DELAWARE RIVERKEEPER

Monitoring the Health of the Watershed:

A Five-Year Summary of Volunteer Monitoring Data

Plus….How To Use Data at the Local Level to Protect Local Streams

Delaware Riverkeeper Network's Citizens' Volunteer Monitoring Program

March 2003

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The countless volunteer monitors who have spent many hours streamside collecting information about their local streams (See Appendix A for volunteer list)

Delaware Riverkeeper Network's Technical Advisory Committee Members (See Appendix C for member names). Extra thanks to: Dick Albert, Mark Barath, Diane Harris, Lauren Imgrund, Bob Limbeck, and Kristen Travers for reviewing and helping with this report.

Delaware Riverkeeper Network's River Mentors, volunteer trainers who provide support to DRN staff and new volunteer monitors (See Appendix C for River Mentor Network)

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Illustrations complements of the US Environmental Protection Agency and photos complements of Jim Pitcherella and Stroud Water Research Center

Additional copies of this report can be ordered by contacting DRN's Schuylkill Office at 610-469-6005 or our main office at 215-369-1188.

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What is a Riverkeeper?

A Riverkeeper is a full-time, privately funded, non-governmental ombudsperson whose special responsibility is to be the public advocate for a water body. A Keeper's clients are the river resource and the citizens who fight to protect it.

The Delaware Riverkeeper's job is to advocate for the Delaware River and all of the tributaries and habitats of the watershed. Supported by a committed staff and volunteers, Delaware Riverkeeper Maya van Rossum monitors compliance with environmental laws, responds to citizen complaints and need for support, identifies problems which affect the Delaware and responds accordingly. Serving as a living witness to the condition of the ecosystem, the Riverkeeper is an advocate for the public's right to protect and defend the environment.

About the Delaware Riverkeeper Network

Established in 1988 upon the appointment of the Delaware Riverkeeper, the Delaware Riverkeeper Network (DRN) is a nonprofit membership organization affiliated with the American Littoral Society, a thirty-seven year old coastal conservation organization based in Sandy Hook, NJ. The Delaware Riverkeeper Network's professional staff and volunteers work throughout the entire Delaware River Watershed, which includes portions of Pennsylvania, New Jersey, Delaware, and New York.

Operating on the belief that the best defense for our aquatic ecosystems lies with committed local individuals empowered with the information and tools to do the job of preserving our waterways; DRN empowers citizens to take more active roles in protecting the creeks and streams that flow through their neighborhoods. Volunteers and concerned individuals are given training, information, support, and the opportunity to participate in a full program of citizen action, water quality monitoring, and stream restoration. When necessary, the Delaware Riverkeeper Network initiates legal action to protect water quality and stream ecosystems.

✂ -

❐ Yes, I would like to become a member of the Delaware Riverkeeper Network.

- ❐ General membership of $35
- ❐ Family membership of $50
- ❐ With any donation over $100 get a free Delaware Riverkeeper Network T-shirt

- ❐ Enclosed is my tax deductible contribution of $ __________

- ❐ Please charge my Visa/MC Number: ____________________ Exp. Date __________

  Signature of Card Holder: ______________________________________

Mail to: Delaware Riverkeeper Network, P.O. Box 326, Washington Crossing, PA 18977

Message from the Delaware Riverkeeper

Dear Water Quality Monitors,
Our streams are living, evolving entities. Ongoing data collection and observations are key to identifying problems that your stream is experiencing in order to create solutions to help protect the stream and allow it to restore.

Your work on the front lines to monitor stream health is critical. But it is equally important that you share your work, your data, and the stream's message of how it is doing with your community. Your information and observations make a difference, can change the way people think about, view and act for the stream you hold so dearly – but this information can only make a difference if it is shared. This report is one way to help get the word out. We hope you will find it a useful tool in that endeavor.

We thank you for your ongoing and tireless commitment to protect our rivers, our streams, our wetlands, our environment and our communities.

For the River,

Maya van Rossum
Delaware Riverkeeper

Delaware Riverkeeper, Maya van Rossum, with a group of dedicated volunteer water quality monitors.

Volunteer Andy McClay, monitoring nitrate levels of Zacharias Creek

Section 1. Purpose of Report

This report is designed to be a tool for Delaware Riverkeeper Network (DRN) volunteer monitors, which can be used to present data to local decision-makers and communities…the next step needed to make all of your monitoring efforts pay off at the local level.

All summary data, graphs, and tables are available in electronic format and selected sections of the report are available at our website. We have included summary data for every site monitored from 1997-2001. This data can be found in the table section of the report. We have also included graphs for selected monitoring sites to offer ideas for data presentation and to provide a closer look at some of the streams that were monitored.

The greatest lesson we have learned from our program and other monitoring programs is that you, the volunteer monitor can take an active and effective role in putting the data into action. While DRN uses data for basin-wide projects and provides technical support to watershed groups and monitors, it is local people who have the greatest success protecting their community streams. Therefore, in addition to providing data summaries and analyses, we also provide ideas for you to get started putting your data into action. We will summarize DRN's monitoring study design, provide nuts and bolts information on monitoring parameters, and illustrate success stories where DRN volunteers have used their data to achieve protection of their local streams.

Highlights of DRN's Study Design

DRN cannot stress enough the importance of developing a monitoring study design before volunteer monitors set foot in a stream to collect their first readings. Study design, put simply, is a logical series of choices about the why, what, how, where, when, and who of your monitoring program. By answering these questions, monitoring programs can implement effective projects that achieve protection and restoration goals.

DRN has a multi-tiered study design that includes seven different initiatives (outlined below). The scope of this report includes data from our chemical and benthic monitoring initiatives specifically.

