An Overview of Surface Water Monitoring Programs in New England and New York:

Recommendations for Improving States' Volunteer Monitoring Efforts

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INTRODUCTION

The goal of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. This means that the water quality of a waterbody is determined by the combination of all of its physical, chemical, and biological characteristics. Monitoring is a way of gathering information about the health of a waterbody by observing, collecting, and analyzing information about its parts. The components that have been chosen to be measured are called water quality indicators.

Ambient monitoring, surveillance of a waterbody's environmental condition, is important for many reasons. It is an excellent way to assess how healthy a waterbody is and to understand the impacts of human activities. In addition, monitoring is an essential tool for making good watershed management decisions and for evaluating the effects of these decisions.

The responsibility to monitor water quality rests with many different agencies. State agencies have important monitoring responsibilities and conduct rigorous monitoring programs. Various federal agencies including the US Environmental Protection Agency (US EPA), US Geological Survey (USGS) and the US Fish and Wildlife Service (US FWS), assist the states, in addition to conducting their own monitoring. Lastly, private entities such as universities, watershed associations, environmental groups, and industries also conduct water quality monitoring.

Data collected by federal, state, and local groups along with private entities are needed to build assessments to make better pollution control decisions. ithout data, we simply cannot know where pollution problems exist, where we need to focus our pollution control energies, or where we have made progress.

The purpose of this report is to provide an understanding and assessment of tools that states can use to expand their freshwater monitoring programs, specifically with volunteers. This report begins with a summary of the New England and New York states' core surface water monitoring programs. In addition, the report provides recommendations for utilization of volunteers in state freshwater monitoring programs.

CONNECTICUT

Connecticut's ambient monitoring program consists of seven full-time employees. Full-time monitoring staff are augmented by approximately six seasonal employees each summer. In 1997, Connecticut began the implementation of a rotating basin approach for monitoring and assessment. Under this approach, a hydrological unit, roughly equivalent to one fifth of the state, is monitored each year, with an annual level of effort including approximately 50 sites. These sites are sampled quarterly for ambient physical/chemical parameters and one time per year for benthic invertebrate community structure. This does not include DEPs surface water monitoring activities associated with Long Island Sound. Please refer to the DEP web site for more information on Long Island Sound monitoring. The state is presently using a state written Microsoft Access program for managing physical and chemical data, which will soon be used for benthic invertebrate (biological) data. Connecticut is committed to using STORET (STOrage and RETrieval) as the ultimate repository for all monitoring data and is currently exploring options with EPA for accomplishing this goal.

PHYSICAL/CHEMICAL MONITORING

The CT DEP/USGS Cooperative Primary Physical/Chemical Monitoring Network is a long-term cooperative program between the CT Department of Environmental Protection (DEP) and the United States Geological Survey (USGS). Since the 1970s, the network has been maintained by USGS. Currently, water quality data are collected at 33 sites on 15 rivers. Over 30 physical and chemical parameters are monitored at an average frequency of eight times per year. Sampling sites are located primarily on the State's largest rivers, interstate rivers, waste receiving streams, and selected unimpaired reference sites.

Over the past decade, coverage has been reduced by approximately 50% due to increasing costs and diminishing funds. This project provides reliable, high quality data that describes the physical and chemical characteristics of the rivers monitored. Many of the sampling sites also include continuous stream flow measurements. The data is used to support trend assessments, determine compliance with water quality standards, estimate loading, and establish reference conditions on minimally impaired waters. These sites will continue to be monitored at an optimum frequency in order to take advantage of the existing extended period of record for trend analysis.

The Rotating Secondary Physical/Chemical Monitoring Network is intended to supplement the primary network site by providing physical and chemical data on selected rivers. Sampling frequency is quarterly for one year, consistent with the rotating basin schedule. Sampling site selection is based on a targeted approach considering sub-basin size, location of wastewater discharges, land use, and resource value. Conventional water quality parameters, toxic metals, and indicator bacteria are measured by means of grab samples. Sample collection and field measurements are performed by personnel from the DEP. Laboratory analyses are conducted by the CT Department of Public Health (CT DPH).

BIOMONITORING

The Ambient Biological Monitoring Program characterizes water quality by evaluating the biological integrity of resident communities of aquatic organisms. Biological monitoring, conducted by the DEP since the early 1970s, has focused primarily on the benthic invertebrate community of wadeable stream segments. Approximately 329 sites on 140 rivers have been monitored to date. Since 1989, assessments have been based on community structure using techniques that are intended to minimize the influence of variables such as habitat, seasonality, and sampling method following a modified version of the US EPA Rapid Bioassessment Protocol (RBP) III. Following the rotating basin strategy, benthic invertebrate monitoring is conducted at approximately fifty sites each year corresponding to the rotation schedule. Since biological monitoring integrates environmental conditions over an extended time, each site is sampled only one time, usually taking place during the fall. Spring sampling is conducted on a limited basis for special studies or to supplement fall sampling. In addition to the rotating basin schedule, approximately ten regional reference sites located across the state are sampled annually.

Intensive Water Quality Surveys are conducted to obtain data that provides the greater degree of spatial or temporal resolution than is generally obtained by routine fixed network monitoring sites. These surveys can include physical/chemical or biological monitoring. While intensive surveys may be carried out in concert with rotating basin approach for monitoring and assessment, most occur outside the general rotation schedule. Details of specific intensive surveys are provided in DEP annual workplans for monitoring activities.

Intensive physical/chemical water quality surveys are conducted to obtain data on selected water bodies during specific environmental conditions, such as during low flow events. Data from intensive surveys may be used to calibrate and verify mathematical models used for Total Maximum Daily Load analyses, in the development of water quality improvement plans, and to measure improvements following implementation of such plans. Often survey design calls for collecting a series of samples from multiple locations on a river segment, its tributaries, and wastewater discharges over a 24 or 48-hour period.

Intensive biological surveys are those biological monitoring activities not associated with the fixed or rotating network of monitoring sites. These surveys can include assessment of resident aquatic communities, tissue contaminants in aquatic organisms, or toxicity testing of surface waters, sediments, or wastewater discharge effluents.

Tissue Contaminant Monitoring of fish and invertebrates has been conducted since the late 1970s. Chemical analyses are conducted under contract with the CT DPH Laboratory Division, or the University of Connecticut Environmental Research Institute. Typical contaminants monitored include PCBs, pesticides, and toxic metals. The primary purpose of this monitoring has been screening for human health risk and for the development of fish tissue consumption advisories for individual waterbodies.

Beach Monitoring occurs at twenty-two State beaches. These beaches are monitored for *Enterococci* group indicator bacteria weekly beginning one week before Memorial Day and ending Labor Day week. Municipalities perform comparable monitoring at roughly 100 other designated beaches in Connecticut.

Nitrogen and Mercury Deposition Monitoring. In partnership with the Connecticut Department of Environmental Protection (CTDEP), the Environmental Research Institute (ERI) of the University of Connecticut has been monitoring wet and dry atmospheric deposition of nitrogen and mercury at eight monitoring stations spread throughout the State since 1997. In prior years (since 1991) two or three sites were monitored. The program is funded through March, 2001. The objectives of the nitrogen-monitoring program are to quantify the rate of nitrogen deposition, compare spatial and temporal differences among stations, and to quantify concentrations and relative loads of nitrite, nitrate, ammonium, and organic nitrogen in wet and dry deposition. Nitrogen is the primary cause of low dissolved oxygen in Long Island Sound bottom waters during the summer. More than 25% of the nitrogen enrichment delivered to Long Island Sound is believed to originate from anthropogenic atmospheric emissions. The data have been instrumental in developing nitrogen-loading estimates and calibrating watershed models to ensure Long Island Sound management needs are properly targeted to all key sources.

VOLUNTEER MONITORING

Volunteer monitoring is a growing source of water quality information in Connecticut. DEP encourages these activities by providing funding, direct technical assistance and Quality Assurance Project Plan (QAPP) support. Quality assured volunteer monitoring data has been used in DEP's 305(b) water quality assessments since 1996. Since 1995, DEP staff have provided technical assistance and data management support for 16 wadeable stream volunteer monitoring programs. The Bureau of Water Management (BWM) encourages volunteer monitoring through Section 319 funded monitoring projects and by providing technical assistance and Quality Assurance/Quality Control (QA/QC) support to volunteer monitoring projects. Monitoring staff have provided support, mainly training and data management, to approximately eighteen specific volunteer monitoring projects and six stream walk surveys (systematically recorded visual observations). A new staff position was added to the BWM in 1998 to provide increased technical support to volunteer projects.

