Community Based Water Monitoring and Beyond
A Case Study: Pennsylvania

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Biography of Author

Diane Wilson is a biologist serving as the Citizens' Volunteer Monitoring Program Coordinator for Pennsylvania's Department of Environmental Protection in the Bureau of Watershed Conservation. She previously worked as an environmental scientist with the Pennsylvania Turnpike Commission, a wetland specialist for the former Pennsylvania Department of Environmental Resources, and an educator in the United States and Swaziland, Africa. In her current position she is responsible for providing organizational, technical and networking resources for Pennsylvania's numerous volunteer water monitors. She has been instrumental in initiating the Pennsylvania Volunteer Environmental Panel, the statewide Snapshot of Water Quality and the Pennsylvania Senior Environment Corps Water Quality Monitoring Program. She holds a Master of Science degree in Biology.

Abstract

Pennsylvania has a rich history of grassroots volunteer water monitoring. A recent survey by Pennsylvania's Department of Environmental Protection's Citizens' Volunteer Monitoring Program indicates that there are at least 138 groups comprising 11,000 individuals who collectively spend more than $1,000,000 on monitoring activities. This paper explores the makeup of these groups as well as the rationale behind their formation and sustained activity. A number of the community based monitoring groups has gone beyond water quality monitoring to restoration activities. This paper also relates the goals and activities of the Citizens' Volunteer Monitoring Program, which was initiated in 1996, to the goals and needs of the community based monitoring groups. Some of the actions taken by the Citizens' Volunteer Monitoring Program to meet the needs of local groups include: the formation of a statewide Volunteer Environmental Monitoring Panel, an extensive training program tailored to individual group's goals and the coordination of a statewide "Water Quality Snapshot". It has also partnered with the Environmental Alliance for Senior Involvement, the Pennsylvania Senior Environment Corps and the Pennsylvania Department of Aging on the organization of a stream monitoring program with standardized protocols and a quality assurance project plan for senior citizens. Most recently, the Citizens' Volunteer Monitoring Program has prepared a handbook for community based monitoring. The handbook is unique in that it does not prescribe standardized protocols for all. Instead it advocates the use of study design and a choice of monitoring methods appropriate to meet the goals of the individual group. The role of community based water monitoring in state assessments will also be explored.

Introduction

Across the nation, many energetic, hardworking individuals - adults and children alike - are involved in community based monitoring activities. They study a variety of surface and groundwater resources. These include rivers, streams, lakes, ponds, wetlands, estuaries, beaches and wells. They often have multiple sampling stations in or on numerous waterbodies. Volunteer monitoring is an integral part of comprehensive national water protection. By monitoring water quality, volunteers empower themselves and their communities to become better water stewards. A well-designed volunteer monitoring program helps participants understand the power and limitations of scientific inquiry. Volunteer monitoring can also supplement professional monitoring in a variety of important ways:

- It can provide a screening mechanism to determine where further study is needed.
- It can assess the effectiveness of restoration efforts in watersheds.
- It may provide the only data available for a particular watershed, especially in remote areas.
- It may help collect environmental data during unusual conditions such as rainfall events or more frequently than routine sampling carried out by resource agencies.
- It can help document the presence of important flora and fauna in a watershed through observation near established monitoring stations.

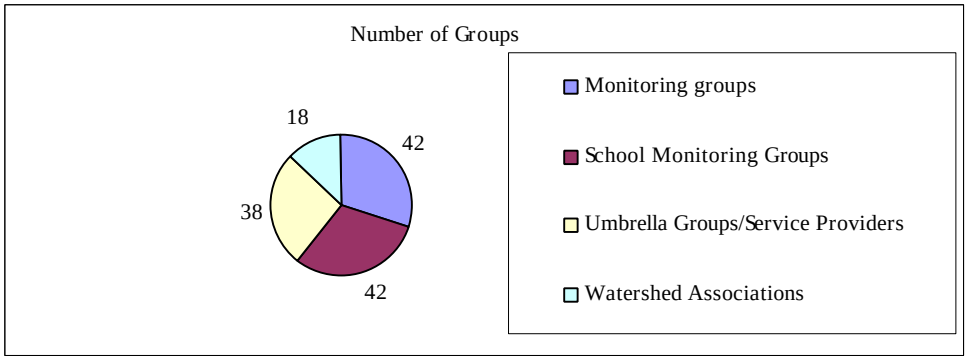
Pennsylvania has a long-lived, dynamic community based monitoring movement that now goes beyond the study of aquatic systems to long term restoration and protection for whole watersheds.

