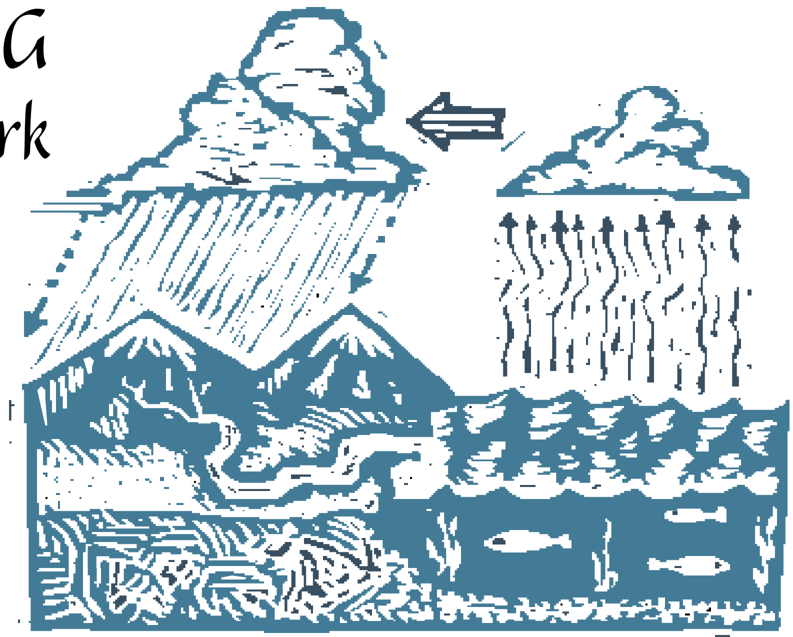
Quarterly publication of River Network
Volume 10, Number 3&4 • Fall '99 / Winter '00

River Voices

UNDERSTANDING How Rivers Work



"Doctor, I feel terrible! I've been physically run down for a few years now.
A couple of months ago, I caught a bad cold I just can't shake. And to top it all off, this afternoon I've fallen violently ill. I think I may have poisoned myself! Or maybe I'm having a bad reaction to the crazy combination of medication I took this morning. Please help! What should I do?"

"Well, I'd hate to take any action here until I'm sure of what we're dealing with. Go home and measure your temperature, height, weight and eyesight every now and then. Here's a thermometer, a micrometer, a sundial, a hammer and a pair of binoculars you can use. Write down your results and mail them to me. If I like the way you did that, I might pay attention to some of your data. And by all means, if a couple of years go by and you think you are still getting worse, give me a call!"

Nonsense? Of course. No physician would prescribe a course of action so clearly out of sync with the nature, seriousness and urgency of the problems implied by the symptoms reported. But similar disconnects occur every day in the field of watershed protection.

Many aquatic ecosystems are crashing. Others are chronically ill but not responding well enough or fast enough to efforts to improve them. The most important human and aquatic life uses of a great many of our waters are impaired or threatened.

And yet our response as a society is often about as inadequate and off-target as the imaginary doctor's response above.

by Don Elder

In our efforts to diagnose national watershed health, we regularly assess conditions in only a small portion of our waters. Even in those, we typically measure only a few things once every few years. What's more, we may realize later we measured the *wrong* things, or used the wrong tool, at the wrong time, perhaps in the wrong way.

Clearly, the quantity and quality of the data we obtain today is not what we need to diagnose our watersheds' health and to prescribe the right actions to protect or restore them.

Government can and should do more. But government will never be able to do everything necessary.

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River Voices

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River Network is a national organization whose mission is to help people understand, protect and restore rivers and their watersheds.

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From the President

Photo: Linda Kliewer

Do you have a radio alarm clock ? If so, information starts assaulting you before you're even fully awake in the morning. During the course of the day, you will be bombarded by newspapers, billboards, television, radio, E-mail, printed materials and telephone calls. Welcome to the Information Age, where it sometimes seems we have so much information we don't have time to make sense of it all. Can we, in fact, have too much information?

You bet! Having information that we don't need or that is outside of a useful context is like wearing hiking boots in a swimming pool. These days, when we seek a vacation it is, to some extent, a vacation from information. Yet, every day we make dozens of decisions to pursue the information we want. If your child needs a dentist, you want the best dentist; if your river is being polluted or channalized, you want to know what you can do.

In short, useless information is an encumbrance. Useful information—information that we can use to guide our actions effectively— is as precious a commodity as exists. And the most precious kind of information is the kind that leads to understanding.

The engineers who planned the damming of nearly every major river in the United States had enormous quantities of information about river flows and morphology, about turbines and electric transmission, and about converting one kind of energy into another kind. But they had no holistic understanding of rivers. Because of that, they had no way to measure the trade-offs required by hydroelectric development. Now, as our society considers dismantling dams across the country, we are searching for that understanding.

According to Mr. Webster, understanding is a mental grasp, the power of comprehending, especially the capacity to apprehend general relations of particulars. It is precisely those general relations of particulars that provide the context which makes information truly valuable. What is the relation of natural river flow to plant and animal life in rivers? What is the relation of sedimentation to the health of rivers downstream of impoundments? For that matter, what is the relation of sedimentation to the upkeep cost and eventual mortality of dams?

> *Useful information—information that we can use to guide our actions effectively—is as precious a commodity as exists.*

Mr. Webster also says that ecology is a branch of science concerned with the interrelationship of organisms and their environments.

Ultimately, that is what river assessment and monitoring are about. Not counting bugs, not taking measurements, not doing lab tests. It is about combining science and sensitivity to understand whole systems and the relationships between the parts; to do so respectfully and in the knowledge that these are living, dynamic systems with their own ways. We may never fully understand the complex web of interrelationships in aquatic ecosystems, but the closer we get, the better we can manage them. And what wonderful fun it is, too!

Sincerely,

Ken Margolis
President

We need to coordinate governmental and non-governmental efforts. We need to target those efforts toward better fundamental understanding of our watersheds and their problems. And we need to involve legions of interested and concerned citizens in the ongoing business of assessing watershed conditions and trends.

Why monitor?

Some activists ask "Why monitor?" They correctly point out that getting obsessed with gathering ever-more data can blind us to clear lessons already learned and divert our attention and resources from actions clearly needed.

Not every river advocate needs to monitor. But good monitoring activities *should* be underway in most of our watersheds. We see five major categories of benefits of long-term watershed-based monitoring programs:

> ...someone gave them a dissolved oxygen test kit, and they felt obliged to use it.

1. **Enhancing environmental education.** People learn best from hands-on experience. One good day in the field studying a river provides more long-lasting environmental lessons than ten lectures endured, a hundred news stories read, or a thousand one-line environmental slogans overheard. Monitoring inevitably promotes greater understanding and awareness in a community. When understanding and awareness grow, greater protection and stewardship almost always follow.
2. **Clearly defining problems.** Monitoring may help confirm fears about watershed problems and trends. It may also help dispel them. By helping us get a firm grip on the nature and magnitude of watershed problems, monitoring helps us focus our efforts and resources on the most important problems to address. When monitoring confirms that a waterbody is clean and healthy, it helps us define the desirable conditions we need to maintain over time.
3. **Pinpointing sources of problems.** Understanding what a watershed's biggest problems are is only half the battle. The other is determining the real *sources* of those problems. A single problem may be the result of multiple sources, and multiple problems may stem from a single source. Thoughtful, comprehensive, adaptive, long-term monitoring helps us be sure we are addressing all the major sources of problems, not just some of their collective symptoms.
4. **Setting standards and goals.** Voluntary and regulatory watershed programs both work best when they are based on solid standards and clear goals. The best standards and goals grow from a well-grounded understanding of historic and current conditions and trends. Without this type of understanding, standards and goals may be set inappropriately. If they are too low, protection and restoration efforts will not be aggressive

enough and opportunities may be delayed or missed. If they are too high, expectations may be unrealistic and the enthusiasm of involved parties may wane over time. Monitoring helps us set the bar at the right level for each watershed.

5. **Providing benchmarks for measuring progress**. Restoration and protection efforts cost money and take time—usually, years. Involved parties need clear evidence that their efforts are making a difference if they are to continue to justify their time, effort and expense. Consequently, monitoring before, during and after intensive protection and restoration efforts helps us explain the importance of current efforts and make the case for new ones.

Photo: E. Ely

Through our River Watch program, River Network helps groups determine what they need to learn about their watershed and how they can best go about learning it. To do this, we guide groups through a standard series of questions and a standard process for answering them. The result is a good study design that can guide immediate and long-term efforts to develop technically sound monitoring and assessment programs.

Our goal is to stimulate more and better watershed monitoring and assessment activities in more of the nation's watersheds. The recent merger between River Network and River Watch Network was a major step in this direction. This issue of River Voices is another.

Improved diagnoses of our watersheds' health can lead to actions that better match the nature and magnitude of the problems that plague our watersheds today. This, in turn, can lead to faster progress toward our nation's long-stated but still widely elusive goals for clean and healthy waters.

Don Elder is the Director of River Network's Watershed Programs.

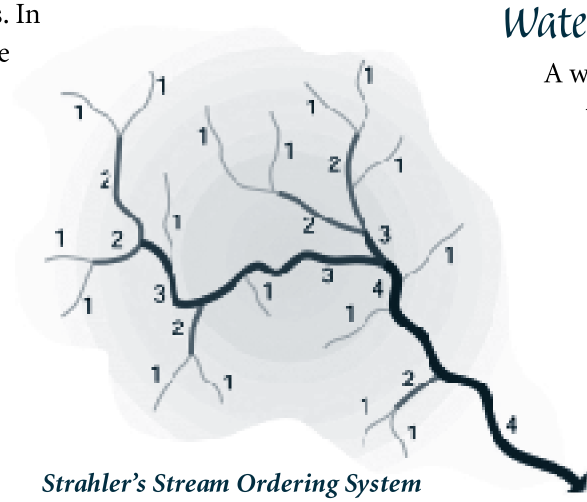
Watershed Health 101

by Geoff Dates

"Clean Water Is Not Enough." When I first read the title of that article by Dr. James Karr, light bulbs went off in my head. Of course it's not enough! Not if our definition of "clean" is crystal clear but biologically inert. Even the drafters of the Clean Water Act knew that the goal is not strictly "clean water." The goal, as stated in the Act, is to restore and maintain the chemical, physical and biological integrity of the Nation's waters. In fact, it's not just the water — it's the forces at work at all levels, throughout the watershed that create the food, habitat, and conditions that make life in and human use of water possible. It's the health of our watersheds.

To restore and maintain healthy watersheds, we need to understand what healthy watersheds are, how humans affect them, and how well our protection and restoration schemes are working. And that goes beyond ecological theories about how watershed forces interact. It goes beyond the models that attempt to predict what happens if we change this feature or that reach of river. It means getting out into the field and seeing what's really going on. It's getting your feet wet. As Colorado hydrologist Dave Rosgen says, "Wear out your waders!" You just can't understand what's going on in your watershed unless you get out into the field. That's called monitoring. Then you try to figure out the story of your watershed's health. That's assessment.

In this article, I'll briefly describe some of the general approaches to watershed monitoring and assessment. But, first, let's define some watershed terminology.



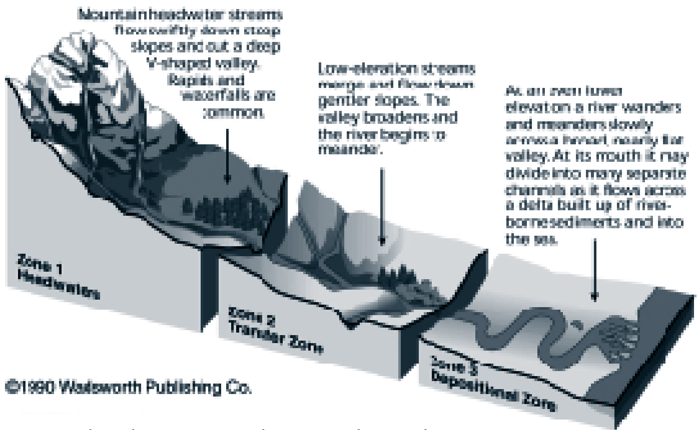
Strahler's Stream Ordering System

From: Stream Corridor Restoration: Principles, Processes and Practices.

