MEASURING BACTERIAL CONTAMINATION

SESSION INFORMATION:

This training session was repeated once during the conference.

Moderator and Presenter:

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Volunteer programs across the United States have been monitoring for bacteria for many years and State agencies are increasingly relying on volunteer monitoring data as a valuable source of water quality information. The traditional bacterial indicators of pollution, fecal coliform and *E. coli,* have been routinely used to assess water quality and classify waters for use. However, their use has also caused much confusion and controversy, especially when it comes to interpreting the data. Many questions about bacterial contamination continue to nag both volunteer groups and agencies, including which indicator organism and method is the best to use, and what the resulting data means. Ultimately the question of whether the pollution source is of human or non-human origin will be asked but, unfortunately, these most commonly used bacterial indicators do not provide a quick and easy answer to that question. Expanding water quality programs, which seek to gather information from areas which were previously unquestioned, have led to surprising results and an inability to immediately attribute a source to the recovery of variable levels of fecal coliforms.

Unfortunately, it is not practical to monitor for all the possible human pathogens that may be present in a waterbody. There are too many pathogens to test for, and methods for some are not yet available or are too expensive and time consuming. The main reason that the pathogens themselves are not a reliable indicator of a human contamination source is because they are shed inconsistently into the environment, which renders them an unreliable measure for conservatively assessing public health risk. Public Health officials have relied on fecal coliforms as an "indicator" to assess the probability of the presence of pathogens. Fecal coliforms are consistently associated with fecal contamination. They are relatively easy to detect and very inexpensive to test for.

Fecal coliforms are a portion of a larger group of related bacteria, the “total coliform” group, whose presence is used to indicate fecal contamination and the possibility that disease-causing organisms (pathogens) are present. One species, *E. coli*, often makes up the majority of fecal coliforms routinely found when sampling recreational water. Conservative Federal and State guidelines and standards were developed to protect the public health and decrease the threat of illness due to recreational water contact. The utility of fecal coliforms as an indicator of fecal contamination is due to their consistent presence in the intestinal tract of warm-blooded animals. They are not, however, an “ideal” tracer of human pollution sources because they are not exclusively associated with human fecal contamination.

The source of fecal coliforms in a waterbody may be solely from native waterfowl and wild animals, such as deer and raccoon. Domestic animals and livestock are a significant contributor of fecal coliforms into rivers, streams, and coastal areas. Some are even present in the soil environment. The importance of conducting a site survey when taking samples for bacteria can not be overemphasized. Noting any evidence of animals having been present when the sample is collected will provide crucial information– and possibly a link to the source later when the data is analyzed. The environmental conditions unique and specific to a site must be considered when interpreting the data. Conditions such as extreme turbidity (which may block the bacteriocidal sunlight (UV) penetration, but may alternately provide nutrients), water temperature, water flow (or lack of it), rainfall, bank vegetation, and even soil type may all influence the survival or die-off of fecal coliforms once introduced into the waterbody. It is important to also realize that human pathogens may be present in surface water even when there are no apparent human sources of fecal contamination, and even when fecal coliforms are not detected.

There are several different methods available to enumerate fecal coliforms and E. coli. The method you choose must be based on what you wish to achieve by sampling. Volunteer monitoring groups that are planning to provide data for use by state agencies are advised to first contact the agencies and find out what method they use and accept, as well as what the agencies' plans are for future sampling in your watershed. There are two standard membrane filtration methods that will enumerate fecal coliforms: mFC and mTEC. These methods employ a specific, differential media that selects for the growth of the target organism. The mTEC method provides both a fecal coliform and an *E. coli* count. These membrane filtration methods do have very specific and critical temperature requirements. These methods should be chosen only if these requirements can be met. Other groups may choose to utilize the easier, less specific, screening tools. However, these "rapid assessment methods" do have limitations about what they can, and cannot, do at this time. Many other methods are currently being developed but they are not validated tests at this time. DNA methods, bacteriophage testing, and antibiotic resistance patterns are all being investigated and may yield surprising and useful information. At this time they are experimental and, if utilized, the results should be analyzed in conjunction with the standard bacteria methods and site surveys in order to evaluate the correlation between the resulting data.