Chemical Monitoring Initiative - Goal: To empower citizens with basic knowledge of water chemistry and parameters that affect their local streams. This knowledge and involvement gives citizens increased tools and credibility when speaking for their local streams. Data collected by our volunteer chemical monitoring teams on more than a dozen parameters are entered into a Delaware River Watershed-wide database maintained by DRN. DRN offers assistance and periodic reports with analysis of data to volunteers interested in using their information at the local level. Data are also used by DRN for basin-wide protection and restoration projects and to alert regulatory agencies of pollution incidents and areas of concern.

Benthic Monitoring Initiative (Bug Madness) - Goal: To empower citizens with basic knowledge and sampling techniques for studying their waterways using benthic macroinvertebrates as an indicator of stream health. This knowledge and involvement gives citizens increased tools and credibility when speaking for their local streams. DRN works with local groups to use this data at the local level and to further its goals of watershed protection. Data are also submitted to regulatory agencies to determine areas of concern or exceptional value and to assist in petitions for stream upgrades.

Riparian Restoration Monitoring Initiative (Adopt-A-Buffer) - Goal: To use trained volunteers and watershed partners to assess (and maintain) riparian restoration projects implemented by DRN and its partners. Photo documentation and a Restoration Project Survey serve the basis of this program. In addition, stream cross sections, bank pin monitoring, wildlife surveys, and benthic surveys are also available if a specific project's study design requires this detail.

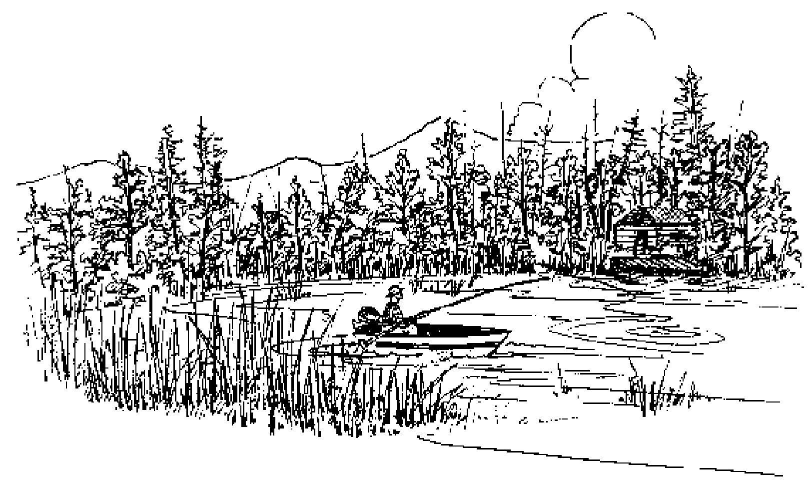
Pollution Monitoring Studies - Goal: To use DRN staff scientists and volunteer monitors to gather data for DRN's environmental law clinic. These studies are focused and often involve sophisticated monitoring techniques and lab analysis.

Monitoring Research Projects - Goal: To elevate the profile and credibility of volunteer monitoring data. Volunteer monitoring data provide valuable information that help protect our local waterways and guide protection measures and volunteers can monitor more sites with greater frequency than agency staff. The Manatawny Creek Study performed in cooperation with the Academy of Natural Sciences' and DRN is an example of this type of study, which compared split samples analyzed by DRN volunteer monitors and the Academy of Natural Sciences' laboratory. These focused studies highlight and further validate the use of accurate volunteer-collected data.

Visual Assessment Monitoring - Goal: To provide watershed groups and restoration practitioners with data to characterize small watersheds. Visual assessments are used to familiarize watershed groups with impacts and issues affecting their local streams. Specifically, these assessments help determine where stormwater inputs are a problem and where riparian restoration, retrofit projects, or invasive species control may be most effective. Groups also use visual assessments to develop and prioritize monitoring locations for their study design.

Pollution Report Hotline - Goal: To provide citizens with the information and appropriate agency contacts they need to report a pollution incident and to get clean up and intervention underway. DRN maintains two toll-free hotline numbers available to citizens who witness a pollution incident. In the Schuylkill Watershed, citizens can call 1-888 HOMEWATERS and in the greater Delaware, 1-800-8-DELAWARE for guidance on how to effectively report and follow up on an incident.

With these seven approaches, DRN is able to use protocols and parameters to fit our needs, the needs of specific watersheds, and local watershed groups. This report specifically summarizes two of the six initiatives listed above – our chemical and benthic monitoring programs.



Data Scope and Data Quality

DRN's Citizens' Volunteer Monitoring Program has been collecting data on stream ecosystems throughout the Delaware River Watershed since 1992. This report shares chemical and biological monitoring data collected by DRN's volunteer monitors in 1997-2001. Table 1 lists the streams and monitoring sites included in this report (See Appendix B) and the Delaware Watershed Map shows approximate locations of DRN's monitoring stations. The majority of data includes stream chemistry parameters. We have also included macroinvertebrate data from our Spring Bug Madness Project (Table 8) for 2000 and 2001.

DRN has a Quality Assurance-Quality Control Plan for our Monitoring Program. Volunteer monitors participating in our Program are required to attend an initial training workshop followed by annual refresher training courses to review techniques and protocols. These trainings incorporate blind samples and external lab checks to test volunteer accuracy. DRN also has experienced River Mentors who assist with one-on-one trainings and QA/QC measures if new volunteers require more attention and guidance (see Appendix C).

DRN monitors use monitoring kits manufactured by Lamotte Company and collect data on a monthly basis. Observations are recorded on a standardized datasheet (see Appendix C for equipment list and datasheet). Monitors collect samples between 10am and 2 pm and do not monitor within 24 hours of a rain event. This frequency and timing allows for monitors to track baseline conditions of their streams. Our protocols are based on equipment manufacturer's instructions and field tested by volunteer monitors.