An Overview of Watersheds

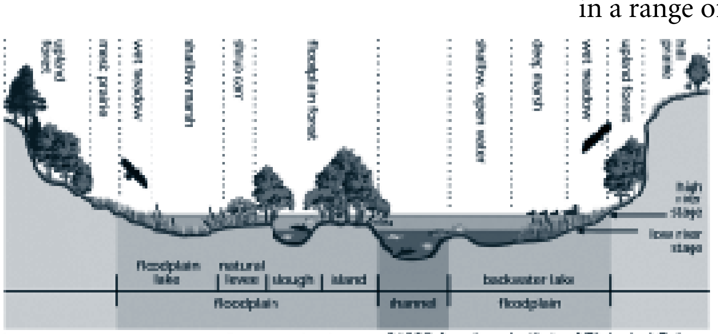
A watershed is an area of land that drains water, and everything in the water, to some sort of outlet. From a plane, looking down on the landscape, I'm struck by drainage patterns. Even in the arid west, drainage patterns jump out at me. Water is a great maker of landforms, and the patterns that water carves in the landscape are striking. Most look like tree branches. And in fact, Strahler's "stream ordering" system uses that concept. The uppermost streams are first-order, two first-order streams form a second-order, two second order streams form a third order, and so on.

Streams begin in headwaters, typically steep areas with V-shaped valleys. These high-energy streams erode material from the slopes and carry it downstream to the transfer zone. Here, larger particles begin to drop out as the gradient flattens and the stream starts to meander. Finally, the stream



enters the depositional zone where the gradient flattens even more and smaller particles are deposited. Water volume, stream channel size, deposition, food, habitat, life forms — all change as you move downstream.

Now, let's look at the sideways view. First, there's the stream channel itself which carries flowing water and sediment. Channels take myriad forms—they may have one thread, or multiple threads. Their curvature may vary. Their cross sections may be v-shaped, u-shaped, rectangular, or parabolic. Flowing water forms the channel. Moving out from there is the floodplain, which carries water that spills over the banks of the channel. Upland terraces form the "banks" of the flooding river. They are formed by the historic sideways and vertical movement of the channel. Uplands are areas that do not flood. They are formed by the larger geologic processes over time.



Now we've set the scene. Let's move to the action. If we are to monitor and assess watershed health, how do we define it?

What Is Watershed Health?

Aquatic ecosystems are not simple. Neither are definitions of ecosystem health. So, as we explore these definitions, we'll also delve into the science of aquatic ecology.

Watershed health can be viewed as the combination of biological integrity, physical integrity and dynamic equilibriums. Karr defines *biological integrity* as conditions that support living communities of organisms that are the result of natural evolutionary and bio-geographical processes. These communities have the full range of structure (e.g. species composition, genes) and functions (e.g. biotic interactions, food and energy flows) expected in areas with minimal impacts from modern human society. The living communities in an aquatic system are, first of all, a direct reflection of the evolutionary processes played out in a given ecoregion. Human society affects those forces and therefore the biota. To assess the health of our watersheds, then, we must assess the health of their living communities in a range of conditions that reflect human impacts, from minimal to severe. We compare the condition of biota in areas with significant human impacts to areas with minimal impacts (a.k.a. reference conditions) to assess degradation and disturbance.


Photo: E. Ely

A possible way to look at *physical integrity* is in terms of stability in the way the water flows over the landscape (fluvial geomorphology). David Rosgen defines stability as the ability of a stream over time (in the present climate) to transport the water and sediment produced by its watershed while maintaining the elevation of its bed, neither raising it with the long term depositing of bottom material or lowering it with the long term erosion of bottom material.

Yet another concept of health is *dynamic equilibrium.* This is the ability of an ecosystem to adjust to disturbances and be self-sustaining. This requires the ecosystem to be able to maintain its original form and return to this form relatively quickly after a disturbance. It also requires a good description of the reference condition as a benchmark against which to compare change.

Healthy Compared to What?

Each of these definitions of health describes a desired end state. Applying this to any particular watershed requires a good description of the reference condition. Actual reference sites are elusive in the real world, because virtually all of our watershed ecosystems have been altered in some way. So, the reference condition often used is the "least impaired." These are places where human impacts, though present, are minimal and the ecosystem is thought to be fairly close to its *natural* condition. We measure and describe these places so we can compare other sites to them. Understanding reference conditions is the basis for assessing change caused by humans.

Now we run into another problem: we can't compare a site in the depositional zone to a site in the headwaters. They are naturally different. So, we must come up with a way to classify our waters so we're comparing apples with apples. This means we need a reference site for each type of water. Simple in theory — but try finding a reference site for a big river in a depositional zone. That's where cities tend to be located.

One way to avoid this dilemma is to develop theoretical reference conditions. Water quality criteria in state water quality standards are meant to describe conditions which, if met, will support specified uses. The main problem with this approach is that they tend to be based mostly on concentrations of water column materials. We're back to the "clean water" problem.

So, where does that leave us? In an imperfect world. We use water quality criteria if we have to, and actual reference conditions if we can find them. Regardless, once we've decided on the benchmarks we'll use to assess watershed health, in order to find out what's going on in our watersheds, we've got to get out of our offices and measure things.

How Do We Measure Watershed Health?

To truly monitor and assess the health of our watersheds, we would need to monitor all their physical, chemical, and biological features — everywhere and all the time! Obviously, we can't do that. So, we need to make choices about the indicators (measurable features) that we will track and how, where we'll track them, and how often. We'll explore that decision-making process later, in (*Getting Started*, pg. 13)

We might think about understanding the health of our watersheds as a process of trying to understand:

- the reference conditions,
- the stresses placed on those natural conditions by humans,
- the response of the watershed to the stresses, and
- the response of the watershed ecosystem to our attempts to reduce the stresses.

There are 6 basic approaches to doing this. Each involves monitoring and assessing an aspect of the ecosystem.

1) Water Quality: the physical, chemical, and biological characteristics of the water column.

The water column of rivers, lakes, estuaries, and marine areas is a complex "soup" made up of water and materials dissolved or suspended in it. As they run over the land, weathering the continent, rivers pick up and carry a variety of materials: sediment, heat, bacteria, dissolved gases, dissolved major ions, nutrients, suspended and dissolved organic matter, toxic organic chemicals, and metals. These are either naturally-occurring (from the dissolution of the earth's rocks, living things, or the atmosphere) or discharged as pollution (a harmful human-caused change in water quality). Any of these materials can be present as a part of natural conditions, or in concentrations or amounts sufficient to cause disruption of ecological processes or functions.

Measuring the materials in the water column is probably the most common type of watershed assessment. There are two basic approaches:

- a sample of the water is taken and analyzed for the indicator of concern either on site or in a lab,
- some sort of probe is lowered into the water column where it reads the concentration or level directly.

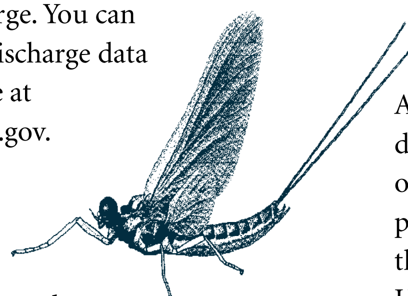
2) Hydrologic Processes: the duration and frequency of certain flows.

How fast, how much, how deep, how often, and when water flows are basic to understanding watershed health. After all, it's the flowing water that erodes the land, shapes the channel and creates instream and riparian habitat. The basic measurement is discharge (flow). This is the amount of water flowing past a point within a given period of time, usually in cubic feet (or meters) per second. In any given waterway, flow varies over time and space. The natural range of flows, in the absence of human impacts, is called the "natural flow regime." The

> "When rivers can no longer support living thngs, they will no longer support human affairs."
>
> from Restoring Life in Running Waters by James Karr and Ellen Chu

channel, the habitat, and the aquatic biota adapt to this variability. In fact, some life needs this variability to survive.

Flow is computed by measuring the cross sectional area of the stream channel (width of the water times depth of the water), measuring the speed of the current, and multiplying the two. Measurements are taken under a variety of flows. The US Geological Survey maintains an active network of stream gauges which it usesto calculate discharge. You can frequently get discharge data from this source at www.water.usgs.gov.



Water is also flowing through the subsurface as groundwater. Water moves according to gravity and pressure through the subsurface. Areas where surface water enters the ground are called recharge areas. Areas where the groundwater meets the surface are called springs and seeps. Sometimes, after prolonged periods without rain, groundwater flow is the sole source of flowing water in streams. This is known as base flow. That may be all that keeps your canoe afloat, or your fish in water! Yet, if we pave over a watershed, we prevent rainfall from entering the groundwater. Water that would normally take days, or even weeks, to reach a stream channel, gets there in minutes and is gone!

3) Geomorphic Processes: the channel-forming processes and conditions.

As water flows over the landscape, it carves channels that carry water and sediment to larger water bodies, and eventually the ocean. In the process, it creates habitat, the physical foundation for living communities.

There are three basic geomorphic processes:

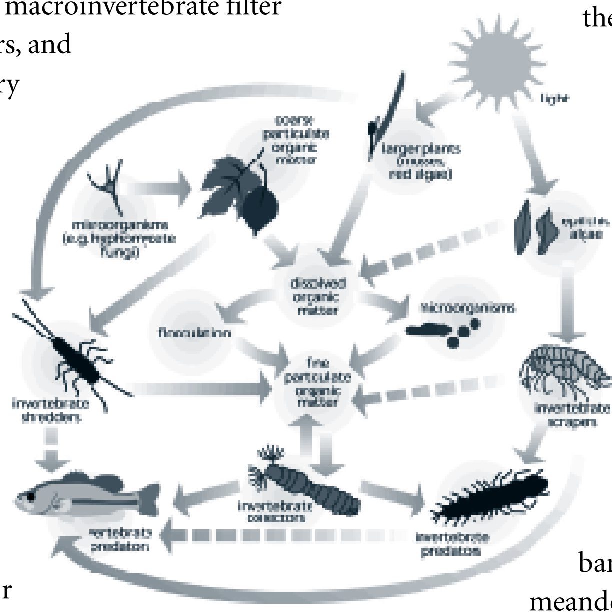
- erosion: the detachment of soil particles by rain, surface runoff, gravity, wind, or ice.
- sediment transport: the movement of the eroded soil particles in flowing water.
- sediment deposition: the settling of eroded soil particles to the bottom of a water body.

Assessing these processes is extremely difficult due to their complexity, the number of measurements needed, and the long time periods involved to really understand how these processes vary over time and space. However, the measurements themselves are not difficult.

Streams naturally form and maintain themselves. Human activities can change the amount of water, sediment, and the processes that streams use to maintain stability. They adjust to human activity by altering their channels to accommodate these impacts. This process of adjustment produces instability. At some point, they restore the balance and stabilize in a different form, or restore their original dimension, pattern, and profile. Geomorphic assessment produces data that can be used to track these changes.

4) Biological Communities: the characteristics of assemblages of terrestrial and aquatic life.

Aquatic ecosystems are food webs made up of living things, with energy provided by the sun. Food comes from growth of plants on the stream bottom and in the water column. It also drops in from overhanging vegetation or is carried into the stream by surface runoff as particles or in solution. Microbes (bacteria and fungi) colonize the larger food particles, making it more appealing to benthic macroinvertebrate shredders, who proceed to eat it, digest it, and excrete it as fine particles. Meanwhile, dissolved organic matter is taken up by microbes, creating a feast for benthic macroinvertebrate filter feeders, collectors, and grazers. Predatory invertebrates fish, hunt, and eat smaller prey or parasitize larger prey. As each critter feeds, it digests and excretes fecal material, which in turn becomes food for some other type of feeder. So, food is constantly being produced, consumed, and recycled in the stream environment. Then there are the terrestrial predators like amphibians, mammals, and birds that also feed in the stream.



From: Stream Corridor Restoration: Principles, Processes and Practices.

Food provides the energy and raw material to make and grow living things; the stream is a web of interactions centered around producing and consuming food.

Human activities that change the food source, impair life cycles, or change habitat will affect at least one type of critter and likely more. For this reason, biological communities are especially rich indicators of ecological health.

5) Habitat: characteristics and assessment of the quality of the terrestrial and aquatic habitat.