The presence, absence, and magnitude of indicator concentration found in a waterbody must be interpreted within the context of all available information. Building a relationship with the state and federal agencies involved in your watershed, and soliciting the guidance and assistance from universities, private laboratories, and town facilities will provide unparalleled support as your program begins testing for bacteria.

PROGRAM ROUNDTABLE B

SESSION INFORMATION:

Moderator:

Connie Fortin, Fortin Consulting Inc.

Presenters:

Mary Carchrie, Director, Cape & Islands Senior Environment Corps
Forming a Senior Environment Corps
(abstract only)

Gary L. Comer, Jr., Extension Agent, Indian Lake Watershed Project
Master Watershed Stewards
(abstract only)

John McCoy, Waterwatch Victoria, Australia
Waterwatch – Data Use, Data Confidence, Australian Style
(abstract only)

Dr. Robert Williams, The Rivers Project, Southern Illinois University
The Rivers Project
(abstract only)

PROGRAM ROUNDTABLE B

Forming a Senior Environment Corps

CONTACT INFORMATION

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The Senior Environment Corps began five years ago as a project of our local Retired and Senior Volunteer Program (RSVP). It now includes approximately 50 RSVP volunteers and 37 AmeriCorps Members. Our affiliations are with the Environmental Alliance for Senior Involvement (EASI), the Corporation for National Service, town and county governments, the Massachusetts Executive Office of Environmental Affairs, the Massachusetts Military Reservation Joint Programs Office, and the Waquoit Bay Estuarine Research Reserve, among others.

This presentation provided attendees with information on how to tap into the resources of the Corporation for National Service, EASI, and the others listed above to form a Senior Environment Corps. These agencies each have valuable contributions to make to water monitoring programs but, they do require a bit of organization (MOU's, job descriptions, time logs, etc).

PROGRAM ROUNDTABLE B

Master Watershed Stewards

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The Master Watershed Stewards is a volunteer water quality education curriculum that takes the unique holistic approach of addressing water quality issues on a watershed level. The primary goal of the program is to increase water quality awareness by educating a diverse group of local citizens so that they can make informed decisions and initiate actions to protect and improve the quality and sustain ability of their water resources. The secondary goal is to develop a watershed-based volunteer water quality curriculum that can be adapted and implemented in watersheds in other counties and states.

Participants of the program are given the opportunity to participate in 30 hours of instruction. Over 12 individual teaching sessions are offered each year, including such topics as: Groundwater Quality, Wetlands, Land-use Planning, Home Water Quality Awareness, Agricultural Best Management Practices, Yard & Garden Best Management Practices, and Volunteer Water Quality Monitoring Techniques.

Volunteers are certified as a Master Watershed Steward Interns upon completing the educational portion of the program. After completing 30 hours of approved volunteer time, participants become certified as Master Watershed Stewards. Volunteer activities range from water quality monitoring activities to assisting with educational events and activities.

As part of the Master Watershed Stewards curriculum , a 198-page manual was developed. This manual was designed as a 3-ring binder, with each chapter being a stand alone unit or component of a watershed. The current manual includes 8 chapters.

Chapter 1: *Issues and Ethics: Water Quality in Your Neighborhood*
Chapter 2: *Lakes: The World Beneath the Waves*
Chapter 3: *Streams: The Rivers in Your Back Yard*
Chapter 4: *Volunteer Stream Monitoring: Measuring Stream Health*
Chapter 5: *Wetlands: The Importance of Being Wet*
Chapter 6: *Ground Water: Our Hidden Water Resource*
Chapter 7: *Agriculture and Water Quality: Food and Water for the Future*
Chapter 8: *Yard and Garden: Environmentally Sound Gardening*

PROGRAM ROUNDTABLE B

Waterwatch – Data Use, Data Confidence, Australian Style

CONTACT INFORMATION

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Community monitoring began in Australia in the 1980s primarily as an awareness raising tool. Since that time, the community has developed increased skills and knowledge in monitoring procedures. Both the data collectors and the data users are placing greater demands on the data to be accurate and useful.

Waterwatch Australia encourages appropriate procedures and techniques for the collection of data. While it is not always necessary to collect data to a fine degree of precision, it is important that the methods used result in accurate, reliable and good quality data. Data must also be collected at the level of precision for the purpose for which it is to be used. Not all Waterwatch groups are interested in collecting information to the same standard. Waterwatch recognizes that with groups of different ages, different technical abilities, and different objectives, there will be different standards in the collection and analysis of data.