A volunteer stream monitoring guidance document has recently been completed and is available at the department's web site, www.dep.state.ct.us. This document is directed at persons or groups interested in becoming involved in citizen monitoring activities and is intended to encourage volunteer programs to adopt a tiered approach. The tiered approach is designed to channel their activities in a way that will optimize the value to DEP of the information collected, while maintaining interest and enthusiasm on the part of the volunteers. The department also loans equipment, purchased through a 319 grant, to volunteer monitoring groups.

Lake Monitoring by Citizens. Citizen water quality monitoring in lakes is accomplished in a variety of ways in Connecticut. Some lake groups hire professional consulting limnologists to collect and interpret data on their lakes as often as monthly or as infrequently as once during the growing season. Other communities have residents who collect data and pay for chemical analyses at commercial laboratories. The Connecticut DEP assists lake communities who are interested in starting a monitoring program by developing a scope of services that outlines a program for a lake that meets the water quality concerns of the community. When the Connecticut Lakes Grant Program is funded and the lake provides public access, the Department will encourage communities to apply for a 75% cost sharing grant to defray the cost of their regular monitoring program or increase the scope of existing programs.

MAINE

The Maine Department of Environmental Protection (ME DEP) has a broad sampling program to assess water quality conditions. Water sampling programs are conducted to carry out two sections of environmental law: the Water Classification Program, and the Protection and Improvement of Waters. The DEP's sampling program is made up of four components:

- Ambient Water Quality Monitoring which determines attainment based on standards, assesses whether discharges violate standards, contamination levels, and aquatic community condition, and assesses trends in water quality.
- Treatment Plant Compliance Monitoring assesses compliance with wastewater discharge licenses and determines water quality effects of combined sewer outflows.
- Investigations respond to complaints of unlicensed discharges and other environmental concerns.
- Modeling is used to predict the effects of present and proposed discharges using water quality data and computer modeling.

In addition to these programs, data are provided by the Penobscot Indian Nation (PIN), the United States Geological Survey (USGS), United States Environmental Protection Agency (EPA), Department of Marine Resources (DMR), and many volunteer groups.

PHYSICAL/CHEMICAL MONITORING

Maine's Lake Monitoring and Diagnostic Studies monitor temperature, transparency, dissolved oxygen (DO), as well as phosphorus, chlorophyll, and sediment samples from selected Maine lakes, ponds, and tributaries.

The goal of ***Maine's Dioxin Monitoring Program***, established in 1988, is to determine the nature of dioxin contamination in the waters and fisheries of the State. DEP is required to sample fish once a year, below no more than 12 known or likely sources of dioxin, such as, bleached pulp mills and municipal wastewater treatment plants. DEP is also required to sample sludge from the same facilities once each quarter as an aid in the identification of sources of dioxin.

BIOMONITORING

Maine DEP's ***River and Stream Biological Monitoring Program*** provides water quality information for a wide array of programs and initiatives. These include general, long-term monitoring; impact evaluation downstream of point source discharges; evaluation of impacts from toxic contamination through the Surface Water Ambient Toxins Program; and evaluation of the impacts of hydropower activities. Sampling takes place from July through September.

Presently the ***Biological Monitoring Program*** has established approximately 300 monitoring stations throughout the state, on about 90 different rivers and streams, a few

of which have been sampled annually for up to 13 years. The program is based on determining the number of genera or species of benthic macroinvertebrates in a standardized sampling unit. Other data are also collected at each station including water velocity, dissolved oxygen, temperature, depth and width, conductivity, substrate composition (sand, gravel, stones, etc.), and a description of the surrounding area (percent tree cover, land use, etc.).

Over the past 10 years, the Department has developed methods for the biological assessment of benthic macroinvertebrates. A statistical protocol has been developed that examines the macroinvertebrate community data in detail. The analysis places sites within one of Maine's three water quality classifications (Class A, Class B, Class C) based on the probability of attaining the standards of any given classification. Sites which fail to meet the minimum standards of Class C are grouped in a "non-attainment" class.

VOLUNTEER MONITORING

The Volunteer Lake Monitoring Program (VLMP) collects water quality information by trained volunteers who are required to attend periodic recertification workshops in order for their data to be accepted by ME DEP. It is one of the largest and oldest citizen-based environmental monitoring programs in the country. The VLMP mission is to provide protection for nearly 6,000 lakes in Maine through the acquisition of scientific data, and to raise public awareness about the extraordinary ecological, aesthetic, and economic value provided by the lakes of Maine.

Most volunteers obtain transparency readings using a Secchi disk and viewing scope. Volunteer monitors are asked to take transparency readings approximately every two weeks, beginning in early May, and continuing through September or October. Annual lake water quality determinations and the analysis of long-term trends are dependent on the number of readings taken each summer and the number of complete seasons of data available. Some volunteers also measure dissolved oxygen levels, or are trained to identify invasive exotic plants before they spread and create severe problems for lakes. New methods and parameters of the monitoring program are being added annually.

Funding for the VLMP is now provided through grants from the Environmental Protection Agency (EPA), the Maine Department of Environmental Protection (ME DEP), from charitable foundations, and from individuals. However, the greatest value of the program is provided by the hundreds of volunteers.

The Surface Water Ambient Toxics (SWAT) Program, established in 1994, provides information on contamination from persistent organic and inorganic toxins in the environment. The program relies extensively on the use of fish and shellfish tissue analysis to detect the presence of toxins in the environment and incorporates biomonitoring approaches.

Maine participates in the Gulf Watch program, along with the other states and provinces surrounding the Gulf of Maine. This program monitors mussel tissue and gathers other

data relevant to issues of toxic contamination in the Gulf of Maine. ME DEP has initiated a comprehensive long-term water quality monitoring program in conjunction with the Atlantic Salmon Conservation Plan to assess the quality of seven rivers that have indigenous Atlantic salmon populations. The program incorporates testing for an array of physical, chemical and biological parameters with the assistance of a corps of volunteers provided by each watershed council. Data are used to assess potential water quality effects on salmon and to mitigate potential stresses.

ME DEP Partners in Monitoring is a program coordinated by the Maine State Planning Office and University of Maine Cooperative Extension in cooperation with the ME DEP and DMR to gather water quality data in coastal rivers and estuaries. The Atlantic Salmon Conservation Plan incorporates the use of volunteer monitors provided by each of the participating watershed councils on Maine's salmon rivers. Individuals are trained and supplied by the ME DEP to conduct water quality testing. The ME DEP and Maine Atlantic Salmon Commission provide staff, financial, and data management support for the program.

MASSACHUSETTS

Water resource monitoring and assessment activities of the Department of Environmental Protection's (DEP) Division of Watershed Management (DWM) are performed by personnel of the Watershed Planning Program. The goals of the DWM monitoring program are to:

- Assess whether the condition of the water resources of the Commonwealth are of sufficient quality and quantity to support their multiple uses, and to report findings through watershed assessment reports and the §305(b) Report

- Identify causes and sources of water use impairments as the first step toward developing water quality and quantity management strategies

- Characterize and rank existing and emerging problems to target implementation strategies and funding from §319 and other grant programs

- Provide data for the development of predictive simulation models in support of the calculation of Total Maximum Daily Loads (TMDLs)

With the implementation of the Massachusetts Watershed Initiative (MWI), a five-year rotating basin schedule was established to carry out watershed assessment and management functions. During the first year of the cycle, public outreach activities and reconnaissance are performed to determine what information is available and what data will need to be obtained during the monitoring phase in "Year 2". Part of the outreach process involves gaining input from local "stakeholders" as to what water resource issues and problems are of most concern to them. DWM formulates monitoring plans aimed at filling the information gaps that were identified. This has resulted in a targeted monitoring program aimed at sites of known or suspected poor water quality. These sites tend to be of most interest to the public and/or are in most need of remedial action. For this reason the information may be site-specific and often cannot be extrapolated much beyond the sites actually monitored.

While attempting to respond to local, site-specific monitoring needs, DWM's program continues to place emphasis on obtaining information that can be used to assess the Clean Water Act national goal uses of aquatic life protection, and primary and secondary contact recreation. As such, the program has been marked in recent years by a shift toward the use of biological monitoring techniques and ecological "response indicators". Typical elements of the DWM monitoring program are summarized in Table 1.

Table 1
Massachusetts Typical Monitoring Program Elements

1) Synoptic Lake Surveys:
- Provides partial assessment of recreational and aquatic life uses (including the presence of non-native species).
- Attempts to assess all lakes in the watershed larger than 10 acres.