Profile of Community Based Water Monitoring Groups in Pennsylvania

A survey completed in 1999 by the Citizens' Volunteer Monitoring Program of the Pennsylvania Department of Environmental Protection indicates that there are at least 138 groups comprised of more than 11,000 individuals involved in some sort of voluntary monitoring in their communities. The number of groups more than doubled since a 1997 survey by the program which documented the existence of 63 groups.

Groups were asked to categorize themselves as monitoring groups, watershed associations that include monitoring as one of their activities, school monitoring groups or umbrella groups that provide some sort of services for volunteer monitors in addition to actually monitoring water resources. The results are depicted in figure 1.

Figure 1



Program Size

The community based monitoring groups tend to be small. The median size is 20. Table 1 shows programs with 20 or fewer volunteers account for the majority of the groups. This tends to underscore the grassroots nature of the volunteer monitoring efforts in Pennsylvania. Many programs consist of a small group of concerned citizens monitoring a small watershed or stream stretch.

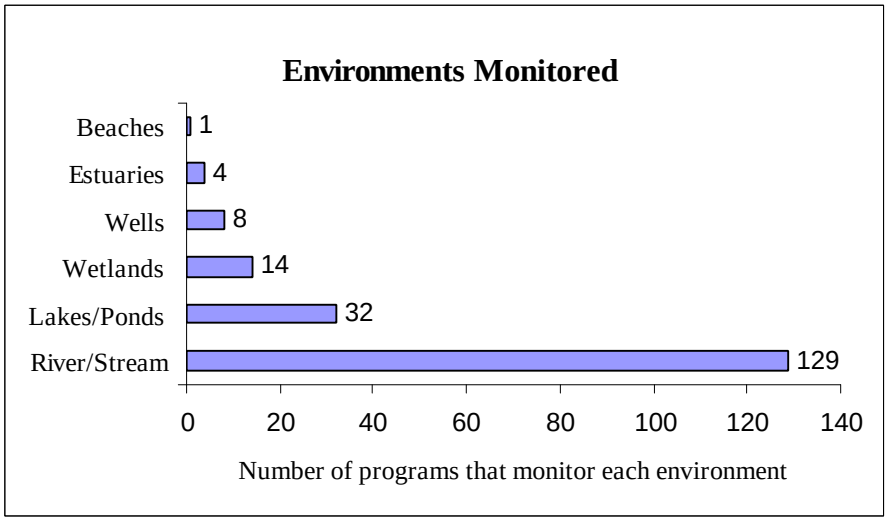
Table 1
Program Size

Volunteers	*Number (% of all programs)*
1 -20	83 (60%)
21- 50	32 (23%)
51 - 100	8 (6%)
101 - 1000	13 (9%)
>1000	1 (<1%)

Environments Monitored

Pennsylvania has nearly 84,000 miles of rivers and streams. So it is not surprising to find that 93 % of all groups reported monitoring this environment as shown in Figure 2. This is similar to the 1997 survey results, which indicated 90% of groups monitoring flowing waters. While lakes finished a distant second with only 32 groups or 23% reporting lake monitoring this number has increased from less than 10% (7 groups) in 1997. Fifty percent of groups are monitoring more than one environment as well as reporting an interest in watershed planning, land use survey and wildlife monitoring. All this indicates a move away from a concentration of efforts on a single stream stretch to a concern with the entire watershed.

Figure 2



Indicators Monitored

Table 2 shows the number of volunteer monitoring programs that monitor each indicator. Since so many groups monitor river or stream environments, indicators that are typically monitored in flowing water tend to rank high in the table. The top three indicators - pH, water temperature and dissolved oxygen - also scored high in the previous survey. They are relatively easy to measure and are important indicators of the ability of surface waters to support the fourth indicator - benthic macroinvertebrates. Nutrients - nitrates and phosphates, which are difficult to measure accurately in the field, are popular amongst the volunteers because of the importance of these indicators in gauging non-point sources of pollution. The low number of groups that measure pesticides and hydrocarbons reflects the unavailability of accurate low cost analysis methods. Costly laboratory analysis is usually the only option available to volunteers. It seems likely that many more community-based groups would want to test for these indicators if they had the resources to do so. Since this is not the case, volunteer monitors assess the biological response of organisms such as macroinvertebrates, fish, aquatic vegetation, birds and other wildlife. The abundance and diversity of these organisms reflect the overall health of the system and suggest whether toxic levels of pollutants may be present.