Habitat is where living things live, grow, feed, and reproduce. As water flows downstream, it carries particles of various sizes and carves its channel. Particles get distributed according to the current velocity — particles drop out of the water or stop moving when there isn't enough energy to carry them. Point bars form when relatively large particles get deposited on the inside of a bend and force water against the opposite bank. There it cuts into the bank, tearing its soil and pushing that bank outward, forming a meander. Deposition at the bar tends to balance erosion at the opposite bank, and as this process continues, the meanders become more extreme. Riffles form in the center of the channel and are separated by deeper areas known as pools, where rocks are absent. Pools form on the outside of the bends or in places where the water scours out a hole. Both pools and riffles provide macro habitats for stream life. In addition, the composition of the bottom provides all sorts of micro habitats for critters to hide in, cling to, or feed from.

6) The Human Context: the social, economic, and political context within watershed management decisions are made.

Ecological processes take place in the context of myriad social, political and economic decisions. Or is the other way around? Regardless, these decisions can and do have dramatic effects on watershed ecosystems. Understanding these decisions, and their potential impacts, is as important as understanding ecological processes.

Here are a few things to look at:

- What is the status of your waters under the state water pollution laws and regulations?
- Who holds permits to withdraw and discharge to your waters?
- What are the local and regional planning and zoning regulations?
- What are the state land use laws and regulations?
- Who makes decisions that affect your waters?
- Where do people work?
- Where do people recreate?
- What do people value about the watershed?
- Who lives near the water?

This is by no means an exhaustive list, and will vary depending on your watershed.

Putting It All Together

As we described above, watershed ecosystems are not static. This presents a challenge for understanding how they work. How are we to interpret changes in what we measure? Are they natural changes, or are they human-caused? That's one of the main challenges in monitoring and assessment. One of the main considerations in choosing an approach should be whether it will help you separate natural variability from human-caused variability. That's where good assessment design — making the right choices — comes in.

Our rivers and streams have been straightened, raised, lowered, lined, narrowed, widened, diverted, and dammed. Their watersheds have been paved, cut over, plowed, and mined. They've been cut off from their floodplains by levees. When we change the river, its channel, and/or its landscape, we affect how well it does its job of carrying water, food and sediment. The river will adjust, and if we're in the way, we'll either have to spend a fortune to keep the river in its place in an unstable condition, or we'll have to get out of the way and let the river do its job.

Geoff Dates is the Director of River Network's River Watch Program.

An expanded version of this article, with references, is available at: http:// www.rivernetwork.org/wshealth.htm

Getting Started

by
Geoff Dates

Designing a scientifically-credible and realistic watershed monitoring program involves making choices about the why, what, how, where, when, and who of your monitoring effort. A study design is a written document that describes the choices you make about why, what, where, when, who, and how you intend to monitor the water. We suggest a ten-step process:

Step 1: What Is Already Known About Your Watershed?

Start out by asking yourselves some questions and collecting existing information on the conditions and issues in your watershed. Here are a few of the questions to ask:

What are your group's goals for the watershed? This provides the context for your monitoring program. Hopefully, you have this information readily available.

What are your waters of interest? List the major rivers, tributaries, lakes or ponds that your group is interested in, regardless of whether you have any plans to monitor them. We suggest that you pick a watershed that you'll be able to adequately cover with your assessment, considering your group's resources, time availability, and energy. Delineate this on a topographic map, and use this as your reference map.

What are the land and water uses in the watershed? List the different land use types and the percent of the land area in each type in the watershed that contains each water of interest.

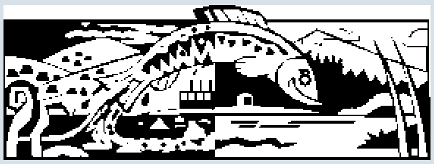
What is the current status of your waters of interest under the state water quality laws and regulations? The states reports to EPA and Congress every two years with a list of all the waters of the state and how they measure up to water quality standards. See Locating Existing Information (p. 30) for tips on how to access this valuable information.

What are the most pressing water quality issues facing your waters of interest? Based on your research, briefly describe the issues that will need to be addressed in order for your stream or lake to support designated and identified uses and values, deal with the threats, and solve the problems. Issues can be existing or a potential conflict among these uses and values. Issues can also be concerned with the existing or potential impacts of these threats on uses and values. A few examples might be:

- Loss of riparian or lakeshore habitat to development;
- Recreation impairment caused by pollution from inadequate or failing on-site septic systems;
- Shoreline erosion due to clearing and development;
- Aquatic life impairment due to sedimentation.

Step 2: Why Are You Monitoring?

At this point, you've learned about the "official" status of your waters of interest with regard to the state's water quality standards. Now you are ready to decide your reasons for monitoring. What information



Uses, Values, and Threats Workshops

Public workshops are a great way to involve watershed residents in your program, to learn about how your river or lake is being used, what people think is important, and problem areas. They are also a good way to build a list of potential monitoring volunteers. After all, they came to your workshop, they must be interested in the water!

Publicize one or more *Uses, Values, and Threats Workshops*.At each workshop, explain your program ideas. Then assemble topographic maps, or some other clear base maps, that cover your watershed.

Invite participants to identify and locate water use areas, special attributes and problem areas using labeled or color-coded "post-it" notes. You can learn a surprising amount about your water body through this exercise.

do you need to address the issues? What is the purpose of your monitoring? What specific water-related questions are you trying to answer? Who do you expect to use your results and for what?

a. Monitoring questions

Think about the key issues you identified in Step 1. What information might you need to address them? Next, think about how to turn these issues into one or more questions that it would be helpful to answer. Then, design your monitoring program to answer these questions.

For example, if the issue you're concerned about is a conflict between a waste discharge and swimming at your favorite swimming hole, you might frame the following monitoring question: *Is swimming in the swimming hole a health risk?*

If your issue is the threat of polluted runoff from a large paved area near a river, you might frame the following question: *What is the impact of the parking area on the ecological health of the river?*

If the loss of lakeshore vegetation is your issue of concern, you might frame the following question: *What is the impact of the loss of shoreline vegetation on aquatic plants and animals in the littoral zone?*

Questions can be framed many ways, but the more specific the better.

b. Monitoring Purposes

At this point you will be prepared to design a program that will collect the most useful information with the least amount of time and expense. An effective and efficient program will:

1) Define present watershed conditions.
2) Characterize existing and emerging problems by type, magnitude and geographic extent.
3) Provide information to help design strategies to reduce and control pollution and to manage land and water.
4) Provide information that will be helpful in evaluating the effectiveness of reduction, control and management strategies.
5) Reveal trends in watershed quality.

c. List the intended uses and users of the information you collect

As you think about how to build a program that will do these things over the long term, think carefully about who you expect to use this information, and what you expect them to use it for.

Identify the decision-makers who are (or should be) interested in the answers to your questions. Find out what actions they might take or decisions they might make as a result of your information. List these decision-makers (users) and the actions or decisions (uses). Consult with the decision-makers to find out if and under what circumstances they will use your information.

Step 3: What Will You Monitor?

Streams are very complicated systems of inter-related physical, chemical, and biological characteristics, often referred to as "indicators." Which indicators you choose to monitor should depend upon the question(s) you are asking as well as your available human and financial resources.

There are literally hundreds of indicators that you could measure. Remember that selecting indicators is a logical process that considers your specific monitoring question and your capabilities. And, you've set up a technical committee to help you make these choices (right?). Here are some things to consider when selecting indicators:

Scientific Considerations:

- Does it help answer your question?
- Can you observe or measure and quantify it?
- Does it respond to changes over a reasonable time period?
- Does it respond to the impacts you're evaluating?
- Can you isolate the conditions that cause it to change?
- Does it integrate effects over time and space?
- Does it respond to changes in other indicators?
- Is it a true measure of an environmental condition?
- Is there a benchmark or reference condition against which to evaluate it?
- Does it provide early warning of changes?


Photo: Gary S. Wolfson/The Gainesville Sun

Practical and Program Considerations:

- Do you have the human and financial resources to measure it?
- How difficult is it to monitor?
- Does it help you understand a major component of the ecosystem?
- Is it understandable/explainable to your target audience?

Step 4: What Are Your Data Quality Objectives?

Data quality objectives are the quantitative (numerical) and qualitative (narrative) terms you use to describe how good your data needs to be in order to be useful. You will need to establish data quality objectives for *sampling* for each sample type and *analysis* for each indicator. The objectives guide you in your selection of sampling and analytical methods — you match your methods to your data quality objectives.

Setting data quality objectives may be the most challenging part of designing your monitoring program. In part, it's a "chicken-and-egg" situation. How do you know what you can do before you try? In fact, unless you are preparing a Quality Assurance Project Plan (QAPP), you may not need to set objectives before you start monitoring. You may be able to experiment and then assess your capabilities.

Step 5: How Will You Monitor?

Determining how you will monitor involves making choices as to the appropriate sampling and analytical methods, both in the field and in the lab, that meet your data quality goals. Here are some things to consider:

Scientific Considerations:

- Does it meet your data quality objectives?
  - How accurate is it?
  - How precise (reproducible) is it?
  - What is its detection limit?
- Will it measure the indicator in the range that you need?
- What lab facilities are required?
- What equipment is required?
- Does it yield samples that are representative?
- Is it comparable to methods used by agencies collecting similar information?

Practical and Program Considerations:

- Do you have the human and financial resources to do it?
- How difficult is it?
- How time-consuming is it?
- Will it produce data useful to the target audience?

Step 6: Where Will You Monitor?

In Step 1, you identified your waters of interest. Now it's time to identify the specific locations at which you will collect monitoring information. There are several decisions to be made here:

- Where in the watershed?
- At the site: where in the water column (what depth)?
- At the site: where across the channel?

There are many types of monitoring sites. Generally, we recommend two different categories of monitoring sites:

1) General Watershed Assessment Sites — different types of sites throughout the watershed that represent background conditions as well as conditions resulting from human activities.

2) Stream Impact Assessment Sites — sites which bracket a particular pollution source or sources in order to determine its impact.

Beyond this, it makes sense to classify your sites into homogenous groupings. For biological monitoring, the goal is to group sites where aquatic biota are similar both in their natural undisturbed condition and in their response to disturbance.

When researchers select the number of sampling locations they will monitor, they may use complex mathematical equations that are geared to producing the type of data they want. For most of the programs we work with, we recommend a non-mathematical approach to selecting sampling locations.

Step 7: When Will You Monitor?

Next, you will put together your sampling schedule. Since the time of day, frequency, time of year, and weather conditions sampled greatly affect your results, consider these when you establish the sampling schedule.

Time of year: Human use and aquatic ecosystems change with the seasons. Water flows, temperatures, chemistry, food sources, and the level of biological activity all vary with seasonal cycles.

Frequency: How many times should you sample? As with everything else, it depends on the question(s) you've asked as well as the indicator. If you're trying to establish baseline conditions or monitor impacts, you should collect water samples as often as practical, in as many different conditions, and for as many years as possible. For other types of surveys, once per year is enough.

Time of Day Sampled: Certain indicators, like dissolved oxygen and pH vary according to the time of day. In order to understand this daily variability, you may have to sample these indicators at different times of the day, perhaps even hourly over several 24-hour periods. For others, like benthic macroinvertebrates, the time of day is not important.

Special Weather Conditions: Weather affects aquatic ecosystems in profound ways — some reduce stress and some cause stress. Consider sampling a variety of weather conditions: storm events, droughts, "normal" conditions, relatively hot weather, cool weather, etc.

Step 8: What Are Your Quality Assurance Measures?

Quality Assurance (QA) measures are the operating procedures used to assure and assess the quality of the information you collect. QA is designed to assure that the information you collect meets your data quality goals as described in Step 4. Quality Assurance measures are chosen for each indicator for each survey.

Step 9: How Will You Manage, Analyze, and Report the Data?

Dealing with data involves converting raw data into useful information that sheds light on the answers to your monitoring ques-

Getting Started, cont.

tions. That process has three main steps: 1) Data Management, 2) Data Analysis, and 3) Data Reporting. Managing data includes recording it, entering and validating it, and summarizing it. Analyzing data includes making sense of it and finding the story. Reporting data involves telling the story in various ways to various audiences.