2) Fish Toxics Monitoring:
- Provides assessment of fish consumption use.
- Attempts to monitor two waterbodies per watershed plus 5-6 public requests each year.
- Data are provided to DPH for risk assessment and health advisories if necessary.

3) Benthic Macroinvertebrates:
- Provides a direct measure of aquatic life use for rivers and streams.
- Utilizes EPA Rapid Biomonitoring Protocols (RBP III).
- Monitors 4-10 sites per watershed each year (approximately 25 – 50 total sites per year).

4) Additional Biomonitoring:
- Periphyton community assessments and chlorophyll analyses.
- Fish population assessment methodology in development.

5) Water Quality Sampling:
- Priority is given to filling data gaps in support of 303d/TMDL development.
- Site/issue-specific sampling is available on limited basis.
- Statewide strategic monitoring program is in development.

PHYSICAL/CHEMICAL MONITORING

River Water Quality Monitoring. Historically, river surveys were typically performed during low-flow, dry-weather conditions, which generally represented the worst-case scenario with respect to the assessment of impacts on receiving water quality from point discharges. Today, increased attention is focused on the identification and control of nonpoint pollution, and survey methods are changing to reflect this shift in emphasis. For example, wet-weather sampling may provide the most reliable information pertaining to nonpoint pollutant loading from stormwater runoff and, when compared with dry-weather survey data, may further distinguish the effects of point and nonpoint pollution sources. Surveys are conducted every five years to update old data, and to examine conditions following remedial action such as a major upgrading of a treatment plant, or the implementation of Best Management Practices (BMPs) for controlling nonpoint sources of pollution.

River surveys are sometimes supplemented by wastewater discharge sampling which serves to document pollutant loading from point sources to the river at the time of the survey, and to assess compliance with NPDES discharge permit limits. Once sampling is completed and data are received from the laboratory, results are presented and discussed in technical memoranda or published watershed assessment reports.

Finally, stream discharge measurements may be made to supplement data from USGS stream gages. Discharge measurements provide data for the calculation of pollutant mass loading, as well as for assessing the impacts on stream biota of low-flow conditions resulting from drought and/or water withdrawals.

The DEP's ***Lake Water Quality Monitoring Program*** was formally initiated in the summer of 1974 and was significantly expanded in its scope during most of the 1980s. Historically, limnological sampling was conducted to determine baseline lake conditions, monitor post-implementation projects, and respond to public concerns about lake problems. The focus of monitoring has changed over time and lake monitoring has been incorporated into the Watershed Approach. Lake monitoring is now conducted in the context of a review of issues within each basin. While overall lake monitoring that occurs is less than at the peak of the monitoring program, the monitoring conducted is targeted in the highest priority areas.

Lake sampling by DWM is now primarily limited to biological surveys of the macrophyton communities and "in-situ" measurements using metered probes. Baseline surveys by the DEP are occasionally scheduled under special request or to provide data for TMDL development. The Department of Environmental Management (DEM) has been conducting baseline surveys on lakes associated with state parks since the early 1990s and, when provided, the information generated from these surveys has been incorporated into waterbody assessments.

A baseline survey is generally conducted in one day and consists of bathymetric mapping of the lake; physical, chemical, and biological sampling of the open water areas, tributary stream(s), and outlet; and a quantitative and qualitative mapping of the aquatic macrophyton community in the lake. The primary purpose of this survey is to estimate lake trophic status and identify any point and nonpoint sources of pollution. The lake is sampled during the summer months when productivity is high.

Less intensive "synoptic" surveys have two primary goals. First, they provide information necessary to make a minimum assessment of lake quality. Second, they are used to document the spread of several non-native and potentially nuisance aquatic plant species that are known to be present in the Commonwealth.

BIOMONITORING

The in-stream biomonitoring activities conducted by DWM include: macroinvertebrate rapid bioassessment, bioaccumulation, fish population assessments, and microbiology. DWM biologists perform habitat assessments and conduct biological sampling to supplement other water quality monitoring and management programs and make

recommendations about the control of toxic effluents and thermal discharges through the NPDES permitting process.

Assessment of Benthic Macroinvertebrate Communities. Rapid bioassessment protocols (RBPs) are used to monitor the health of benthic macroinvertebrate communities as indicators of pollution impacts. These methods were developed to minimize laboratory time requirements for taxonomic identification and enumeration of benthos. Kick-net samples are collected at sites for upstream/downstream comparisons, comparisons against a regional or surrogate reference, or for long-term trend monitoring at fixed sites. Two different levels of analysis are employed, RBP II or RBP III, depending on the objectives to be served.

Based on scoring of several metrics, three categories of impairment are discerned by the RBP II (nonimpaired, moderately impaired, and severely impaired), while the RBP III distinguishes between four (nonimpaired, slightly impaired, moderately impaired, and severely impaired). The RBPs are conducted at up to 50 sampling sites per year.

Bioaccumulation assessment includes the Toxics-in-Fish Monitoring Program aimed primarily at the assessment of human health risk associated with the consumption of potentially contaminated freshwater fish. Fish tissue monitoring is conducted to assess the levels of toxic contaminants in freshwater fish, identify waterbodies where those levels may affect human health, and identify waters where toxic chemicals may influence fish and other aquatic life.

Microbiological monitoring includes algal identifications and chlorophyll determinations. Results of these analyses are measures of primary production and are used to evaluate the trophic status of lakes, ponds, and impoundments. Data from riverine and coastal waters are used to identify those waterbodies subjected to nutrient enrichment and consequent algal and macrophyte growth. Algal indicators of the presence of elevated metal concentrations, nutrient enrichment, or other pollutants are noted.

VOLUNTEER MONITORING

Volunteer monitoring programs vary considerably with respect to their mission and goals. DWM uses data from citizen monitoring groups and other external sources if they are of known and documented quality. This is ensured by requiring the development of, and adherence to, Quality Assurance Project Plans (QAPPs), the use of state-certified (or equivalent) laboratories, and final citable reports that present the monitoring data.

The Massachusetts Watershed Initiative has supported volunteer monitoring by:

1) establishing a Citizen Advisory Committee
2) providing monetary support for regional monitoring support centers (e.g., university laboratories, etc.)
3) administering a grant program to build monitoring capacity of individual groups
4) providing technical guidance and training in monitoring, quality assurance, etc.

NEW HAMPSHIRE

The New Hampshire Department of Environmental Service (NH DES) protects the state's surface water through its active lakes and rivers monitoring programs, including the biological analyses of lakes and rivers. During the year, NH DES conducts thousands of water analyses on state waters, including those used for drinking water, as well as industrial and municipal wastewater effluents. The Water Division oversees lake and river volunteer monitoring programs, a public beach and swimming pool/spa inspection program, and an acid rain monitoring program. The division reports on the quality of over 14,000 miles of rivers and over 160,000 acres of lakes every two years.

PHYSICAL/CHEMICAL MONITORING

River and Stream Monitoring

DES (Department of Environmental Services) initiated a rotating watershed monitoring program in 1989. At that time, the State was divided into three areas: Connecticut River basin, Merrimack River basin, and Androscoggin, Saco, Piscataqua and Coastal River basins. The intent of dividing the State in this manner was to allow each basin to be sampled at least once every three years.

From 1989 to 1992, approximately 300 samples were collected from 100 stations each year. Included among these stations were the five National Water Quality Surveillance System (NWQSS) and twelve Primary Monitoring Network (PMN) trend stations which are located throughout the State. Since 1989, these seventeen trend monitoring stations have been sampled each year regardless of which basin was being focused on.

Parameters that are typically measured at each sampling station include:

> *E. coli*, dissolved oxygen, temperature, conductivity, pH, chlorophyll a, BOD, alkalinity, hardness, metals (aluminum, copper, lead, zinc), turbidity, total solids, total suspended solids, nitrate, ammonia, total kjeldahl nitrogen (TKN), and total phosphorus.

From 1993 to 1996, the regular rotating basin sampling program was changed in order to focus on waterbodies that had shown potential water quality violations. The goal was to: verify if water quality exceedances, based on limited data, are violating state standards, identify the cause of the violation, and eliminate or abate surface water quality violations. In 1997, DES resumed the rotating basin sampling program.

Lake Monitoring

NH DES operates a number of lake monitoring programs. The overall goal is to assess current conditions and trends in order to determine if the existing regulatory framework is sufficient to protect lake water quality or, conversely, if new controls are needed.