Table 2

Indicators Monitored

Rank	Indicator	Number(%) of Programs
1	pH	127 (92%)
2	Water Temperature	126 (91%)
3	Dissolved Oxygen	106 (77%)
4	Macroinvertebrates	104 (75%)
5	Nutrients (Nitrates and Phosphates)	101 (73%)
6	Alkalinity	75 (54%)
7	Turbidity	65 (47%)
8	Habitat Assessment	56 (41%)
9	Flow/Gauge	50 (36%)
10	Hardness	46 (33%)
12	Site Inspections	45 (33%)
13	Fish	37 (27%)
14	Rainfall	37 (27%)
15	Aquatic Vegetation	35 (25%)
16	TSS/TDS	31 (23%)
17	Chlorides	30 (22%)

18	Metals	29 (21%)
19	Coliform Bacteria	25 (18%)
20	Birds/Wildlife	23 (17%)
21	Debris Cleanup	22 (16%)
22	Secchi Transparency	17 (12%)
23	BOD	16 (12%)
24	Conductivity	13 (10%)
25	Photographic Survey	13 (10%)
26	Watershed Mapping	10 (7%)
27	Sediment Assessment	8 (6%)
28	Stream Channel Morphology	7 (5%)
29	Chlorophyll	6 (4%)
30	Pesticides	4 (3%)
31	Pipe Survey	3 (2%)
32	Hydrocarbons	3 (2%)
33	Acidity	2 (1%)

Data Uses and Users

Figures 3 and 4 show the data uses and data users reported by the groups. The majority of groups reported multiple uses for their data and more than one data users. The number one use for community based monitoring data is education with the groups themselves as the primary user of data collected. This is an interesting result because ensuring that volunteer collected is put to some use is often the dilemma for coordinators of community based monitoring programs. The last thing volunteers wish to do is collect endless mountains of data that will grace the shelves of storage sheds for years to come. Discussion of volunteer data use often turns to identifying data users outside the organization such as the state and federal government. Yet this survey indicates that the groups themselves are using the data and in large part to educate themselves and their communities. Pennsylvania has over 2000 municipalities that govern land use decisions. It is no surprise then that volunteer monitoring groups identify local government as a popular data user as the concern of many community based organizations is the effect of development on their watersheds.

