refractometer. *The Volunteer Monitor* 14(1):20-21 (Winter 2002).

Ocean

Ocean
blue, gray, and green
gallops up to the shore
like a friendly puppy, licking
your toes.

Joanna K., age 11
Edgecomb, Maine

On the Shores of Goose Lake

Bronzed
By last summer's breath
Last golden leaf
Drifts to your feet
Calling
Go now.

Scales bright
Against the night sky of river
Last shining salmon
Fights the icy water
Urging
You must fly.

Last sun ray
Caressing your feathers
Fades away
Uttering
Follow me.

Last chipmunk
Cheeks bulging
Walnuts and berries
Chirping
Hurry! Take wing!

First icicle
Frosty ornament
Adorns the bare, sleeping maple
Whispering
Farewell geese.

Madeline W., age 11
Seattle, Washington

Fish

Swimming in the river,
Curving her small shining body
Like shimmering stars swimming back
Into the deep sea
Being the fish of Joy.

Ella S.-W., age 9
Berkeley, California

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Fifth National Monitoring Conference

May 7-11, 2006, San Jose, CA

Hold the date! Representatives from professional and volunteer water monitoring programs will be convening in San Jose, California, May 7-11, 2006, for the National Water Quality Monitoring Council fifth national monitoring conference, "Monitoring Networks: Connecting for Clean Water."

Volunteer monitoring was strongly represented at the Council's last conference (in 2004) and we're looking forward to an even more prominent role in 2006. Start planning now to come and share your expertise, learn new skills, and expand your network. Topics to be addressed include:

- Data sharing
- Designing monitoring programs to meet multiple objectives
- Expanding the role of volunteer monitoring
- Establishing state and regional monitoring councils
- Monitoring across political boundaries

As the conference date approaches, more details will be posted at http://water.usgs.gov/wicp/acwi/monitoring/. Questions about the conference may be addressed to nwqmc2006@tetratech-ffx.com, 410-356-8993.

Upcoming Events

River Rally 2005

May 20-24, Keystone, Colorado. At River Network's sixth annual National River Rally, citizen leaders from around the country will come together to celebrate rivers, learn new technical and programmatic skills, and renew their energy and sense of purpose. www.rivernetwork.org.

Wetlands Institute 2005

July 3-9, Victoria, British Columbia, Canada. A primarily field-based course covering wetland mapping, inventory, and restoration techniques. Only 15 registrants accepted. For more information contact Lisa Mose, BC Wildlife Federation, 250-423-2654; wetlands@bcwf.bc.ca.

Biological Monitoring Courses

August 2005, Warren County, New York. The Stream Bioassessment Institute (August 15-19) covers protocols for physical, chemical, biological, and bacteriological stream monitoring. The Benthic Macroinvertebrate Identification Program (August 22-26) focuses on laboratory identification. www.hudsonbasin.org.

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RESOURCES

Volunteer Monitoring Fact Sheets

Fact sheets prepared by the University of Rhode Island and University of Wisconsin Cooperative Extension services cover such topics as Designing Your Monitoring Strategy, Training Volunteer Water Quality Monitors Effectively, and Building Credibility: Quality Assurance and Quality Control for Volunteer Monitoring Programs. Available at www.usawaterquality.org/volunteer/ or contact Elizabeth Herron, emh@uri.edu, 401-874-4552.

Spanish-Language Manuals

Three Georgia Adopt-A-Stream monitoring manuals are now available online in both English and Spanish. Visit www.riversalive.org/aas.htm and click on "Resources & Materials" to download Getting to Know Your Watershed (Introducción a Cuencas Hidrológicas), Visual Stream Survey (Muestreo Visual de Arroyos), or Chemical and Biological Monitoring (Manual de Monitoreo Biológico y Químico en Arroyos).

Spanish Materials for Educators

Spanish-language resources for educators are available from the following organizations:

- Earth Force GREEN: *Protecting Our Watersheds* curriculum and instruction booklets for monitoring kits; www.earthforce.org.
- US Geological Survey: Water Science for Schools website, http://ga.water.usgs.gov/edu/; for Spanish version click on "La Ciencia del Agua para Escuelas."
- Project WET (Water Education for Teachers): Spanish-language Educators Guides are available to Project WET participants; www.projectwet.org.
- Give Water a Hand: www.uwex.edu/erc/gwah/.

NAWQA Water Quality Reports

A series of water quality reports from the US Geological Survey (USGS) National Water-Quality Assessment (NAWQA) Program describes water quality status and trends for major river basins across the country. The free reports are rich with information—summarized in graphs, tables, and text—from the in-depth NAWQA studies of each basin. For more information: http://water.usgs.gov/nawqa; nawqa_info@usgs.gov; 703-648-5716.

Fundraising Guide

River Network's *River Advocates Fundraising Guide* covers the gamut of fundraising strategies (grants, business partnerships, memberships, bequests, events, and more) with accompanying case studies and sample proposals. Accessible at www.rivernetwork.org.

Guide to Clean Water Act

Coming soon: the expanded second edition of River Network's *The Clean Water Act: An Owner's Manual,* with new material on using the Clean Water Act to solve real-world watershed problems, updated references, and more local stories. For availability check www.rivernetwork.org/marketplace.

Rain Feeling

The nap time rain
sings lullabies
And throws all kinds
of flowers on your head
shimmering stars
and rainbows

Jessica M., age 7
San Francisco, California

Reflections

Alyson D., age 13
Lafayette, Louisiana

Goldfish

Clear flowing
Water
Rushes down
Stream
As tiny
Glazing
Goldfish scatter
To
Their mother
Like
Lightning.

Stefani G., age 8
Clarkston, Michigan