Step 10: What Are the Tasks and Who Will Do Them?

Every large project needs a clear outline which describes roles and responsibilities. In this step, briefly describe the major tasks and key program personnel that might be associated with a monitoring program.

An expanded version of this article, with references, is available at http://www.rivernetwork.org/getting.htm.

WHY WRITE A STUDY DESIGN?

Preparing a study design may be the most important step in organizing your whole monitoring effort. Think of it this way: in 10 years someone is looking at your water quality data and wants to know how you came up with those numbers. This person should be able to find out by reading your study design document. Besides documentation, a study design serves some very important purposes for your group and to the people you hope will use your data:

- it forces you to focus on what you are trying to accomplish with your monitoring program;
- it prevents waste of time and money on equipment and procedures that are inappropriate for your group or goals;
- it allows you to select the most appropriate monitoring strategy to address the issues that are important to you and your community;
- it allows everyone who might use your data to assess the quality of your results since you clearly document your sampling and analysis methods and quality assurance procedures;
- it minimizes the impact of changing personnel on the continuity of your monitoring activities because anyone can read your study design and "pick up the threads;"
- it allows your group to re-evaluate your monitoring study every year in an orderly manner and make changes as needed; and,
- you can very quickly and easily convert your study design document into a Quality Assurance Project Plan.

The Wide World of Volunteer Monitoring

by
Eleanor Ely

Today, an estimated half-million U.S. volunteers are monitoring aquatic environments across the country. Inspired by the belief that everyone — not just professionals with specialized degrees — can study the natural world and collect meaningful data, these trained volunteer monitors spend countless hours in the field making careful observations and measurements.

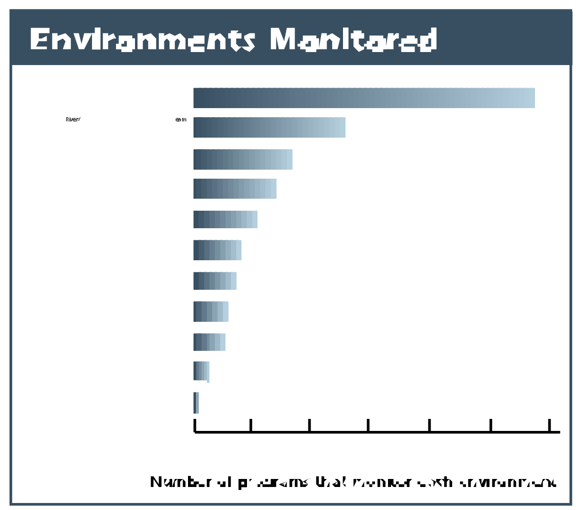
In 1998, a nationwide survey of volunteer monitoring programs was conducted to collect information for the fifth edition of the *National Directory of Volunteer Environmental Monitoring Programs*, which lists 772 monitoring programs. This article is based on the results of that survey. Please note that the survey focused mainly on groups that monitor aquatic environments — streams, lakes, estuaries, and wetlands. There are, in addition, many volunteer programs in the U.S. that are monitoring non-aquatic environments — mapping terrestrial wildlife, or surveying birds populations, or documenting forest health — and most of these are not included in the statistics provided below.

Early Beginnings

Volunteer lake and stream monitoring programs got started in the Northeast and Great Lakes regions, and many of those pioneering programs are still going strong after 20 or more years: The Izaak Walton League of America's Save Our Streams Program, founded in Maryland in 1969; Maryland's Save Our Streams/Adopt A Stream program, started in 1970; Maine's Volunteer Lake Monitoring Program, 1971; Minnesota's Citizen Lake Monitoring Program, 1973; the Michigan Cooperative Lakes Monitoring Program, 1974, and the New Hampshire Lakes Lay Monitoring Program, 1978.

Environments Monitored

Most programs don't limit their activities to a single water body type: 53% monitor more than one environment (i.e., estuary plus stream, or lake plus wetland), and 27% monitor three or more. Rivers are the aquatic environment monitored by the largest number of volunteer monitoring programs: out of the 772 listed programs, 585 include river monitoring among their activities. Lake monitoring is the second most common.



While the groups listed in the *Directory* primarily monitor aquatic environments, they also recognize that a water body does not exist in isolation. All parts of a watershed are connected, and to gauge the health of, say, a lake, you need to look not just at the lake itself but at the upstream tributaries and the surrounding land uses. So it's not surprising that many programs engage in construction site inspections, land use mapping, or storm drain monitoring, all of

The Wide World of Volunteer Monitoring, cont.

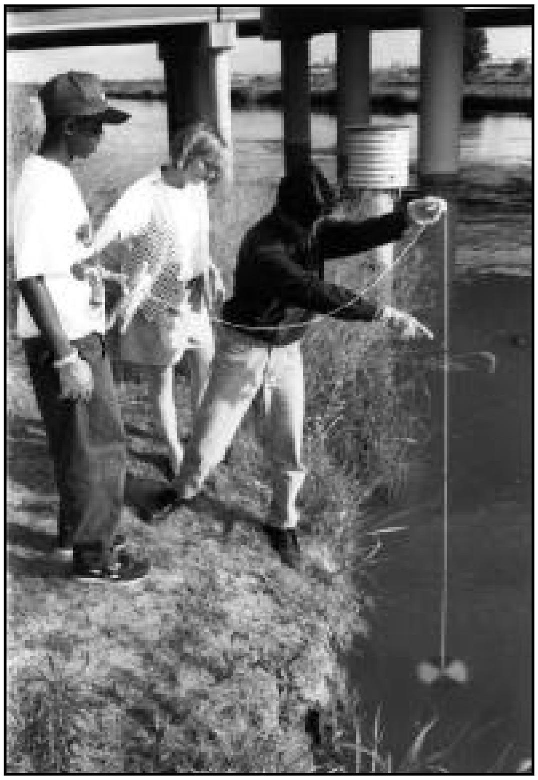


Photo: Wayne Baker

which help identify land-based sources of pollution to a water body. Others include surveys of terrestrial wildlife. For example, bird or amphibian populations in the area surrounding a wetland give many clues as to how well the ecosystem is functioning.

What Do They Monitor?

Volunteer monitors — or citizen scientists, as they are sometimes called — have not been afraid to venture into almost any branch of environmental science. Many volunteers perform biological studies — for example, identifying stream insects, or watching out for invasive species, or banding birds. An even larger number are engaged in chemistry as they carry out basic water quality tests (dissolved oxygen is measured by over two-thirds of the programs). Other volunteers are delving into the field of public health, as they test for bacteria in swimming areas or monitor shellfish for paralytic shellfish poisoning, while still others study the physical side of aquatic systems by measuring stream flow rate and channel shape.

The *Directory* survey found that the "big three" parameters are temperature, dissolved oxygen, and pH. Each of these is measured by over two-thirds of the groups surveyed. These three parameters are relatively easy to measure and are also important indicators of the ability of any surface water to support aquatic life. Other widely monitored parameters are stream macroinvertebrates, nutrients (phosphorus and nitrogen), water flow, and turbidity.

The parameters a group monitors depend to some extent on the type of water body being studied. In many lakes, a major concern is excessive growth of algae and aquatic plants, caused by nutrient overenrichment. Thus the Secchi disk — a quick, simple, low-cost way to measure water clarity — is extremely popular among lake monitors. Many lake programs also monitor chlorophyll (a measure of algal growth) and nutrients.

For river and stream monitoring, bottom-dwelling macroinvertebrates (primarily aquatic insect larvae) are an ideal parameter because they integrate impacts over time. Even after pollutants themselves have been flushed downstream, their effects can still be seen in the invertebrate community.

Wetlands consist of both land and water, making them biologically rich and complex. Thus wetland programs often monitor living things — aquatic and terrestrial vegetation, birds, amphibians, and exotic invasive species.

Estuary monitoring programs tend to monitor similar parameters as lake programs, with the addition of salinity.

Other Activities

Most volunteer monitoring programs do more than just monitor. They participate in a variety of stewardship activities, the most popular being debris cleanups, restoration projects, storm drain stenciling, and community outreach.

Number of Volunteers

A conservative estimate of volunteer monitors nationwide is over a half million. Most are involved in small, local efforts; over half the programs surveyed work with 50 or fewer volunteers. At the other end of the scale are several very large statewide programs such as Kentucky Water Watch, which reported 33,147 total volunteers. School-based monitoring is tremendously popular, with over half the nation's volunteer monitoring programs working with teachers or students.

Survey Data on the Web

The Volunteer Monitoring Directory is available on the Environmental Protection Agency's volunteer monitoring Web site at http://yosemite.epa.gov/water/volmon.nsf. The online *Directory* includes updated information since the 1998 print version was published.

Photo: Wayne Baker

This article was adapted from the Introduction to the fifth edition of the National Directory of Volunteer Environmental Monitoring Programs. Eleanor Ely is the editor of The Volunteer Monitor newsletter and co-author of the Directory.

Copies of the National Directory of Volunteer Environmental Monitoring Programs, fifth edition, may be obtained at no charge from NSCEP. Call 800/490-9198 and order publication number EPA 841-B-98-009.

Case Study: Missouri Stream Team

by
Tim Rielly

The Missouri Stream Team Program began in 1989 as a volunteer-based stream cleanup program. Established on the principle that citizen involvement was essential to resolving the State's water quality issues, the initial activity of Stream Team #1 was a massive litter pick-up on Roubidoux Creek, a trout stream in Pulaski County. They enlisted the help of local citizens from Waynesville, MO and the surrounding rural areas, local government and U.S Army personnel from Ft. Leonard Wood, a nearby base.

In 1992, volunteers indicated in a survey that they would like to do more than just pick up trash; they wanted to monitor the water quality of their adopted stream. As a result, the Volunteer Water Quality Monitoring Program was born. Monitoring workshops started in 1993 to provide education on water quality issues and teach volunteers how to monitor stream water quality. From the beginning, sponsors were amazed at the number of people that signed up for workshops. Word of the programs quickly spread and classes soon were full and had waiting lists.


Photo: Wayne Baker

Though Stream Team and the Volunteer Monitoring Program are two distinct programs, they are closely linked. The Volunteer Water Quality Monitoring volunteers are taught how to assess their watershed, monitor water chemistry, collect and identify macroinvertebrates and measure stream flow. Initially, one level of training was offered to volunteers to cover all of these parameters. Over time, it has evolved to the current offering of four levels of training, including watershed mapping and macroinvertebrate monitoring, monitoring and meaning of water chemistry, and quality assurance efforts. Other topics covered in the workshops include law and advocacy, safety and trespass, and site selection.

The data collected by volunteers is used to inform and educate people on the condition of Missouri's streams. It is also used by the Department of Natural Resources for baseline data, trend information, to locate emerging problems and supplement agency data. Volunteer data is used for the semiannual 305(b) report to EPA on the state of Missouri's waters and to supplement agency data for NPDES permits. Local and county governments continually request data from the program to aid in local decision making.

Photo: Bill Brinson

Today the Stream Team Program has 1422 teams operating throughout the state of Missouri, while the Volunteer Water Quality Monitoring Program has trained 2047 volunteers in introductory workshops. Both programs continue to grow at a brisk pace. Former program coordinator Sharon Clifford, said "The Program has been so successful that staff has grown from two to nine and they still must run as fast as they can to meet with the demand of the public for information and training on stream issues and water quality."

Tim Rielly is the Volunteer Water Quality Monitoring Coordinator for the Missouri Department of Natural Resources.

For more information:

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web site: www.mostreamteam.org

GREEN: Helping Youth Get their Feet Wet

What is the best way to ensure the health of our rivers in the future? The answer is simple: excite young people about water monitoring now. The Global Rivers Environmental Education Network (GREEN) does just that.

"GREEN is all about youth getting their feet wet. By getting into a river, they learn science. They take that science to change public policy. These are real world lessons that bring education to life."

— William Stapp
founder of GREEN

GREEN is a network of teachers and young people committed to understanding, improving and sustaining watersheds. Just take the students at McCarthy Middle School, outside of Boston, for example.