Figure 3

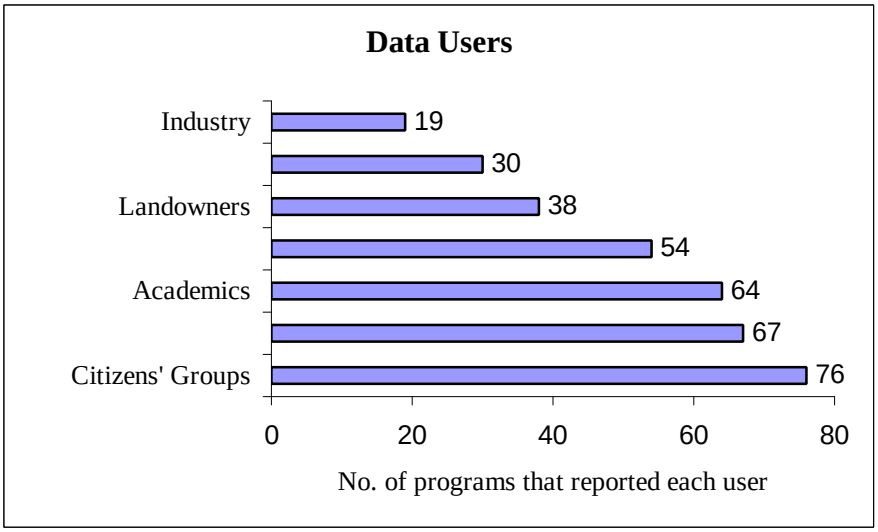
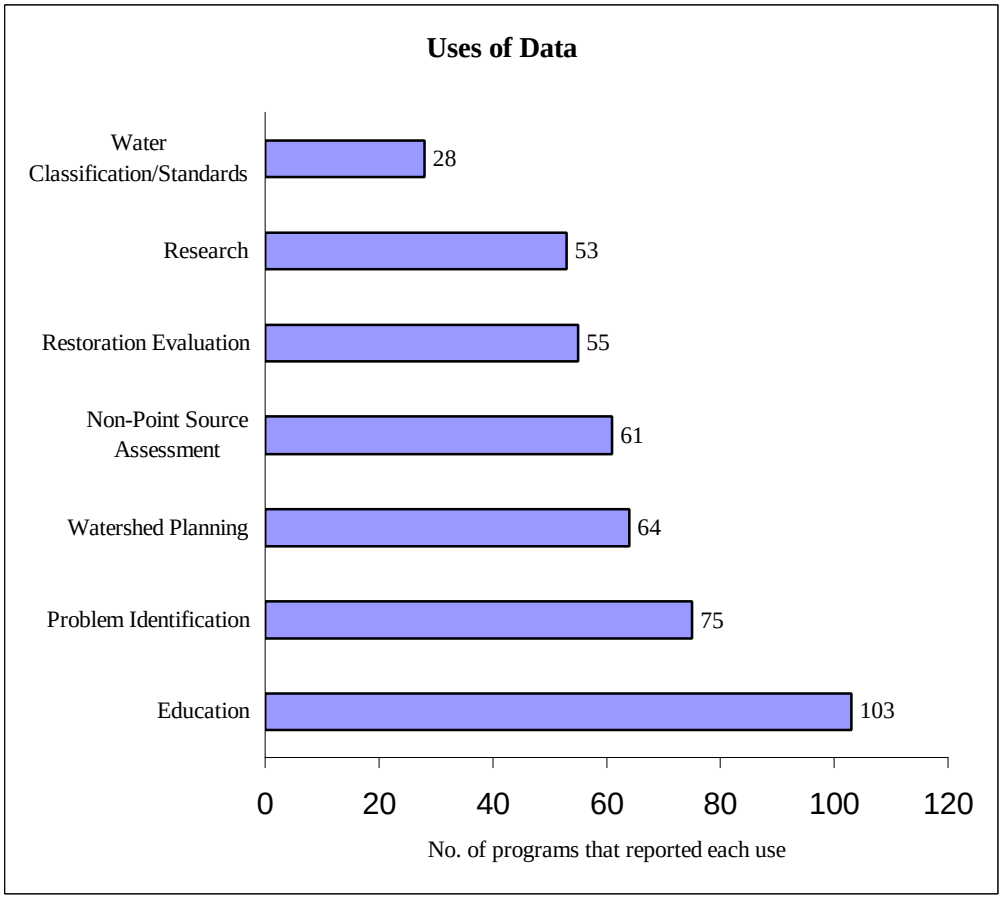


Figure 4



Funding

Community based water monitors collectively spend over $1,000,000 in Pennsylvania annually. Survey findings about the annual budgets and source of revenue for community based monitoring tends to underscore the local and grassroots nature of the movement in Pennsylvania. Although the range for budgets is from $0 - $100,000, the median approximate annual budget is $3,000 with many groups operating on $500 or less. Figure 5 illustrates funding sources. 54 groups or 39% of the total number reporting, chose "other" as a source of funding which is nearly always local. Common examples include school districts, community based fund raising events and municipal agencies. In addition 53 groups (38%) reported that funding comes largely from dues paid by monitors. So, not only are volunteers willing to give of their time to know their water resource better but they are also willing to pay to do so.

Table 3

Funding Source	***Number of Groups***
Other	54 (39%)
Dues	53 (38%)
State Government	31 (23%)
Foundation	20 (15%)
Corporation	18 (13%)
Federal Government	18 (13%)

Quality Assurance
Thirty-five groups or 25% of the total reported having a written study design and 36 groups or 26% reported having a Quality Assurance Project Plan.