The DRN Monitoring Program has a Technical Advisory Committee comprised of nineteen representatives from environmental consulting firms, universities, agencies, and other non-profits, who assist DRN staff and help guide DRN's monitoring initiatives (see Appendix C). DRN is also a monitoring service provider for the Consortium for Scientific Assistance to Watersheds, a Pennsylvania state-wide program designed to assist local watershed groups with technical guidance on the development of monitoring study designs. Finally, DRN is a steering committee member of the Keystone Watershed Monitoring Network that works to standardize and improve volunteer monitoring throughout the Delaware Watershed.

Section 2. Basics on Monitoring Parameters

Water chemistry is complex with many relationships and factors affecting the concentrations of substances in our streams. Concentrations vary naturally in streams and depend on geology, soil, vegetation, and climate of the watershed. There are also fluctuations in concentrations dependent on the time of day and the season. The chemical water quality of a stream is healthy if naturally occurring substances are present in concentrations appropriate for the stream ecosystem and aquatic life. Problems arise when human activities change these natural concentrations or introduce foreign substances that may be toxic. This section provides summary information about the chemical and biological parameters included in this report to help you better understand these complex relationships.

Dissolved Oxygen

Almost all plants and animals, whether living on land or in water, require oxygen for their survival. In water, oxygen is present in a dissolved form and is measured as the oxygen gas present, in milligrams (mg), per liter (l) of water. Milligrams per liter (mg/l) can also be expressed as parts per million (ppm). Dissolved oxygen (DO) can also be measured as percent saturation which takes into account temperature. Saturation is the maximum level of DO that would be present in the water at a specific temperature, in the absence of other influences.

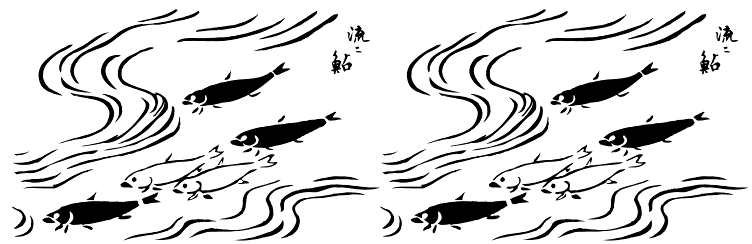
The amount of oxygen in water is a function of gas transfer from the atmosphere to surface waters. This transfer is assisted by the mixing action of wind, waves, riffles, and other turbulence that facilitates air mixing with water. When present, during the daylight hours, aquatic plants also add a substantial amount of oxygen to the stream via photosynthesis. At night, these same plants dramatically decrease DO resources due to respiration, as they use up oxygen. Since photosynthetic activities of floating and rooted aquatic plants are dependent on light, oxygen-producing processes occur nearer the water surface.

DO has a daily cycle, affected by temperature and photosynthesis. Water's ability to hold DO is decreased under warmer conditions. For example, streams near a cooling water discharge point or in an unshaded section of stream usually have higher temperatures and therefore, lower dissolved oxygen levels. Generally, the lowest DO is likely to occur during the hottest time of the year, at low flows, just before dawn (hottest temperatures and highest respiration of plants). Because the temperature of a stream varies daily, and even hourly, it is important to factor out the effect of temperature when analyzing dissolved oxygen levels in a sample of water. Percent saturation can be used to eliminate this variation due to temperature.

Increased organic pollution and nutrients (nitrogen and phosphorous) from fertilizers, manure piles, lawn waste dumped in or near streams, leaking septic systems and inadequate sewage treatment facilities indirectly decrease DO by stimulating the growth of algae and aerobic bacteria. When this algae uses up the excess nutrients, it dies, and the bacteria decay process robs the water column of DO. Increased sediment loads and stormwater runoff can also decrease dissolved oxygen. Dams may cause an oxygen deficit in the impoundment as water temperatures increase. When this water is released from the spillway, it may have less oxygen due to increased organic matter (in the form of plant and animal remains) that tends to accumulate in ponds below the surface (often, directly below the spillway, DO levels may be extremely high due to increased turbulence).

Many organisms begin to experience stress as dissolved oxygen levels drop, much like you would feel walking on a mountaintop at 8,000 feet. At DO levels of 5.0 milligrams per liter (mg/l) in warm-water fisheries (or 6.0 mg/l in cold-water fisheries), this stress is becoming large enough that scientists are able to see less diversity in our biological monitoring techniques, as the old, young and weak individuals die off. Some hardier species may be able to tolerate levels below 4.0 mg/l, but they are far from thriving and absolute lethal levels for these hardier species are reached at 2.0 mg/l.

In summary, oxygen is affected naturally by temperature, flow, aquatic plants and bacteria, altitude, and dissolved or suspended solids. Human activities affecting DO include removal of riparian vegetation, urban development, organic and nutrient inputs, and dams. Generally, oxygen supplies are lowest in the summer months, just before dawn, when waters are warmest, bacterial decomposition is at its highest, and photosynthesis is at its lowest.



Temperature

Temperature regulates virtually all physical, chemical and biological processes, whether on land or in the water. Water temperature directly influences the types of organisms found in the stream. In aquatic systems, most organisms are cold-blooded and are finely adapted to a specific temperature regime and fluctuations from this regime often cause stress. Temperature regulates:

- oxygen levels
- photosynthesis rates
- the metabolism of animals
- bacterial and parasitic reproduction
- decomposition rates

- insect emergence
- timing of migration and reproduction of fish species
- and aquatic life's resistance to disease and toxins.

