VOLUNTEER OUTREACH TACTICS THAT WORK

SESSION INFORMATION:

Moderator:

Greg Bryant, Texas Natural Resource Conservation Commission

Presenters:

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(no paper submitted)

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Guerilla Outreach Tactics for Volunteer Monitoring Programs

VOLUNTEER OUTREACH TACTICS THAT WORK

Guerilla Outreach Tactics for Volunteer Monitoring Programs

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Tired of competing with bigger organizations with communications and fund-raising staff? Local officials not recognizing your program? Volunteer attrition have you down? Newspapers, radio, and television ignoring your press releases?

It's time for Guerilla Outreach Tactics! Get and keep the volunteers that you need with simple, fun, and effective techniques. Carve out your niche with and around other organizations to keep yours new and vital by reaching out to new audiences and making partnerships. Get noticed—and funded—by local businesses and corporations. Learn how to get the media to your event and receive the coverage that you deserve.

Although there will be some discussion of working with the media, the focus of this interactive and fun workshop will be sharing non-traditional ideas and examples of outreach tools that work at the ground level and go directly to your audience.

Because of the highly visual and interactive format of this workshop, it is not possible to fully represent its content in these proceedings. Please contact presenter for further information.

Things to remember when creating outreach materials…

- Know your intended audience or try to create materials with broad appeal
- Don't forget to tell your audience *what's in it for them*
- Off-beat, quirky humor can be a plus
- Keep the format clean and simple with lots of "open space"
- Use color when possible—colored paper is inexpensive and some printers don't charge more to substitute one colored ink for black ink
- When possible, use bold and expressive images instead of a lot of text
- Use pictures of kids, retired people, or others to help target your intended audience
- Readable, unique fonts are a plus, but don't use more than two (or three at the very most). Consistently use one or two (for titles and text) to create a unique identity for your organization
- Simple, bold images are better than many smaller ones without a unifying style or theme
- People like maps, graphs, and charts (in moderation) to help them visualize issues, data, or story locations
- Use endorsements from prominent citizens or inspirational quotes
- Scanning three-dimensional objects like insects and plants can create striking, copyright-free images
- Don't leave the back of business cards blank! Use the space for a series of messages about your organization or things that people can do to improve the environment

More ideas for guerilla outreach…

Do Make it personal

- Save correspondence so that you can use personal quotes in flyers, brochures, newsletters, funding appeals, press releases, videos, and more
- Scavenger hunts are great publicity and help make people aware of their surroundings
- Bring sign-up sheets to every event or display

In your face!

- Hang posters on the backs of bathroom stall doors and leave brochures in recreation area washrooms
- Wear name tags, bring business cards, fact sheets, brochures, and flyers to meetings and other events
- Create and distribute book covers with your message and other information

Judge a group by its cover—or title

- Use innovative headlines for newsletter articles, press releases, or brochures such as, "Of Hamburgers and *E. coli*: A Water Quality Parable" or "Would You Drink Coffee Made Without a Filter?" (the latter article draws a comparison between coffee filters and shore land buffers)

The essence of good marketing

- Under a "free samples" sign, have cups of drinking water with funders' or program names as the "sponsor"
- Send "samples" with press releases—bugs, water in vials, exotic plants, more…

Get them in on the ground floor…

- Have a contest to name a newsletter
- Have a contest for photography or artwork for use in brochures, annual or water quality reports, calendars, or other publications
- Kids' art and contributions are great ways to assure distribution (and purchase) of publications

For the gift that keeps giving…

- Send a thank you card right away
- Gift wrap deliverables before presenting them to funders
- Send out press releases about new funding and send a copy with a media coverage list and clippings to the funder

Dress the part

- Wear a suit to a public hearing, legislative committee meeting, or appointment with a funder
- Don a fish or Dragonfly costume to a fair or protest event
- Wear Dragonfly earrings or a vest decked out in flies or to an anglers' presentation

Don't miss a photo opportunity!

- Buy an inexpensive camera and take it everywhere to record any events like poor construction practices, volunteers at work, *E. coli* waiting to happen, wildlife sightings, meeting attendees…

Just wanted to see if you were listening…

- Hide something in the text of volunteer training materials such as "congratulations for reading through this manual—please call me so that I can buy you an ice cream cone"
- Bury twisted humor in the text so that they get used to looking for it—and reading everything

Working with the media

- Identify the environmental journalist or find the hot buttons for your general coverage reporter
- Develop a relationship by supplying information about subjects and events other than your own
- Pick up the phone and call the journalist—many prefer this direct contact but always ask first if they are on deadline or if it is a good time to talk
- Summarize information in press releases in the first couple of sentences—with hundreds or thousands of releases pouring in every day, grabbing instant attention is essential if you want the editor to keep reading

- Use a short, attention-getting headline: "Long River Not Safe for Local Residents" instead of "*E. coli* in the Long River Exceeds 600 Counts" or "Franklin Savings Bank Renews its Commitment to Water Quality" instead of "Local Business Donates Funds to Local Volunteer Water Quality Monitoring Program"
- Don't be afraid to use humor or put a human face on your story or issue—for instance, "Bugs Are People, Too"
- Include colored maps, graphs, and charts illustrating your story, event, or data—but don't overwhelm—not more than a couple of sheets unless more is requested
- A good story will often contain a good photo element—make your story visual
- The more people that are involved, the more likely you will receive coverage—indicate how many students, volunteers, or organizations are affected or are a part of your event or issue

Selected resources for low-budget outreach material creation…
Microsoft Publisher is an inexpensive layout program and provides a large selection of clip art, available through catalogs, office supply stores, and software outlets.

Broderbund has a variety of inexpensive image collections and layout software. http://www.printeverything.com 319/395-9600

Dover Books has a large selection of copyright-free clip art including archival collections that you can scan. Contact your local bookseller to order or call 800/223-3130.

Idea Art has a variety of custom-look papers, business cards, note cards, and other presentation tools. http://www.ideaart.com 800/433-2278

Paper Direct has a variety of custom-look papers, business cards, note cards, certificates, and other presentation tools. http://www.paperdirect.com 800/272-7377

Viking Office Products has an above-average selection of colored and unique papers, cards and photo-paper supplies. http://www.vikingop.com 800/421-1222

Topo! Interactive Maps by Wildflower Productions CD-ROM map software allows users to customize topographical maps that can be printed or inserted into publications (not available for all areas). http://www.topo.com 415/558-8700

Creative low-budget publication design.1998. Pretzer, Mary. North Light Books. Contains examples and advice on expensive design techniques.

The Volunteer Monitor, Volume 9., No. 2, Fall 1997, Issue, topic: Community Outreach. http://www.rivernetwork.org or email volmon@rivernetwork.org

River Voices, Summer 1996, Spring 1996, and Fall 1994 issues http://www.rivernetwork.org

Ready, Set, Present! 1999. Schoen, Jerry; Walk, Marie-Françoise; Tremblay, Michele L., Massachusetts Water Watch Partnership. Advice on data presentation including layout, graphs, charts, maps, oral presentations, and interactive displays.

SIGNS OF LIFE: MONITORING THE HEALTH OF WETLANDS

SESSION INFORMATION:

Moderator:

Leah Graff, Save Our Streams, Izaak Walton League of America

Presenters:

Leah Graff, Save Our Streams, Izaak Walton League of America
Successes and Challenges of a Nation-wide Wetland Monitoring Handbook and Training Session

Tom Danielson, USEPA Wetlands Division
Evaluating Wetland Health

Klaus Richter, King County Department of Natural Resources
King County's Wetland-Breeding Amphibian Monitoring Program

Charlotte Shover, Dakota County Environmental Education Program
Dakota County Wetland Health Evaluation Project

SIGNS OF LIFE: MONITORING THE HEALTH OF WETLANDS

Successes and Challenges of a Nation-wide Wetland Monitoring Handbook and Training Session

CONTACT INFORMATION

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Wetland Conservation and Sustainability Initiative

The Izaak Walton League's Save Our Streams Program (SOS) has been involved in volunteer stream monitoring for more than thirty years, and is well-known for its biological monitoring method using aquatic macroinvertebrates (stream insects and crustaceans). In 1996, Save Our Streams launched the Wetlands Conservation and Sustainability Initiative with the goals of educating the general public about wetland ecology, functions, and values and of providing a way for citizens to become involved in wetland stewardship activities such as monitoring.

SOS recognized a need for volunteers to become involved in wetland monitoring. Volunteers can use monitoring to learn more about wetland ecology and specific wetland habitats in their communities. Volunteer monitors can record changes in wetlands over time to determine the success of mitigation, creation, enhancement and restoration projects. In addition, volunteers can use data on wetlands to help protect local wetlands at public hearings.

Challenges of Developing a National Monitoring Guideline for Wetlands

As a national program, SOS chose to develop a monitoring guideline that could be used in any type of wetland located within any region of the country. This was a difficult task because wetlands are diverse and complex. The term wetland is not precise. Rather, wetland is a generic term for any area that is wet for some part of the year, has soils that were formed under wet conditions, and supports flood-tolerant vegetation. A wetland can be the forested floodplain of a river, the area along the edge of a lake with grasses and sedges, a shallow depression in a farm field that dries up in the summer, or a salt marsh along a protected shoreline. Those kinds of variations and more can be found among wetlands all located within the same town. To that, add all of the wetlands found in the different climates and regions of the country and the diversity and complexity increases to the point where it is sometimes difficult to understand how all of these vastly different areas can be lumped together under the umbrella of wetlands.

This diversity and complexity of wetland habitats provides challenges for monitoring wetlands. While stream monitoring lends itself to national indicators of water quality, wetlands vary so greatly within and across regions that monitoring protocols to determine the health of wetland ecosystems must be developed locally. In spite of this challenge, the Save Our Streams program of the Izaak Walton League recognized the need for a comprehensive introduction to wetland monitoring for volunteers across the country.

Save Our Streams researched existing monitoring protocols and developed instructions and data collection forms that can be used nationally in any wetland ecosystem. The Wetlands Conservation and Sustainability Initiative teaches volunteers to monitor vegetation, soils, hydrology, human impacts to the wetland and the watershed, and the use of the wetland by mammals, birds, reptiles and amphibians. Save Our Streams teaches wetland monitoring through two-day training workshops and the Handbook for Wetlands Conservation and Sustainability.

Monitoring to Understand Wetland Ecology

Some of the monitoring instructions and forms in the Handbook for Wetlands Conservation and Sustainability (such as soil, hydrology, and plant monitoring) are designed to give people a better, in-the-field education about what wetlands really are. This background information will not help determine whether or not the wetland is healthy, or if there are changes in the wetland. Rather, the information is designed to help people recognize a wetland and to provide some general background on potential impacts to wetlands. For Save Our Streams, these monitoring techniques serve the equally important purpose of education.

Monitoring Wetlands to Capture Long-term Trends

For measuring long term changes in plants and getting a better sense of overall plant diversity, Save Our Streams stresses the importance of permanent monitoring locations and setting up transects. Many volunteer monitoring programs may use GPS (global position systems) units to set permanent monitoring locations, but SOS gears publications toward the general public that may not have access to these tools. Plants and animals are monitored along transects at set monitoring locations, which can provide information on species declines or overabundance, or track populations of invasive exotic species that may threaten the overall diversity of a site. Photos taken at set

locations over time also provide useful information on changes in wetlands and can be used to present information effectively at public hearings.

In-depth Monitoring of Specific Parameters

The Handbook for Wetlands Conservation and Sustainability contains information on some more intensive monitoring techniques, such as trapping amphibians and installing groundwater wells. This information was geared toward individuals and groups that monitor wetlands for a specific purpose, such as to track amphibian use. For macroinvertebrate monitoring to assess wetland health, the Wetlands Conservation and Sustainability Initiative refers people to local groups that are developing protocols for a specific wetland type or geographical area.

Challenges in the Field

Setting permanent monitoring locations along a transect using stakes, compasses, and measuring tapes was challenging to volunteers with no previous experience. Changes made to the training workshops that helped address this issue included adding instruction in how to use a compass and explaining how to set transects by drawing diagrams in the classroom before demonstrating the process outside.

Another challenge was plant identification. As a national program, SOS traveled to different parts of the country to teach wetland workshops. Good wetland plant field guides for each region are hard to find. Using guides for the entire country limits the number of plants listed. SOS began collecting plant lists for the workshop field sites in advance and making custom field guides of only those plants found in the wetland. It was very helpful not to have to flip through huge guides, especially for the volunteers less familiar with plant identification and using field guides. In the Handbook for Wetlands Conservation and Sustainability, Save Our Streams suggests making field guides specific to the wetland being studied as an educational activity.

SIGNS OF LIFE: MONITORING THE HEALTH OF WETLANDS

Evaluating Wetland Health

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Partly due to the fact that physical and chemical conditions create such a great variety of biological conditions in wetlands, measurements of pH, dissolved oxygen, and total suspended solids give a limited picture of a wetland's health. It is valuable to look at the plants and animals themselves in order to gain insight into the ecological functioning and biological condition, or integrity, of wetlands. Biological integrity is the ability to support and maintain a balanced, integrated, adaptive biological system having the full range of elements and processes expected in a region's natural habitat.

Scientists can use bioassessment methods to directly measure biological condition of wetlands and determine if wetlands have been impaired by human activities. If a state, tribe, or other organization detects a warning signal during the screening process, it can then conduct a more detailed and thorough assessment. Many states using bioassessments in streams are finding that they save time and resources by screening a large number of sites with "rapid" bioassessments and then following up with more detailed assessments (including expensive chemical and physical tests) when appropriate.