Longevity and Sustainability of Programs
Volunteer monitoring is not a new concept in Pennsylvania. The average age of the groups surveyed is 7.5 years with 5 groups reporting over 20 years of monitoring and 3 groups with over 30 years of monitoring.
Many groups form around a single issue such as concern over a certain development that watershed residents believe will adversely impact water resources. An example is the White Clay Creek Streamwatch, which began in 1990 due to concerns caused by the rapid development taking place in the watershed. Another group, the Little Juniata Watershed Association, was formed when a group of anglers noticed a dramatic decrease in the mayfly population. The anglers alerted a Pennsylvania Department of Environmental Protection biologist who confirmed their findings. The decrease in macroinvertebrates in the Little Juniata River was attributed to a pesticide spill of unknown origin. The volunteers are now assisting the Department of Environmental Protection in monitoring the recovery of the river ecosystem.
While it is typical that a group form around a single issue, those groups that sustain their programs over many years are usually driven by a number of concerns about the health of their streamstretch or watershed. These groups move beyond the single issue that brought them together and often become involved in efforts to educate the community. They also become involved in restoration activities based on the data they collect.

Pennsylvania Department of Protection Citizens' Volunteer Monitoring Program
The Pennsylvania Department of Environmental Protection has a Citizens' Volunteer Monitoring Program that was initiated in 1996 to provide support and technical assistance to community based water monitoring efforts. The goals of this program include:

- Fostering stewardship by helping communities find the tools needed to meet their own goals in gathering information about water resources.
- Giving the department a better understanding of water resources by receiving quality assured data from volunteers.

Volunteer Environmental Monitoring Panel and Statewide Network
In order to meet the needs of the dynamic community of volunteer monitors, the Citizens' Volunteer Monitoring Program has undertaken a variety of activities including the formation of a statewide Volunteer Environmental Monitoring Panel. The Panel is made up of representatives from the volunteer monitoring community, business and industry, the agricultural community, organizations that provide services to volunteer monitoring groups and resource agencies. One of the original intentions of the panel was to create a forum for discussion and sharing of information among various entities involved in or concerned about monitoring and water quality issues. The format of the panel is presently being broadened to create a wider network. This will allow more community based monitoring groups to become involved and will allow more opportunity for other local input and discussion. The network will also help create a better forum for community based groups in a region or watershed to share data, experiences and equipment and to better coordinate their efforts with each other. The network will be launched at a statewide summit of volunteer monitors in the year 2000.

Technical Handbook
Community based monitors in Pennsylvania use a variety of methods for sampling and analysis. Instead of attempting to prescribe standardized protocols for all 138 groups, the Citizens' Volunteer Monitoring Program in collaboration with the panel has prepared a draft technical handbook - *Designing Your Monitoring Program, A Technical Handbook for Community-Based Monitoring in Pennsylvania* - that includes a study design process. This process is a logical series of choices about the why, what, when, where and how of monitoring. With a written study design, each group will have a clear game plan to guide them through their monitoring program and lend credibility to their data collection and any actions that result from information gathered. The group also identifies the data user in this process so that clear data quality objectives and quality assurance measures can be set up front before monitoring occurs. Defining a purpose, data use and data users are clearly the most critical part of the study design process advocated in the handbook.

Four potential purposes are defined in the handbook as described below:

Purpose A: Education and Awareness to promote watershed stewardship, raise awareness of watersheds as living communities, give participants experience in scientific inquiry, and improve awareness of local officials of the impacts of decisions (including cumulative impacts) on the watershed. The information collected will be used to increase people's understanding and appreciation of the way watersheds work. The goal is that they will act on this understanding to minimize their impacts on the integrity of the ecosystem.

Purpose B: Baseline Data Collection for trend analysis, problem and positive attribute identification, and screening. The information collected will be used at the community or watershed level to track trends over a relatively long period of time, to see if the ecosystem and human uses of it are improving, staying the same, or getting worse. Or, the information will be used to quickly identify problems in order to assess the need for some corrective action or further study. Conversely, the information can be used to identify successes or community assets to enhance human uses of the watershed.

Purpose C: Community and/or Watershed Level Assessment of current conditions and the effectiveness of solutions, development of community-level non-point source remediation plans. The information collected will be used at the community or watershed level to assess the current condition of the watershed in order to identify the nature and extent of problems (impairments of ecological functions and human uses). This may lead to the development of a non-point source remediation plan by communities under the state's unassessed waters strategy. Finally, this same information, gathered over time, will be used to assess the effectiveness of the plan, or specific measures, in restoring watershed integrity and human uses.

Purpose D: State and Federal Agency Assessment of current conditions and the effectiveness of solutions. Supplement agency data collection and for use by research entities. The focus for the Department of Environmental Protection's use will be on assessment and planning, rather than enforcement actions that require strict protocols and chain-of-custody procedures.