Fifty-four students at the McCarthy Middle School in Chelmsford, Massachusetts (30 miles northwest of Boston), surveyed town residents and identified the declining water quality of Black Brook as the community's most pressing environmental issue. The brook — which flows along the southern boundary of the school property — is a major tributary for the Merrimac River, affects the town's drinking water supply and was once an important local recreational waterway for swimming and fishing. Using a GREEN water monitoring kit, the students discovered the dissolved oxygen in the water measured well below the level that the government considers acceptable. The students brought in experts who discovered that the brook's flow was being cut off upstream due to filling activity by homeowners and a partially collapsed underground culvert.

Photo: Adèle Ho

While GREEN has been working with youth for 15 years, during the Fall of 1999 it became a program of Earth Force, based in Alexandria, Virginia. The union was a natural fit since Earth Force has been helping youth across the nation discover and implement lasting environmental solutions in their communities since 1994.

GREEN offers a variety of resources including manuals, action guides and water testing kits, all designed to help young people identify water quality problems in their watershed and take action on those problems. GREEN materials are currently being used by over 2,000 educators nationwide, and in all 50 states.

A key resource of GREEN is *The Field Manual for Water Quality Monitoring* by William Stapp and Mark Mitchell. The manual is considered the industry standard for educators in guiding youth through the step-by-step process of water quality monitoring. GREEN has also launched an on-line Hands-On Center (www.earthforce.org/green) to provide more information and activities. The Hands-On Center also helps participants take the critical step of taking action based on their findings.

Photo credit: Earth Force

Find out more about GREEN at www.earthforce.org/green. The web page provides the latest information on GREEN action guides, water monitoring kits and other informational resources. Earth Force is particularly interested in hearing from educators and watershed facilitators engaging young people in the protection of vital water resources. Please send your stories or contact information to: green@earthforce.org.

Moving From Data to Information

You're staring at a bunch of numbers. A lot of them. Maybe you've collected them, or someone else has. How do you turn that data into information? Does it tell a story?

by Geoff Dates

First, you need to know *why* you (or someone else) collected these data. What question was being asked; what was the purpose for the data gathering? Then, you've got to review *how* the data were collected. Was there any quality control? Who were the intended users? *(See "Getting Started" on pg. 16.)*

Data Rich and Information Poor...

Let's take an example. I'm looking at 9 pages of data. Each page is a list of aquatic insect families with numbers next to some. Here's a very small excerpt . . .

Families in Major Groups	D	D	D	Mean D
Ephemeroptera				
Baetidae	4	13	3	6.66
Baetiscidae	0	0	0	0
Caenidae	0	0	0	0
Ephemerellidae	15	25	9	16.33

…only the list goes on and on for both sides of the pages. Literally hundreds of numbers. What do they all mean?

Figuring out the story behind the data is a process of: 1) reviewing the study design, 2) managing and summarizing the data, 3) analyzing the data, 4) telling the story. I'll use this example to illustrate the process.

1) Review the study design ...

Go back to the study design and find out the essentials behind these data. In this example, we find that these biological data were collected to assess the effectiveness of best management practices on a New England dairy farm. The question was: *what is the impact on the benthic macroinvertebrate community in the brook before and after best management practices are installed?*

The study design tells us a number of things:

a) what kind of indicators were monitored (we'll focus on critters for this example),

b) methods used (River Watch's adaptation of EPA methods),

c) sites monitored (one above and two below the farm),

d) when and how frequently monitoring was done (once per year in the fall), and

e) quality control (replicate sampling with verification of identifications and archiving all samples).

From the study design, we understand that the data in the table to the left are the number of critters (density) in each family (in the "D" columns) that were identified in each of 3 samples (one "D" column for each sample) per site each year. These numbers are averaged to come up with the "mean D" (average density) for each family. At least we now know what we're looking at.

2) Manage and summarize the data…

Data management includes two steps:

1) Entry: Data should be entered into a computer data management application, either a spreadsheet or a database.
2) Validation: The entered data must be checked against the field and lab sheets to assure that they have been entered correctly and that the values are reasonable.

Next we've got to reduce the data set to a summary so we can see patterns and trends. Statistics and metrics are frequently used to summarize large data sets. Commonly-used *summary statistics* include averages (arithmetic means), geometric means, medians, ranges, and quartiles. For biological data, summaries called *metrics* are frequently used. These are different ways of looking at complex community data that describe various attributes, like abundance, diversity, composition, pollution tolerance and feeding ecology. Let's look at how the data looks when summarized using metrics:

Though it may still look a bit complicated, it's a lot easier to look at than nine double-sided pages of numbers. A little explanation: Site 3 is upstream of the farm — the reference site. Sites 2 and 1 are downstream, with site 1 being the furthest downstream. Best management practices were installed in 1993. You might begin to see patterns, which I'll discuss below.

Tables and graphs are commonly used tools to help you look at part or all of large data sets. You could develop a series of graphs to summarize the results and help you better see patterns. (see p. 35 for more about using graphs.)

3) Analyze the data …

Now that you've reduced your data to a few manageable summaries, look at it systematically. Follow the four steps to data analysis:

a) assemble needed information, including that which you didn't personally collect, like maps, and other data sets,

	Site 3			Site 2			Site 1		
Summary Metrics	**1992**	**1993**	**1994**	**1992**	**1993**	**1994**	**1992**	**1993**	**1994**
Organism Density/Sample unit	144	250	248	-	136	352	589	292	224
EPT Richness	14	16	14	-	7	13	17	15	18
Total Taxa Richness	24	23	24	-	18	23	29	22	27
Biotic Index	4.7	3.2	3.3	-	4.5	3.7	6.8	3.9	3.1
% Contribution of Dominant Family	25%	23%	29%	-	28%	21%	44%	25%	16%
% Composition of Shredders	2%	5%	7%	-	0%	4%	2%	10%	15%
Ratio of Scrapers/Filtering Collectors	1.07	1.50	0.34	-	0.08	0.45	1.61	1.00	1.11
% Composition of Selected Major Grps									
Mayflies	14%	42%	18%	-	13%	34%	7%	32%	41%
Stoneflies	6%	13%	18%	-	15%	8%	2%	8%	13%
Caddisflies	19%	17%	46%	-	25%	33%	5%	20%	32%
Midges	0%	4%	0%	-	7%	15	23%	0%	0%
Beetles	31%	15%	10%	-	2%	1%	1%	1%	2%
Worms	19%	5%	0%	-	28%	7%	44%	22%	5%
Other	11%	4%	7%	-	11%	18%	18%	17%	8%

b) develop findings (observations about the data),

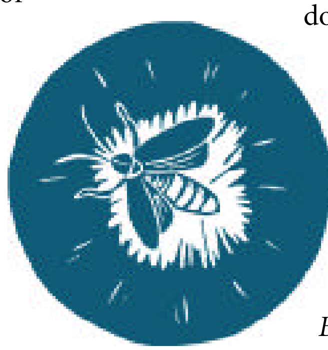
c) develop conclusions (explanations of why the data look the way they do), and

d) develop recommendations (for further study or action).

Each of these steps moves from fact to opinion. Using our example, let's see what we can make of the above data summaries.

First, we would assemble maps of the watershed and any other existing or historical data or information we (or others) have collected.

Next, we would come up with some observations about the data (findings). Look at the Summary Metrics chart on page 27 again, particularly at the mayflies at site 1. They increase steadily over the 3-year period from 7% of the sample to 41%! We don't yet know why, or even if it means anything, but the % composition of mayflies certainly changed. So did the stoneflies and caddisflies. In fact, looking at the percent of all three groups combined, they went from making up 14% of the sample in 1992, to 86% of the sample in 1994. These happen to be aquatic insects that, as groups, are sensitive to pollution. That's a trend in the right direction.



Speaking of pollution tolerance, look at the biotic index. This is a measure of the pollution tolerance of the critters found, from 0 (highly intolerant) to 10 (highly tolerant). Now look at site 2 in 1992. Whoops, no data! Too bad, because all the metrics change between 1993 and 1994 and it would be nice to know if the trend began between 1992 and 1993. Oh well … gaps in data are common. The biotic index at all sites decreased, suggesting that pollution-sensitive critters made up more of the samples over time. Data analysis is really a matter of asking a set of common-sense questions. A few are suggested by the example:

- Do results change from year to year at the same site?
- Do results change upstream to downstream?
- Do results meet your reference conditions, either an actual site or water quality standards?

Now you can turn the answers to these questions into *findings.* For example:

Between 1992 and 1994, mayflies increased from 7% of the sample to 41%.

Next, *conclusions* explain your findings. They essentially answer your study question. For example:

The installation of best management practices improved the benthic macroinvertebrate community over the 3-year period.

In looking at the chart, notice that the community composition also improved upstream of the farm between 1992 and 1993, so you would need to explain that too.

Finally, what do you *recommend*? In this example, you might recommend periodic monitoring to confirm the apparent improvement. Or, if improvement hadn't been found, you might recommend different best management practices.

Review and analyze the data "in-house" to develop preliminary findings, conclusions, and recommendations. Then, be sure to review the data and your interpretation of it with an advisory group or technical committee. This group should involve local, regional, and state resource people who are familiar with monitoring and with your waterbody. They can verify, add to, or correct your interpretation of the results. Review the data and your interpretation of it with the people who will use your data — for example, the public, waterbody users, and government officials.

4) Tell the story...

Once you've figured out the story behind your data, you will need to develop a presentation plan and then package the data in different ways.

The Plan. First, focus your message. In our example, we might boil it all down to a simple message: *BMP's = a healthy aquatic community.* Then agree on the target audiences. The audiences for your data are your intended users. Remember them? You identified them back in study design Step 2 ("Why Are You Monitoring?"). They can range from the general public to resource managers and regulators in federal and state agencies. Identify the major presentation opportunities where you can deliver the message to your target audiences.

Package the Data. You may have used dozens of tables and graphs to come up with your story. Now you need to decide which one(s) to use to tell it. Ask yourself this question: what's the one image that best tells the story? There are many ways to report your results: through video, written reports, maps, the Internet, oral and slide presentations, and others. Tailor your reports to your audience. We recommend that you at least produce a written report that summarizes your work and the results for your most rigorous audience. Remember that the style, length, and content of your report should be geared to the audience you are addressing. This is the basic foundation for all your other presentations. When you've completed your most comprehensive written report, you can prepare different types of presentations for different audiences.

Data doesn't do anyone any good if it stays on paper in your desk. If you turn it into information and then get that information into the right hands, you can make things happen!

Suggested Generic Written Report Format

I. INTRODUCTION
Provide brief description of the area and your program (including maps).

II. PROJECT DESCRIPTION
Briefly summarize your study design.

III. RESULTS

A. How were the data analyzed?
B. Findings
C. Conclusions
D. Recommendations

ACKNOWLEDGMENTS
Recognition for those who made your program possible.

REFERENCES
Describe information sources used to prepare your report.

APPENDICES
Summarized data and any other information that you wish to include, but would detract from your narrative report.

Locating Existing Information

If I don't monitor, where can I find information on my river's health? There are many existing sources of information on your watershed. The Clean Water Act requires your state water quality agency to collect some basic information and report to EPA and Congress every two years. That information is legally available to the public, and can be used to answer numerous questions:

What are the problems in my watershed?

• Status report on the waters in your state [305(b) report]

Every two years your state water quality agency is required to submit a report to the EPA summarizing the health of all waterbodies in the state. This report also includes a list of waters whose quality does not support the human and aquatic life uses the state has designed for them.

• List of impaired waters in your state [303(d) list]

The Clean Water Act also required state water quality agencies to compile a list of the waters that do not meet standards — in other words, the waters that are not healthy enough to support the uses designated for that river such as recreation, cold water fishery or drinking water supply. This list, required every two years, has been the focus of much attention over the last few years. Activists around the country organized to make sure that a 303(d) was developed for every state and territory for the 1998 submittal. The due date (normally April 1, even years) has been postponed because of new rules that are being developed regarding the list's components and timing. The list can be used to identify problems that have been documented and will be addressed at some point in the near future.

by
Gayle Killam

What's causing the problems?

• List of dischargers to state waters

Every state water quality agency issues permits under the National Pollution Discharge Elimination System (NPDES) and should have a list of the entities discharging to state waters and the permits that allow them to do so. In many states, it is becoming easier to request this type of information because agencies are posting it to their website.