Water temperature has a daily and seasonal cycle. As sunlight and air temperatures increase throughout the day, so does the water temperature. Springs discharging cool groundwater are natural buffers that keep stream water temperatures cool in the summer. Water temperature is also influenced by the quantity and velocity of the stream. The sun has much less impact in warming streams with large, swift flows than streams with small slow flows.

Human activities can alter the temperature regime of a stream. Thermal pollution can originate from power plants and industrial facilities that use water for cooling purposes and from return flows of irrigation systems. However, deforestation and improper land use are often greater factors. As trees on riparian lands are removed the stream receives greater amounts of direct sunlight, increasing both temperature and algal production, and decreasing the amount of oxygen present. Removal of streamside vegetation, particularly trees with their strong root systems, can result in more erosion. Erosion increases the amount of particles in the water and turbid water absorbs more sunlight and heat. Stormwater that has been heated from paved surfaces will also increase stream temperature. In addition, stormwater peaks and frequent flooding widens the stream channel, allowing more exposure to sunlight and potential for increased thermal impacts. Finally, as water temperature increases, ammonia toxicity increases (ammonia originates from fertilizers, septic tanks, manure piles, etc.).

Since organisms are adapted to specific temperature ranges, even small fluctuations can impact the health of a stream. The optimal temperature ranges for aquatic life depend on the species, but in general, ranges from 5°C to 25°C are tolerable for aquatic species. When temperatures rise above 25°C, these levels are lethal for salmonids (fish in the trout or Salmonidae family) and some aquatic insects.

Optimal Temperature Ranges for Aquatic Life

Cold Range (5-13°C)	**Cool Range (13-20°C)**	**Warm Range (20-25°C)**
Steelhead, pink, chum, coho, sockeye, chinook, cutthroat, kokanee, rainbow trout, brown trout, brook trout, dolly varden, smelt, sculpins Mayflies, caddisflies, stonefiles	Coho, chinook, cutthroat, lamprey, sturgeon, shad, dace, shiners, stickleback, walleye, sculpins Mayflies, caddisflies, stoneflies, beetles	Bass, shiners, bluegills, bullheads, carp, catfish, suckers, peamouth, squawfish, crapple Dragonflies, true flies, some caddisflies

(Complements of Adopt-A-Stream Foundation)

pH

pH is a measure of how acidic or basic a solution. The pH test measures the concentration of hydrogen ions (H^+) and hydroxyl ions (OH^-) and is based on a scale of 0 to 14. A ph of 7.0 is neutral while lower numbers indicate an acid nature (more H^+ ions), and higher numbers indicate basic conditions (more OH^- ions). The pH scale is logarithmic which means that each incremental change is equal to a ten-fold increase or decrease in the acid or base.

Each stream tends to have a narrow range of pH values but most levels fall between 6 and 9. Natural unpolluted rain water has a pH as acidic as 5.6. As rainwater falls through the atmosphere, it absorbs carbon dioxide, forming carbonic acid. Where soils are alkaline (basic), like in limestone streams, pH levels may be greater than 7. These basic qualities often help buffer the stream, giving the stream an ability to maintain a constant pH even when large amounts of acid or base enter the stream. Aquatic plants, when present, also impact pH levels, causing pH to have a daily cycle. Photosynthesis causes increases in pH as plants remove carbon dioxide from the water during the day. Conversely, at night, pH decreases as plants give off carbon dioxide during respiration. As the pH changes, so do the chemical reactions in the water. For example, as pH increases, smaller amounts of ammonia are needed to reach a level that is toxic to fish. As pH decreases, the concentration of metals may increase because highly acidic water acts as a solvent, leaching metals from the sediments and substrate.

Aquatic organisms generally prefer a pH range of 6.5-8.0 (9.0 for marine) and deviations from this can have serious effects on the health of a stream. A pH of 4.0 or below can destroy aquatic eggs and larvae, and frequently results in fish kills and/or mutations. Low pH leaches metals from soils and rocks, resulting in poisoning and deformities. While the effects of high pH levels (above 9.0) are not as well documented, it is likely that these also cause mutations in aquatic organisms. In areas where coal mining is present, mine drainage often has acidic pH levels as low as 4.0, making streams inhospitable to wildlife. Acid rain also decreases pH levels (PA receives the most acid rain of any state). Acid rain is formed when nitrogen oxides and sulfur dioxides are released from our cars and fossil fuel burning power plants.

Nitrate-Nitrogen

Nitrogen makes up about 80 percent of the air that we breathe and is an essential component of proteins. In aquatic systems, the inert gas Nitrogen is converted to useable forms by bacteria, which are then taken up by algae and other plants. Nitrogen occurs in natural waters in various forms including nitrate (NO_3), nitrite (NO_2), and ammonia (NH_3). Nitrate (or nitrate-nitrogen) is the most common form tested in water.

While nitrates are essential to plant growth, an overabundance can lead to eutrophication (increased plant growth), often blocking sunlight to the water column. When all nutrients are used up by algae, this excess algae dies and the natural decay process robs dissolved oxygen from the stream, potentially causing fish kills and other impairments to aquatic life. Nitrate is not usually the limiting growth factor for plant growth (phosphorus is the limiting factor).

Nitrogen levels are affected by ammonia in acid rain, freezing and thawing of soils, forest fires, and recycling by vegetation and retention by the soil’s humus layer. High levels of nitrogen are generally the result of improperly treated sewage from treatment plants or leaky septic systems; runoff from over-fertilized agricultural fields, lawns, and golf courses; pet, livestock, and other animal waste; detergents; and industrial effluent. In addition to leading to eutrophication, high levels of nitrates also impact human health. The national drinking water standard is 10 mg/l nitrate-nitrogen and drinking water should not exceed this level. In many cases, rural communities where farms are in operation, have levels of nitrate-nitrogen higher than this in their wells. These elevated levels can cause blue baby syndrome or methemoglobinemia which is hazardous to infant animals and humans. This blood disorder is caused when nitrite interacts with the hemoglobin in red blood cells. Unlike hemoglobin, the methemoglobin formed in this interaction cannot carry sufficient oxygen to the body's cells and tissues.