The information collected will be used by the Pennsylvania Department of Environmental Protection in conjunction with its own data, as part of its biennial assessment for Congress of the state of the state's waters (under section 305(b) of the federal Clean Water Act). The handbook also contains more than 20 "surveys" or monitoring packages that can be tailored to the goals and needs of the groups.

Training and Technical Assistance

The Citizens' Volunteer Monitoring Program has an extensive training program that is tailored to the needs of the volunteer monitoring groups. Over the three years of its existence the Citizens' Volunteer Monitoring Program in collaboration with River Network and other service providers has held over 50 workshops on topics of interest to community based water monitors including: Increasing Your Credibility; Instream Methods for Monitoring Chemical, Physical and Biological Indicators; Abandoned Mine Drainage and Monitoring; Quality Assurance and Quality Control; Monitoring Study Design; Stream Corridor Restoration and Monitoring; Lake Monitoring. The program also provides "workshops on demand" which are specifically planned and tailored to the goals of a particular group. The Citizens' Volunteer Monitoring Program also provides technical assistance and mentoring to community based monitoring groups.

Pennsylvania Senior Environment Corps

The Citizens' Volunteer Monitoring Program has worked with the Environmental Alliance for Senior Involvement to create ten Senior Environment Corps sites throughout the state. The Pennsylvania Senior Environment Corps use standardized protocols under the guidelines of a statewide Quality Assurance Project Plan to assess physical and chemical indicators of stream health once a month at about 300 sampling stations. They also do a habitat assessment and a water quality rating using benthic macroinvertebrate communities twice a year. This data can be used as a screening tool to determine where further study is needed and the success or failure of restoration efforts. The data is housed in a statewide database that includes an open component that can be utilized by other volunteer monitoring groups not following the Corps' standardized protocols. The Citizens' Volunteer Monitoring Program and the Pennsylvania Senior Environment Corps are working together to revise the statewide Quality Assurance Project Plan for this project.

Watershed Snapshot
The program in collaboration with the Delaware River Basin Commission plans and implements an annual statewide *Watershed Snapshot*. The goals of this event are to:

- Promote watershed education and awareness
- Recognize the ongoing efforts of community based water monitoring groups
- Foster the link between community based water monitoring groups and professional monitors
- Promote and strengthen the network of community based water monitors

During *Watershed Snapshot* thousands of volunteers and professionals collect water quality data at their routine sampling stations during a ten-day period in April that includes Earthday. They employ the scientific equipment and methods of analysis they have available and routinely use. No limitations are placed on how to choose the monitoring sites. In many cases, streams or lakes are chosen based simply upon their proximity and accessibility to participants. Participation packets containing data sheet with space to record data about physical, chemical and biological indicator along with a habitat assessment are sent to hundreds of addresses across the state. Data sheets are returned to the Citizens' Volunteer Monitoring Program. The program compiles the data into a report that can be used as an educational tool. The data is "democratized" - all data is used without regard to the data quality objectives employed - to develop a “picture” of the overall water quality in Pennsylvania. The data collected can be used to get a better picture of the ranges in results that can be expected, as well as determining trends and effects of physical influences upon water chemistry.