Lake Surveys are conducted each year on a number of lakes. The lakes are sampled, in both the winter and summer, for various physical, chemical, and biological parameters (pH, alkalinity, apparent color, specific conductance, chloride, sulfate, Ca, K, Na, Mg,

total phosphorus, total kjeldahl nitrogen, nitrate nitrogen, *E. coli,* phytoplankton, zooplankton, chlorophyll, Secchi disk, macrophytes, DO/temp. profile, and bathymetry). The data provide information on current baseline conditions, long-term trends, water quality compliance, and are used to classify the lakes according to trophic condition. The surveys also provide information on acid rain impacts and aquatic nuisance and exotic weed distributions. Thirty to forty lakes are currently surveyed annually.

The Acid Rain-Lake Outlet Monitoring Program samples twenty accessible lake outlets twice each year, during the spring and fall overturn, for acid rain related parameters (pH, alkalinity, nitrate, sulfate, conductivity, color, chloride, calcium, and aluminum). Both short and long-term trends of the impacts of acid rain on non-remote lakes are documented.

Acid Rain-Remote Pond Monitoring is conducted each spring at the surface waters of a number of inaccessible remote trout ponds by helicopter in conjunction with the NH Fish and Game Department's fish stocking program. A total of 57 different lakes have been sampled since 1981, and a core of approximately 20 are sampled each year for pH, alkalinity, nitrate, sulfate, conductivity, color, chloride, calcium, and aluminum. The program provides short and long-term trend data on acid rain impacts to remote ponds.

Lake Sediment Monitoring consists of collecting sediment cores. The cores are analyzed for heavy metal concentrations as well as phosphorus. The program provides information on historical levels of metals in the sediment and will relate metal levels with external factors such as motor boat activity, urban runoff, and acid rain. The number of cores collected varies each year based on available resources.

BIOMONITORING

Instream Macroinvertebrate / Fish Monitoring

Biosassessments typically examine species richness, species composition, population size and trophic composition of resident aquatic organisms. Such information may help to reveal if aquatic organisms are adversely impacted by the integrated effects of different pollutant stressors over long periods.

In 1995, DES received a grant from the EPA to initiate a long-term biological monitoring program in the State of New Hampshire. The DES biomonitoring program utilizes GIS-based information in order to select non-impacted "reference" sites as well as impacted or "impaired" sites each year. Potential sites are selected based on road density, population statistics, adjacent land uses, and proximity to facilities such as wastewater treatment plants, landfills, and state/federal superfund sites. Sites are then randomly selected out of the candidate pool. Approximately 150 "reference" sites have been biologically assessed since 1995 and some "stressor" sites are beginning to be selected in order to have a complete range of water quality conditions in New Hampshire for development of numerical biological criteria. The biomonitoring program routinely collects three specific types of data; biological data, habitat data, and physical/chemical data.

Two aquatic communities are assessed for the biological data component, fish and macroinvertebrates. The two communities provide an overlap on assessing ecological health and have the ability to reveal particular "stressors" (i.e. flow) that may be exclusive of one particular group. The fish community is also included as it is a useful tool for assessing bioaccumulative effects of contaminants, and is something that can be easily related to by the general public when reporting.

As part of the biomonitoring program, water quality parameters such as dissolved oxygen, acid neutralizing capacity, pH, temperature, nutrients, and conductivity are also routinely tested. Other measurements and analyses are taken as deemed necessary.

Malformed Frog Monitoring occurs throughout the state using volunteer monitors. DES holds training workshops at selected locations throughout the state to train volunteers. In 1998, over 80 citizens conducted independent frog surveys.

Fish Tissue Monitoring in the State is coordinated by DES and includes the use of volunteers and cooperative projects with the US Fish and Wildlife Service and the NH Fish and Game Department. Fish analyses for mercury are primarily conducted by the Department of Health and Human Services (DHHS), Division of Public Health Services Laboratory. The risk to public health through consumption is determined by the Risk Assessment Bureau of DHHS. Fish tissue analyses are typically done in surface waters where there is a perceived or potential problem, although a routine program exists for fish mercury concentrations in all surface waters. Other analyses may be conducted for special studies.

Beach Monitoring occurs at over 160 public bathing beaches throughout the State once or twice a year during the summer recreational season for *E. coli* bacteria. The data determine compliance with bacterial standards for swimming areas and trends in bacterial levels.

VOLUNTEER MONITORING

Water quality information collected by volunteers is a valuable addition to DES monitoring programs. The volunteers usually live in proximity to the waterbody they monitor, and possess an intimate knowledge of the history and present condition of the watershed area. Volunteers alert DES of water quality threats and potential violations for investigation. Volunteer data are used to gain an idea of water quality at times and locations not covered by DES sampling programs. With rigorous training and appropriate Quality Assurance/Quality Control (QA/QC), volunteer data can supplement the ambient sampling program and help build a strong set of baseline data statewide. Volunteer monitoring can result in the early detection of water quality changes, allowing DES to trace potential problems to their source before a more severe impact occurs.

New Hampshire's Volunteer Lake Assessment Program (VLAP) and the University of New Hampshire's Lakes Lay Monitoring Program (LLMP). The VLAP monitors an estimated 130 lakes and the UNH Monitoring Program monitors between 50 – 60 lakes.

There is flexibility with what is sampled and how often it is sampled. Volunteer monitors carry out multiple tests at the deepest spot in their lake (or on large lakes in multiple basins), and test any flowing streams that feed or drain the lake. Monitors test the lake anywhere from 1 to 6 times per summer, with an average of three. The VLAP Coordinator or an intern visits each lake once per summer to train/retrain the volunteers and conduct sampling with them. During the annual visit, two additional tests are performed. These additional tests are dissolved oxygen, and plankton haul. The volunteers' samples include:

At the lake's deepest point:

- Transparency;
- Turbidity, pH, Conductivity, Total Phosphorus;
- Acid Neutralizing Capacity; and
- Chlorophyll-a.

At the tributaries and outlets:

- Turbidity, pH, Conductivity, and Total Phosphorus.

Other:

- *E. Coli*.

All of the samples are kept on ice and transported by the volunteers to the DES in Concord within 24 hours of collection. The samples are then analyzed by biologists at the lab.

Beginning in 1995, DES through the Volunteer Lakes Monitoring Program requested volunteers to freeze fish they had caught and to bring the fish to DES. The fish are then turned over to DHHS for mercury analyses in fillets.

New Hampshire's State Clean Lake Program is designed to protect lakes from aquatic nuisances and restore lakes that have aquatic nuisance growth. The program has several parts. It includes an exotic weed control program that is designed to manage existing infestations of exotic plants and to prevent the spread of non-native weeds into New Hampshire's lakes. Matching grants are made available to the public for the management of existing exotic plant growths. The public education component includes a Weed Watchers program that consists of volunteer lake residents maintaining a constant awareness of any new or unusual plant growth in the lake. The Clean Lakes program also includes the investigation and resolution of non-exotic aquatic nuisances, investigation of alleged water quality violations, and when funds are available, assistance in conducting lake diagnostic studies on VLAP lakes.

New Hampshire's Volunteer River Assessment Program (VRAP). The huge success and popularity of VLAP serves as a model for the Volunteer River Assessment Program (VRAP). In 1998, DES initiated VRAP to complement VLAP.

VRAP is an educational and technical assistance program designed to support and coordinate volunteer monitoring of New Hampshire rivers. The main goals of VRAP are as follows:

- To educate the public about rivers and water quality;
- To organize groups to monitor water quality according to their goals;
- To provide monitoring guidelines, equipment loans, and technical training;
- To standardize data collection and management; and
- To report results and recommendations to volunteers.

VRAP aims to offer volunteer groups assistance with general organization, cooperative goal formation, study design, sampling site selection, technical training, and equipment loans for river monitoring. VRAP assists existing watershed associations, local river management advisory committees and other established river groups in New Hampshire that have implemented volunteer river monitoring programs, and supports new monitoring efforts. The education and outreach activities of the program are intended to foster a greater sense of responsibility toward water resources among schools, businesses, local governments and individuals.

VRAP loans meters and provides training for volunteers to measure DO, air and water temperature, pH, turbidity, and specific conductance. The program typically recommends that these parameters be tested every other week during June, July, and August to provide baseline data throughout the season. The sampling is conducted rain or shine and volunteers record the current and previous three days' weather conditions as well as characteristics of the site and any comments they feel important. Additional analyses may be supplemented by DES and groups are encouraged to apply for funding to cover the cost of parameters such as bacteria, nutrients, and metals.

NEW YORK

The New York State Department of Environmental Conservation (NYS DEC) Division of Water (DOW) has initiated a monitoring and management strategy toward water resources and water quality that integrates numerous division activities into a coordinated and comprehensive program. The goals of the strategy are to provide: 1) a complete and thorough evaluation of monitoring data, 2) a comprehensive assessment of water quality throughout the state, and 3) a coordinated approach to improving and protecting water resources. This strategy requires each unit in the division to look beyond individual program objectives and consider what contributions the program can make to the comprehensive monitoring and management efforts of the entire division.