Bioassessment can also be used to determine if a wetland has been damaged by human activities. Many stressors can damage biological communities, such as habitat alteration, invasive species, pesticides, acidification, toxic chemicals, nutrient enrichment, hydrologic modification, or sedimentation. By observing the presence, absence, and relative proportions of indicator plant and animal species, scientists can analyze the health of a wetland and can determine which of these stressors may be causing problems. Indicator species are those that react predictably to natural conditions and/or human impairments. Typically biological assessments combine several potentially indicative measures in order to arrive at a robust picture of wetland health - also known as an Index of Biological Integrity (IBI). For more information about wetland biological assessment, see EPA's web page: www.epa.gov/owow/wetlands.

In addition, wetland bioassessment is useful in helping to protect and restore wetlands, or in evaluating the performance of protection and restoration activities or watershed management plans. The information provided by biological assessments can help agencies prioritize and target activities to protect and restore wetlands. Also, by periodically conducting bioassessments, states and tribes can track the condition of wetlands and learn which management activities have worked as planned and which have not. With this knowledge, states, tribes, and land-use managers can improve future management plans and maximize their wetland protection efforts.

Wetland Bioassessment Pilot Projects have been undertaken by several agencies and institutions across the U.S., including in the states of Oregon, Washington, Montana, North Dakota, Minnesota, Wisconsin, Michigan, Ohio, Maine, Massachusetts, Pennsylvania and Maryland. Representatives from many of these states have been involved in an EPA effort to develop appropriate monitoring protocols and different indicators for assessing the health of the various wetland types that occur within the United States. The EPA Wetlands Division and other agencies have been convening a group of scientists from federal and state agencies and academia called the Biological Assessment of Wetlands Work Group (BAWWG), and the group is publishing a series of wetland bioassessment reports that will be available for volunteer monitoring groups as well as professionals.

One of the most important roles that volunteer wetland monitors can play in evaluating and protecting wetlands is to screen wetlands for possible problems. "Screening" refers to an initial assessment conducted by volunteers that indicates to professionals those areas in need of remedial action and/or greater study. Screening by volunteers is not as detailed or as fine-tuned as a professional study is, but can roughly assess the condition of a large number of wetlands or other water bodies. Volunteers can often discern through their monitoring any big problems occurring in wetlands. This function of discovering problems in wetland health can supplement (but certainly not replace) state staff, who are often too busy to get out in the field to a large number of wetlands. Although volunteers can do valuable work on their own, it is essential for the organization coordinating them to have a paid, full-time volunteer coordinator so that the volunteer network remains strong and on task.

A new tool to help organizations coordinate volunteer wetland monitors is *Volunteer Wetland Monitoring: An Introduction and Resource Guide,* which is a new EPA publication to be released in the next month. The guide

provides helpful hints on starting projects and also evaluates existing publications and manuals on volunteer wetland monitoring. For copies, call the EPA Wetland Help line: 1-800-832-7828.

One prime example of a pilot program involving volunteers in a modified wetland bioassessment is a project in Massachusetts that began last summer. The Wetland Health Assessment Toolbox (W.H.A.T.) for evaluating coastal wetlands is a partnership among three local groups in northeastern MA (Salem Sound 2000, 8 Towns and the Bay, and the Merrimack Valley Planning Commission), the UMass Extension, MassBays Program, and Massachusetts Coastal Zone Management. WHAT is partly sponsored by EPA. For more information about WHAT, call Bruce Carslisle at MA CZM: 617-626-1200, www.magnet.state.ma.us/czm/wastart.htm.

The goals of the coastal wetland monitoring project are to train volunteers to evaluate the health of estuarine salt marshes, and to promote citizen stewardship for wetland protection. The evaluation technique used - W.H.A.T. - is a multi-metric and integrated assessment program developed for both freshwater and salt marsh wetlands. W.H.A.T. examines individually:

- water chemistry
- land use
- hydrology
- vegetation
- invertebrates
- avifauna

Subsequently, the indices from each of the above parameters are combined into a comprehensive overall integrated score of health.

The organizers of this volunteer salt marsh monitoring program began the process with a series of workshops on each of the above parameters, all of which were well attended by volunteers. Volunteer enthusiasm was maintained through:

- refreshments and socializing at the initial meeting
- certificates of attendance at the workshops
- free copies of slides and photos taken during the workshops
- final social wrap-up meeting with refreshments, and presentation of WHAT t-shirts
- data base of participants for follow-up mailings giving results of monitoring, future activities, workshops, etc.
- reports in the quarterly newsletters on the status of the monitored salt marshes

Although wetland bioassessment is a powerful tool and a promising way to involve volunteers, it is certainly not the only way and may not be the best way. Depending on the circumstances, it may be more appropriate to use volunteers to follow up on tracking wetland mitigation projects and to find out if the projects were actually done, to monitor effects of tidal restrictions, etc.

SIGNS OF LIFE: MONITORING THE HEALTH OF WETLANDS

King County's Wetland-Breeding Amphibian Monitoring Program

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Introduction
The protection of open space, natural drainage systems, and wetlands and their wildlife have consistently been rated major natural resource issues of concern by residents throughout King County (King County 1991a) and the nation (National Research Council 1992). Wetlands are recognized as essential landscape components of integrated aquatic ecosystems that include ground water, lakes, streams, and estuaries, with their hydrology and water quality linked to that of our ground and surface waters. Thus the water from which we drink, the lakes in which we swim, and the streams in which we fish depend on the health of our wetlands.

Under the Federal Clean Water Act the biological integrity of wetland water quality is protected. Consequently, biomonitoring is now directly applied to assess water quality and anthropogenic impacts to prevent harm to human health (Adamus 1996, Danielson 1998). Amphibians, especially, are considered early warning signals of water quality deterioration. For example, their distribution, abundance and richness are considered sensitive indicators of overall changes in water regimes, sedimentation, water quality and landscape stress (Sparling et al, in press). Unexpected deaths, physical deformities and altered fecundity have catapulted amphibians into a nationwide effort to link their health to wetland condition and to human health (Adamus 1996, Danielson 1998). In Minnesota and Vermont, frog deformities may be directly linked to water quality (Douglas et al. 1999). Here in King County, unexpected frog mortality has occurred and been attributed to pond water quality while deformities in salamanders from undetermined causes have also been documented. Wetland-breeding amphibians have been shown to be especially susceptible to changes attributable to urbanization (Azous 1991, Richter and Azous 1995, Richter and Azous 1997). The state endangered Oregon spotted frog (*Rana pretiosa*), for example, most likely has disappeared from King County, Washington wetlands because of land use and associated aquatic habitat changes (McAllister and Leonard 1997).

Indeed, ecological and physiological characteristics of amphibians associated with free water or wet environments and specifically species with aquatic eggs, larvae, and adults may be particularly sensitive to habitat disturbance, desiccation, pollutants, ultraviolet radiation, pH, and diseases. These biological attributes make these taxa ideal for bioindication of wetland health. Simultaneously, amphibians are charismatic and interesting animals with large, easily identifiable egg masses that are readily– and often joyously– surveyed by volunteers.

Monitoring Goals
The main objective for the Wetland-Breeding Amphibian Monitoring Program is to provide King County and its citizens with long-term, up-to-date amphibian and wetland information for planning and regulatory purposes through an active public outreach and education program. The specific goals are to:

- Identify the occurrence of the State-endangered Oregon spotted frog (*Rana pretiosa*) a species that requires special consideration for environmental protection in Washington State and King County's permit review program.
- Determine land uses compatible with wetland and amphibian conservation objectives, including protection and recovery of wetland habitats and amphibian species most sensitive to human activities.
- Provide data to help develop and implement regulations for the protection of amphibians and their habitat.
- Identify the population distribution status of other County declining species, such as the western toad (*Bufo boreas*), red-legged frog (*Rana aurora*), and northwestern salamander (*Ambystoma gracile*).

- Obtain standardized baseline inventory data on the distribution, abundance and health of amphibians in King County wetlands, and then continue to monitor over regular intervals to assess amphibian, wetland and watershed health.

- Provide information to King County, Washington State Department of Fish and Wildlife, Washington State Department of Ecology, and Federal Resource Agencies for developing regional wetland and wildlife management programs.

- Develop an effective public outreach and education program to train citizens to monitor amphibians and wetland conditions and to foster wetland stewardship.

Methods

Public Outreach and Education
I initiated the Wetland-Breeding Amphibian Monitoring Program by targeting wetlands in the East Lake Sammamish Basin in 1993. This watershed basin was chosen because it exhibited one of the highest development rates in the County, and because of the large numbers of wetlands expected to be impacted by development. Moreover, since I was developing an entirely new volunteer program I felt it would be best to initially start within one specific area to develop our citizen outreach and technical survey protocols prior to expanding the program to other watersheds. In 1994 I added wetlands in a second (Big Bear Creek), and in 1995 wetlands in a third (Evans Creek) watershed because of escalating development pressures in these areas and increased volunteer interest. Although this outreach and education program initially targeted citizens in these three priority basins, we included volunteers from throughout the Puget lowland region within King County as additional funding and staff became available. We then also collectively recruited participants through public announcements of the Volunteer Monitoring Program in the Surface Water Management and WLR Newsletter, Downstream News, the Water Tenders Newsletter (reaching Bear Creek volunteers), and personal contacts.

Within each watershed I initially selected wetlands with open water, aquatic bed, and emergent vegetation habitat classes (Cowardin et. al. 1979) from the King County Wetland Inventory (King County 1991b). I chose wetlands with these specific habitat classes because of their high probability of supporting breeding amphibians (Richter 1998). We then chose a subset of wetlands from each watershed based on their accessibility, existence of supportive property owners, and an absence of dogs and fencing. Wetlands without breeding amphibians were surveyed only one or two years.

In February of each monitoring year we sent brochures to previous volunteers announcing trainings and asking them to continue in the program. We conducted follow-up phone calls to anyone who didn't respond. Evening refresher courses were offered to familiarize past volunteers with amphibian identification and to provide clarification on additional information required in updated data sheets.

We held a one-day workshop in late February or early March prior to each survey season. For the workshop we prepared a standardized package that included a field equipment list, waterproof survey data sheets, diagnostic amphibian identification guidelines, egg development charts, keys to larvae, copies of relevant articles, sampling protocols, and maps to the assigned wetlands (Richter and Ostergaard 1999).

The morning of each workshop was dedicated to a slide presentation and hands-on laboratory session describing amphibian ecology and discussing adult, egg, and larval identification. We emphasized the species characteristics for identifying all potentially occurring subadult and adult wetland-breeding amphibians, particularly differences between similar species (i.e., Oregon spotted and red-legged frogs, northwestern and long-toed (*Ambystoma macrodactylum*) salamanders, and long-toed and western red-backed (*Plethodon vehiculum*) salamanders). We also highlighted the identification of large, easily spotted, egg masses of northwestern salamander, red-legged frog, and western toad as well as the smaller egg masses of the long-toed salamander and Pacific treefrog (*Hyla regilla*). Volunteers were provided with laminated photographs of red-legged frog, Pacific treefrog, northwestern and long-toed salamander and their egg masses for use for field identification. Hence, we are confident of the identification of species using adult morphology and egg mass characteristics.

In the afternoon of each workshop, we visited select wetlands to demonstrate monitoring protocols. We practiced methods for searching, identifying, and censusing adult and amphibian egg masses. We clarified the description of habitats and other important wetland features, and filled out wetland survey data forms. Each participant was

assigned one or more wetlands to monitor. New volunteers re-surveying wetlands previously surveyed were provided with the earlier surveyor's field notes to facilitate monitoring and to guide re-censusing of known breeding locations. Volunteers were either assigned a partner from within the program or encouraged to invite another interested person. Consequently, two people were always at a wetland to help each other in case of emergencies, to assist with surveys, and to provide companionship. Volunteers checked with private property owners prior to surveys. If property owners did not want volunteers at their wetland, we assigned volunteers to a different site.

Field Surveys
Upon arrival at a wetland we instructed volunteers to conduct a visual search of the shoreline and shallow standing water with binoculars for adults and juveniles along the shore. We then asked volunteers to slowly wade and look for amphibians and eggs in slow-flowing or still water up to 90 cm (~3 ft.) deep among areas of thin-stemmed emergent and thin-stemmed woody vegetation. At potentially favorable sites, volunteers were specifically instructed to carefully search for amphibian eggs attached to vegetation below or at the water's surface. These search methods are similar to those recommended by scientists for basic amphibian surveys (Thoms et. al., 1997).

One measure of the health of amphibian populations was determined by examining egg masses. We therefore asked volunteers to describe unusual egg conditions including sterile eggs, dead embryos and fungal material in egg capsules, all of which suggest death. We assumed egg mortality values exceeding 5% of total eggs as abnormal based on reference sites that have shown at least some mortality among egg masses (Richter, unpublished manuscript). We considered wetlands and watersheds to be impaired when detections of native species declined within a wetland, adults were sighted but no eggs were found, the percentage of unhealthy clutches to that of total clutches exceeded 5% of all masses, and bullfrogs were present.

Quality Assurance/Quality Control
I deliberately selected amphibians with easily sighted and identifiable life stages (i.e., red-legged frog and northwestern salamander adults with large, unique egg masses) for volunteers to monitor to minimize the chances of misidentification. We checked all surveys and recordings for unusual observations. Unusual sightings were verified by checking documentary photographs and with follow-up site visits by qualified staff. Staff dip-netted larvae to confirm amphibian use identified by volunteers. Staff also visited a number of wetlands in late summer to determine water permanence and thereby confirm the possibility of northwestern salamander and bullfrog sightings at wetlands, as both these species require wetlands with year-round standing water for successful reproduction.