The Role of Community Based Monitoring in State Assessments
DEP uses data in a variety of ways that focus primarily on monitoring the ecological health of the waters and impacts of toxic pollutants on public health. One of the monitoring activities carried out in assessing the state of the waters is a long-term water quality network of 150 fixed monitoring stations on rivers, streams and lakes throughout the state. These stations are located in major streams, selected reference waters, and selected lakes. Each of the stations is sampled for stream discharge or lake height and for a variety of chemical and physical indicators. A biological evaluation using benthic macroinvertebrates is carried out once per year at routine stations and three times per year at reference stations. This water quality network does not cover the majority of Pennsylvania's 84,000 stream miles. Consequently the state has undertaken an Unassessed Water Strategy to evaluate all of these waters with priority given waters where there is potential for non-point source pollution. DEP also carries out Aquatic Life Special Water Quality Protection Surveys. The purpose of these surveys is to assess the need for special protection and to revise the state water quality standards if necessary. DEP also conducts Cause/Effect Surveys to determine if specific sources of point or non-point source pollution are causing known problems. Use Attainability Studies are carried out to review and revise if necessary water quality standards to ensure that designated fish and aquatic life uses are protected. DEP also carries out lake assessments and maintains an Ambient and Fixed Station Network Monitoring Program to monitor the general quality of groundwater.
Community based monitoring plays a vital role in state assessments. Volunteer monitors in Pennsylvania sample daily, monthly, semi- annually and quarterly at over 3000 sampling stations throughout the state. The information that is collected in a variety of ways can be used to supplement the 150 stations on the water quality network. It can and also has been used as a screening tool to raise a red flag to trigger a Cause /Effect Survey or a Use Attainability Study.
Data collected under a written quality assurance/quality control plan that follows strict criteria concerning age of data, identification of a stream segment, and frequency of sampling has been used in the compilation of the Water Quality Assessment 305(b) report and resulting 303(d) list of impaired waters.
The handbook - *Designing Your Monitoring Program, A Technical Handbook for Community-Based Monitoring in Pennsylvania* - has an entire tract dedicated to educating the public on how a monitoring program must be designed and implemented if the goal is to have data usable in the 305(b) report and 303(d) list if the stream segment is not attaining the applicable water quality standard. The Citizens' Volunteer Monitoring Program in collaboration with the Pennsylvania Department of Environmental Protection's Division of Water Quality Assessment and Standards solicited outside sources of data to be utilized by the Department in the 303(d) listing process. Watershed associations, community based monitoring groups and others were sent a letter with detailed guidance on data collection and reporting requirement. Ten groups responded with five submitting data usable for

the year 2000 303(d) listing. A training session will be planned and implemented by the CVMP in the year 2000 to offer specific guidance to groups who want to collect data for use in the year 2002 305(b) report and 303(d) listing.

There are pathways that go beyond these more traditional avenues for use of data collected by community based monitoring groups. The CVMP conducted an extensive review of programs within DEP to solicit additional potential uses for citizen collected data. The list of potential uses includes:

Riparian buffer monitoring – Volunteers would monitor the effects on stream quality when buffers are restored.

Wetland monitoring – Volunteers would check wetland losses and function changes (forested to emergent), monitor replacement sites, monitor advanced compensation wetlands, assess watersheds to locate areas for wetland restoration projects and inclusion in the wetland registry.

Habitat monitoring – Volunteers would monitor habitat loss including streams, wetlands and lakes over time.

Survey stream obstructions – Volunteers would locate obstructions in the watershed including debris blockages, constricted culverts, etc.

Watershed field views for abandoned mine land projects – Volunteers would do field views of watersheds impacted by abandoned mining, locate seeps, and field test seeps for quality.

Lake monitoring – Volunteers would do lake trophic studies including physical and chemical profiles.

Habitat surveys for TMDL remediation – Volunteers would perform follow-up biological and physical habitat surveys on streams targeted for TMDL remediation (qualitative biomonitoring and physical habitat evaluation).

Stormwater management plan sampling – Volunteers would acquire physical data for stormwater planning in a watershed.

Monitoring stormwater facilities – Volunteers monitor the workings of stormwater facilities such as ponds, swales and ditches, and monitor their impacts on local watersheds.

Zebra mussel monitoring – Volunteers would check streams for zebra mussels and their impacts, check special substrate samplers for zebra mussel infiltration.

Streamwalks – Volunteers do streamwalks to observe local conditions and to observe problems such as malfunctioning on-lot systems. This will also give agencies an idea of land use and impacts along the stream.

Observe flood protection projects – Volunteer would check flood protection projects to make sure the structures are operational, also check function during and after flood events.

Winter stonefly monitoring - Volunteers monitor adult stoneflies in the winter, will give an idea of stream quality and will assist in setting up additional monitoring in summer/fall.

Watershed field views for nonpoint source remediation projects – Volunteer could do watershed surveys to check on the success of nonpoint source restoration/remediation projects, observe stream conditions near the projects, land use and best management practices.

In addition to these potential projects, DEP will be making a special effort to work with groups that get 319 funding. Volunteer will monitor the impacts of watershed restoration projects completed with the 319 funding.

Summary

Community based monitoring is alive and well in Pennsylvania. It offers an exciting opportunity for individuals to take responsibility for their environment. A well thought out monitoring program could play a vital role in improving local watershed health. There are a large number of monitoring projects that communities and DEP could undertake together to protect and enhance water resources across the state.