The Rotating Intensive Basin Studies (RIBS) Program represents the latest integration of a state water quality monitoring program that was established in the 1960s. The stated objectives of the RIBS Sampling Program are numerous and varied. The objectives include: intensive overall assessment of water quality; long term trends analysis of water quality; comprehensive, multi-media sampling; characterization of background conditions; and the establishment of baseline conditions for other site-specific water quality investigations.

NYS DEC is currently implementing changes to enhance the statewide ambient surface water monitoring effort through the RIBS Sampling Program. The new RIBS strategy employs a tiered approach where rapid biological screening methods are applied during the first year of a two-year study. Then more intensive chemical monitoring is used to follow-up the results of this biological effort in the second year. The new RIBS monitoring cycle will cover the entire state over a five-year period.

PHYSICAL/CHEMICAL MONITORING

In order to address the number and variety of monitoring objectives, the RIBS Sampling Program is actually comprised of three separate monitoring networks. Each of these networks operates concurrently, yet independently, and focuses on distinctly different objectives.

The Routine Network provides continuous sampling (6 samples annually) of water column chemistry (parameters include: nutrients, solids, heavy metals, minerals, volatile organics, DO, pH, conductivity, and temperature), at 19 selected sites across the state in order to monitor basin stream characteristics and determine long term trends in water quality.

The Intensive Network employs more frequent water column sampling (10 – 12 samples per year) along with comprehensive, multi-media sampling (macroinvertebrate, fish, toxicity testing, bottom sediment chemistry) to provide more detailed assessments of water quality in selected drainage basins.

The third network is *The Biological Screening Network,* which relies on biological indicators (primarily macroinvertebrates) to provide a qualitative assessment of water quality at a large number of sampling sites with minimal analytic expense (see Biomonitoring).

Atmospheric Deposition Monitoring focuses on acid rain impacts, which has long been a problem in New York State. Nearly 30% of the waterbodies on the State's PWL (Priority Waterbody List) are listed because of use impairments due to acid rain. Because of the extent and significance of this issue, extensive chemical sampling efforts to monitor the pH of lakes and ponds have long been in place.

BIOMONITORING

Aquatic Life Use is the primary focus of the *Biological Screening Network*. This monitoring effort relies on rapid on-site biological (macroinvertebrate) assessments conducted at a large number of sites during Year One of two-year RIBS studies. The results of Biological Screening provide documentation of basic water quality at a large percentage of waters within a study basin, and help to identify waters for Intensive Network Monitoring in Year Two of the study.

Fish Consumption Use Monitoring provides the basis for NYS DOH (Department of Health) advisories regarding the catching and eating of sport fish. These advisories focus on bioaccumulative substances, primarily PCBs, mercury, and dioxin, reflecting the federal government standards for chemicals in food that is sold commercially.

The Beach Monitoring Program involves state and local/county health departments that conduct weekly beach coliform bacteria sampling programs and perform sanitary surveys at public bathing areas throughout the state. Based on the findings of these surveys bathing use may be restricted, either temporarily or permanently.

VOLUNTEER MONITORING

Due to a recognition of the importance of water resources, various groups (citizen, academic, private, public) across the state have become more involved in the protection of these resources. One growing aspect of this involvement is in the monitoring of water quality. While the level of interest in volunteer monitoring activities presents New York (and other states) with a valuable opportunity, significant issues must first be addressed. To take advantage of this opportunity the state must provide a framework and guidance that recognizes the limitations of volunteer monitoring groups and channels these activities toward producing information that is useful for NYS DEC management programs.

Presently, New York State directs a long-established volunteer lake monitoring program (The Citizens Statewide Lake Assessment Program, or CSLAP). Piloting of a companion volunteer program for the monitoring of rivers is also underway.

The ***Citizens Statewide Lake Assessment Program (CSLAP)***, initiated in 1985, was modeled after successful volunteer monitoring programs in Vermont, Maine, Illinois and Minnesota. It is a cooperative effort between NYS DEC and the New York Federation of Lake Associations (FOLA). CSLAP combines both scientific and educational goals. Lay volunteers from FOLA-member associations are trained by NYS DEC staff to collect lake data and information, which are used to develop management strategies tailored to specific lakes. These management strategies incorporate the collection of reliable baseline and trend data, the identification of problems and recommendations to address these problems, and the education of the public in water quality and lake ecology and protection.

A separate volunteer monitoring program for assessing river water quality is currently being developed and piloted in the Hudson River Basin and is currently being directed by Hudson Basin River Watch, a partnership of various local and state water resource agencies and environmental organizations, and over 60 schools. The goal of this effort is similar to those of CSLAP; to provide a monitoring framework that educates while also channeling volunteer activities toward producing information useful for NYS DEC program management. The monitoring framework is organized over three (3) levels, or tiers. The first tier, *Preliminary Waterbody Screening*, provides information regarding general water quality conditions. The second tier, *Assessment of Use Support*, identifies waterbodies as non-impacted or possibly impacted and requiring further monitoring and verification of impacts. The third tier, *Impairment Documentation*, is used to identify causes and sources of impairments, track water quality trends, and evaluate the effectiveness of improvement efforts.

RHODE ISLAND

Rhode Island's Office of Water Resources (OWR) Surface Water Monitoring Program is designed to gather statewide baseline data in addition to targeted monitoring data. The data are used in establishing and reviewing the state's water quality standards, to measure progress toward achieving the state and federal water quality goals, and to supply information for use in development of permit limits for wastewater discharges. Current surface water monitoring programs include activities conducted by the OWR staff as well as monitoring carried out by other agencies/organizations under contract with OWR. The Surface Water Monitoring Program consists of targeted and probability based station sites, intensive surveys, special studies, and volunteer monitoring programs. OWR staff have developed an Access database to maintain the chemical and physical monitoring data. A customized version of the Ecological Data Application System (EDAS) is being developed for managing the fish and macroinvertebrate (biological) data.

PHYSICAL/CHEMICAL MONITORING

USGS Fixed Monitoring Stations. The OWR has contracted with the United States Geologic Survey (USGS) to conduct riverine monitoring in RI. Samples are collected at seven USGS stations on four rivers for a variety of parameters, which are summarized in Table 4.

Table 2

Parameters measured at USGS fixed stations in Rhode Island.

Measured Quarterly in Water Column

Stream Flow	Trace Elements
Water Temperature	Suspended Sediments
Specific Conductance	Biochemical Oxygen Demand
pH	Phosphorus
Dissolved Oxygen	Nitrogen
Alkalinity	Fecal Coliform and *E. coli.*

Measured Twice Yearly in Water Column

Dissolved Calcium	ROE
Dissolved Magnesium	Turbidity
Dissolved Chloride	Phenols
Dissolved Sulfate	COD
Dissolved Potassium	Color
Dissolved Fluoride	Dissolved Sodium

Measured Once Yearly During Low Stream Flow in Stream Bottom Sediments

Total aldrin	Total DDD
Total DDT	Total endrin
Total PCN	Total heptachlor
Total methoxychlor	Total toxaphene
Total dieldrin	Total DDE
Total endosulfan	Total PCB
Total lindane	Total mirex
Total perthane	Total chlordane

Chemical Baseline Monitoring is conducted by the University of Rhode Island's Civil and Environmental Engineering Department through a cooperative agreement with OWR.

The project has established a baseline monitoring program for the rivers of RI. Since 1991, approximately twenty-five stations have been monitored, with samples collected on a quarterly (seasonal) basis throughout the year. The grab samples are analyzed for trace metals, nutrients, Biological Oxygen Demand (BOD), and other parameters.

The 25 stream stations monitored have afforded a baseline snapshot of water quality conditions on rivers around the state. In addition, this program has allowed for a comparison of chemical water quality with the biological assessment information from the Rapid Bioassessment Protocols studied at these 25 sites.

Lake monitoring within Rhode Island is conducted solely by URI's Watershed Watch Volunteer monitoring program. With the elimination of the Federal Clean Lakes funding in 1995, RIDEM/OWR did not expend any funds to support lake data collection until 1999 when funds were identified to support the Watershed Watch Program. A long term agreement with URI to continue this work is under development. An attempt to monitor lakes 20 acres and greater is now a part of OWR's Monitoring Strategy for lakes. The agreement with URI calls for the additional monitoring of 5 - 10 lakes per year.