Volunteers identified all of the species confirmed by us to be present from dip-net surveys. However, dip netting did not detect one species seen by volunteers at some sites - the long-toed salamander. This may have been either because long-toed salamander larvae were misidentified as northwestern salamander larvae (the two salamanders have a very similar larval form), or because very few salamander larvae were captured in dip-nets.

Results

Public Outreach and Education
From 1993 through 1997 our Wetland-Breeding Amphibian Monitoring Program surveyed a total of 81 wetlands within 26 watershed basins using 126 volunteers. Initially 10 volunteers participated in 1993, then 43 in 1994, 51 in 1995, 33 in 1996, and 64 in 1997. Thirty-two new volunteers participated in 1997. The average volunteer participated for nearly two years (mean 1.75). With the exception of 1993, demand for participation exceeded acceptances. Preference was given to volunteers monitoring within priority watersheds. Thus others wishing to monitor were sometimes turned away.

Our volunteers came from many diverse backgrounds. They included nature enthusiasts; mothers with young children; elementary, junior and senior high school students; members of service organizations; people interested in changing careers; students requiring community service; citizen activists; residents curious about the wetland in their own backyard or down the street; and people wanting to help restore amphibian populations. Volunteers are wetland consultants, engineers, elementary, junior and senior high school teachers, government employees, and other professionals.

Discussion
The seven wetland breeding species of amphibians observed by volunteers are consistent with the seven species found during 10-year intensive surveys of 19 wetlands throughout King County using multiple census techniques (Richter and Azous 1995). Volunteers usually did not detect western toads or bullfrogs during early spring surveys, consequently the presence of these species was determined from additional surveys in late spring and summer.

These surveys document the presence of amphibian species at wetlands, but do not necessarily indicate the absence of others. Hence, there may be more species at monitored wetlands than identified, although it is suspected their numbers may be low. For example, the volunteers have not documented the presence of the Oregon spotted frog. This is unfortunate in light of the fact that the lower Puget Sound basin of King County encompasses the range of this species, which is currently listed as endangered in Washington State, and is being considered for federal listing by the U. S. Fish and Wildlife Service. Many wetlands providing potential habitat for this species remain un-surveyed and may yet contain isolated populations of this species. Perhaps in the future, volunteers at additional wetlands may encounter them.

Repeat volunteer surveys enabled us to identify amphibian population trends at wetlands. Sightings of damaged and dead eggs enabled us to immediately indicate impaired wetland condition. Our surveys suggest that many amphibian egg masses are characterized by a small amount (<5% of total eggs) of mortality. Greater numbers of dead eggs and dying embryos may be attributable to changes in wetland water level fluctuations which expose eggs to freezing and desiccation, poor water quality resulting in attacks by fungi and disease, or by a combination of physical and biological stressors associated with other changes in wetland condition. Alternatively, observations of sterile eggs may indicate amphibian infertility attributable to adult condition, water quality, or watershed land use activities. Collectively, this volunteer information is valuable in that it has identified healthy wetlands and their amphibian biota. It has also documented the decline of amphibians at other sites suggesting that wetland health at these may be imperiled. Volunteers are continuing to monitor as many wetlands as possible.

Volunteer participation in environmental monitoring is becoming increasingly important in providing information to public agencies with multiple demands and tight budgets. While our impacts on the environment continue to increase with growth and development, our ability to monitor changes has been diminished because of the effort and expense required to assess complex interactive environmental changes. Our wetland-breeding amphibian program demonstrates that volunteer participation significantly contributes valuable information to resource agencies for environmental planning and impact assessment. Field reports returned by volunteers have been invaluable to King County in monitoring the distribution and abundance of amphibians in rapidly developing landscapes. These reports also provide the only regularly gathered survey data on the status of amphibians and select wetland conditions in King County. For the first time, we have up-to-date field data on the actual distribution, relative abundance, and health of amphibian populations as well as information on wetland vegetation, water characteristics, and other habitat factors. Moreover, regularly gathered data is providing us with information on changing amphibian and wetland conditions from which we are able to determine whether our land use activities, policies, and regulations are consistent with our goals of wetland protection and responsible development.

Specifically, this program has made valuable contributions to County planning activities. Amphibian surveys, in conjunction with hydrologic and wetland habitat descriptions, continue to be instrumental in environmental review and site restoration strategies for recently purchased County properties. Survey data was instrumental in the recent construction of an amphibian breeding pond and the restoration of upland wildlife habitat. Similarly, amphibian data collected in a Rhododendron Species Garden Pond is providing guidelines for pond maintenance and fountain construction. Finally, volunteer amphibian data has been used to develop management plans for other sites.

Since its inception in 1993, the Amphibian Monitoring Program has become one of the most successful volunteer programs offered by King County. Citizen volunteers from all over the County have been eager to participate in the workshops to monitor amphibians– learning about their ecology, distribution, and health– and also to assess the wetland conditions in which amphibians breed. Nevertheless, participation in the program was limited by qualified staff, program preparation, teaching time, available facilities, and our goal of providing a “hands-on-program” with a field-monitoring component that minimizes wetland disturbance. Volunteers representing federal agencies, other counties, cities, private consulting firms, parks departments, local zoos, schools, and youth groups all participated in the program and educated their constituents.

Despite these early benefits, this program is just beginning to provide rigorous, scientifically defensible population and amphibian baseline and health trend information. It will become increasingly valuable as monitoring continues. Our review of field notes, familiarity with many of the wetlands, and our QA/QC results suggest that our volunteer data is reliable and that our early findings are highly valuable for some planning purposes.

Nevertheless, program improvements are recommended. These should include providing better instructions as currently too much material is presented in to short a time period. Volunteers should also be switched between some wetlands as the absence of amphibians at a site discourages volunteers from continuing to monitor their site regardless of the potential scientific importance of documenting "no sightings." Our program could also benefit

from better recruitment strategies aimed at encouraging volunteers to monitor specific wetlands for information of interest to the County but not necessarily of interest to volunteers themselves. Finally, the program needs to be institutionalized by the County with permanent support. Only through such actions can we continue this highly productive and valuable volunteer program.

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SIGNS OF LIFE: MONITORING THE HEALTH OF WETLANDS

Dakota County Wetland Health Evaluation Project

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Guidance and Quality Assurance/Quality Control Plan available from Charlotte Shover

Background:
The Dakota County Wetland Health Evaluation Project is a partnership between citizens, local governments and local educators working in cooperation with the Minnesota Pollution Control Agency, the Dakota County Environmental Educational Program, two local nature centers, and the wetland consulting firm of BRW, Inc. Dakota County, Minnesota is located just south of the Minneapolis/St. Paul Twin Cities area. Most of the county is in the northern hardwood forest ecosystem.

In concept, the Wetlands Health Evaluation Project is similar to citizen-based stream monitoring programs around the country. In content, however, this project focuses on wetland biology, ecology, and the landscapes surrounding wetlands. Citizens monitor in June for invertebrates and July for vegetation, times of peak importance for their respective biological groups as determined by state biologists.

The goals of the program are:

- To develop methods for biological assessment of wetlands by citizens that are grounded in science and based on technical assessment methods.
- To provide local government with useful, cost-effective information about wetland health that can be used in management decisions.

The 1999 project grew out of a partnership that began in 1995 between the Minnesota Audubon Council and the Minnesota Pollution Control Agency to test a protocol that citizen volunteers could use to gather data on wetlands. We have now completed three years of monitoring in Dakota County, and we will have 11 teams monitoring in eleven communities in 2000. Funding for the program has come from USEPA Region 5 and the Minnesota Legislature.

Monitoring structure:
The structure of the Dakota County Wetland Health Evaluation Project is built on city teams. Teams of adult volunteers are recruited in each community. Ideally, these teams would have 10-15 members. Each team has a team leader, usually a secondary school science teacher or nature center staff person. We also have two citizen monitoring coordinators who work with each team in the field and laboratory to assure the quality of the methodology and data. They are also responsible for ordering equipment and preparing a report. The wetland consulting firm of BRW does quality assurance/quality control checks and prepares data analysis reports. The Minnesota Pollution Control Agency offers three training opportunities:

- field techniques,
- macroinvertebrate protocol and ID, and
- vegetation protocol and ID

Monitoring parameters:
Teams analyze the critters collected according to invertebrate metrics linked to wetland quality. Each of the metrics is assigned a numeric score. The results of the vegetation sampling are run through metrics that highlight specific

parts of the plant community linked to wetland quality. Again, each metric receives a numeric score. When a quality rating for each wetland is determined, each site is classified as:

- high quality: fully supporting aquatic life,
- moderate quality: aquatic life is threatened, or
- poor quality: not supporting aquatic life.

Monitoring results:
Approximately 35 wetlands were monitored by citizen teams in 1999. Generally, the vegetation and invertebrate ratings were very similar, with most wetlands rated as Moderate quality. Results have been similar each year, with most wetlands scoring in the Moderate range.

In 1988 we compared scores from city teams and BRW using the same citizen method. For vegetation, 75% of the observations resulted in similar point scores. Overall, the vegetation scores calculated by the city teams and BRW were similar for most wetlands evaluated. Again in 1988, comparing citizen to professionally-collected data for invertebrates, approximately 61% of the wetland invertebrate scores were similar. It is likely that sampling location, sampling depth, observer experience, number of bottle traps recovered, predation, and number of dip net samples played a role in the observed variation. Certainly the scores for vegetation and invertebrates were similar enough to promote citizen monitoring as a screening approach to wetland health.

What we've learned: Training
We found it helpful to:

- Balance the amount of technical and non-technical information
- Separate field training from protocol and ID training
- Use self-quizzes to help build confidence
- Have teams bring their own invertebrate sample to training. (This reduces workload on the trainer and builds upon the learners' curiosity about what they found).
- Provide identified reference collections to the team leader to use following the training.
- Collect sufficient fresh vegetation to provide each team a labeled set (identified to the genus level) and an unlabeled "unknown" set.
- Provide written training materials to participants ahead of time.
- Provide two ID training sessions for each plant or macroinvertebrate community, a primary 6 hour session and a follow-up 2-3 hour refresher session.
- Hold three public information seminars on wetlands in the winter/early spring to help expand knowledge about wetlands and the summer monitoring program.

What we've learned: Coordination

- Having secondary school science teachers and nature center staff serve as team leaders has benefit to the program as well as in the formal or informal educational setting.
- Paying team leaders a stipend ($100 per metric per wetland) is well worth it. This is a big job.
- Buy-in and support from city staff are critical. People need to know that someone cares about their work and the results they are getting.
- Requiring teams to make presentations to local policy makers in their city ensures that cities consider the data and the value of volunteers in their community.

- Promoting the program and results through local media lets the rest of the community know about the project.
- Celebrating the volunteers through dinners, door prizes, and publishing results from summer monitoring is key to keeping volunteers.

What we've learned: Improved results

- Preparing and adhering to a guidance and QA/QC document that is clearly laid out in an intuitive fashion. Avoiding redundancy is essential.
- Having a citizen monitoring coordinator doing QA/QC checks in the field and in the lab helps the teams do a better job.
- Have microscopes for invertebrate ID.
- Use a simple scoring system
- Increase the number of replicate samples citizens collect
- Have one team sample another team's wetland as a quality check
- Provide examples of completed data sheets for teams to see proper data entry
- Have teams sketch their wetland showing where they sampled and principal plant communities of their wetland

What we've learned: In general

- It is important that state agencies provide the scientific underpinning of the sampling and that the development of wetland biological criteria is on-going.
- Always conduct sampling within the recognized "index periods."
- One size of waders does not fit all. We need to provide several waders of differing sizes.
- Always provide participants with the opportunity to sample a high quality wetland so they can appreciate how biologically rich wetlands can be.
- Make sure that teams work well together and have fun.
- Have fun and recognize the volunteers.

Feedback from volunteers:
It is important to recognize why citizens volunteer for a monitoring program. In a survey, the citizens said they:

- Were interested in preserving wetlands
- Met a lot of people
- Liked the hands-on learning
- Expanded their knowledge
- Liked the training sessions
- Liked wading in wetlands

"It was an opportunity to learn about wetlands, do something important for the environment, and to meet people with those interests." It is not hard to find citizens who care about the environment and are willing to work with their local city to learn more about wetlands in their community.

"To immerse myself in a pond with nothing on my mind but invertebrates, plants, the sunset, and water was refreshing and renewing." We have to remember, that people do monitoring because it fills something special for them.

Closing:
The Dakota County Wetland Health Evaluation Project (WHEP) is one piece of a bigger picture -- protecting the quality of our natural environment as a whole. We are proud to be on the cutting edge of doing wetland monitoring in Minnesota. We hope what we are learning will encourage and support others interested in wetland health in their area. The ultimate dream is that by evaluating the health of all the waters in our community, including wetlands, we will be able to make decisions today that will ensure a healthy natural environment for tomorrow.

Reference materials used in training, in the field, and in the laboratory:
The Minnesota Pollution Control Agency (MPCA) has reference materials available for use during training. Dakota County WHEP provides reference materials to the teams for use in the field or laboratory.