Waterwatch coordinators at a regional program level play the critical role in assisting the community to achieve the quality of data required for the intended purpose. To ensure that community data is sufficient for its intended purpose, Waterwatch Australia has developed a set of National data confidence guidelines and a National Technical Manual. State Waterwatch Programs have or are establishing data confidence procedures and plans. This presentation will outline the National Data Confidence Guidelines and ways that the guidelines are being implemented in regional Australia.

PROGRAM ROUNDTABLE B

The Rivers Project

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http://www.siue.edu/OSME/river

The Rivers Project provides educational materials, equipment, and training on a variety of water monitoring programs. Curriculum materials for high and middle school students and teachers include the Rivers Curriculum Project's (funded by the National Science Foundation (NSF) set of units: Biology, Chemistry, Earth Science, Geography, Language Arts, and Mathematics. Combining the units allows schools to develop an interdisciplinary curriculum based on river study. Week long training sessions are held each summer in varying parts of the US. Teachers who have years of experience at water monitoring conduct the interdisciplinary training.

Funding by the W. K. Kellogg Foundation helped provide educational materials, equipment, and training on a groundwater education program. Materials for middle school students and teachers include a curriculum unit, called H20. Study units on the Zebra Mussel, and other Alien Invaders, have been developed. Students of the Project have produced 30 issues of their writings called "Meanderings" that are all available through the Library of Congress and other libraries. Interested teachers and water monitoring professionals can access the web site (see contact box) for further information.

STATE COORDINATOR'S DISCUSSION SESSION

SESSION INFORMATION:

This was a facilitated discussion with no individual papers or presentations

Discussion Leaders:

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The goal of this session was for individuals who direct, manage, or support a state-agency-based volunteer monitoring program to have an opportunity to network.

There were about 25 session participants. After each person introduced themselves and their program, everyone shared one challenge they were facing today and one success they have had in their program. Challenges or successes could be related to any aspect of implementing a volunteer monitoring program.

The obstacles that received the most mention included:

- Barriers to use of volunteer data and associated credibility issues. Credibility issues ranged from general skepticism about data quality to difficulties with middle management
- Data management. The obstacle most often cited was lack of staffing available for data management– not necessarily technological difficulties
- Balancing staff and resources with the demand for product and services

Other challenges and needs the group mentioned included:

- Marketing products and services to get program beyond survival and into a leadership role in the state
- Developing an on-line data entry form
- Limited staff, need to organize a council or some level of support
- Balancing level of quality control and assurance for volunteers to stay interested with level necessary to have usable data
- Dealing with state legislatures' creation of a "credible data law" with volunteer data
- Communication between the state, volunteers, and others
- Resistance to internal use (within own agency) of data, attributed to lack of time for professionals to use volunteer data

- Having only one source of funding for program
- Recruitment of volunteers in specific TMDL listed segments to assist with TMDL process
- Agriculture community lobbying against volunteer monitoring because of concerns about the state being involved in that "sort" of monitoring
- Simple politics, above and below, left and right -- it's always something
- From EPA perspective, helping programs deal with credibility and getting more regional help
- The PACE of the beast: demand greater than supply, need greater than supply, etc.

We need to share our successes with each other more often. The list of successes included:

- Phosphorus removal on a local lake due to volunteer data
- First newsletter sent to volunteers, first time feedback given to them
- State made it a priority to allocate funding to volunteer monitoring
- Data being used as a screening tool, data being used
- Connecting people with the resource, successful education efforts
- Getting community leaders to dedicate staff time (cities, counties, etc.) to help with limited program staff
- Developed a regional training center with the local university
- By implementing an international component to their volunteer program, leveraged money and staff for local program
- Developed handbook for volunteers
- Able to get regional agriculture community involved in program
- Developed local steering committees to assist program management
- Data management progress
- Data turned into information, got a report completed
- Obtained more staff or more program money
- Developed an on-line site to increase program awareness
- ADVOCACY!
- Longevity – program is 20 years old, that means 20 years of support!
- Collaboration is moving the volunteer effort forward

In a summary discussion, the group discussed what might be of use in the future for state program managers. The primary discussion focused on data management, with suggestions ranging from having more training available to a series of articles in the Volunteer Monitor. Another suggestion was the need for skill training– locally, regionally, and/or nationally– for dealing with political issues. In context, we all must deal with some level of politics but usually don't have any training in this area. We often resist or ignore the politics of volunteer monitoring, and yet this is essential to deal with if we are to continue to make progress. The volunteer monitoring list server was mentioned for all to use as a tool to continue to network. The final suggestion was to have regional or a national gathering designed just for state program managers.