BIOMONITORING

Artificial Substrate Monitoring stations are selected for biological monitoring. These stations include those used for USGS chemical trend sampling. The purpose of this is to relay chemical and biological data. This method has the advantage of providing a uniform sampling habitat for each station, thus reducing the problem caused by varying types of river bottom and depth.

Macroinvertebrates collected on the artificial substrates are classified according to their tolerance of pollutants. For the Division's biological analyses, organisms were counted and placed into one of three categories: tolerant, facultative or intermediate, intolerant or sensitive.

The Rapid Bioassessment Protocol (RBP) Monitoring involves integrated assessment, comparing habitat and biological measures with defined reference site conditions. Since 1992, a network of 45 plus stream riffle-area sites have been surveyed by Roger Williams University in cooperation with and contracted by RI DEM/OWR. Each site is visited during the spring-summer season and macroinvertebrates are sampled (min. 100 organisms per site visit). Data is analyzed using RBP I and II which include varying degrees of field and laboratory organism identification.

The habitat and physical parameters and biological metrics of each station are compared to those of the selected reference station and given an overall bioassessment score. The bioassessment categories include: nonimpaired, slightly impaired, moderately impaired, and severely impaired.

The use of a probability-based monitoring program was implemented during the summer of 2000 with the assistance of EPA's Lexington and Narragansett labs to define sampling locations for biological and chemical monitoring on wadable streams. Approximately fifty sites, located around the state, were randomly selected to conduct EPA's Rapid Bioassessment Protocol IV (macroinvertebrates and fish), and to collect habitat information and water chemistry data.

VOLUNTEER MONITORING

Citizen volunteer monitoring has become an important environmental force within Rhode Island. Its popularity is reflected in the growing number of citizen volunteer monitoring groups and in the increased number of volunteers and monitoring stations being added to existing citizens' monitoring groups.

RI DEM is represented on the Rhode Island Volunteer Monitoring Steering Board, that is an advisory board that oversees volunteer (citizen) monitoring activities around the state. The board facilitates communication between individual citizen groups and has strengthened communication between citizen groups and the state and federal agencies that use their data. Since RI DEM no longer has a full-time Citizen Monitoring Coordinator position, representation on this board has allowed RI DEM to maintain an outreach approach with these groups.

The OWR utilizes the data collected by the various citizen-monitoring groups in the water quality assessments conducted for the 305(b) report. Furthermore, the monitoring data is used as a screening tool to alert the OWR to problem areas where the Department needs to conduct sampling and take action.

VERMONT

The Vermont Department of Environmental Conservation's(VT DEC) Water Quality Division is responsible for monitoring the surface water quality of lakes, ponds, rivers, streams, and wetlands across Vermont. Long-term monitoring programs are designed to assess trends in water quality, as well as to generate baseline water quality information. Monitoring data are used to manage and protect Vermont waters in a proactive manner.

Vermont has 12 full time employees involved in lake and river monitoring programs, and in some cases, over 20 years of monitoring data exist. The following description of VT DEC's water quality monitoring programs and projects can be considered up-to-date as of May 2000. VT DEC's monitoring efforts are classified herein as 'physical/chemical,' 'biomonitoring,' 'volunteer,' and 'other.' Within each of these classes, monitoring projects are further described as 'core,' which are long-term projects, 'diagnostic studies,' which are intended to identify the cause of a particular water quality problem, and 'special studies,' which are monitoring studies intended to provide information and data on a specific water quality issue.

PHYSICAL/CHEMICAL MONITORING

Core Programs

The ***Spring Phosphorus Program*** collects spring-overturn nutrient and physical/chemical data on Vermont lakes and ponds which are 20 acres in size or larger. Parameters include total phosphorus, total nitrogen, alkalinity, calcium, magnesium, hardness, Secchi transparency, and multiprobe profiles (temperature, dissolved O_2, conductivity, pH). Forty lakes have over 10 years of project data, and 12 of these have 15 or more years of data. The Spring Phosphorus database contains over 1500 records collected since 1978.

The ***Lake Assessment Program*** is designed to rapidly assess the extent to which lakes meet designated uses for 305(b) reporting purposes and to gather information to focus lake protection efforts. The degree of sampling intensity for assessment lakes varies with the degree to which impairment must be documented. In general, lakes are circumnavigated and detailed assessment observations are made regarding in-lake and shoreline conditions with respect to designated uses and threats to lake water quality. Detailed notes are made regarding the extent and composition of the macrophyte community. Sampling is performed for total phosphorus, alkalinity, Secchi transparency, and multiprobe profiling. Additional sampling may be performed as necessary to identify departures from VT Water Quality Standards. Since 1989, 238 lakes have been assessed.

The ***River Assessment Program*** is designed to assess the extent to which rivers and streams support designated uses for 305(b) reporting purposes and for focusing protection efforts. The assessment itself involves identifying, compiling, analyzing, and evaluating all water quality data and information as well as point and nonpoint source pollution impacts on designated uses specific to the basins being assessed in any given year.

The VT DEC presently conducts the majority of its assessments on a five-year rotational watershed basis. Rivers and streams in the basins of focus are visited to look for obvious sources of pollution from the land or indicators of problems or threats in streams such as sedimentation, heavy algae growth, or water with unnatural color or odor.

A provider of much of this information is the VT DEC ***Ambient Biomonitoring Network (ABN) Program*** which conducts bioassessments to determine a waterbody's compliance with VT Water Quality Standards. Temperature, nutrients, pH, conductivity, and alkalinity are parameters commonly measured.

The ***Water Level Monitoring Program*** monitors lake surface elevations to establish mean water levels for a variety of purposes, most notably to help determine the jurisdictional boundary of the state's lakes and ponds encroachment permit program.

The Lake Champlain Long-Term Monitoring Program surveys the quality of Lake Champlain waters on a bi-weekly basis, at 12 locations throughout the lake. Eighteen major tributaries are sampled on an event-basis as well. The large physical/chemical parameter list of the program includes: phosphorus, nitrogen, and organic carbon; chlorophyll-a; base cations and alkalinity; TSS; dissolved O_2; conductivity; and pH. As of 1999, this program had assembled a database comprising 4,462 lake and 3,259 tributary sampling events.

The Long-Term Monitoring (LTM) Acid Lakes Program collects chemical and biological data on lakes located in low alkalinity regions (those sensitive to acidification based on the bedrock buffering capacity) to determine the effects of acid deposition on Vermont's lakes. Nearly 200 lakes statewide were surveyed during the winters of 1980 through 1982 to identify the acid-sensitive areas of the state. Eleven lakes selected from these areas are now included in the LTM Program and are sampled at least eight times every year for 16 chemical parameters related to acidification. This data is used to: classify lakes according to their acidification status; evaluate spatial and temporal variability in measured parameters; track changes in acidification status over time as related to reductions in atmospheric emissions of acid precursors (e.g. oxides of sulfur and nitrogen); and evaluate impacts of acidification on aquatic biological communities.

The Stream Geomorphic Assessment Program collects morphologic data on streams throughout the state for purposes of assessing geomorphic stability and developing regime relations for Vermont's streams. Stability assessments allow for the prediction of expected rates of river migration and evaluation of the effects of various land and river management practices on geomorphic stability. Regime relations serve to guide stream alteration and restoration projects as well as helping in diagnostic stability assessments. Parameters measured include channel dimension (cross section), pattern (meander geometry), longitudinal profile, channel substrate conditions, structure and composition of riparian vegetation, and floodplain and valley morphology.

Diagnostic Studies

Diagnostic studies are typically aimed at identifying the cause of eutrophication in Vermont lakes. Over the past 20 years, Vermont has performed numerous monitoring studies, and the results of many of these studies have led to concrete remediation steps. Lakes on which notable diagnostic studies have been performed include Harvey's Lake (Peacham), Lake Morey (Fairlee), Lake Iroquois (Hinesburg), and Lake Champlain. Presently, VT DEC has active diagnostic studies on three large recreationally used lakes (Lake Carmi - Franklin, Lake Parker - Glover, and Ticklenaked Pond - Ryegate).

A wide variety of parameters are sampled in conjunction with diagnostic studies, with the actual tests performed being specific to the project. Standard eutrophication parameters (phosphorus, Secchi transparency, dissolved O_2) are always measured. Other parameters from both the sediment and the water column are measured as needed.

Special Studies

Special studies are those which are performed to gain more information about a particular environmental issue of importance to VT DEC. There are presently three such projects being cooperatively managed by VT DEC.