Reference Materials	Used in training	Provided to teams
Restoring Life in Running Waters: Better Biological Monitoring, James R. Karr and Ellen W. Chu, Island Press, 1999.	*	X
Vegetation:		
Wetland Plants and Plant Communities of Minnesota and Wisconsin, by Steven Eggers and Donald Reed, US Army Corps of Engineers, St. Paul District.	X	X
A Guide to Aquatic Plants: Identification and Management, by MN Dept. of Natural Resources, Ecological Services Section	X	X
A Manual of Aquatic Plants, by N. C. Fasset, The University of Wisconsin Press	X	no, outdated
Vascular Plants of Minnesota: A Checklist and Atlas, by G. T. Ownbey and T. Morely, UM Press, 1992	X	*
Key to the Common Aquatic Plants of Minnesota, Special Publication No. 53, by Richard Carlson and John Moyle, MN Dept. of Conservation	X	?
A Field Guide to Wildflowers of Northeastern and North Central North America, R. Peterson and M. McKenny, Houghton Mifflin Company	X	?
How to Know the Aquatic Plants (2nd Ed.), The Pictured Key Nature Series, Wm. C. Brown Company Publishers	X	?
Manual of Vascular Plants of Northeastern United States and Adjacent Canada, H. A. Gleason and A. Cronquist, New York Botanical Garden	X	*
MPCA developed fact sheets and identification keys for plants	X	X
Aquatic Wetland Plants of Northeastern North America, Crow and Hellquest	if available	?
Through the Looking Glass: A Field Guide to Aquatic Plants, Susan Borman, Robert Korth, Jo Temte, Reindl Printing, WI Lakes Partnership, UW Extension	X	X

Reference Materials	Used in training	Provided to teams
Invertebrates:		
Aquatic Entomology, by W. Patrick McCafferty, Jones and Bartlett Publishers	X	?
Aquatic Insects of Wisconsin, 3rd Ed., Publication No. 3 of the Natural History Museums Council, University of Wisconsin-Madison	X	X
An Introduction to the Aquatic Insects of North America, 3rd Ed., R. W. Merritt and K. W. Cummins, Kendall Hunt Publishing	X	
Freshwater Invertebrates of the United States, 3rd Ed., Robert Pennak, John Wiley and Sons	X	
Ecology and Classification of North American Freshwater Invertebrates, James H. Thorp and Alan P. Covich, Academic Press	X	
MPCA developed fact sheets and identification keys for invertebrates	X	X
"Wonderful, Wacky Water Critters," University of Wisconsin-Extension		X
A Golden Guide: Pond Life, George K. Reid, Gold Books	?	X

KEY:

X = reference is used

? = may not be suitable or practical for team or training setting

* = copy available at the Dakota County Environmental Education Program office and the Dakota County Wescott Library in Eagan

MURKY WATERS? MAKING SENSE OF WATER CLARITY MEASURES

SESSION INFORMATION:

Moderator:

Jeff Schloss, UNH Cooperative Extension

Presenters:

Jeff Schloss, UNH Cooperative Extension
Murky Waters? Gaining Clarity on Water Transparency Measurements

Bob Craycraft, UNH Cooperative Extension
ViewScopes and Secchi Disk Measurements

Jennifer Klang, Minnesota Pollution Control Agency
Using the Transparency Tube in Minnesota's New Citizen Stream-Monitoring Program
(abstract only)

MURKY WATERS? MAKING SENSE OF WATER CLARITY MEASURES

Murky Waters: Gaining Clarity on Water Transparency Measurements

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Does your program measure water transparency? Turbidity? Water clarity? Secchi Disk Depth? Aren't these all the same thing? Why do some groups report turbidity as JTU while some use NTU and others use FTU or even FNU? Is it possible to convert Secchi Disk measurements to turbidity? What about those "turbidity tubes" everyone is using? What do they actually measure? This introduction will provide an overview of the above mentioned methods. It is meant to provide a lead into the two following presentations that will present more specific studies regarding water clarity measurement protocol and the use of "turbidity tubes" in volunteer monitoring programs.

The Secchi Disk

Father Peitro Angelo Secchi was a Jesuit astronomer and science advisor to the Pope. The commandant of the Vatican fleet, Commander Cialdi, requested that Secchi study the water transparency of the Mediterranean Sea. Aboard the papal steam ship *L'Imamacolata Concezione* on April 20, 1865 Cialdi recorded the first documented measurements of water transparency made by Secchi. Fr. Secchi lowered a white disk attached to a line down into the water and noted the depth of its disappearance from view. Thus, the "Secchi Disk" was born. Why were sailors interested in ocean water clarity? The clarity of the water could indicate what current the ship was in. For example, the Sargasso Sea in the Atlantic Ocean is extremely clear compared to coastal upwelling currents, which have much higher productivity of plankton and thus less clear waters. So water clarity would help determine which current the ship had encountered, important information for navigation.

Secchi and Cialdi experimented with two types of disks, a 43 cm disk of white clay and a 60 cm diameter disk of sailcloth painted white and stretched over an iron ring. He also experimented with different colors including yellow (the color least absorbed by ocean waters) and brown (red is the color most absorbed but red dyes tend to be unstable). The standard oceanographic Secchi Disk used today is 40-60 cm in diameter dependent on the typical Secchi depth measured. It is all white. The standard limnological (lake) disk is smaller, 20 cm (8 inches) with alternating black and white quadrants. This is attributed to Whipple who in 1900 modified the white disk since lakes could have bright or dark bottoms depending upon their depth, geology and bottom cover. Larger black and white disks have been used by scientists measuring transparency in the clearest lake waters like Crater Lake, where Secchi depth can reach 144 feet (44 meters!).

Secchi Disk Depth is a function of the absorption and scattering of light by particles and dissolved substances in the water (Figure 1). The particles include algae, sediments and detritus (organic particulates). The dissolved substances are the organic acids that result from the breakdown of plants and algae. They may be from the plants and algae of the waters or may originate from the drainage of wetlands or wet humic soils somewhere in the watershed. For more turbid systems the Secchi depth is affected more by the particulate components in the water but our research shows that in clearer waters the Secchi depth can be greatly influenced by the dissolved components (see further discussion of this below). For all extensive purposes the Secchi Disk acts as a contrast "target" and the Secchi Disk depth is the point where there no longer remains any contrast between the disk and the water background. For this reason, the intensity of the light within a certain range will not necessarily greatly impact the readings obtained.

Secchi Disk Methodologies: Things get murky

> *The Secchi Disk is perhaps the oldest, most durable, the most controversial and potentially indispensable tool of the contemporary limnologist. … If it weren't for volunteer lake monitoring programs, the Secchi Disk might have slowly been lost from the inventory of limnological instruments.* — Dr. Bob "Secchi Dip-In" Carlson (1995).

Why such a contradicting commentary from the organizer of the Great North American Secchi Dip-In (an event that occurs every year during the first two weeks of July; refer to http://dipin.kent.edu)? It is true that the most common parameter measured by all volunteer lake monitoring programs is Secchi Disk transparency. Also, the concept

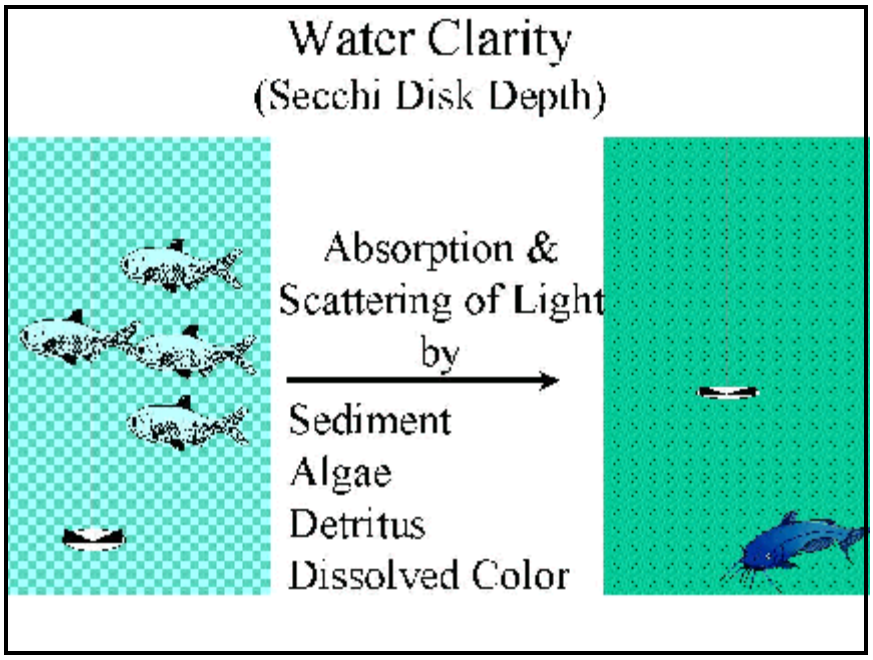

Figure 1

behind the measurement and the concept of water clarity is very intuitive and can be easily explained to the general citizenry. However, his additional comments refer to the inconsistencies in the methodology used and the potential difficulties in the comparison and interpretation of the resulting data produced.

Although Secchi Disk measurements are as old as the science of limnology, there is still no one agreed upon protocol of measurement. First of all, the definition of the Secchi depth has varied between practitioners. Some use the depth at which it is "just visible"; others have noted the depth of disappearance. Most current limnology field manuals and Secchi researchers suggest using the average of the depth of disappearance and the depth of re-appearance when the disk is raised. Even Secchi was well aware of the reasons for variations in transparency depth. During his studies he employed umbrellas and used the shadow of the ship for shading and compared measurements. He concluded that the critical factors in the measurement of the Secchi depth were the diameter and spectral reflectance of the disk, a calm or stormy sea, angle and reflections of the sun, reflection of the sky on the water surface, and shadows on the submerged light path. As for sun angle, it is generally agreed that the measurements should be made as closest to true noon as possible. Secondarily, it is important to take measurements before the sun approaches the angle where most of the light reflects off of the water's surface instead of penetrating the water. This will vary depending on time of year and season but many programs recommend readings between 10am and 2pm while some allow readings between 9am and 3pm. In the latter case, be aware of daylight savings time changes, which may require a shift to true time readings.

The reflectance of the disk is a factor that comes to play during the construction of the disk and it is generally recommended to use a "flat" finish of paint and not a "glossy" one. The former will diffuse the reflection off the disk at all angles while the latter can complicate measurements made when the disk is slightly "off angle," as it will deflect light unevenly. Theoretically, the reflectance should be standardized but that would be a daunting task. The use of an all black Secchi Disk, promoted by the New Zealand limnologist R. J. Davies-Colley, best tackles this problem, as well as some of the other theoretical optical intricacies involved, although it has not caught on in the research community in other countries—let alone volunteer programs. Another construction consideration (and measurement protocol) of the disk involves the use of non-stretching line or fiberglass tape if a marked line is to be used. This can also be avoided if a measuring stick is used to measure the line but that involves taking out yet another piece of equipment for sampling.

Even more controversial than a black vs. white, vs. black and white disk is the effort to deal with the optical state of the water's surface (reflection, glare, glitter). The easiest approach, but one less practical, is to only measure on days of perfect conditions. A more common approach is to employ the recommendation of Father Secchi and take readings off of the shadowed side of the boat. While this often solves the surface interference issues it may actually introduce larger errors especially in cases where the Secchi Disk depth is shallow or ranges through the depths

shaded by the boat's shadow. The optical oceanographer J.E. Tyler in his 1968 review of Secchi Disk optics goes into great detail on why taking a reading on the shadow side is problematic and employs a column full of equations and diagrams. In essence, his conclusion is that due to the optical properties involved, readings become less comparable with each other under changing time, sun angle (and boat type) and even brightness (which typically is not a factor that normally influences proper Secchi Disk measurements). Bob Carlson indicates that this shadow factor can vary Secchi Disk readings by as much as 15%.

To be able to make readings on the sunny side of the boat and deal with the interference from glare, reflection and glitter, many groups employ a "view scope". This usually is a 4" or greater diameter tube with or without a lens on its bottom end or a face seal on its upper end. An attached handle facilitates holding the tube just below the surface of the water to view the descent of the disk. To minimize reflection within the tube the interior is painted black. A plexiglass lens on the bottom end will keep water from entering the tube and splashing around. These apparatus can be homemade or obtained from commercial sources. A recent design modification in the commercially made scopes places the lens at an angle to the end of the tube to keep reflection off of the lens to a minimum. A good face seal (neoprene works well) at the top end or shading of the observer's head can also minimize this reflection. Some practitioners have used face masks, view boxes and even children's pool toys (inflatable "fish scopes" and view rafts) but a rigid scope has the most utility for most applications. The length is not a factor for a wide enough tube but care must be taken to only submerge the tube bottom a shallow, set distance. This is often accomplished by marking a line on the outside of the bottom end of the tube or submerging the tube until the end cap that holds on the lens is just under the surface.

European limnologists and pioneer American limnologists employed view-scopes in their Secchi measurements but there are many volunteer programs that have not. Theoretically the scope accounts for many of the non-clarity-related interference already discussed above. Independent investigations by volunteer monitoring programs in Minnesota and New Hampshire (See Bob Craycraft's paper, *ViewScopes and Secchi Disk Measurements "What's the Difference"*), and most recently, by researchers on reservoirs in New York have demonstrated that higher precision of measurement can be achieved between observers by using a scope. Our results in New Hampshire also indicate that the scope allows for a greater sensitivity in Secchi measurements for lakes with deep Secchi depths. Does that mean that groups currently not using a scope should start? That all depends on the goals and data objectives of your program. If you have already been taking many measurements and have a long-term program, changing your methodology will complicate multi-year comparisons. You may want to live with a potential loss in the precision of your measurements. If you monitor systems that have very shallow transparencies or are only interested in large water clarity changes, the scope may not make any difference at all in the interpretations of your measurements. If however, you monitor pristine systems or are interested in documenting subtle differences in water clarity or are concerned about precision between observers, you may want to consider using the scope.