STUDENT VOLUNTEERS TAKING ACTION

SESSION INFORMATION:

Moderator:

Robert Furtado, Lower Colorado River Network, Anderson High School River Watchers

Presenters:

Bill Fleming, University of New Mexico, New Mexico Watershed Watch
Watershed Planning and Monitoring by Local Student Stakeholders

Torrey Lindbo, The Saturday Academy, Student Watershed Research Project
Advantages of Student versus Agency Monitoring

Ann Lyon, Green Acres Foundation
Schools/Townships Unite to Protect Water Quality
(abstract only)

STUDENT VOLUNTEERS TAKING ACTION

Watershed Planning and Monitoring by Local Student Stakeholders: New Mexico Watershed Watch

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Introduction.
New Mexico Watershed Watch is a student watershed planning and monitoring program sponsored by the state Department of Game and Fish. The program provides teachers with instruction on methods for water quality monitoring, riparian habitat evaluation, and watershed planning. Watersheds are viewed holistically and land use impacts on water quality are emphasized. Issues of interest to the community where each of the 20 schools are located provide the motivation for monitoring and planning activities.

Schools focus on small watersheds (less than 100 km^2) with the following objectives: 1) involving secondary school students in hands-on, real-life projects to assess watershed health and water quality with spectrophotometers and other state-of-the-art equipment; 2) encouraging an interdisciplinary approach to watershed planning which identifies impacts of land use on water quality; 3) developing scientifically credible field methodologies to create long-term databases on watershed health which are used by state and federal environmental agencies. Teachers and students attend two training workshops each year to learn chemical and biological analysis techniques. At the end of the school year, all schools meet to present results of the year's monitoring and compare the health of 20 small watersheds in the state.

Students evaluate watersheds by collecting monthly water quality and quantity data on streamflow, pH, turbidity, nutrients, total dissolved solids, ammonia, and selected heavy metals. An evaluation of the species composition and biodiversity of macroinvertebrates and fish indicates the biotic health of the watershed. Riparian assessments are done in the spring and fall to monitor characteristics ranging from channel stability to streambank vegetation cover. Maps of land use, land ownership, soil stability, topography and human impacts are used in an overlay format to identify priority problem areas. Watershed plans are then formulated to improve water quality and restore degraded riparian and upland sites. This paper focuses on a rapid assessment procedure for riparian health and documents how one school compared the upper and lower reaches of two adjacent watersheds in New Mexico. In this example, the results of the riparian assessment were used to identify critical sites and watershed plans were then formulated to rehabilitate the degraded areas.

Riparian Health Assessment in Small Watersheds
Although riparian ecosystems are not equally healthy, there are no generally accepted criteria for evaluating and comparing them. Riparian "health" is defined here as a set of environmental conditions that result in the long-term sustainability of the riparian habitat. The quality of the riparian habitat refers to how well it supplies the physical, chemical and biological needs of the organisms living in a stream reach (Miller 1990). In an ecosystem view of the restoration of the riparian system of the Kissimmee River, Dahm et al. (1995) associate "health" with the degree of "connectivity and interactions between the abiotic and biotic variables of the river and floodplain." Riparian ecosystem structure and function respond to both abiotic and biotic forces, and this paper focuses on twelve indicators of the health of these forces, ranging from hydrologic discharge to macroinvertebrate family diversity.

Twelve criteria are used to numerically evaluate riparian habitat using geomorphological and biological parameters. Each criterion is semi-quantitatively evaluated on a scale of 1 to 4, with 4 the healthiest and 1 the least healthy. This approach is based upon systematic sampling by the author in more than twenty communities since 1988. As illustrative examples for the purposes of this paper, the index is applied to two subalpine watersheds near Santa Fé, New Mexico, comparing them using the criteria. The Río en Medio, site of the Santa Fé Ski Basin, was rated "good" (with a score of 2.9), while an adjacent undeveloped watershed, the Río Tesuque, was rated "excellent" (with a score of 3.9). The method can be taught in a half-day and stream reaches can be evaluated in about an hour by experienced students.