• Discharge permits

The NPDES discharge permits themselves explain what the discharger is allowed to release into the river. It can be compared with the problems for the river listed in the 305(b) reports or the 303(d) list.

Industry permits will explain what performance the discharger should achieve with its treatment technology. Reviewing neighboring and cumulative permitted discharges can provide a more thorough picture of the health of your river than the agency may represent.

Municipal permits explain what cities need to treat in their wastewater. These permits also describe which industries release into the municipal system instead of directly into the river. These passthroughs can be toxic in significant amounts and usually are untreated by the municipal treatment process. You can identify additional problem chemicals to examine in your river by finding out what chemicals are coming from industries which release into municipal systems.

• Wetland permits (Section 404 of the Clean Water Act)

Permits required for the discharge of dredged or fill material are issued by the Corps of Engineers (404 permits).

In most cases, these permits apply to physical alteration of any aquatic site, including wetlands. By obtaining the list of these permits (or the permits themselves) in your watershed, you can identify and locate the activities that may be destroying habitat or contributing damaging soil to the river. Be sure to ask for both the individual and general permits. Most 404 permits are issued as general permits — called Nationwide Permits — under broad categories of activity.

How do we find out information on unregulated pollution sources like agricultural activities?

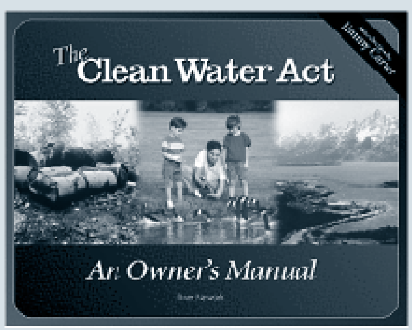
• Soil and Water Conservation Districts

Soil and Water Conservation Districts work most closely with the agricultural community to improve practices and address problems. By getting in touch with the SWCD working in your watershed, you can find out about known problems and ongoing or completed studies on agricultural pollution.

• Watershed Restoration Plans/ Total Maximum Daily Loads (TMDLs)

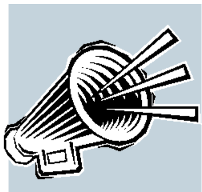
These plans are required in watersheds where impairment has been documented. They are intended to determine the maximum pollution allowed into the waterway and to divvy up the allocation among the identified sources. If there are TMDLs in progress or completed in your basin, they can be additional sources of information.

Gayle Killam is the Coordinator of River Network's Clean Water Organizing Project.



The Clean Water Act: An Owner's Manual has been praised as "a concise and understandable roadmap" to the Clean Water Act. This down-to-earth, information-packed book explains crucial sections of the Act, turning legalese and scientific terminology into language you can use. Filled with references, web sites and other resources, this manual costs $25 and is available from River Network.

Using Information to Generate Action



Once you've gathered the data and written the report, you may be able to use it to enforce a clean-up of your river for drinking water or endangered species, identify high quality waters for protecting, challenge development threatening the river, or to improve the monitoring for dangerous chemicals.

What audience would be the most receptive to the information you have? Whose behavior are you trying to change?

STATE AND LOCAL AGENCIES

It is important to understand that your state agencies cannot know everything about every waterbody, nor can they monitor each one sufficiently to be aware of the day-to-day changes that you may see.

What to do?

Call the agencies. Talk to the staff working on your watershed. Share with them any information you have. Ask them what else they know about the quality of the water. Ask them whether your river is listed on the impaired and threatened waters [303(d)] list. Ask them whether watershed restoration plans (TMDLs) or source water assessments (required by the Safe Drinking Water Act) are being done on your river. Both of those processes should involve citizen input but often do not. Ask to be put on mailing lists for discharge permits, wetland dredge and fill permits or TMDL committees.

by
Gayle Killam

INDUSTRIES AND MUNICIPALITIES

Industries and municipalities may be very receptive to citizens' concerns about what is being discharged into the river. By raising concerns to a company, you may be able to encourage improvement in their processes that is not mandated by their permit or other laws. You also may be able to alert them to some problems in the river that they may be contributing to unknowingly.

What to do?

Call the companies that do business in your community. If they release pollution into the river, talk with them about the quality of the water above and below their discharge. Ask them about their discharge monitoring reports. Dischargers are required to keep records of what comes out of their pipes. These reports are submitted monthly and are public records. They can be obtained from the state agency.

If the industry does not release pollution directly into the river, ask them what efforts they are making to reduce the use of toxic chemicals or the runoff from their building's roof and parking lots, which can contaminate groundwater.

DEVELOPERS, BUSINESS PROPERTY OWNERS AND NEW HOMEOWNERS

While there is increasing education of contractors through the permit process in some parts of the country, many developers and contractors will only comply with the bare minimum as required by law — sediment fences and obstructions near stormdrains to impede the sediment flow from the land. Without sufficient resources to educate developers and contractors and to inspect construction sites, areas with rapid development are experiencing significant erosion and sedimentation into their rivers. When owners take possession of their new homes, they are seldom aware of the problems that can be caused by runoff from their bare land. A connection needs to be made from developer to contractor to homeowner.

What to do?

Contact the developer and ask if they are using controls for erosion and sedimentation. Call the state or local water quality agency and explain what you have seen; ask them to visit the site and to talk with the general contractor about these problems. The state or local agency may also have additional data on the river.

ELECTED OFFICIALS

Elected officials seldom are fully aware of the condition of the waters that run through or are part of their community/district. If you are not getting any response from the relevant agencies or those responsible for the sources of pollution, drawing the attention of elected officials can be the way to get changes to begin.

What to do?

Document the problem. Bring your written report to the elected officials. Attach evidence of concern from their constituents, such as a petition or letters. Make the case for protecting property values and the value of a clean river in their jurisdiction. Ask for their help in dealing with the situation.

Is there someone in the agency who is influential in the organization responsible for the pollution problems that (s)he can call? Would (s)he be willing to make a public appearance on behalf of the health of the river and the economic interests that depend on it? Would (s)he be willing to let you use her/his name on a letter or petition to the agency or responsible organization?

YOUR NEIGHBORS/COMMUNITY

It will always be helpful to involve more members of your community to address a problem in your river. Taking the time to discuss your concerns with your neighbors will be well worth the effort because more people can increase attention, accomplish more monitoring, and contact more influential people. There will always be greater power in numbers.

What to do?
Go door-to-door with information or a petition, hold a community meeting or use the local newspaper to communicate your concerns about the river and solicit assistance.

MEDIA

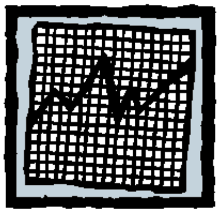
You can inform more citizens, garner support and gain visibility and influence by using different forms of media coverage to make change happen. As mentioned above, community or small town newspapers are often a great way to get the information you have about your river out locally and to encourage more people to help improve the health of your river. Work with reporters, editorial boards or write letters to the editor at local or more widely circulated newspapers. Radio stations are often looking for community interest stories, and television news stations may be willing to pick up your story if you have documented your concerns and can make a case for the newsworthiness of the problems. Try talking with weather forecasters who can educate the public about pollution problems associated with runoff. They can also take advantage of very sophisticated mapping technologies.

What to do?
Call up the newspapers, radio stations and television stations. Pitch your information and concerns to a specific individual if you know of a good reporter or contact. Otherwise try to establish a relationship with someone in the organization who will be willing to listen to your story. It may take some time to get a story covered, but it is time well spent if it ends up on the front page or on the 6:00 p.m. news.

It's time to act. As concerned citizens, we need to augment the regulatory system that will never be able to monitor and inspect every river in the country. Once we gather information, we can use it to create change in our watersheds. Citizens, business leaders and regulators all care about our watersheds — let's share the information we have to encourage them to do what's best.

Using Graphs to Tell Your Story

by
Meg Kerr



Somewhere in that pile of computer printouts covered with columns of numbers, a story is buried. Your challenge is to transform those numbers into a message that inspires people to action.

Graphs are one of the most valuable tools for telling your story, particularly if you're trying to convey trends and relationships. Because graphs present data in a "coded" format, a graph can compress reams of information into a simple visual image. But there's a danger here — if people can't decipher the code easily and correctly, they won't get your message.

What makes a good graph? The same qualities that make a good story. It should be easy to follow. It shouldn't be cluttered up with extraneous information. Most important, it should have a point. Don't get carried away with all the fancy options in your computer's graphing program. The best graphs are simple in design and have a limited number of elements.

It's worth taking some time to make graphs pretty. Graphing software defaults may be all right when you're making quick preliminary graphs for your own use, but for a poster or presentation strive for something a little more artistic.

As a monitoring group, you also want people to believe that your story is true. A sloppy or confusing graph will make people wonder if you know what you're talking about. And a misleading one — for example, one that unrealistically exaggerates small differences — makes you look untrustworthy.

If you're just starting out, remember that learning how to use graphing software programs for the first time can be very time-consuming. Also, not every software program is capable of producing the finished graph you want.

What Type of Graph?

Line graphs, bar graphs, and pie charts are the three main types of graphs a monitoring group will use.

Line graphs are good for emphasizing the *relationships* between data points — for example, changes in conditions over time or space — and can often illuminate trends in data. They usually display time or space along the x-axis (horizontal) and water quality parameters along the y-axis (vertical).

Bar graphs put more emphasis on the individual points. They are useful for comparing the level of a pollutant at one station over time or at several stations at one time, and for displaying summarized data.

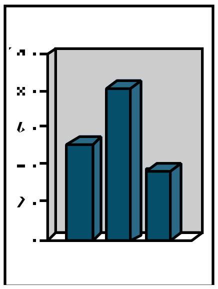
Pie charts use a segmented circle or "sliced pie" to display the relative abundance of various components of the whole. They're easy for the general public to understand, but can only be used for data that can be expressed in terms of proportions, or percentages, of a whole. Some types of data that work well in pie charts are land use (acres of forest, wetland, etc. in a watershed), populations (numbers of trout, carp, etc. at a station), and pollutant loadings (see #4).

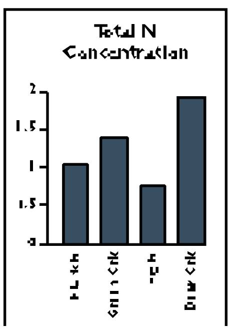
Stacked bar graphs provide another way to show data as proportions of a whole. They're

Using Graphs to Tell Your Story , cont.

especially useful when you want to show comparisons between several similar "stacks" (see #3).

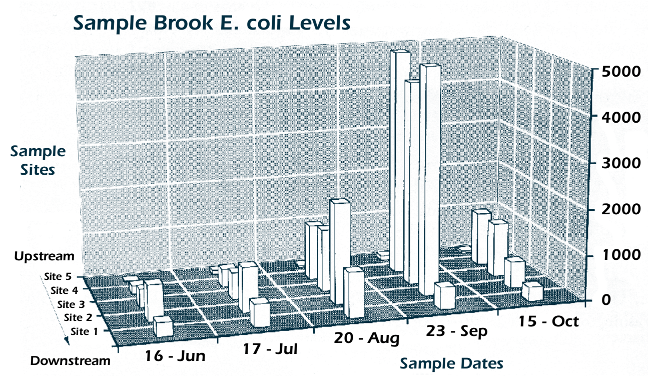
The following examples show some of the different types of graphs, and illustrate some important graph-making do's and don'ts.





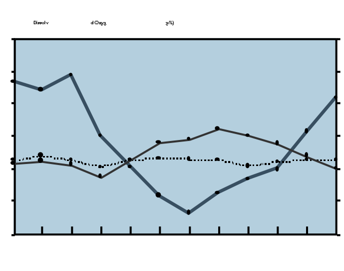
1. When to use 3-D

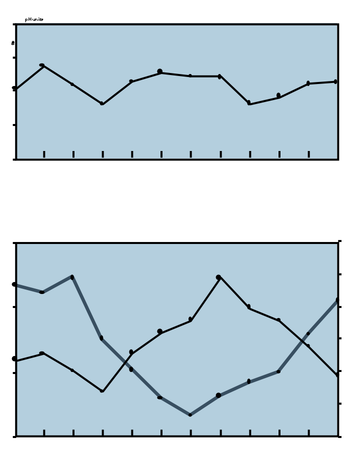
The two charts at left show the same data. Although the 3-D version is more eye-catching and might be preferable for a poster or slide show, the flat version is better if you want people to actually read the percentages off the graph. It's hard to line up the tops of the 3-D bars with the scale on the y-axis. *Moral:* Don't automatically make every bar graph 3-D just because it's easy and looks fancy.