Can you convert or compare Secchi measurements?
Theoretically, on a calm day with little glare or reflection on the water surface, the Secchi depth measured, with or without a scope, should be comparable. We are currently examining the results of a multi-year comparative effort that involved volunteer monitors and professionals in a wide range of lakes and conditions and have found that the conversion is not just a simple correction factor. Sky, sun, wind, water conditions and time of day all play a part in the difference, as would be expected. The important take-home message is to make sure that no matter what your Secchi Disk protocol of choice is, you document the conditions that occurred and the time of the measurement. This will eventually allow for conversion or comparison using reported factors or your own methodology comparisons.

What Are We Measuring Anyway?
One of the reasons for using a Secchi Disk stated above is that it is an easy to understand measurement. Water clarity by itself can be important: many people will not even think of swimming in a lake, river or ocean if they can't see their toes! Also, a change in transparency over time indicates something is occurring in the water. Thus, Secchi Disk depth vary seasonally, after rain events, or with heavy recreational use. These variations can indicate water quality impacts. Water quality trends over the years can also be documented with a time series of Secchi depths. In fact, independent studies done on Vermont and Minnesota volunteer program data disclosed that Secchi Disk depth data was better able to detect long-term trends than either phytoplankton (as measured by chlorophyll *a*) or nutrient (total phosphorous) monitoring.

We should expect Secchi depth to be related to light extinction through the water column. Our research indicates a very good correlation between Secchi depth and sunlight extinction measured using an underwater irradiometer (essentially a waterproof light meter). In fact, some programs use the results of the Secchi Disk depth to determine the extent of the integrated water sample that is to be collected for lab analysis. Since many lake programs are

interested in assessing lake productivity (phytoplankton and plant growth) the estimated depth of the photic zone (waters in which photosynthesis takes place) is an important factor. Limnology texts suggest the Secchi Disk depth represents relative light depths ranging from 1 to 15 percent of the surface light. Our measurements made in a wide range of New Hampshire Lakes with Secchi Disk transparencies ranging from 1.8 to 14 meters disclose the Secchi depth occurred at 1.3 to 11 percent of the surface illumination with a mean of 5.5 percent and median of 5.0 percent (n=66). The aforementioned texts report the photic zone to range between 2 to 3 times the Secchi Disk depth. Our results for NH lakes indicate that it is probably closer to (or just less than or greater than) twice the Secchi depth for our lakes. Values at that depth range from less than 0.1 percent to 1.3 percent with a mean of 0.4 percent and a median of 0.3 percent.

Secchi disk measurements alone are often made as a surrogate for other more complicated or expensive measurements. Many states have Secchi Disk- based criteria or standards. A few use clarity as the primary basis for management decisions. This is fine if you are very sure of how your system works and either phytoplankton (floating algae) or suspended sediment always exclusively dominate as particulates. Or, it may be that it is just the clarity of the water you are concerned about. If this is not the case, care must be taken when it comes to interpretation of measurements. It may be a phytoplankton bloom one week, a sediment event the next and an influx of colored water from an adjoining wetland the next. Similarly, relying on a Secchi Disk measurement alone to calculate a trophic state index may be risky. To add to the confusion, certain conditions such as the thin layering out of phytoplankton at the thermocline of a stratified lake (termed metalimnetic layering) can make the disk instantly disappear well before the upper water conditions would dictate. This phenomenon will wreck havoc with modeling, indexes and water quality criteria based on Secchi Disk alone.

To address the “what” is being measured by the Secchi Disk dilemma some groups turn to apparent color measurements. Apparent color is the color of the water due to both particulate and dissolved components. It differs from dissolved “true color” which is measured after filtration so it can not be ascertained in the field. The underlying assumption is that algae tend to impart golden, green, blue-green or reddish brown hues while sediments in water tend to be gray or yellow to light to dark brown in color. The apparent color, as seen by viewing the white quadrant of the disk (sometimes set to one half of the Secchi depth) is matched to a color on some sort of color strip or color chart . The Ohio program developed the “Custer Color Strip” (named for its originator Clyde Custer) based on standardized Pantone colors (available at printing centers) that is used by other programs as well. Some groups use the standardized colors found on “Munsel” soil color books while others use a series of paint chip samples. A few field science and educational supply houses sell a standardized color chart devised for stream bottom color description that may also be used for this purpose. By documenting the color at the time of measurement, some insight as to what is affecting water clarity may be gained.

Our program has volunteers monitor Secchi Disk depth, along with chlorophyll *a* (an estimate of algae biomass) and dissolved water color (particles filtered out). Sediment is not directly monitored as it is difficult to get accurate suspended sediment yields in our generally pristine waters unless large volumes of water are filtered. However, by comparing all of our results together we can generally interpret what influence each of these plays on water clarity (while sediment is not measured directly, a decrease in water clarity that does not correspond to an increase in chlorophyll *a* or dissolved color can be attributed to sediment). For New Hampshire lakes we have found for the most part that neither chlorophyll *a* or dissolved color alone explain the variations in Secchi Disk transparency as well as the combination of the two (Table 1). Also, dissolved color tends to gain in influence at levels at or greater than 20 standard color platinate units and at Secchi depths greater than 10 meters.

Table 1. Secchi Disk (SD) as Surrogate for Chlorophyll (CHL) and Dissolved Color

Treatment	R-Square
1/Seccchi Disk v ln Chlorophyll *a*	0.690
1/Secchi Disk v ln Color	0.545
1/Secchi Disk v ln Color , ln Chlorophyll *a*	0.791

N=61; UNH Lake Survey Data 50 Lakes June-August 1999

Turbidity

While some programs refer to Secchi Disk transparency as a turbidity measurement, this is not correct. The origin of turbidity measurement dates back to about 1900 when Whipple (the same guy who painted the Secchi Disk black and white) and Jackson devised a method that involved holding a flat-bottomed, calibrated glass tube over a special candle and pouring the water sample into the tube until an observer looking from the top of the tube could no longer see the image of the candle flame. Unlike the Secchi Disk measurement where just the distance (depth) was noted these measurements were calibrated to a known standard of suspended material. The tube was calibrated in Jackson Turbidity Units (JTUs) with measured dilutions of a standard solution of silica (diatomaceous earth) in distilled water. The number of JTUs varies inversely and nonlinearily with the height of the sample (e.g., a sample which measures 2.3 cm has a turbidity of 1,000 JTUs whereas a sample measuring 72.9 cm has a turbidity of 25 JTUs; 1 JTU represented 1ppm of silica). This facilitated the measurement of water samples from systems too shallow or with too great a flow to utilize a Secchi Disk. Over the years other materials were calibrated to JTUs (clay, Fuller's Earth, acid washed stream bed sediments) and the system was modernized by replacing the candle with a light bulb and increasing sensitivity using a series of neutral density filters. The major limitations that lingered, however, was that the minimum detectable limit remained at about 25 JTUs and there was not an acceptable primary standard that insured comparability of measurements.

By the early 1970s, Formazin, a chemically created polymer, was established as the new primary standard for turbidity. A certain design of Turbidity Meter, the Nephelometer, became the preferred instrument of turbidity measurement. It offers much greater sensitivity and minimizes differences between observers as it measures turbidity photometrically. The basic design requires that the instrument measure the amount of light scattered at 90 degrees when a beam of light is transmitted through the sample. Most current nephelometers employ two light detectors (Figure 2) one at 90 degrees to the incident light, and one directly in the beam's path to measure transmitted and forward scattered light. The second detector is used to minimize the inferences of color and larger particles. This instrument employs the ratio between the two detectors to calculate the sample turbidity. Units are reported as Nephelometric Turbidity Units (NTU; the most popular), Formazin Turbidity Units (FTU) or Formazin Nephelometic Units (FNU) which are all equivalent. Due to Formazin's short term stability and toxic nature, secondary standards that have been formulated in comparison to the primary standard are in more common use. These substances offer many times the shelf life and less danger of poisoning. For those groups that have data quality objectives that require EPA or state acceptance, there are set design standards that a nephelometer must have. They include the following:

- The detector should be centered at 90 degrees +/- 3 degrees to the incident light path.
- The maximum distance traversed by the incident and scattered light within the sample tube is 10 cm.
- Instrument sensitivity should permit detection at a turbidity difference of 0.02 NTU or less in water less

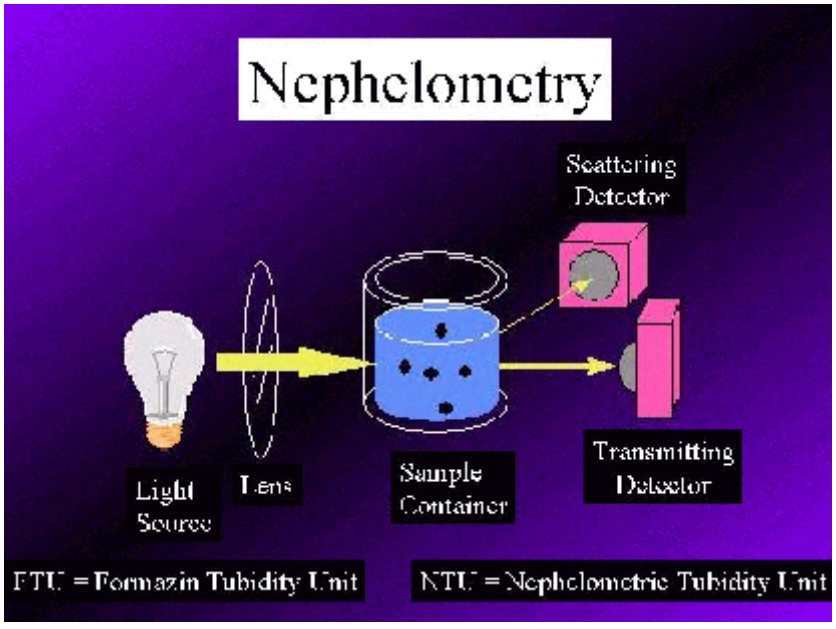

Figure 2

than 1 NTU.

- The detector and any filter system are to have a spectral peak response between 400 and 600nm.
- The light source should be a tungsten lamp operated at a color temperature of 2,200 to 3,000 Kelvin

Some recent Nephelometers, Turbidometers and in-situ Turbidity probes, even some with higher precision and sensitivity than EPA approved units, do not meet the above requirement of a tungsten lamp as they employ a more monochromatic LED light source (generally in the red or near infra-red wavelengths). These may be acceptable under the international ISO standard for turbidity, ISO 7027. However, unless there is a move to performance based standards or you can demonstrate inter-calibration between these and an approved unit, your data may be considered "qualified." We have actually compared these LED units to tungsten lamp units and found the LED based units have a greater accuracy as they tend be less affected by high levels of dissolved color which causes more interference at the blue end if the spectrum than at the red end.

As expected, due to the optical principles employed, the turbidity of a water sample will generally correlate very well with suspended sediment content. Many states have existing standards or criteria for turbidity that may cover contact recreation, drinking water, aquatic habit or general surface water quality. Some lake, river and coastal groups use nephelometers in their monitoring programs but typically these units are cost limiting, generally running between $500 and $1,000 for accurate meters.

Turbidity Tubes

A relatively new apparatus on the scene, the "turbidity tube" is gaining in popularity in its use by volunteer stream monitoring groups and teachers and students involved in Project GLOBE. It consists of a transparent plastic or glass tube (usually between 1 and 2 inches diameter) that has some sort of visibility target (often a "mini" Secchi Disk) at its bottom end that is open at its top. The observer pours water into the tube until the target can no longer be seen. This is sort of a hybrid process that combines the Secchi Disk and Jackson Turbidometer approaches. The height of the water level is documented using some sort of scale that is marked or etched on the side of the tube. Some tubes are fitted with a drain hole located at or near the bottom while others add a short length of tubing and a hose clamp or even a large syringe to more accurately control the water level during measurement.

The first documented use of a turbidity tube has been attributed to Noel Morgan who in 1991 employed a 2 liter plastic soda bottle marked and calibrated in NTUs to estimate turbidity in the storm runoff of Australian farms. Cost effectiveness was the major underlying factor in his design and these were typically very turbid systems being monitored. Sometime around the same time or slightly after, an article in the GREEN Program Newsletter documented the use of a long glass tube fitted with a syringe level control to measure river water turbidity in Africa. This unit was calibrated in centimeters above the visibility target. By 1994 the "Aussies" had developed a mass production model of the turbidity tube at a cost slightly over $10 a piece. This unit was a comparatively sleek model, two feet of polycarbonate tubing about 1 ½ inch in diameter with a black painted target (wavy lines) on a white background. The units were calibrated in NTUs. The Australian Waterwatch Program conducted a nation-wide turbidity monitoring event during national Water Week employing over 700 tubes.

In 1996 an Australian delegation from Waterwatch attended and presented at the 5th National Volunteer Monitoring Conference in Madison Wisconsin. In addition to teaching us all of the verses of "Waltzing Matilda" (and explaining the majority of the words!) they left some of their turbidity tubes in their wake. Interest in the use of these tubes peaked and programs in this country started experimenting with these tubes. Currently, stream volunteer groups and GLOBE participants use a tube calibrated in centimeters. This is the general preference as this type of linear scale offers a greater ease of taking a reading and a higher precision of measurement. The NTU scale is a non-linear, logarithmic one that has different distances between major markings and therefore makes interpolation between the calibrated marks difficult. It is much easier to develop a conversion equation for obtaining estimations of turbidity from the centimeter scale. While this should be done for your own specific waters, there are general conversion graphs for GLOBE participants by scientist advisors at the University of Arizona that have been made available. These conversion factors generally work best in the higher range of turbidity encountered (10 to 400 NTU in this case).