Several authors, such as Barbour and Stribling (1991) and Jacobi et al. (1995), have suggested criteria for evaluating the health of riparian habitats in the Western United States. Although their criteria are heavily oriented toward stream habitats for fish, indices have been adapted for a wider range of organism classes, including birds (e.g. Fleming and Schrader 1998). A riparian environment that is healthy for fish and birds is considered healthy for a wide range of ecosystems organisms (Chiras 1998; Nebel and Wright 1998; Dahm et al. 1995).

Water quality is a critical issue in Western watersheds and the riparian survey method evaluates two of the most important in an indirect way: sedimentation and stream insect biodiversity. The amount of fine material (less than gravel size) is evaluated quantitatively with a "streambed geology" parameter and the degree of sedimentation with sand and silt is determined with "embeddedness." The biotic health of the riparian zone is indicated in a general way by the diversity of macroinvertebrate insect families. Data collection by New Mexico Watershed Watch deals with water quality comprehensively through the following monthly determinations: turbidity, temperature, pH, conductivity, nutrients (nitrate and total phosphorus), and metals (copper, zinc, aluminum and lead).

For an optimum aquatic environment, several authors conclude that at least 0.05 cubic meters per second (cms) – equivalent to 2 cubic feet per second (cfs) – are necessary to support a high-quality, coldwater fishery (Barbour and Stribling 1991; Oswood and Barber 1982). The ability of a stream to produce and maintain a stable environment in the substrate is indicated by the flow (Ball 1982). If less than 0.01 cms are flowing, the habitat is considered "poor", including headwater streams with small catchment areas (Barbour and Stribling 1991). Streamflow is measured quickly and inexpensively by timing the number of seconds a floating object takes to travel 10m in the stream, resulting in the velocity (m/sec.) The cross-sectional area of the stream reach is measured in square meters, and this value is multiplied by velocity to obtain the flow.

Streambed geology and embeddedness are critical for the maintenance of necessary void spaces in the substrate for macroinvertebrate habitat, which need a continuous flow of water, oxygen and food sources. Stream reaches are evaluated by walking in a zig-zag pattern, stopping every two steps to determine the size of material in front of the evaluator's boot. If more than 50% of material is comprised of grain sizes in gravel, cobble and boulder categories, the habitat is considered optimal (Barbour and Stribling 1991). At least 20 samples should be chosen in each reach and a range of grain size percentages calculated. If more than 50% of the substrate is sand size or smaller, the habitat is considered "poor." Even though a somewhat coarse evaluation, an estimate of the percentage of fine material is considered a valuable indicator of upstream watershed disturbance.

Embeddedness measures how much of the surface area of larger substrate particles are surrounded by fine sediment (sand, silt and clay; Platts et al. 1983). This parameter allows an evaluation of the substrate as a habitat for benthic macro-invertebrates and fish spawning (Barbour and Stribling 1991). Heavy silting is an indication of upstream watershed disturbance and is known to cause a reduction in insect diversity and production (Minshall 1984).

The ratio of bankfull channel width to depth (the width at the top of the bank determined by its extent when full of water, usually once a year), is optimal for fish and aquatic insect habitat if less than 7:1 (Rosgen 1994). A very wide and shallow stream with a width/depth ratio of more than 25:1 is considered poor habitat for fish and the macroinvertebrate food supply they depend on (Gibson 1994). A tape measure and meter stick are used to measure the width and depth of the channel.

Upper bank stability is considered excellent if less than 10% of the banks are vertical and unvegetated, while more than 50% of bank area in an unstable and eroding condition is rated poor (Barbour and Stribling 1991). Streams with unstable banks often have degraded instream habitat for fish and aquatic insects (Plafkin et al. 1989). The steeper the bank, the greater the likelihood for erosion and loss of soil into the stream because steep banks are less likely to hold vegetation cover . The evaluator looks upstream and downstream from the reach to estimate the percentage of visible bank length that is not vegetated and actively eroding.