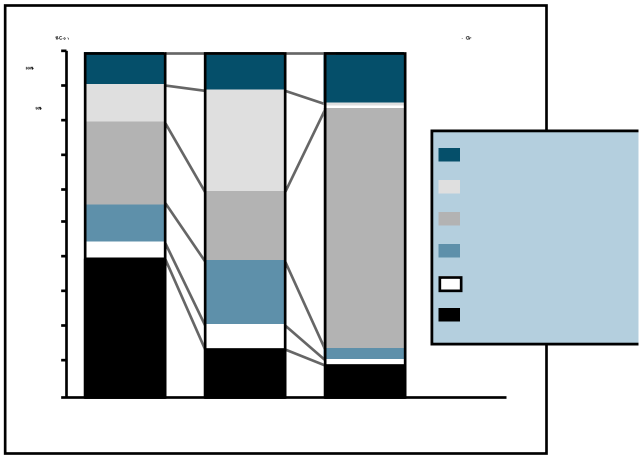
The chart at right, on the other hand, shows a situation in which 3-D is genuinely useful in helping you visualize the data set as a whole. This one graph shows an entire season of fecal coliform data. Several separate 2-dimensional graphs would be required to display the same information. Although you have to study this graph for a few minutes to really "get it," your efforts will be rewarded because the graph clearly conveys an important message — namely, that the farm has a clear and consistent impact on bacterial levels. (You can see other patterns too — for instance, counts are highest in September. To help interpret this pattern you would need more information, such as weather and flow data.)

2. Use the appropriate scale





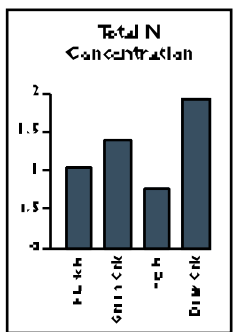
It's tempting, and sometimes useful, to plot more than one parameter on the same graph for easy comparison — but be sure the scale on the y-axis makes sense for all the parameters. The graph at the near right (based on an actual graph from a volunteer monitoring group) has some problems. Look at the line for pH — what does it tell you? Not much. Changes in pH have been obscured by plotting pH on a scale that runs from -5 to 25. The line for DO is also somewhat flattened. The solution (far right) is to use two graphs stacked one on top of the other. Now each parameter has a scale that makes sense.

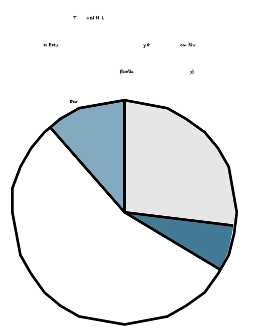


3. Stacked bar graphs

A stacked bar graph can be used to compare percent compositions at several sites — in this case, macroinvertebrate counts at a reference or control site, a site upstream from a pollution source, and a site downstream from the source. A series of pie charts would not have done the job quite as well, because it's harder for viewers to directly compare areas of pie slices than heights of stacked bars.

This graph requires some sophistication to interpret. The viewer needs to know, or be told in a caption, that most mayflies, stoneflies, and caddisflies are pollution sensitive, most beetles are moderately sensitive, and most worms and midges are pollution tolerant. With this information, the story becomes clear. Because the downstream site contains relatively more pollution-tolerant organisms and relatively fewer pollution-sensitive organisms, we can conclude that the pollution source is having an impact on the stream.





4. Concentrations versus loadings

The bar graph at right shows average annual total nitrogen concentrations at the mouths of the four rivers that empty into an estuary, and the pie chart shows the average daily load of nitrogen contributed to the bay by each river. Loading is calculated by multiplying instream total nitrogen by stream flow. Concentrations can't be shown in a pie chart (because they are not additive), but loadings can. A table showing the loading calculations helps readers interpret the graphs.

Each of these graphs tells a different piece of the story. The bar chart tells you about conditions in the rivers themselves, while the pie chart tells you which rivers have the greatest impact on the estuary. Taken together, they make an interesting point: Big River is contributing the most nitrogen to the estuary even though it has the lowest nitrogen concentration. So if you're interested in lowering nitrogen concentration in the estuary, you'd probably want to target your efforts at Big River. But if you're more concerned about levels in the rivers themselves, you would target Bear Creek.

Meg Kerr is Program Coordinator, University of Rhode Island Coastal Resources Center, which brings community interests together with government and business to create more sustainable communities. This article is reprinted with permission from the Spring '95 issue of the Volunteer Monitor. Meg can be reached at 401/874-6522 • E-mail: mkerr@gsosunl.gso.uri.edu

Rivers of Colorado Water Watch Network

Rivers of Colorado Water Watch Network, nick-named River Watch, was founded in 1990 by the Colorado Division of Wildlife. The River Watch program has two goals. The first is to collect reliable, consistent, water quality data of such quality that anyone who wished could make better decisions regarding the use of that river resource. (This includes regulators, educators, managers, federal, state and local governments, consultants, private land owners, stakeholder groups and industry.) The second goal is to provide educational opportunities for teachers, students, and citizens to understand the value and function of their river ecosystem.

The agency considers this an on-going, long-term program; participants keep equipment valued at $8,000 as long as they continue to monitor. The agency, in return, provides support, supplies and an avenue for their data to be put to use. The program is funded through the national US Fish and Wildlife Restoration Act with dollars available to Game and Fish agencies; teacher, student and citizen volunteer time is counted towards the necessary funding match. To date, 260 schools or groups monitor over 120 rivers at 565 stations around the state.

Since water resource managers will never have the resources to "get all the data," water quality decisions were being made with little or no data. Data from the River Watch program have begun to fill this gap.

by
Barb Horn

Through their connection to the Colorado Division of Wildlife, River Watch staff knew the necessary level of data collection, which parameters were important, the best frequency for collection and the other components of a sampling, and the importance of quality assurance and control plans. Plans were created according to where the data was going to go, who would be using it, and the needs of those users.

Initially, many water quality professionals viewed the program as a "cute new educational opportunity," but doubted it would ever produce usable data. To assist in gaining acceptance of the data, students and volunteers made presentations to the Colorado Water Quality Control Commission. They also provide an annual update on progress and Quality Assurance and Quality Control (QA/QC), and report data and QA/QC information annually. The program's attitude is, "We disclose all, invite all and share the experience and thank everyone. We pro-actively involve the decision makers."

Colorado is truly a headwater state, with all rivers flowing out of the state and no rivers flowing in. With seven major river basins and more than 4,000 miles of rivers, water that leaves Colorado indirectly or directly impacts 31 other states.

One Commissioner told the group of how she came to accept their data. She looked out her office window one day to see a River Watch School sampling below her office. She watched, liked what she saw, and changed her opinion.

Photo: Colorado Water Watch

Members from the program have educated decision-makers on the complexity of collecting good data, on the "red tape" perceived by citizens trying to get involved. In return, the Commission has educated the participants on the complexity of decision making and the need to factor socioeconomic, technology, feasibility, and livelihood issues into decisions. In Colorado numeric standards in each watershed are reviewed every three years. This "use" of volunteer-collected data in water quality stream standard hearings has become a "baseline" use.

Photo: Colorado Water Watch

Citizens who have proposed changes in stream standards have since partnered with cities, conservancy districts, watershed protection groups, waste water treatment facilities and the like to find common solutions to local problems.

Other important partnerships have formed. About 25 schools have formed partnerships with local governments to enhance, preserve, restore, and/or reclaim the river and riparian zones in their communities. More than a dozen schools have initiated watershed stakeholder groups to focus on protection of headwaters.

Data from Silverton High School, located at 10,000 feet, held up against samples collected by the state health department, US Geological Survey, Bureau of Reclamation, and a mining company. The data were used to determine clean-up targets for a local mine because the school collected data in winter when no other entity did. Students who lived on the Front Range documented low dissolved oxygen levels and later discovered that a train full of barley had crashed, dumping the organic matter into the stream and causing a small fish kill due to the drop in dissolved oxygen. In addition, parks, basin planning agencies, state and federal agencies use the data for their planning.

Program coordinators have learned to recommend patience and planning. They take the time to build partnerships and communicate with all stakeholders, from data collectors, managers and users. They find the time investment worth it — these partnerships can last forever.

Colorado Water Network is sponsored by the Colorado Division of Wildlife under the Department of Natural Resources, Colorado Division of Wildlife, 6060 Broadway, Denver, Colorado 80216. Website: http://198.59.8.68

Barb Horn is Water Watch Network's Project Manager.
She can be reached at 303/291-7388 • E-mail: barb.horn@state.co.us

TIPS

from Rivers of Colorado Water Watch Network

- Build partnership resources into the budget (money for phone calls, meetings, plans, travel, etc.).
- Create a long-term strategic plan and make every decision based upon that plan. Have frequent evaluation and the courage to change directions if necessary.
- Keep up with current issues and evaluate your direction in light of new issues. Take advantage of short term momentum, but always attempt to steer energy into something with sustainability.
- Make data management as important as data collection. Without good management, data is less likely to be used.
- Make data presentation a priority; have a plan on how to get data back to your users, the public, and targeted audiences.
- Share your successes, failures, methods, manuals, and the like. We need all of us out there to make a difference!

The Charles River: Testing the Waters

From May through October, Charles River Watershed Association (CRWA) tests water quality in the Charles River Basin five times weekly at four different sites. Test results indicate levels of bacteria (fecal coliform) for each site. Bacteria levels are measured by counting colony-forming units of fecal coliform per 100 milliliters (about a teacup of water) after test samples have incubated for 24 hours. The presence of fecal bacteria in water suggests contamination with sewage or feces, which in turn could mean that disease-causing bacteria or viruses are present.

Photo: CRWA

A series of flags are used to educate the public about the status of the river's waters. A blue flag is posted when the bacteria level meets the boating standard (less than 1,000/100ml) set by the Massachusetts Department of Environmental Protection.

If the bacteria level count exceeds 1,000/100ml on a sampling date, a red flag is posted to indicate a health risk; water quality near the testing site on red flag days does not meet the boating standard.

Most red flag days occur after heavy rainfall when storm drains and sewer system overflows flush pollutants into the river. CRWA research shows that the Basin does not meet state boating standards over 25% of the time after a heavy rain.

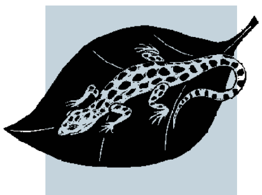
Photo: CRWA

In 1999, the second year of the program, more boaters recognized and comprehended the meaning of the color-coded flags and subsequently altered their behavior. At private and university boating clubs, 50% of the boaters who train on the river regardless of conditions at least wash after a workout on red flag days, while the public boating centers have established protocols on river use during red flag days. For example, the canoe and kayak rental center closes operations and the public sailing and windsurfing club cancels youth and windsurfing programs on red flag days.

For further information about CRWA's methodology for water testing please see www.crwa.org

Hudson Basin River Watch

by
Sharon Behar



Hudson Basin River Watch (HBRW) is a volunteer river monitoring project whose goal is to improve the water quality of the Hudson River and all its tributaries. HBRW is a vital and growing partnership of over 100 schools and dozens of environmental organizations and water resource agencies. Project objectives are to train volunteers how to identify Hudson Basin water quality problems, to monitor the physical, biological, and chemical characteristics of Hudson Basin waters, and to use the information in river restoration and protection efforts.

HBRW is a project of the Open Space Institute, Inc., and sponsored in large part by the New York State Department of Conservation Hudson River Estuary Program, and the Hudson River Foundation.

FOR MORE INFORMATION:
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E-mail: reed@netheaven.com

Beginning as a project of 6 schools in the headwaters of the Adirondack Mountains 8 years ago, HBRW now has 15,000 students involved annually and two part-time staff. This year, a record 300 students and water resource professionals attended the Clean Water Congress in Albany.