In effect, the "turbidity tube" is actually more a "transparency tube" in terms of the underlying optics of the measurements, especially since these days turbidity is synonymous with nephelometry. However, tube readings do generally correlate very well to turbidity and suspended sediment for within system measurement and for low color waters as indicated by reports from the Minnesota monitoring program (see Jennifer Klang's paper, *Using the*

Transparency Tube in Minnesota's New Citizen Stream Monitoring Program). This is most likely due to the fact that sediment tends to be the predominate particulate in the rivers and streams monitored.

As with Secchi Disk measurements, care needs to be taken in standardizing your protocols. Consideration should be given to:

- Whether the readings are taken in the shade or sun
- The position of the observer in relation to the sun.
- Appropriate target design and length of tube to cover the range of clarity.
- Whether a standard diameter of tube should be used.

While there have been no recommendations on the best way to approach measurements, preliminary research by our program suggests these considerations are of consequence while taking turbidity measurements: Readings in a bright environment can be significantly different than the same sample viewed under more subdued light. This may be a function of the observer's acclimation to bright light or due to stray light from the side of the tube causing interference. Using the head of the observer to shade out the sun above was important in minimizing glare during measurements. Only at high dissolved color levels or for clearer water conditions that necessitate the almost filling of the tube did the "mini-Secchi" target make measurements easier to determine compared to the wavy line target of the Australian tube since. The small distance between the lines on the latter target was problematic for determining the reading in those measurements. No significant difference was found when using tubes of different diameter (1.5 and 2 inches) over a range of different turbidity and color levels.

Dissolved color greater than about 15 platinate units started to influence the comparability of "transparency tube" measurements and turbidity values. The minimum detection level for the manufactured tubes used in our studies was about 10 NTU. This may be improved through the use of a longer tube. However, the longer the tube, the more cumbersome the measurement may be. Perhaps an improvement in design that employs a mirror and prism set that can be economically designed to measure more pristine waters without necessitating an oversized tube can be made.

With the "transparency tube" river and stream and river monitors now have a low cost water clarity device akin to the Secchi Disk of lake and coastal monitors. But just as with Secchi measurements, care needs to be taken in standardizing the monitoring protocol and in interpreting the results.

Last Words

So, are things becoming clearer? Or are they just more transparent? Just remember, even with the simplest of measurements complications can ensue. Thus, standardization and supplemental observations will remain the key in understanding the optical dynamics of your waters and the interpretation of changes measured. Be sure never to call a Secchi Disk measurement turbidity if I am around—there are many other proper options like clarity or transparency. Theoretically the proper way to measure Secchi Disk depth is by using the average of the depths of disappearance and reappearance of a flat painted, standard sized disk off of the sunny side of the boat with the sun overhead and a viewscope in hand (Phew!). But then again, you need to consider the impact to your already existing program of a change in protocol. You <u>can</u> interchange NTU, FTU and FNU at will but JTU implies a lack of a specific primary standard referenced. More expensive Nephelometers will be required to measure very low turbidity levels. However, the "<u>TRANSPARENCY</u> Tube" (take note of this important name change) may make a fine addition to your monitoring program.

MURKY WATERS? MAKING SENSE OF WATER CLARITY MEASURES

ViewScopes and Secchi Disk Measurements

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Water transparency (Secchi Disk) readings are probably the most commonly collected measurements among volunteer water quality monitoring programs stemming from their simplicity and their low costs. When used properly, the water transparency measurements can be a good estimator of other water quality measurements including microscopic plant "algal" growth, suspended sediments and dissolved "tea" colored waters. However, there is no standardized method of collecting Secchi Disk transparency measurements, thus making comparisons among water quality monitoring programs difficult and diminishing the interpretive power of the water clarity readings.

Some water quality monitoring programs require that Secchi Disk transparency measurements be collected on the "sunny side" of the boat while other water quality monitoring programs require the Secchi Disk measurements be collected on the "shady side of the boat". Furthermore, some water quality monitoring programs advocate the use of a ViewScope (PVC pipe, sometimes fitted with a lens) which the volunteer looks through when collecting the water transparency measurements, while other programs do not.

Anecdotal information collected by volunteer monitors participating in the University of New Hampshire Lakes Lay Monitoring Program noted a sharp contrast between Secchi Disk measurements collected with and without a View Scope, particularly under sub-optimal conditions including waves and very sunny days during which glare made water transparency measurements extremely difficult. Additional data collected by professionals (University of New Hampshire research team) further suggested that precision was reduced in the absence of a ViewScope especially under adverse weather conditions. A water transparency study was subsequently initiated, to determine the best way to collect water transparency measurements, and to determine the impact of both the sky (i.e. clear, cloudy) and lake surface (i.e. calm, ripples, waves) conditions on Secchi Disk transparency measurements.

Study Conditions:
University of New Hampshire Lakes Lay Monitoring Program participants were invited to participate in the study and included a total of 33 New Hampshire lakes ranging from nutrient poor (oligotrophic) to nutrient enriched (eutrophic) lakes with a Secchi Disk transparency range of 0.5 to 13.7 meters (1.7 - 45.2 feet). Supplemental Secchi Disk comparison data were also collected by the UNH research team at selected lakes for comparison with the volunteer monitor data. Water transparency measurements were collected under each of four different conditions on each sampling date:

- Sunny side of the boat without the ViewScope
- Shady side of the boat without the ViewScope
- Sunny side of the boat with the ViewScope
- Shady side of the boat with the ViewScope

Replicate water transparency measurements were collected for each treatment as time permitted to determine precision. The Secchi Disk used in this study was a 20 cm diameter plate with alternating black and white quadrates while the ViewScope was approximately 0.75 meters with black interior and a Plexiglas plate on the end that was flush with the water during observations. Secchi Disk transparency measurements were recorded to the nearest tenth of

Table 1: Secchi Disk Transparency Study Weather Data.

Sky:	Clear	Hazy	Cloudy	Overcast
Lake:	Calm	Ripples	Waves	White Caps
Wind:	Calm	Breezy	Gusty	Windy

a meter (4 inches). The study also consisted of the collection of weather data on each sampling occasion as summarized in Table #1. Weather data were collected in three general categories (sky conditions, lake surface conditions and wind conditions) to test three general assumptions:

- Reproducibility (precision) will be reduced in the absence of the ViewScope under adverse weather conditions.
- Increased glare will result in decreased water transparency measurements in the absence of a ViewScope.
- The difference between Secchi Disk Transparency measurements collected with and without a ViewScope will increase with increasing wave size.

Results:
The median precision was high among the four water transparency study conditions when measured by both the volunteer monitors (3% for each of the four conditions) and by the UNH research team (1 - 2% for the four conditions). However, closer examination of outlier data points (those water transparency measurements that exceeded 10% precision) indicate the results become less reliable in the absence of a ViewScope when collected by both the volunteer monitors and the UNH research team (Figures 1 and 2). The most reliable volunteer monitor results were obtained on the sunny side of the boat when using the ViewScope followed closely by measurements collected on the shady side of the boat with the ViewScope.

Figure 1: Percent volunteer readings exceeding 10% precision.

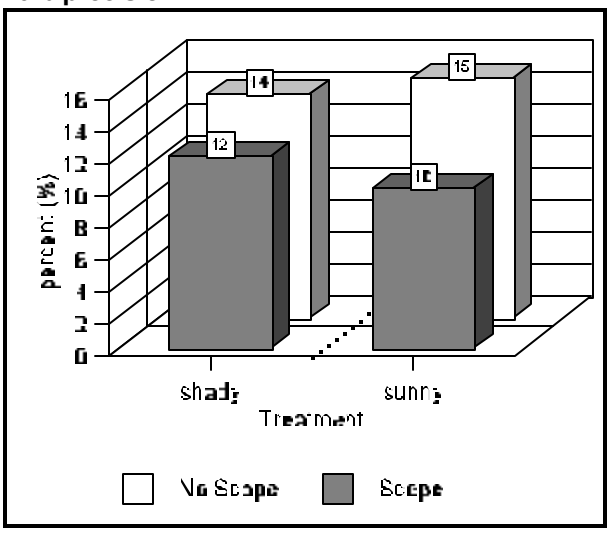
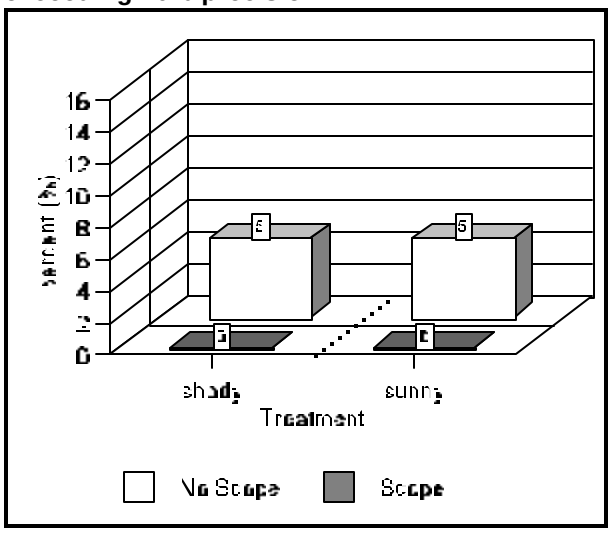


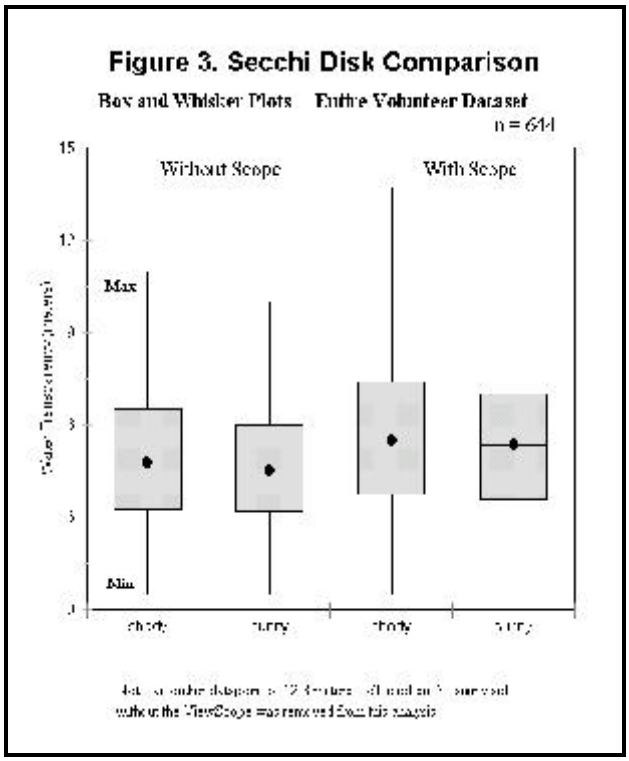
Figure 2: Percent professional readings exceeding 10% precision.



Upon further examination of 644 paired water transparency readings collected by the volunteer monitors, it is evident that water transparency measurements collected in the absence of a ViewScope are not as well dispersed, particularly in the ultra-clear lakes, as water transparency measurements collected with a ViewScope (Figure 3). The "compression" of data in the absence of a ViewScope, particularly for extremely clear lakes, might result in a decreased ability to detect water clarity changes. Thus, the data collected as part of this study indicate water transparency measurements collected while using a ViewScope are preferable to water transparency measurements collected without a ViewScope based on the precision data. The "compression" of water transparency data in the absence of a ViewScope also suggests a potential shortfall of water transparency data collected without a ViewScope. New volunteer monitoring programs should consider the use of a ViewScope when developing their protocols while preexisting monitoring programs that do not currently use a ViewScope might consider collecting measurements both with and without a ViewScope. This would facilitate direct comparisons with the historical data while the data collected with the ViewScope would increase the precision of future measurements.