When nitrate levels are greater than 1.0 mg/l as nitrate-nitrogen (or 4.4 mg/l as nitrate), you can suspect degraded water quality and unnatural sources of nitrogen entering the system. From the biological perspective, no nitrate limit is established in the water quality standards however; in a general sense, less is better.

Phosphates

Phosphorous usually occurs in nature as phosphate and is crucial for the formation of DNA and proteins. Phosphate (PO_4) is found in two forms in aquatic systems and both can either be dissolved in the water or suspended (attached to particles in the water). Organic phosphate is bound to plant or animal tissue. Inorganic phosphate (ortho-phosphate) is the form most readily available to plants, and thus the most useful indicator of immediate problems with excessive plant and algal growth. Ortho-phosphate is also the easiest form to measure.

In many natural waters, phosphate concentrations are normally low (less than 0.01 mg/l). When levels become greater than 0.1 mg/L, this often indicates pollution. Phosphate is usually the limiting nutrient for plant growth, meaning it is in short supply relative to nitrogen. Inputs from treated sewage and leaky septic systems; over fertilization of crops and lawns; commercial cleaning operations; and deforestation and draining of wetlands supply an abundance of phosphate that result in extremely high levels of plant productivity or eutrophication. When these plants die, the decay process robs dissolved oxygen from the stream, often causing impairments to aquatic life.

Bacteria

Fecal coliform, E. coli, and enterococci bacteria are found naturally in the feces of warm-blooded animals. Fecal coliform by themselves are not disease-causing agents but warm-blooded animals, especially humans who are infected with pathogens such as viruses, bacteria, and parasites, can pass these pathogens into the environment through their feces. These specific pathogens (polio and many others) are generally difficult to monitor. So, agencies instead monitor the levels of fecal coliform, which are indicator organisms. High fecal coliform counts may indicate the presence of these dangerous pathogens.

Concentrations of pathogenic bacteria have been correlated with increased concentrations of sediment. The organisms attach to sediment particles and hitch a ride, escaping their invertebrate predators, absorbing nutrients from the sediment and lengthening their short lives. These bacteria also enter streams from poorly managed agricultural and manure stockpile areas, failing septic systems and sewage treatment plants, urban runoff, and pet waste. In many cities, bacteria also enter streams from combined sewer overflow systems (CSO) – systems where the stormwater and sewer water are combined in the same system of pipes. After a heavy rain, when these systems are inundated with stormwater, untreated or inadequately treated human waste may be diverted into the stream to avoid flooding of the sewage treatment plant which is unable to process the increased volume. Some cities have begun building retention basins to hold this excess waste instead of discharging it directly into the nearby stream to help alleviate this pollution source. Others have undertaken efforts to separate the two systems. Trenton, NJ had corrected their CSO problem about 25 years ago. Others, like Philadelphia are working on mitigating the problem.

To measure indicator bacteria, water samples are collected in sterilized containers, filtered, and incubated at a specific temperature and for a set time. Colonies that form during this incubation are counted and recorded as the number of colony producing units per 100 ml of water (CPU/100 ml). As a general rule of thumb, safe drinking water should have fecal coliform counts of 0 CPU/100 ml. For safe swimming water, levels should be less than 200 CPU/100 ml, and for boating, levels should not exceed 1000 CPU/100 ml. However, local, state, and federal standards may allow higher levels.

Macroinvertebrates

Macroinvertebrates are invertebrates (organisms with no backbone) that can be seen with the unaided eye. Most benthic (bottom-dwelling) macroinvertebrates found in streams are aquatic insects or the aquatic stages of insects along with clams, worms, and crustaceans (crayfish, crabs, shrimp). Some macroinvertebrates live on the bottom of rocks found in riffle areas of a stream and others live on submerged aquatic vegetation, streambank vegetation and woody debris.

Macroinvertebrates are an excellent indicator of long-term stream health. Since they live in the stream year-round and are generally sedentary, they are not able to escape from pollutants (where as fish can usually swim away). For instance, if a chlorine discharge had impacted a stream a month before chemical sampling, a chemical test will not detect this past incident, since the evidence will literally have been washed away with the stream flow. However, the benthic community will still have not recovered from this incident, and therefore impairment could be documented. Plus, macroinvertebrates tend to have short lifecycles (one season or less) so studying the long-term impact on returning adults can be documented in a shorter amount of time. Macroinvertebrates also represent important links in the food web as recyclers of nutrients and food for fish.

Macroinvertebrates are relatively easy to collect and identify and equipment needed is fairly inexpensive. Macroinvertebrates can be categorized by their pollution tolerances. For example, some organisms, like stoneflies and non-net-spinning caddisflies are pollution sensitive while other organisms like horsehair worms and black fly larvae are pollution tolerant. By determining the types and numbers of organisms found in a sample, you can determine the overall health of a stream. Generally, the more diverse the macroinvertebrate community, the healthier the stream.

With these basics on water chemistry, bacteria, and macroinvertebrates, you will have a better understanding of what your measurements really mean when you review the tables and graphs located in Section 4. For more information on these parameters and several others, see Appendix D.