A draft basin-wide guidance document has been developed to standardize local projects throughout the basin. Study design workshops were held regionally to help implement the guidance manual. A forthcoming HBRW web site will facilitate data reporting and use. Some additional highlights:

- The NY State Department of Environmental Conservation is turning to HBRW for help in developing a statewide program
- There is a large and active AmeriCorps program, whose members have become leaders in watershed education as they build bridges between schools and local organizations.

- NYC Soil and Water Conservation Districts and schools are poised to begin a coordinated water and terrestrial (biodiversity monitoring) program as part of the HBRW.
- The network has been garnering support and participation from a broader audience including inner city schools, the corporate community, and the state.

HBRW provides:

- Trainings for teachers, volunteers and coordinators on water quality monitoring methods and program design and lending of equipment.
- On-going technical and organizational support to school and citizen groups.
- Coordination and networking of program efforts and data reporting throughout the Hudson Basin.

Sharon Behar, a Watershed Program Manager for River Network, has worked closely with Hudson Basin River Watch.

Guiding Principles

by George Constantz

Like many big areas of human endeavor, watershed science is evolving. Every year there are fresh hypotheses that need to be tested, new methods that require fine-tuning, this season's equipment we get to play with.

What might be the next major step in the science of river conservation? Some say it will be integrating groundwater, surface waters, and the atmosphere into a 3-dimensional dynamic model. I'm guessing it might be real-time, satellite-sensed water quality monitoring. All my colleagues have their own prediction, but nobody really has the corner on truth. I can hardly wait.

Regardless of what changes arise, some principles remain timeless. Here are some principles that I believe will continue to help us through changing times:

- Operate within a watershed mindset.
- Understand enough watershed science to be able to place your watershed, its issues, and your findings within the relevant continuum so that you can teach others and understand the limits of your data.
- Embrace inclusiveness.
- Fuel your work with passion, but steer it with data.
- Solutions need to be site-, situation-, and time-specific.
- Maintain an evolving wall-sized map of your watershed.
- Seek help freely: scientific advisors, fundraising tutors, strategic planning facilitators.
- Have confidence that your stream will recover on its own if you've removed its stressors and it can still be recolonized by its native species.
- Do not reinvent the wheel — exploit preexisting resources.
- Practice adaptive management.
- Seek opportunities for continuing education: mentors, conferences, technical publications, internet.
- Follow an evolving quality assurance/quality control plan.
- Maintain evolving checklists: running meetings, field work, lab supplies.
- Do not trespass.
- Thou shalt not speak outside the limits of thy data, i.e., do not overextend conclusions.
- Make your data available to everyone.
- Don't let a lawyer discourage you from thinking in terms of perpetuity.
- It's not either jobs or the environment — it's both.
- It's not rocket science — it's harder.
- If you know that you will make a difference, you will.

Dr. George Constantz, the watershed resource specialist at the Canaan Valley Institute in Davis, West Virginia, helps grassroots groups build scientific and organizational capacities.

References and Resources

A Partial List

RIVER NETWORK PUBLICATIONS

Testing the Waters: Chemical and Physical Vital Signs of a River. This manual covers nine water quality indicators, information you need to design your study and deal with the data once you've carried it out, and how to use the information to take action. 211 pages. $25 plus shipping and handling.

Program Organizing Guide. This manual leads you through an 11-step process to help organize effective and sustainable programs. It can be used to initiate a new program or to assess the progress of an existing one. 24 pages. $10 plus shipping and handling.

Study Design Workbook. This workbook systematically guides you through the decision-making process of determining the purposes of your monitoring program; selecting appropriate water quality indicators, methods and sites; deciding who to involve; setting a schedule; and setting up a quality assurance program. 39 pages. $10 plus shipping and handling.

Coming Soon!

Living Waters: Using Benthic Macroinvertebrates and Habitat to Assess Your River's Health. This comprehensive resource provides background information about macroinvertebrates and the role they play in the river ecosystem, four options for monitoring them, detailed procedures for each option and how to interpret and present your results. 200 pages. (to be published in Spring, 2001.)

To order a River Network publication, contact:

River Network Publications
520 SW 6th Avenue, #1130
Portland, OR 97204
503/241-3506

OTHER PUBLICATIONS

Stream Corridor Restoration: Principles, Processes, and Practices, by the Federal Interagency Stream Restoration Working Group, 1998. This book is the result of a cooperative effort among fifteen Federal agencies and partners to produce a common reference on stream corridor restoration. It is entirely available on the web at http://www.usda.gov/stream_restoration. Printed version: $71 plus shipping and handling; CD-ROM: $60 plus shipping and handling. Call 800/553-6847.

National Directory of Volunteer Environmental Monitoring Programs, fifth edition. Copies may be obtained at no charge from NSCEP. Call 800/490-9198 and order publication number EPA 841-B-98-009.

Restoring Life In Running Waters, by James Karr and Ellen Chu, 1999. Describes the declining state of our aquatic resources, how biological monitoring provides a truer sense of what's going on in water column chemistry, and the authors' views on how biological monitoring should be done. Published by Island Press. www.islandpress.com.

Rapid Bioassessment Protocols for Use In Streams and Wadeable Rivers, by Michael Barbour and others, 1999. This manual provides "rapid" methods for assessing periphyton, benthic macroinvertebrates, and fish. The document is available from EPA (# EPA 841-B-99-002). http://www.epa.gov/owow/monitoring/rbp/.

Streamkeeper's Field Guide: Tom Murdoch and Martha Cheo. 1996. This accessible and easy-to-read guide uses cartoons and copious illustrations to cover basic watershed ecology. It's available from the Adopt-A-Stream Foundation in Everett WA. $29.95 plus shipping and handling. To order, call 206/388-3313.

Aquatic Habitat Assessment, by Mark Bain and Natalie Stevenson, 1999. A compendium of what the authors consider the best methods to assess fisheries habitat. It covers a broad range of methods from the watershed scale down to microhabitats and contains procedures. The book is published by the American Fisheries Society and can be ordered on the Web at http://www.fisheries.org/publications/ It can be downloaded at http://www.fisheries.org/publications/bookpdf/aquaticintro.htm.

Rapid Watershed Planning Handbook, by the Center for Watershed Protection, 1998. A comprehensive guide for managing urban watersheds, not a "how-to" for gathering data, it recommends broad approaches for assessing the condition of urban watersheds. Order from the Center for Watershed Protection, 410/461-8323.

Volunteer Monitoring Methods Manuals are published by the EPA for streams (1997 - #EPA 841-B-97-003), lakes (1991 - #EPA 440-4-91-002), and estuaries (1993 - EPA 842-B-93-004). Each briefly discusses planning the monitoring effort, describes step-by-step procedures for a number of water quality indicators, and suggests ways to present the results. Available free on the Web: www.epa.gov/OWOW/monitoring/vol.html and from EPA's Office of Water. Call 202/260-7018.

The Volunteer Monitor's Guide to Quality Assurance Project Plans contains helpful information for those faced with the daunting task of writing one. The Guide (publication #EPA 841-B-97-003) is available free on the Web (http://www.epa.gov/OWOW/monitoring/vol.html) and from EPA's Office of Water. Call 202/260-7018.

Data To Information, by Geoff Dates and Jeff Schloss, 1999. A guide book written primarily for coastal volunteer monitoring groups in New Hampshire and Maine. The basic principles and process described in it are applicable to any monitoring program. The guide covers data entry and validation, summarizing your data, interpreting your data, and then telling the story. Available from the University of Maine Cooperative Extension. Call 207/832-0343.

"Ready, Set, Present!" by Jerry Schoen, Marie-Francoise Walk, Michele Tremblay, 1999. Now available from the Massachusetts Water Watch Partnership to monitoring groups who want to learn how to deliver their data to their intended audiences, or who are just looking for examples and new ideas. Cost is $5 per copy. To order, call 413/545-5531, E-mail: mfwalk@tei.umass.edu or visit www.umass.edu/tei/mwwp/datapresmanual.html, for more information.

The Volunteer Monitor. Published twice yearly, the Volunteer Monitor is a free newsletter facilitating the exchange of ideas, monitoring methods and practical advice among volunteer monitoring groups across the nation. To subscribe, contact: River Network, 520 SW 6th Avenue, #1130, Portland, OR 97204; 503/241-3506; or via E-mail at: volmon@rivernetwork.org. The newsletter is also available online at: www.epa.gov/owow/volunteer/wm_index.htm.

The Field Manual for Water Quality Monitoring - 12th edition, by William Stapp and Mark Mitchell. An industry standard for educators in guiding youth through the step-by-step process of water quality. $25.95. To order, call 703/519-6877 or visit: www.earthforce.org/green/catalog.

ONLINE RESOURCES

EPA's Volunteer Monitoring Website: www.epa.gov/OWOW/monitoring/vol.html. Includes volunteer monitoring fact sheets, directories, events, manuals and links to other sites.

The Volunteer Monitoring Directory is available on the Environmental Protection Agency's volunteer monitoring Website at http://yosemite.epa.gov/water/volmon.nsf. The online Directory includes updated information since the 1998 print version was published.

USGS Data. The US Geological Survey website posts specific discharge data, real time flow and stage data from: www.water.usgs.gov.

About River Network

River Network was founded in 1988 in the conviction that the solutions to river degradation are primarily local and must be created by citizen action, watershed by watershed. In 1999, we merged with River Watch Network of Montpelier, Vermont.

Our **Watershed Programs** include River Network's:

- **River Watch** program, which helps people monitor and assess watershed problems and their sources, determine how clean and healthy their rivers and streams are, and evaluate the effectiveness of watershed protection and restoration activities.
- **River Source Center**, which provides state-of-the art information to river and watershed advocates through publications, referrals, our web site, and a toll-free hotline for personalized assistance.
- **Organizational Development** services, helping people build healthy organizations through training and personalized assistance in board development, fundraising, strategic and program planning.
- **River Protection Tools** program, which helps people learn about available river conservation techniques, program, and laws. Our national Clean Water Organizing Project provides training on understanding and using the Clean Water Act.

The River Conservancy is our initiative to directly preserve some of America's best rivers by acquiring riverlands for long-term protection. We have acquired over 40,000 acres of key riverlands to date.

A river of information runs through us

info@rivernetwork.org
www.rivernetwork.org

- Using our toll-free number, our E-mail lists and our web page, you can connect with our river resource center and river conservationists nationwide. We track state-of-the art river protection and organizational development tools, techniques and strategies — and will send information, help you do research or network you with another group. If we don't know the answer, we'll help you find someone who does.
- *River Voices*, our popular quarterly journal, is filled with updated news and research on topics of interest to groups across the country — from small dam removals to board development.
- You'll get the password to log onto our Partner-only web site — where we will continually post updates on funding sources, upcoming events and trainings, an equipment exchange, river clipart…and other items of interest to the river community.

And we'll show you the money, too!

- Through our competitive Partner Grant program, we fund some of the core work that helps build sustainable organizations.
- Our *River Fundraising Alert* will guide you through the do's and don'ts of fundraising — complete with successful ideas being implemented by other groups just like yours.
- Our regularly updated *Directory of Funding Sources for River and Watershed Conservation Groups* saves you hours of research by compiling your best funding prospects in one handy location.

Don't wait until you're over your head— invest in your success today!

Nonprofit organizations, individuals and agencies are invited to join the Partnership. For annual dues of only $60, you will receive:

- *River Voices* ($35 value)
- *River Fundraising Alert* ($35 value)
- *Directory of Funding Sources for River and Watershed Conservation Organizations* ($35 value)
- A copy of either *Starting Up* or *How to Save a River* (up to $40 value)
- Access to our 1-800 hotline (invaluable!)
- Access to our Partner-only web page (precious!)
- The opportunity to apply for Partner Grants (up to $4000)
- And more - including invitations to national, regional and local events and workshops and discounts on other River Network publications (priceless!)

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River Network works to support you and your needs. We provide training and technical assistance to our Partner groups. River Network does not promote legislation or represent your organization in legal matters.

You will receive your initial set of Partner materials, including your choice of:
(check one)

❑ ***How to Save a River***

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River Network exists to help locally-led groups survive and grow. We provide individualized support, publications and trainings created with you — the river conservationist — in mind. When you join the growing number of River Network Partners, you immediately tap into the best thinking the watershed movement has to offer.