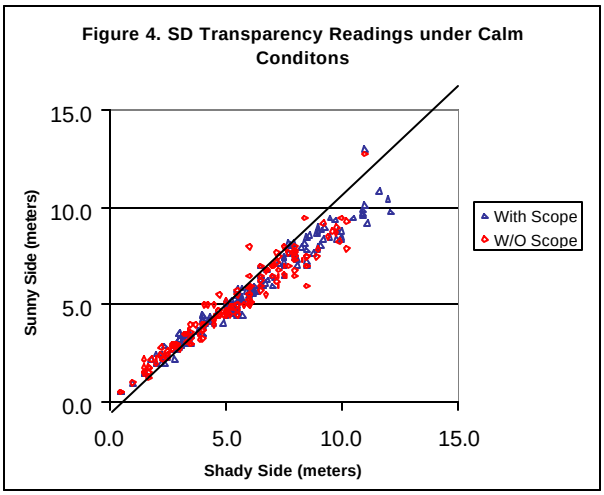
So what is the impact of weather conditions on the Secchi Disk transparency measurements? While water quality monitoring programs strive for consistency in their Secchi Disk transparency measurements, there might be times

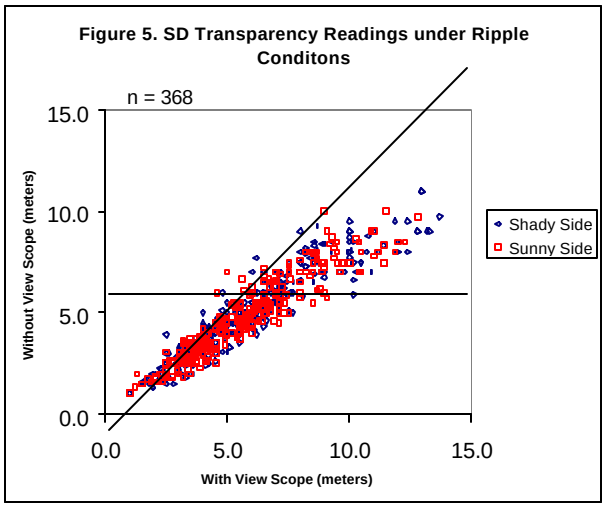
where external variables can impact the measurements. For instance, groups might collect their readings on the sunny or the shady side of the boat but during high noon there might not be a shady side of the boat or on a cloudy day there is no true sunny side. If water samples are collected under such "undesirable" conditions, how comparable is that data to the data collected under "desirable conditions? Furthermore, do the differences increase as the lake conditions shift from a calm surface to a surface characterized by ripples or waves? Analysis of over 500 paired water samples collected by volunteer monitors indicates the Secchi Disk transparency measurements (particularly when collected with the ViewScope) were generally higher on the shady side of the boat, but these readings generally differed by no more than ten percent (Figure 4). Water transparency measurements collected without the ViewScope included more outlier data points, and appear to be more sensitive to whether they are collected on the sunny or shady side of the boat. As wave action increased, the volunteers could see considerably deeper on the shady side of the boat, particularly when a ViewScope was not used (possibly the result of increased glare that was minimized/eliminated when using the ViewScope). Thus, while the water transparency measurements are normally comparable whether collected on the sunny or on the shady side of the boat, the difference does increase under wavy conditions. One might consider collecting the lake surface condition data, if you are not already doing so, to help you interpret your water clarity data in the future.



So how comparable are water transparency measurements collected with and without a ViewScope? This question becomes most important if you want to compare your water transparency data to another water quality monitoring program's data, yet you use a ViewScope and they do not. Volunteer monitor data collected under various lake surface conditions ranging from calm lake surface conditions to wavy conditions indicate that measurements collected with the ViewScope (whether on the sunny or shady side of the boat) are generally higher than the measurements collected without the ViewScope. Furthermore, the difference between readings collected with and without a ViewScope become greater as the lake surface becomes rougher and the difference is often in excess of 15 to 20%. It is also worth noting that if the Secchi Disk readings are deeper than approximately six meters, the difference between measurements collected with and without a ViewScope become more variable (Figure 5). Thus, one must use caution when comparing water transparency data collected using different methods, particularly when the water transparency values are extremely deep.

Future Considerations:





While the data previously examined indicates the ViewScope does increase precision and is preferable to water clarity measurements collected without the ViewScope, we must keep in mind that the water transparency measurements are often used as a surrogate for microscopic plant "algal" and suspended sediment levels. Future analyses will look more closely at the relationship between the Secchi Disk measurements and other water quality parameters to determine whether or not the ViewScope significantly increases the interpretive power of the water clarity data.

We also intend to take a closer look at the possibility of conversion factors that would facilitate "direct" comparisons among water transparency measurements collected using different methods. Future analysis of the water transparency data will look at the effect of sky conditions (i.e. sunny day, cloudy day) in conjunction with the lake surface data to better understand the complex interaction of sky and surface conditions. Continued data collection by both volunteers in the UNH Cooperative Extension Lakes Lay Monitoring Programs and the professional field staff will fill current data gaps and allow for further analysis of the data.

MURKY WATERS? MAKING SENSE OF WATER CLARITY MEASURES

Using the Transparency Tube in Minnesota's New Citizen Stream-Monitoring Program

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Minnesota offered a statewide Citizen Stream-Monitoring Program for the first time in 1998. The program centers on volunteer measurements of stream water clarity using the transparency tube, originally developed in Australia, as a simple tool for monitoring stream water quality. Looking down into a tube filled with a stream water sample, water is released through a valve until the black and white symbol on the bottom is visible. The water depth is recorded (in centimeters) when the symbol becomes visible, which are marked on the side of the tube. During each stream visit, volunteers rank their stream for stage (Low, Normal, High), Appearance, and Recreational Suitability. In addition to weekly stream readings, volunteers track precipitation on a daily basis, and are asked to take more frequent stream readings following rain events when possible.

Data collected by volunteers are permanently stored in the EPA's water quality database, STORET. Statistically significant relationships have been identified between stream transparency and turbidity, and transparency and Total Suspended Sediments (TSS). In the same way as Secchi transparency allows for the estimation of chlorophyll-a and total phosphorous, relationships among stream transparency, turbidity and TSS could provide a basis for citizens and the state to characterize the health of a stream by estimating these significant water quality parameters with a simple tool. Future work will focus on continued development of the volunteer program statewide, and further evaluation of relationships among transparency and other water quality parameters through studies currently being conducted on Minnesota rivers.

YOU FOUND WHAT? ROUSING REPORTS AND POWERFUL PRESENTATIONS

SESSION INFORMATION:

Moderator:

Marie-Françoise Walk, Massachusetts Water Watch Partnership

Presenters:

Marie-Françoise Walk, Massachusetts Water Watch Partnership
Developing a Data Presentation Plan

Joan Martin, Huron River Watershed Council
Creating Engaging and Effective Creek Reports

Joe Payne, Friends of Casco Bay
(no paper submitted)

YOU FOUND WHAT? ROUSING REPORTS AND POWERFUL PRESENTATIONS

Developing a Data Presentation Plan

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Resources:
For a copy of "Ready, Set, Present!", a data presentation manual for volunteer water quality monitoring groups written by Jerry Schoen, Marie-Françoise Walk, and Michele Tremblay in 1999, send a $5 check to MassWWP at the above address

To enquire about availability, call 413/545-2842

Data presentation should not be first thought about when a volunteer monitoring program is finished collecting, analyzing, and interpreting data. It's at the study design stage that program managers need to plan their data presentation strategy.

Every (respectable) program has clear goals for its surveys, whether those goals are to build a solid water quality database for future trend analysis or to document a pollution source in the watershed. While state agencies' monitoring goals are usually to assess a water body's health, volunteer monitors tend to be more 'action oriented'–trying to get people to *do* something about the results.

In the study design, we identify our data users and how (we hope) they will use our data. Having done that, we can decide the best approach to deliver our data to those users (in order to get the desired action out of them): Will they want a report? Would they prefer an entertaining slide show? Or are they more likely to use information they find on a web site?

Knowing in advance how we will present our results is not necessarily going to change how we conduct our surveys, but it is going to help immensely in gathering the tools we'll need to do a fantastic job in presenting our data, and it will make it easier to get our audience to act as a result.

At the planning stage, we think not only about which *package*s (reports, slides, exhibits) and *venue*s (town meeting, empty store front, newspaper, Trout Unlimited Annual Dinner) we will use, but also how our audiences think and how they can be persuaded. This step guides our decision in gathering materials throughout the monitoring season: Should we develop background educational materials such as fact sheets or a watershed ecology primer? Or, should we take emotionally charged photos of dead fish, cows relieving themselves in a stream, or squashed toads on the road? (For a more in-depth look at tools, venues, and motivation strategies, see "Ready, Set, Present!", Schoen *et al*, 1999, see contact box above.)

A data presentation plan will include the following items:

- Description of program issues
- List of data use objectives
- List of data users
- Processing style of data users - and IEP factor (Inform, Educate, or Persuade)
- Breakdown of knowledge points needed for audience to act (see example below for list of six knowledge points)
- List of presentation types used
- List of venues
- List of toolkit elements to prepare

Taking an example to illustrate this plan, let's look at the Deerfield River Watershed Association's (DRWA) bacteria sampling program, concentrating on a single issue:

Description of program issues:
DRWA wants to document whether the river and tributaries meet Massachusetts water quality standards for primary contact recreation; in other words, is it safe to swim in the river?

List of data use objectives:
DRWA wants river users to make appropriate decisions about recreating at various locations in the watershed.

List of data users:
There are two major data users:

- The swimmers themselves
- The local Boards of Health (BOH), who have a direct interest in the safety of local waters.

Processing style of data users
From here on, we will distinguish between the swimmers and the Boards of Health.

- Swimmers need information they can process at a glance: short blurbs, visuals.
- BOHs need precise and well documented information, such as a report, maybe supported by a live presentation, or a personal communication.

There is also the issue of how to use data with these audiences. There are basically three ways data can be utilized: to *inform* people of conditions, to *educate* them on how conditions occurred and will affect their enjoyment of the river, or to *persuade* people to act on survey results. We refer to this concept as the "IEP" factor.

In the DRWA situation:

- Swimmers will mostly need to be informed if the river is polluted, and perhaps educated about sources and consequences.
- BOHs will also need to be informed, but may need to be persuaded to take action (by eliminating the source, perhaps, or post the area as unsafe for swimming).

Breakdown of knowledge points needed for audiences to act:
For good watershed decision making, decision makers must:

- Know the *condition* of the water body,
- Understand *watershed ecology*,
- Know the *causes* of any problems,
- Know the *sources* of problems,
- Know the *impacts and consequences* of conditions, and
- Know what *solution*s are possible.

Of those six points, DRWA thinks it needs to focus on:

- For swimmers, condition and impacts: they should know whether the river is polluted, and if it is, that they may become sick with ear infections or intestinal distress.
- For BOHs, condition, sources, solutions: they should also be informed of the current conditions, and may appreciate hints about where the problems originate and how they can be solved.

List of presentation types used:
There are a variety of presentation types which can be used: reports, live talks, exhibits, articles in the media, flyers and newsletters, radio/TV shows, web postings, and more.

From the little research performed through the steps above, DRWA concludes that the appropriate presentation types are:

- For swimmers–exhibits and newspaper bites.
- For BOHs– report, live presentation, phone call.

List of venues:
Once we know what type of presentation we will use, we can decide *where* we will take those presentations: at a fair, on-site, at the library, in the bank lobby, in the mail (report), in the news/entertainment media, on our web site, at a club dinner, a committee meeting, in a brochure or a newsletter?

DRWA chooses the following:

- Swimmers: On-site exhibits: some simple display at the actual swimming locations; local newspaper articles or factoids (a brief news update).
- BOHs: Formal report sent in the mail with a follow-up phone call; live presentation at the BOH monthly meeting.

List of toolkit elements to prepare:
Now we have all the information required to decide what "tools" we will need for our various presentation strategies. Monitoring groups benefit from building a toolkit over time, allowing them to be prepared for presentation opportunities. If we have already produced the right pieces, we can quickly respond when someone requests a dinner speaker, when we get a call from a newspaper reporter, or when a town meeting comes up. The toolkit may include a formal written report, an informal report, a press kit (contact name at various media, instructions for producing letters, interviews, press releases, etc.), a prepared slide show, and/or ready-to-use exhibit or display. The toolkit should also contain the basic components to use in the packages: graphs, maps, photographs, fact sheets, props, art work.

DRWA needs:

- Graphs
- Signs (such as a swimmer in a circle with a removable bar across it)
- Map of sites
- Written blurb
- Report
- Slides or overheads

Through the simple example above, we can appreciate that having prepared all year toward its data presentation package, a group is much more likely to actually use their data and convince potential data users to take action: there is no (or less) last-minute panic to put together a talk for the local Audubon Chapter's annual meeting or an exhibit for the Fall Festival.

In short, planning a program's data presentation strategy does add a little work up front, but this small investment of time and brain cells really pays off if it results in *actions* to enhance the watershed. All that is necessary for planning is: first, focus on a message; second, define data users; third, determine how data users process information; and last, prepare a list of venues and a toolkit for pre-canned presentation packages.

Table 1: Data Presentation Worksheet, with Deerfield River Watershed Association example.

Issue	Data Use Objective	Data Users	Information Processing Style	IEP Factor	Knowledge Points	Presentation Type	Venue	Tools Needed
Is river swimmable?	*Want people to become familiar w/ issue and make good decisions re swimming*	*1- Swimmers* *2- BOHs*	*1- short blurb, visuals* *2- report, oral presentation*	*1- I,E* *2- I,P*	*1- Current conditions, impacts* *2- Current conditions, sources, solutions*	*1- Exhibit, newspaper blurbs* *2- Report, phone call?*	*1- On-site exhibit, media* *2- Report, BOH meetings*	*Graph, background info, sign (graphic) site map, report, slides/ overheads*

YOU FOUND WHAT? ROUSING REPORTS AND POWERFUL PRESENTATIONS

Creating Engaging and Effective Creek Reports

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The *Huron River Creek Report*, discussed and quoted in this paper, is available from the Huron River Watershed Council (above).

Marie-Françoise has explained how to decide which kinds of presentation types to include in your toolkit. A common choice is the written report, which was a primary presentation choice for our goals.

The Huron River, which is in southeastern Michigan, is in pretty good shape. Part of it is a state-designated Natural River and it is widely recognized as a good smallmouth bass fishery. The watershed covers 900 square miles, much of which is rapidly developing farmland. The goal of our Adopt-A-Stream Program is to help people to protect the river system. We work primarily by supporting Creek Groups and other local residents in their protection efforts.

Our monitoring program studies the ecological health of our river system. We study the physical conditions and the benthic macroinvertebrates at over 50 sites. (We do not routinely measure chemical water quality parameters.) Through monitoring since 1992, we have learned the quality of the various creeks relative to other parts of the river and have identified some of the threats to the river. Now we need to let people know about their creek and what it needs from them.