Section 3. Using Data To Protect Streams

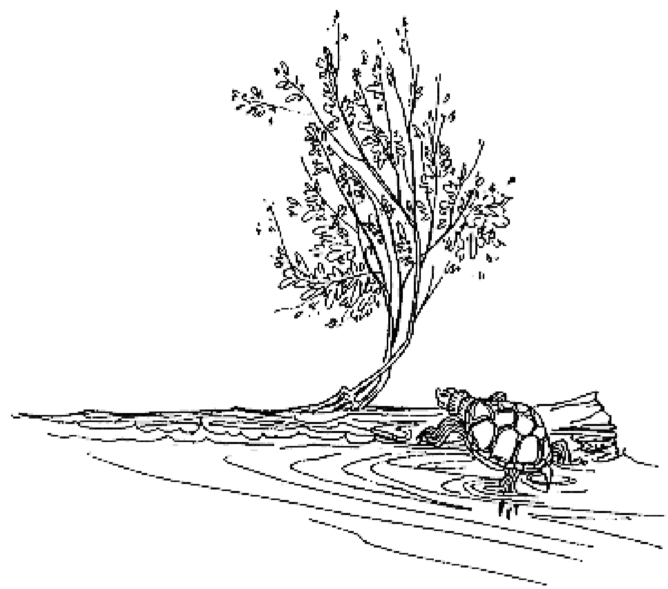
Throughout the watershed, there are many monitoring efforts underway. However, collecting data is only one piece of the puzzle. In order to see positive results from your monitoring efforts, you need to summarize and use your data at the local level to initiate good things for your watershed. Let your data work for you! The worst case scenario is that you or your group spend time monitoring and collecting data, but never really take those data to the different groups and decision-makers in your community to encourage specific restoration or protection measures….In a nutshell, do not be afraid to use your data. To inspire you and give you some ideas of the power of your data…and of you, we have highlighted a few general uses of monitoring data and then listed success stories accomplished by DRN volunteer monitors, just like yourself.

Reporting and Stopping Pollution

One of the best things that comes out of having many eyes and ears along our streams on a monthly basis is the detection of pollution incidents that would otherwise go unnoticed. There have been many occasions where DRN volunteer monitors have reported pollution impacts directly to the state agencies for further investigation and cleanup. From catching illegal dumping and discharges along streambanks to following a turbid cloud of water upstream to its source, to contacting the county conservation district about failing silt fences and lack of BMPs at construction sites, DRN volunteers have reported over 80 incidents over the past four years that we are aware of and we're sure there have been more.

Educating Communities

People won't change bad watershed habits if they don't know any better. Monitoring can be one of the best ways for people to learn what impacts they and their neighbors are having on their local streams. Providing people with the training and tools they need to understand the basics of water quality has been one of the most effective ways to build strong river advocates for our local streams. Monitoring has led to empowerment at the local level, and has helped groups and individual citizens speak knowledgably about their concerns, with monitoring data available to support their points. Many groups have used their data in slide presentations around their watersheds; others have used their monitoring equipment and know-how to educate local school groups and private adult citizens. Finally, some groups have boosted volunteer involvement and membership numbers by making colorful door hangers and flyers that illustrate trends in their watershed and the impact a local watershed group can make to affect these trends. Education can change people's habits, one person or one classroom at a time. Salem County Watershed Taskforce, Charlie Fisher, Friends of Mingo Creek, Stony Creek Anglers' Water Monitoring Committee, Pompeston Creek Watershed Association, and Hay Creek Watershed Association are examples of groups who have participated in education and outreach activities with their data. Join in on the fun and spread the word!



Restoring Streams, Pompeston Creek Watershed Association

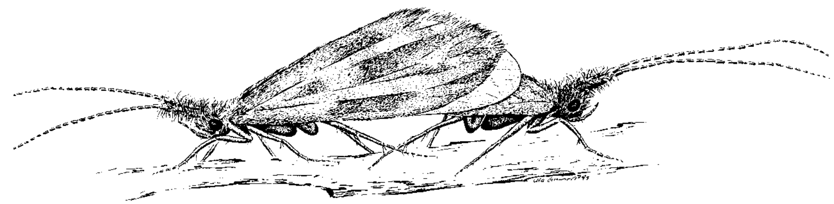
Pompeston Creek Watershed Association (PCWA) has been monitoring water quality on Pompeston Creek for almost five years. During this time, nutrient and bacteria data have been collected and used to notify municipalities of elevated levels of nutrients in the Pompeston. In addition to keeping officials informed of the high nutrient counts and encouraging NJ DEP to do something about these elevated levels, PCWA has taken initiatives on their own to help clean up the creek.

In February 2001, PCWA teamed up with DRN and OMNI Environmental Consultants and used their data to secure funding through a NJ DEP 319(h) Grant. This grant has given PCWA the resources to implement several stormwater retrofit projects at existing detention basins to decrease stormwater runoff and filter out nutrients before the water enters the Pompeston. The group has involved local school groups and other community organizations in these planting projects and brought programs like Americorps into the mix to teach participants about pollution using a 3-Dimensional Watershed Model. In addition, PCWA has implemented several streambank restoration projects to help decrease erosion and soils entering the Pompeston Creek. For more information about PCWA, contact Debbie Lord, PCWA President at dglord@aol.com.