If the ratio of distance between riffles to stream width is between 5:1 and 7:1, heterogeneity for aquatic insects and fish is optimal, while a ratio of more than 25:1 is considered a poor habitat (Frissell et al. 1986). Since benthic communities thrive as a result of integrated environmental factors (substrate, food availability, current etc.), and species have preferences for alternative substrate types, it follows that maximum variability in streambed morphology should support higher species diversity (Barbour and Stribling 1991). Upstream land use activities can profoundly change pool/riffle relationships, as well as human-caused changes in flood and low-flow discharge (Frissell et al. 1986). The evaluator uses a tape to measure the average distance between riffles and the width of the channel.

Vegetative buffer strips are effective in filtering pollutants such as sediment and nutrients from streams, and several authors consider 18 meters of buffer width to be sufficient for many riparian situations (Schueler 1987). Where riparian areas have very steep slopes and/or heavily fertilized agricultural runoff, a buffer of more than 18m may be necessary. This parameter rates the entire riparian buffer zone on the side of the stream nearest to disruption (road, housing development, row crop, etc.), and if the vegetated width is less than 6m, it is considered poor (Barbour and Stribling 1991). A tape is used to measure the width of the least buffered side of the stream reach.

Vegetative diversity is evaluated by determining whether at least 10 different species occur in the riparian zone, which is scored as optimum (less than 3 species is considered poor). The concept of species evenness, or relative density of each plant species in the riparian zone, is not considered here, but could be included in future method refinements. Vegetation cover, expressed as a percent, is estimated by randomly choosing a transect direction to walk and noting at every other step either vegetation cover or bare soil. Ninety percent vegetation cover is considered an adequate cover for erosion control, while less than 50% is considered poor (Brooks et al. 1996, Fleming 1998).

Shading provided by a vegetative canopy cover is important in reducing summer water temperatures and as a mediating factor in the solar energy available for photosythetic activity and primary production (Barbour and Stribling 1991; Platts et al. 1983). Diversity of shade conditions is considered by Barbour and Stribling (1991) to be optimal, with different areas of a stream reach receiving direct sunlight, complete shade and filtered light. The evaluator estimates the percentage of sun and shade by looking upstream and downstream from the middle of the stream reach.

Important indicators of the long term health of a watershed are abundance and diversity of species of aquatic macroinvertebrates (Jacobi et al. 1995). Insects remain in streams during transitory periods of floods, drought, periods of turbidity or heavy metal inflow. Benthic insects are affected by chemical pollution and physical changes such as temperature, pH, discharge and sediment resulting from upstream land use activities. The presence or absence, as well as the relative numbers, of species less tolerant to watershed disturbances are important indicators of riparian health (Fleming and Schrader 1998, Jacobi et al. 1995).

Stoneflies (Plecoptera) are generally the order of insects most sensitive to human impacts, such as sewage pollution (Jacobi et al. 1995). The absence of stoneflies may indicate phosphorus or nitrogen in higher than natural concentrations. Usually stoneflies are a smaller percentage of the insects (10-20%) and are often the first to disappear with increased human impacts (Gibson 1994). Mayflies (Ephemeroptera) are also sensitive to watershed disturbances, but can be 20-40% of the total number, and may be the next order to disappear in a stressed watershed. If an insect collection is dominated by midges or worms, the watershed and stream are probably highly degraded (Jacobi et al. 1995). The different families, and percentages of each family, are indicators of the health of the watershed (Fleming and Schrader 1998).

A 1m-wide screen, with openings of approximately 1mm (mosquito-net size), is used to collect insects from the stream. The screen is attached to wooden stakes and is held in the stream for 3 minutes while a second evaluator disturbs upstream bedload material so that aquatic insects will be captured on the screen. The screen taken out of the stream and the insects removed from the screen with tweezers and put in an open container for evaluation.

Application to Watersheds Near Santa Fé

The methodology was applied to two adjacent watersheds in the Santa Fé National Forest, 15 miles northeast of Santa Fé, New Mexico in the Sangre de Cristo Mountains. Each watershed is slightly over one square mile in area, ranging in elevation from 9,800 feet to 11,100 feet. The Río en Medio watershed is the site of the Santa Fé Ski Basin, in which approximately 35% of watershed area has been developed with parking lots, lodges, septic tank fields, ski runs and lifts. The Tesuque watershed is in a relatively undeveloped condition, with one road used only for hiking, ski touring and the maintenance of telecommunications antennae on Tesuque Peak. This "paired watershed" approach enables a comparison of the effects of land use upon contiguous stream systems.