Our reasons for choosing the Report format
We need something that concerned folks can give to the people they talk to about their creek. We want to have something that people can take away, that they will both read and learn from. While additional forms of presentation would be useful, this is the one we started with because we can distribute it to all three of our audience categories (volunteers, community "decision makers," and residents in the communities who will promote the river issues).

How shall we present the data?
My first thought was to compile all the information we had gathered into neat tables and write about the facts, trying to explain them. The first draft contained pages of words plus a few tables of data and a sketched map. It was NOT inviting to the average reader. As we moved toward the goal of affecting the readers' behavior, as well as their understanding about rivers, we changed the format drastically. Our transformation was greatly helped by the suggestions made by many early readers. We distilled the data into pictures of the conditions of the local creek. We separated out the explanations of concepts to sidebars. The result was an engaging report that the intended audience is actually reading. One elected official said that she had never paid any attention to the creek before, but this report was so informative she thought it should be given to all the school children in the watershed.

Focus on the purpose of the report:

- The major threats are people's behaviors and the rapid pace of land development in southeastern Michigan.
- We primarily want to change what happens during all phases of development, including design, construction, and maintenance.
- We also want to change resident behavior, including landscaping and maintenance.

Therefore, we included 1) data about the local creek, 2) what the creeks need in order to be healthy, and 3) what the community can do for the creek.

Write for the audience:

- The volunteers: (The volunteers are adults and families, with an occasional small scout troop.)
- The community Decision Makers in each of the 55 communities

- Residents in the communities who will promote the river issues.

This is not a river that has economic meaning or any other sense of urgency for most of our audiences. We have tried to present the data and the river concepts in understandable language.

Focus on what you would most like your audiences to do:

- Improve the design of residential and commercial development.
- Adopt master plans and ordinances that protect all parts of the river system, including wetlands, flood plains, riparian zones and flow regimes.
- Monitor the execution of good designs, and the maintenance of protective measures.

The format we have developed is filled with small pictures. The *Huron River Creek Report* includes:

- A large photo of the creek on the cover.
- A map of the entire Huron River watershed showing the location of the creek.
- Facts about the creek, including how the land is being used and what is unusual. For example:

  > "Most of the land is cleared and covered by buildings, pavement, and mowed lawns. There are seven parks, some of which are undeveloped. The remaining portion of the basin continues to be developed."

- Note that each page of text has sidebars to explain unusual terms that appear bolded in the text. For instance, on the first page we explain what a Drain Commissioner is. Small graphics accompany each brief explanation to intrigue the reader to read them.

  > "The County **Drain Commissioner**'s main duties are to manage storm water and prevent flooding. This focus evolved from the desire of early settlers to farm swampy land."

- A brief history of the creek.

  > "Malletts Creek flows north through a channel that was cut by the **glacier** 14,000 years ago. The entire Huron River originally flowed south through this channel, before changing to its current course. If you want to see a cross section of that ancient channel, look from Arborland Mall west, along Washtenaw Road to the County Farm Park on the far hill."

- A map of the creekshed with locations where the public can enjoy it.
- Special characteristics of the creek, including the results of studies previous to ours.
- A description of the physical characteristics of the creek. This may include some identified problems.

  > "Malletts Creek suffers from extreme variations in flow that can be characterized as **flashy**. After storms, the water rises so quickly that the creek has carried huge objects like automobile engine blocks, while during dry periods the creek is so shallow that children can walk in it. For instance, on June 12, 1999, the creek went from a quiet flow of 1.5 cubic feet per second to 500 cfs in 1½ hours!"

- An explanation of the methods and analysis used in the study.

  > "Some indicators of a high quality stream are stable banks with a broad corridor of trees and shrubs, **riffles** free of **silt** deposition, fairly stable temperatures, and a benthic population that includes several groups that are sensitive to organic pollution. The

population in a degraded creek will be restricted to those few types of creatures hardy enough to survive."

- The results are shown with small drawings on a map. The illustrations show the extent of diversity compared to what it would be if it had the quality of the best site in the Huron system (Figure 1). We also show a map of the location of highly sensitive creatures (Figure 2).

- The conclusions point to the need to change the way land is developed and our own behaviors.

  "All of us are responsible for the sorry state of Malletts Creek. Homeowners, businesses, churches, the City, and the University all do things without realizing how they will hurt the creek, such as fertilizing lawns, building parking lots, applying pesticides, filling wet areas, and mowing stream banks."

- If the creek has an active creek group, there are photos and short descriptions about what people are doing for the creek.

  "Ron has monitored Malletts and other creeks in the Huron system for many years. This year he replaced his lawn with prairie plants to help the creek and the butterflies. "It's much more interesting than a lawn!" He said. "The neighbors love it. They walk by daily to see what is blooming."

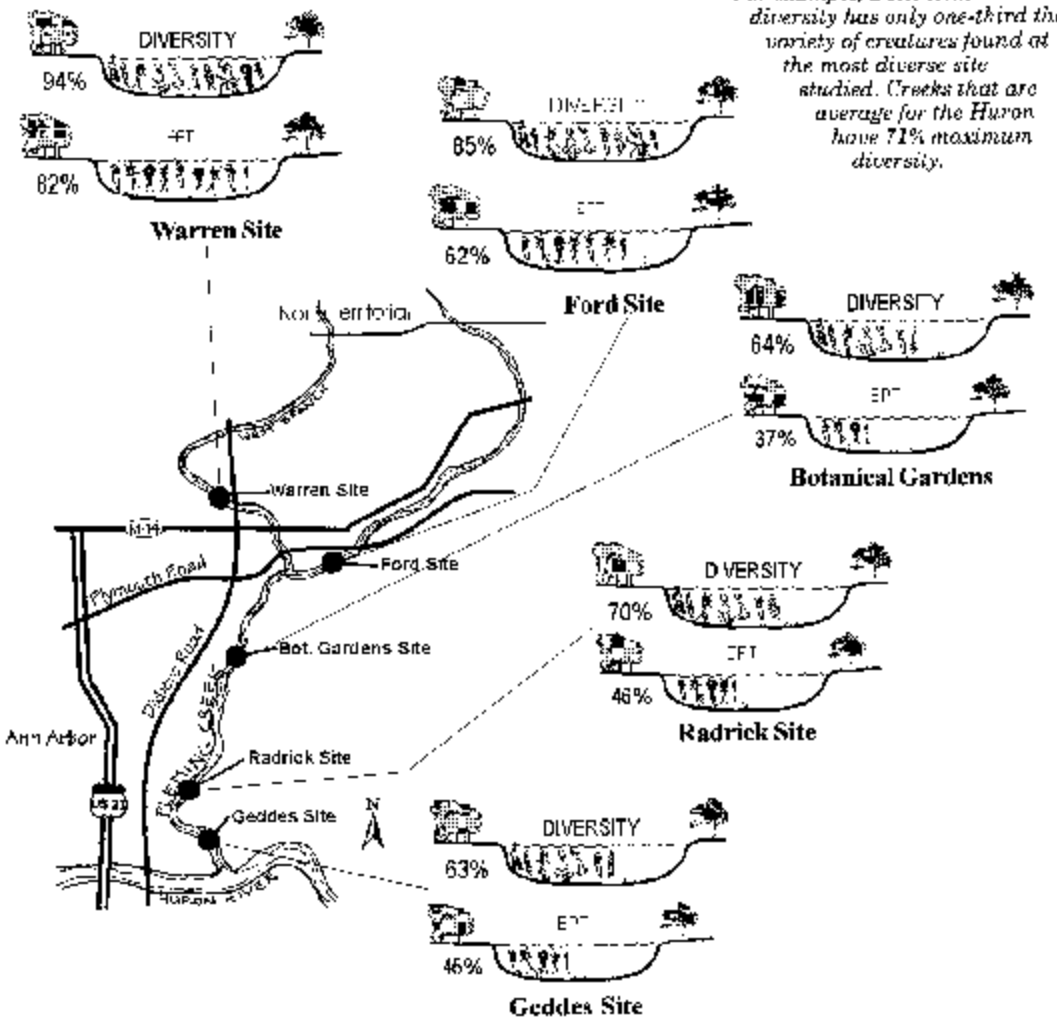
- The last page describes What You Can Do.

- Here is one idea to help a small staff cope with the challenge of writing reports on all of the creeks: Invite watershed residents to help you gather information for reports on the creeks. We have circulated a form requesting photographs and stories about the name, the history, the way land is being used, etc.

POPULATION DIVERSITY

The high diversity found in the West Branch indicates a high quality creek. Diversity was good at the Ford site but only mediocre at the sites further downstream. The data shown here have been adjusted for the size of the creekshed, in order to compare sites of different sizes.

Diversity in the population indicates good creek quality. Greater diversity at a site means that the conditions are good for a variety of kinds of creatures. The % shows how this site compares to the best site in the Huron River system. For example, a site with 33% diversity has only one-third the variety of creatures found at the most diverse site studied. Creeks that are average for the Huron have 71% maximum diversity.



EPT: Many of the EPT families require a high quality creek. "E" are mayflies (Ephemeroptera), "P" are stoneflies (Plecoptera), and "T" are caddisflies (Trichoptera). If many kinds of EPT are present, the site probably has high quality. The % shows how the EPT indicators of the site compare to the best site in the Huron River system. For example, a site with 25% EPT has only one-fourth the variety of EPT families found at the site with the most variety in EPT. Creeks that are average for the Huron have 48% of the maximum EPT.

6

Figure 1: A map from a *Huron River Creek Report* illustrating macroinvertebrate diversity at various monitoring sites.

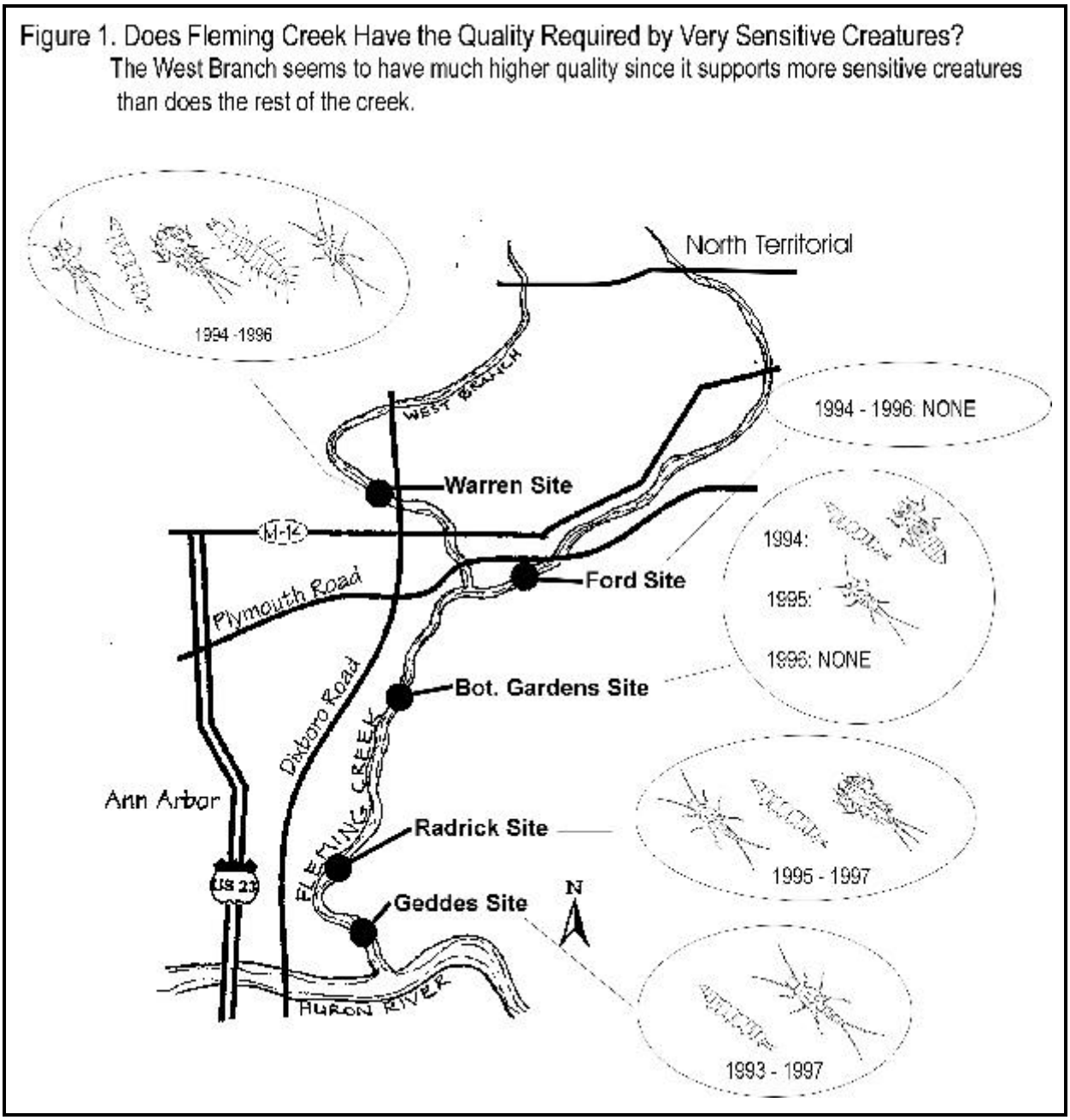


Figure 2: A map from a Huron River Creek Report showing the location of highly sensitive macroinvertebrates.