Building Monitoring Partnerships, Calicoon Creek

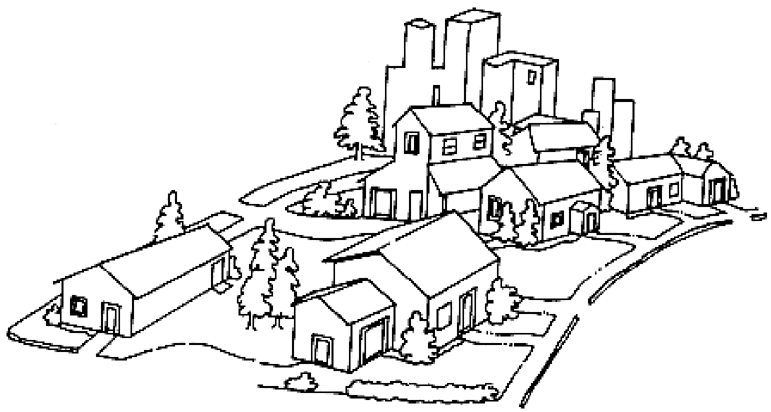
Stephen Fleckenstein, private citizen and DRN volunteer monitor has taken on the effort of extensively monitoring Calicoon Creek, a New York tributary to the Delaware River. In 1993, Stephen began working with DRN using Lamotte kits to monitor three sites in the Watershed. Due to some high nitrate and bacteria readings, Steve worked with the Sullivan County Water Quality Coordinating Committee (SCWQCC) to secure funding for an extensive, 112 sampling event study to determine "hot spots" in the Watershed. Studies have also been done by the Delaware River Basin Commission (DRBC) and the National Park Service (NPS) and Stephen has examined their data as well.

This survey indicated high nutrient and bacteria counts originating from smaller tributaries flowing into Calicoon Creek. In 1999, streamwalks were conducted to take a closer look at these tributaries and observations suggested that high nutrients were originating from unfenced pasture and feedlots, along with impacts from a hotel where sewage effluent, thermal pollution, and swimming pool drainage was apparent. In addition, stream surveyors noted inappropriate lawn practices where streamside owners were dumping lawn waste into the stream. Stephen has summarized all of his data, along with others data, in an extensive report which has helped secure funding to stop these impacts. To date, Stephen's reports, persistence, and partnerships have helped secure thousands of dollars of funding to fence streambanks on local farms, and implement best management practices (BMPs) to stop pollution from entering Calicoon Creek. For more information about Stephen's efforts, contact him at sflecken@sullivan.suny.edu.



Preserving Healthy Streams, Shohola Creek Watershed Conservancy (SCWC)

SCWC members are lucky to live and work in a high-quality watershed in Pike County, PA dotted with state gamelands, state forests, summer camps for youth, and private hunting club properties amidst smaller Pennsylvania towns. However, more and more pressure from development is crowding into the watershed, as commuters from New Jersey and New York are willing to drive longer distances and enticed by realtors' slogans, "Live Where You Play". With help from DRN and the Consortium for Scientific Assistance to Watersheds (C-SAW), SCWC is using their water quality data to petition for an upgrade of some of the tributaries that feed Shohola Creek. They hope that this petition results in upgrading these tributaries from High Quality status to Exceptional Value, which will increase protection of the resource to the highest level under state law. For more information on SCWC and to get involved, contact Joe Zenes, SCWC President at pocojoe@ptd.net.



Changing Homeowner Practices, Cooper River Watershed Association

The Cooper River Watershed Association (CRWA) members and DRN volunteers including, Roxane and Max Shinn, Shirley Ivins, Dennis Deering and Doris Carey discovered a 132% increase in ortho-phosphate levels at their monitoring location. To pinpoint where these extra nutrients were entering the river, a team of volunteers organized and began monitoring several additional sites upstream of their original monitoring location. They found that the pollution was originating from the North Branch of the Cooper where two new residential developments were under construction and new sod was being lain down. DRN approached the Camden County Municipal Utilities Authority (CCMUA), the regional sewer treatment plant for that area. The CCMUA agreed to insert an educational letter written by the volunteer monitors and DRN into their 6,000 monthly billing statements. The message was lawn care without toxic chemicals; the link between home-applied pesticides and cancers in children; and NJ's homeowners right-to-know law (prior notice before your neighbor has a lawn application). The volunteer monitors also printed 3,500 door-hanging leaflets and canvassed the neighborhoods in the North Branch to get the word out about protecting their community and the Cooper River. Contact Roxane Shinn, Co-Chair of CRWA, at rcshinn1@aol.com for more details on this project.

Filling Data Gaps, Otter Creek

Otter Creek is a small tributary that flows into the Delaware River in Bristol, PA. In most cases, state agencies do not have the resources to monitor the majority of smaller streams and tributaries in their jurisdiction. This was the scenario for Otter Creek, so the Pennsylvania Department of Environmental Protection (PA DEP) requested DRN's water temperature data collected by volunteer monitors, Bill Hilton and Mick Jeitner. This PA DEP request was made in response to a local industry's application to modify it's thermal discharge. Volunteer data gives agencies and decision-makers an idea of the health of a watershed, particularly if accompanying metadata is included listing the equipment and QA/QC measures used to obtain the data.

Cleaning up Coal Mining Impacts, Schuylkill Headwaters Association (SHA)

In Pennsylvania, the headwaters of the Schuylkill River suffer from the legacy of anthracite coal mining. SHA members and volunteer monitors, including Desiree Vernickie, Jeff Hertzog, Paul Lohin and Bill and Lorie Reichert, are systematically working to clean up these historic mine drainages, one project at a time. In 2000, SHA worked with DRN and Kimball Associates to perform an assessment on the Upper Schuylkill Watershed, which listed and prioritized mining and other pollution impacts in the study area. Volunteer monitoring data and other citizen surveys were provided for inclusion in the report and an Access database with GIS capabilities was created to house historic and future monitoring data. Today, SHA and its partners have used this report and additional monitoring data they have collected to secure funding to clean up three high priority discharges. Volunteer monitors are presently collecting data pre and post treatment of the discharges which include limestone diversion wells, implementation of BMPs at existing culm piles, and wetlands restorations to track progress and stream improvements over time. For more information on SHA's work in the headwaters of the Schuylkill, contact Lorie and Bill Reichert at breichert@losch.net.