Two riparian surveys were conducted in each watershed, one at the base and a second approximately 0.3 miles upstream. This approach evaluates how upstream land use affects the overall riparian health of a stream, and helps to locate sites for subsequent mitigation. Results of the two surveys were averaged for each watershed. The Río en Medio had an average rating of 2.9 and Tesuque Creek 3.9. Major differences were less riparian vegetation and more sediment and embeddedness in the Río en Medio. A total of 486 insects were collected from the Río en Medio and 518 from the Río Tesuque by students of Santa Fé Preparatory School during 1993-94. Both streams had all 3 major orders, but the Río en Medio had a lower percentage of stoneflies (19%), compared with 29% for the Río Tesuque.

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STUDENT VOLUNTEERS TAKING ACTION

Advantages of Student Versus Agency Monitoring

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Background
The Student Watershed Research Project (SWRP) was created in 1991 as a partnership between university researchers, high school teachers and state and local agencies, including: Oregon Dept. of Environmental Quality, US Geological Survey, Unified Sewerage Agency, Clackamas River Water District, Oregon Graduate Institute, Pacific University, and Portland State University. Each existing and new partner provides an essential component for meeting the SWRP project goals.

During project formulation, agency and university scientists identified the "kernel" of key watershed components for our local area, the western Cascade region of the Pacific Northwest. Methods were selected to allow 8-12th grade students to collect high quality, reproducible data that would complement agency efforts. These parameters include water quality, riparian vegetation, and habitat assessment. There are currently 28 teachers involving 800 students in the study of these components on 65 sites in the Portland/Vancouver area of Oregon and Washington.

Each partner plays a crucial role in implementing the SWRP program. Agency partners provide technical support for initial and ongoing participant training. Local agencies are key in identifying streams and monitoring sites for which monitoring information is needed. Many of the schools involved in the SWRP program monitor areas which agencies rarely, or in some cases never, see. Increased geographic monitoring coverage is one of the major benefits of the SWRP program to our agency partners. The key to this benefit is ACCESS – school groups from local communities have connections to watershed residents. The perception for many private landowners is that student monitoring = education = non-threatening, whereas agency representatives may be responsible for enforcement, not just information gathering and assessment.

The SWRP program enables teachers to act as volunteer monitoring coordinators who train and involve their students in watershed analysis. SWRP staff coordinate the QAPP for all teacher/student groups involved in the program. Coordination includes pre-sampling analysis of unknown samples, professionally analyzed duplicate field samples, data auditing and reporting, and coordinating an annual data presentation forum (Student Watershed Summit). The Summit provides incentive for students to analyze and interpret their data and to present findings and recommendations to agency scientists and the community at large.

The SWRP program has two implicit goals: education and monitoring. The primary monitoring goal of the program is to provide complementary baseline data, which increases monitoring coverage, especially on unmonitored tributaries. Collection of this baseline information over time is useful for red-flagging, problem identification and habitat or water quality improvements.

Measuring Monitoring Success
Education and long-term monitoring are two distinct goals that require their own measures for success. From a monitoring perspective, data usage is the primary measure of success. The pure numbers of reports generated is a tangible way to report data usage for grantors, but there are several levels of data utilization that our program has tracked over the past nine years. The two primary reporting avenues are those generated by SWRP and those prepared by students.

<u>Reports Generated by SWRP</u>
Each year, SWRP reports data to local and state agency partners. Custom reports are generated for each agency based upon their geographic coverage so that agencies only receive data which is relevant to their area of interest and responsibility. The fact that state and local agencies are one of the final destinations for SWRP's data is one of the best motivators for student involvement and attention to detail.

State data usage: Producing state-usable data sets the bar for high quality data collection.

- Data are included in state database; provided for 303(d) update; and were used in last Triennial Surface Water Quality Review.

Being credited in a statewide publication has resulted in huge credibility for the SWRP program and has opened the door to additional data users. But does inclusion in the state database or inclusion in reports constitute "satisfactory" usage of data?

Local data usage: Local usage of SWRP data actually puts the data to work.