The EPA-sponsored ***REMAP Assessment of Mercury in Sediments, Waters, and Biota of VT and NH Lakes Project*** is a three-year effort to identify the lake types occurring in VT and NH which have elevated levels of mercury in fish and in upper trophic-level biota. The parameter list for this integrated collaborative monitoring project is large, and includes standard limnological measurements; base cations and aluminum; and mercury (Hg) in total and methyl phases in sediment, water, and biota. There is also a paleolimnological component to the project, which aims to determine the extent to which atmospherically deposited Hg has entered lakes in the study set.

The ***Best Management Practices Effectiveness Demonstration Project*** is a stream monitoring effort designed to assess the efficacy of best management practices in controlling nonpoint source pollutant runoff. This cooperative VT DEC-USGS project employs an upstream-downstream approach to pinpoint the reductions in pollutant runoff attributable to specific installed 'BMPs.' This project is being carried out on streams in one agricultural and one urban setting in the Lake Champlain Basin.

In conjunction with the ***Paleolimnology of Vermont Lakes Project***, VT DEC is collaborating with the University of Vermont to develop a set of indicators of present and historical trophic status that are based on the paleolimnology of carbon and nitrogen stable isotopes ($d^{13}C$ and $d^{15}N$). Using cores from the sediments of several lakes, VT DEC is working to identify the extent to which the present trophic conditions in these lakes deviate from the historic background. Such information will be instrumental in understanding the extent to which productivity (and thus phosphorus) has been elevated since the lake watersheds were first disturbed.

BIOMONITORING

Core Programs

The ***Ambient Biomonitoring Network (ABN)***, conducted by biologists in VT DEC's Biomonitoring and Aquatic Studies Section (BASS), was established in 1982 to: monitor long-term trends in water quality as revealed in changes over time to ambient aquatic biological communities; evaluate potential impacts from point and nonpoint permitted direct and indirect discharges, ACT 250 projects, nonpoint sources, and spills on aquatic biological communities; and establish a reference database to assist VT DEC in establishing Vermont-specific biological criteria for water quality classification and use attainment determinations. Since 1985, VT DEC has used standardized methods for sampling fish and macroinvertebrate communities, evaluating physical habitat, processing samples, and analyzing and evaluating data. The program has led to the development of a Vermont-specific fish community Index of Biotic Integrity (IBI) and guidelines for determining water quality classification attainment by using both macroinvertebrate community biological integrity metrics and the IBI. Approximately 75 sites per year are assessed using fish and/or macroinvertebrate assemblages. Alkalinity, pH, conductivity, temperature and such measurements as percent substrate composition, embeddedness, percent canopy, percent and type of periphyton cover, and approximate velocity are routinely monitored. From 1985 to 1999, approximately 1,225 stream assessments were completed using macroinvertebrates and/or fish from about 850 stream reaches.

The ***Aquatic Macrophyte Monitoring Program*** collects baseline information on aquatic plant communities in Vermont lakes by conducting descriptive surveys using a pre-established plant cover scale. This program has been active since the late 1970s, and information is available from 164 discrete surveys.

VT DEC conducts numerous ***Aquatic Nuisance Species Searches and Surveys*** each year to search for new populations and monitor existing populations of nuisance aquatic species, primarily Eurasian watermilfoil (*Myriophyllum spicatum*), water chestnut (*Trapa natans*), and zebra mussels (*Dreissena polymorpha*). This includes what is presently the longest ongoing zebra mussel monitoring program in the nation, the ***Lake Champlain Zebra Mussel Monitoring Program***. In conjunction with the zebra mussel program, 11 in-lake and 12 shoreline stations in Lake Champlain are monitored for larval and settler zebra mussel presence and density on a bi-weekly basis. In addition, adult zebra mussel surveys are performed at selected shoreline locations during late summer. There are 1,466 veliger, and 651 settler records within this program's seven years of data records.

Special Studies

The ***Biodiversity Monitoring Program*** evaluates the status of selected biological species and communities. Specific activities include: distributional surveys of aquatic plant, fish and macroinvertebrate species listed by the Vermont Endangered Species Committee as rare, threatened or endangered, or of special concern; distributional surveys of other communities not currently listed but having species considered likely candidates for eventual listing (e.g. snails); and monitoring of biological communities or community

types whose diversity is threatened (e.g. Lake Champlain mussel and cobble/shale macroinvertebrate communities which are threatened by zebra mussels). Data are used to: describe species distribution; identify species/communities at risk; and develop management plans for the protection of identified species/communities.

The ***Vermont Wetlands Bioassessment Project*** is a coordinated effort between VT DEC and the VT Nongame and Natural Heritage Program to document and understand the biological and physical characteristics associated with seasonal pools (vernal pools) in Vermont. Since 1999, the project has collected biological, physical, and chemical data from 28 seasonal pools throughout the state. Information collected on the invertebrates, amphibians, algae, and plants associated with seasonal pools will be used to develop a biological monitoring program to assess and monitor the ecological health of seasonal pools in Vermont.

The ***Lake Bioassessment Project*** is the principal vehicle by which biological criteria are being developed for Vermont lakes. This monitoring effort was originally launched in 1996 as a cooperative project with the State of NH. The project has developed consistent protocols by which the trophic status, and the phytoplankton, macrophyte, and macroinvertebrate communities in lakes can be measured. To date, 12 NH and 31 VT lakes have been included in the project. The goal of the project is to develop numeric measurements of the communities listed above to assess aquatic life use attainment. At present, trial multimetric criteria have been developed for the phytoplankton community and are in development for macrophytes and macroinvertebrates.

The ***Lake Champlain Long-Term Monitoring Program*** also performs biological sampling, which is primarily aimed at assessing phytoplankton, zooplankton, and macroinvertebrate communities.

Other ***Biological Monitoring Projects*** either ongoing or conducted on a periodic basis include:

- Monitor macroinvertebrate community compositional changes before and after the mechanical cutting and shredding of water chestnut on Lake Champlain. The goal of this small monitoring project is to assess the impact of a potential new water chestnut control technique, mechanical shredding, on the macroinvertebrate community.

- Monitor non-target impacts to aquatic biota on lakes chemically treated in 2000 with SONAR® to control Eurasian milfoil infestations.

- Monitor the effects on both target and non-target organisms of copper sulfate treatments to control the snails partially responsible for swimmer's itch in a pond.

- Monitor the effects on non-target fish and macroinvertebrates in those rivers subject to lampricide (TFM) treatments.

Northern Leopard Frog Surveys in the Lake Champlain Basin are VT DEC's response to reports of malformed frogs in the Lake Champlain Basin (LCB) of Vermont in the summer of 1996. Malformed frogs were reported from twelve sites in five counties within the LCB. Systematic field surveys were initiated in 1997, targeting the northern leopard frog (*Rana pipiens*). The frequency and morphological characteristics of gross abnormalities among newly metamorphosed northern leopard frog (NLF) populations have been recorded at 20 sites within the LCB. VT DEC has examined over 6,000 NLF's since 1996, and external malformations have been detected in 7.5% of the frogs examined. VT DEC continues to gather data characterizing the gross abnormalities and describing the frequency and occurrence of abnormalities within NLF populations at 10 established sites within the LCB.

All findings are reported to the North American Reporting Center for Amphibian Malformations (http://www.npwrc.usgs.gov/narcam/). VT DEC also continues to collaborate with the National Institute of Environmental Health and Sciences and the National Wildlife Health Center and other researchers, providing environmental samples and specimens to help further the malformed frog investigation.

VOLUNTEER MONITORING

Citizen groups are becoming increasingly involved in monitoring, education, protection and restoration projects in Vermont. VT DEC provides assistance and training to volunteers whenever possible. Watershed associations are presently active on approximately 26 rivers and many lakes in the state. VT DEC has developed a directory listing the various watershed associations and their activities in "Current Programs of Vermont Watershed Associations – 1998" with a lake association addendum listing active lake groups.

Core Programs

The Vermont Lay Monitoring Program equips and trains local lake users to measure the nutrient enrichment of lakes by collecting water quality data following a rigorously documented and quality assured methodology. This citizen-monitoring program is mainly based on trophic parameters and monitors approximately 40 lakes and 25 Lake Champlain stations per year. All Lake Champlain stations and many inland lakes in the program are sampled for chlorophyll-a, total phosphorus, and Secchi transparency. The remaining inland lakes in the program, from which limited data are needed, are sampled only for Secchi transparency. All sampling occurs on a weekly basis during the summer. The tremendous success of the Lay Monitoring Program is largely due to the approximately 120 volunteers. Since the development of the Lay Monitoring Program in 1979, valuable data have been generated on 91 lakes and 36 Lake Champlain stations. Fifty-six inland lakes and 36 Lake Champlain stations have five or more years of full season data. In addition to their standard monitoring, Vermont's citizen lake monitors also assist in the Aquatic Nuisance Species Watchers Program (see below), and in collecting valuable data for the Lake Bioassessment Program.