Upgrading New Jersey Streams

In November 2000, the 106th Congress (with a push from DRN and other citizen groups) designated portions of the Lower Delaware River as a National Wild and Scenic River System. Shortly after, DRN got to work to encourage NJ Dept of Environmental Protection to upgrade tributaries, which flow into this section of the River. To back up our request for stream upgrades on these tributaries to "Category One Waters", DRN used volunteer monitoring data to help justify our request. Volunteer monitoring data was submitted for the following NJ creeks and rivers: Alexauken Creek, Blacks Creek, Canton Drain, Cool Run, Manumuskin Creek, Maurice River, Menantico Creek, Oldmans Creek, Paulinskill River, and Rancocas Creek. In all, we recommended upgrades for 35 different tributaries.

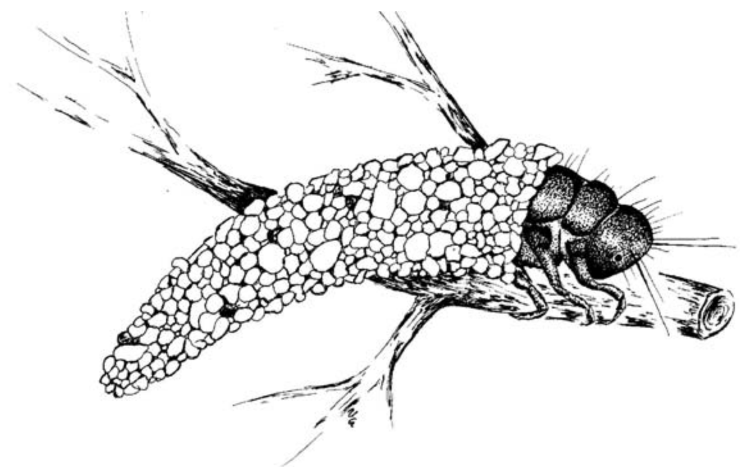
Monitoring Earth-Moving Activities, Zacharias Creek

During Spring Bug Madness 2000, DRN and volunteer monitor, Calvin Flowers, noticed a streambed laden with sediment. Investigating further upstream, it was obvious that a dilapidated silt fence located at a new development site was the culprit. A large gully had formed under the silt fence eroding much of the bank down the steep hill and into Zacharias Creek. DRN reported the incident to Montgomery County Conservation District, the party responsible for enforcing Erosion and Sediment Controls for the county, and the contractor was ordered to install hay bales and other devices to fix the erosion problem. For more information on how to monitor earth-moving activities in your community, contact Faith Zerbe at 610-469-6005.

What is your Story?

The volunteers who made these successes happen are just like you. Caring citizens – who started out with the passion and interest to monitor and learn about their local streams. We hope that this collection of stories inspires you to use your own data to achieve similar successes for your local streams and communities. In addition to getting assistance from Delaware Riverkeeper Network to do this, local watershed groups are a great organizational resource that would be a good place to start. If there is no local watershed group in your area, think about starting one. We have worked with many volunteer monitors who have taken the lead in developing local groups throughout the watershed. Contact nature centers, municipal officials, state agencies and others who may be interested in learning more about the watershed they live and work in and may want to get involved.

Sharing your data and using it at the local level to clean up your home watershed can take some effort, but in the end, when you see positive steps being taken, the time spent will be well worth it. Good luck!



Section 4. A Look at DRN Monitoring Data

Now that you have a feel for what actions and successes can come from volunteer monitoring. Let's take a look at DRN volunteer monitoring data that can be used to take similar actions in your watershed.

This last section provides a compilation of the data that volunteer monitors have collected between 1997 and 2001. If you have collected data for our Program during this time period, it is in this report. Data is organized by sampling code. For a list of the sampling codes and the streams and sampling stations they represent, refer to Table 1 located in Appendix B. This section is organized in the following format.

1) A selection of graphical data generated to use in specific protection efforts for particular streams. Graphs will vary due to customized work that was performed to assist specific groups and individual monitors with data analysis and presentations in their local communities;

2) Summary table for all sites that are part of our chemical monitoring database (Table 2);

3) Summary table for consistent sites (sites with at least 12 data points) that are part of our chemical monitoring database (Table 3);

4) Dissolved Oxygen Alert – lists all consistent sites and streams where DO levels were below optimal (Table 4);

5) Nitrate Alert - lists all consistent sites and streams where nitrate levels were below optimal (Table 5);

6) Orthophosphate Alert- lists all consistent sites and streams where orthophosphate levels were below optimal (Table 6);

7) pH Alert - lists all consistent sites and streams where pH levels were below optimal (Table 7); and

8) Summary table of macroinvertebrate data collected during Bug Madness in the Spring of 2000 and 2001 (Table 8)

These graphs and tables were produced using Microsoft Excel and presented using Microsoft PowerPoint. We hope they will give you ideas for how you or your watershed group can use and present your data to your local community and decision-makers. Due to space restrictions, we could not include specific graphs for each monitoring site, but if you would like a copy of this detailed data for your stream, please let us know and we would be happy to provide you with this information.

Wrap Up

Since 1991, Delaware Riverkeeper Network, citizens, and local watershed groups we work with have been using volunteer monitoring data to protect streams throughout the Delaware River Watershed. From submitting volunteer data to be included in Rivers Conservation Plans and Restoration Plans to stopping pollution incidents occurring on a local stream, there are a variety of ways that vigilant monitoring has led to protection and improvement of our local streams and rivers. We thank all of our volunteer monitors who are working hard in their communities to monitor and protect their local streams. Keep up the good work and do not hesitate to contact DRN for further help and advice on how to use data at the local level.