- Data have been used in watershed assessments prepared by Watershed Councils and SWCD's

- Sampling sites have been included in Watershed Council GIS projects

- Existing, current, and future data are being used to determine restoration project effectiveness by several local friend's groups and a regional parks and recreation district

- Local municipalities and cities utilize SWRP data in their annual NPDES reporting process

Reports Generated by Students

Student data reporting, outside the SWRP's data presentation Summit, varies based on the teacher and students involved. Most student groups are content knowing that SWRP has submitted audited data reports to the natural resource managers. But several cases exist where student action led to changes in their watershed. These changes were brought about through two very different approaches – the "agency alarm" and community outreach.

"Agency alarm": Student findings result in agency action

- Students found zero fecal coliform bacteria and very high chlorine values in an urban stream. They verified these findings with SWRP's QC lab and reported their findings to the Department of Environmental Quality. They then began talking to neighbors and reviewing neighborhood maps to determine which properties had swimming pools, a likely culprit, adjacent to the creek. This information was also provided to DEQ. RESULT: DEQ took direct action to remedy the situation. They did not issue a fine, but the pool has not drained into the creek since.

- After five years of consistent macroinvertebrate data collection and findings, students discovered a crisis in the population and taxa richness at their site. The macroinvertebrate decline was correlated to increased sedimentation and turbidity– vastly worse than in prior years. An investigation upstream revealed a huge development with improper erosion controls. Students reported the development, and their findings, to the local municipality. RESULT: A fine was given, a stop work order was implemented, and proper erosion controls were installed. Two years later students began to document a recovery in the macroinvertebrate population.

Community Outreach: Students utilize their own findings to educate and change the habits of their community

- Students found much higher coliform levels than "baseline" obtained during the previous 5 years of monitoring. Follow-up monitoring revealed an upstream rancher moving cattle across the stream. Students from the local community explained their findings and based on those findings, the rancher changed his timing for moving cattle across the stream. This is a great example of watershed residents simply not being aware of the impacts they have on water quality.

- Students compiled a survey about the water quality of local streams. They gathered responses to their simple survey from local residents. Their presentation was an analysis of how the community rated water quality in their local streams compared to the average Water Quality Index they calculated from their SWRP monitoring (which they've computed for the past several years they have been monitoring the streams). RESULT: The students found that the community thought their streams were in "Moderate" condition, and that the Water Quality Index scores were "Medium." Students interviewed the mayor, and from there, presented their findings to the city planner, the school board, and the city council.

- After a couple years of monitoring, students monitoring a sub-urbanizing salmonid-bearing stream noted how easily impacted the stream was. Perceiving very little community recognition of the local watershed, students applied for a small grant to create a short informational door-hanger. Students spent a great deal of time canvassing neighborhoods to increase awareness for the local watershed.

- NRCS used students with monitoring experience, through SWRP, to conduct runoff of blueberry studies. NRCS lacked the personnel to perform testing, and the landowner refused state agency access for the test but was interested in working with two students from the local community.

Conclusions

- Submitting data to state and local agencies IS important if for no other reason than to validate the usefulness and quality of the data being collected.

- Students can make a significant impact in their local community

- Local usage is probably the most satisfying use of data

STUDENT VOLUNTEERS TAKING ACTION

Schools/Townships Unite to Protect Water Quality

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The Greenacres Water Quality Project began in 1992 with the goal of enhancing science and math education at local schools. Greenacres works by using students to provide water quality managers with on-going, cost-effective, accurate watershed information. Greenacres Foundation works as a catalyst to forge self-sustaining partnerships between local schools and township councils to identify and resolve water quality problems. This hands-on interdisciplinary program:

- enriches math and science education,
- correlates with Ohio's State Academic Proficiency Standards,
- encourages real-world problem solving and critical thinking,
- promotes community involvement through service learning, and
- engages students in the local political process.

Greenacres Foundation works with the Cincinnati Metropolitan Sewer District, Ohio Department of Natural Resources, Hamilton County Soil and Water Conservation District, Ohio EPA, the Hamilton County Board of Health, and Izaak Walton League to implement the program. These partnerships enhance community awareness, develop local "ownership" of water resources, and promote positive public relations. Students have successfully worked to resolve problems with failing septic systems, leaking sewer lines, broken lift stations, illegal dumping (concrete, construction waste, medical waste, used dry cleaning solvents, and plating wastes), and improper discharge of chlorinated pool water.

The presentation described the program and its benefits including how to set up a similar program. Participants received a handout detailing how the program operates including tips on how to work with townships, local agencies, school boards, and Parent Teachers Associations (PTAs) to share responsibilities and resources.