The ***Citizen Lake and Watershed Survey Program*** provides survey sheets and technical training for volunteers, lake and watershed associations, and other interested groups to enable them to perform screening-level assessments to identify potential nonpoint sources of pollution to lakes by conducting in-lake, lakeshore, and lake watershed surveys.

The ***Aquatic Nuisance Species Watchers Program*** trains citizen volunteers to monitor for the presence of important non-native aquatic species. The program is currently focusing on monitoring for Eurasian watermilfoil, water chestnut, and zebra mussels. There are presently 124 ANS Watchers throughout Vermont.

The ***Volunteer Acid Precipitation Monitoring Program*** was initiated in 1980 to assess the impact of the 1970 Clean Air Act, which mandated the improvement of air quality in the vicinity of midwestern and southeastern fossil fuel burning plants. Precipitation samples are collected on an event basis by dedicated volunteers at five sites throughout Vermont (Mt. Mansfield, Underhill, Morrisville, Holland, and St. Johnsbury). The volume and pH of each storm event is recorded. Additional parameters such as conductivity and wind direction are recorded at individual stations. These data are used to: assess spatial and temporal variability in the pH of bulk precipitation; and assess changes in the pH of bulk precipitation over time and as related to reductions in atmospheric emissions of acid precursors (e.g., oxides of sulfur and nitrogen).

OTHER MONITORING

Core Programs

The Fish Contaminant Monitoring Project is managed by VT DEC and performed in cooperation with the VT Department of Fish and Wildlife. Edible tissue from game fish acquired throughout the state is analyzed for mercury and other contaminants, and these data are used in the setting and subsequent refinement of Vermont Department of Health fish consumption advisories.

WHY AND HOW TO USE VOLUNTEER MONITORS

This section is designed to assist states in the improvement of their use of volunteer monitors. It is key that the states understand the importance of volunteers. Volunteers are able to supplement states' programs which have limited resources. Volunteers are proving to be quite an asset to many states. For example, volunteers alert NH DES of water quality threats and potential violations for investigation. In addition, volunteer data are used to gain an idea of water quality at times and locations unable to be covered by DES sampling programs. Data are also used for 305(b) reporting. With the states' rigorous training and assisted Quality Assurance/Quality Control, volunteer data have been used to supplement the ambient sampling program and helped to build a strong set of baseline data statewide.

Vermont has also been using volunteers for some time now to collect baseline data from important waterbodies. Vermont provides assistance and training to volunteer water quality monitors. They have allocated funding for a volunteer coordinator position for their Citizen Lake Water Quality Monitoring Program. This program provides the state with valuable long-term data for Lake Champlain and for many other waterbodies.

Citizen volunteers are becoming increasingly involved in monitoring the quality of our waters. There are many ways agencies can increase their use of volunteers. Volunteer coordinators can act as moderators and mentors for volunteers so that the data collected are usable by the agency. Volunteer monitoring programs are being formed at a rapid rate. Because of this increased activity, many agencies are increasing the use of volunteer data. For example, the number of volunteer monitoring groups in Rhode Island is growing so fast Rhode Island has developed an advisory board to oversee the states' volunteer monitoring activities. This advisory board has strengthened communications between the volunteers and both state and federal agencies.

We have exemplified how a few of the states of New England and New York employ the use of volunteer monitors. The following sections describe how a state can improve their relationships and the use of volunteer monitors.

VOLUNTEERING, WHY PEOPLE DO IT AND HOW TO KEEP THEM HAPPY

If your agency wants to design meaningful rewards for your volunteers, a good starting point is to look at the reasons people volunteer in the first place. What do the volunteers hope to get? How can the agency/organization help meet those needs and expectations? Some common motivations for volunteering are:

- To have an impact
- To be an advocate
- To be part of a particular organization
- Because of a commitment to a cause or belief

- To be part of a team
- To get to know a new community
- To meet people and make friends
- To learn something
- To explore a career
- To gain experience and build their resume
- To gain a sense of personal pride and fulfillment
- To feel needed and appreciated
- For fun
- As an excuse to do something they love
- To use a particular skill
- To give something back to the community
- Because they were asked
- As part of requirements for graduation from high school or college

A couple of years ago, Sandy Fisher, Director of the Florida Lakewatch program, was pondering a question close to the heart of every volunteer monitoring program coordinator: how to keep volunteer monitors involved and motivated. To gain insight on this question, she decided to go back and review the notes she had made on conversations with volunteers who left the program. Fisher reasoned that identifying the main causes of volunteers leaving the program would serve to guide improvements to serve the volunteers. Not surprisingly, the notes indicated that many Lakewatch volunteers had left for reasons beyond the control of the program. Some had moved away from the lake; some had stopped monitoring because of health problems; and others no longer had time for monitoring because of life changes (such as taking a more time-consuming job or having a baby).

What interested Fisher more were the causes of volunteers leaving the program that could be influenced by Lakewatch procedures. The most important of these was lack of frequent and meaningful feedback on their work. Deficiencies in the initial screening process were another significant factor, especially in the early years of the program. In addition, some volunteers left when monitoring lost its novelty.

Many volunteers became discouraged because of deficiencies in the comment process. Long delays were the worst problem. Because of low staffing levels at Lakewatch, volunteers were, by necessity, left to maintain their own motivation-with little or no encouragement, interaction, or reporting of results-for over a year at a time. Not only were reports delayed, but, to make matters worse, when reports finally did arrive they often consisted of data tables that meant little to most volunteers. Lakewatch staff lacked the time to translate monitoring data from each of the program's 400 lakes into a format suitable for the layperson. Put most simply, volunteers could not quantify the impact of their efforts.

Enlisting the right volunteers for the job is also important for keeping them involved. In the early years of Lakewatch, the program coordinators mistakenly believed that it would be difficult to find volunteers to do regular monitoring. Consequently, everyone who

expressed interest was encouraged to participate. There was no mechanism for screening out volunteers who had goals and expectations inconsistent with Lakewatch goals. Volunteers were accepted into the program with misconceptions like:

- expecting their data to result in a specific action by an agency
- believing that a single sampling could give them all the information they wanted
- not understanding the value of long-term baseline data
- wanting to test for "pollution" (such as mercury, bacteria, or toxics)
- not understanding the value of the water quality variables measured by Lakewatch

Ultimately, these volunteers left when they realized that their goals were not compatible with the Lakewatch program.

Finally, some volunteers gradually lost interest in monitoring because there were no more challenges and nothing new to learn. As Fisher points out, Sampling a lake is like feeding the dog—it's not difficult and can even be enjoyable, but it's basically repetitious. And after a while, the necessity of using consistent techniques can make the volunteer feel like a robot.

Based on Fisher's observations, Lakewatch formulated an action plan to keep volunteers motivated and reduce attrition. Fisher reports that as of spring 1996, most of the points in the action plan were being carried out. For example, the lab now sends volunteers interim data reports every few months. Once a year, each volunteer receives a cumulative report, usually including a handwritten comment or observation.

At times, carrying out the plan has required an extraordinary level of effort and commitment. To attain the goal of "a meeting in every Lakewatch County," Fisher attended 25 evening and weekend meetings last year, sometimes driving as much as 5 hours each way). However, she has no doubt that the effort was worthwhile. "In my opinion," Fisher states, "face-to-face contact is the single most important thing you can do to keep volunteers in the program."

RECOGNIZING VOLUNTEERS

It is essential that you show your volunteers how much you appreciate their work. The best rewards are those that match the volunteers' reasons for getting involved. For volunteer monitors, training itself is an important reward. In addition, seeing their data used is probably the greatest motivator of all. Listed below are 23 ideas, gathered from volunteer monitoring programs around the country, for recognizing and thanking volunteers. But don't let this list intimidate you into feeling you have to rush right out and plan an awards banquet, design a T-shirt, or schedule a rafting trip. Every program is unique and the rewards should reflect the goals, work, and spirit of each organization.

1. For each of our projects, we hold a picnic, barbecue, or party. This lets all the monitors on a particular project get to know each other better. - Maryland Save Our Streams

2. We offer monthly "enrichment classes"-for example, a natural history slide show, a field trip to a wildlife refuge, or a behind-the-scenes tour of a museum or aquarium. - Beach Watch (CA)
3. We take our volunteer leaders to lunch. Until recently, staff members paid for this out of our own pockets-but after four years it finally occurred to me that a volunteer organization ought to have a "volunteer recognition budget."-Community Creek Watch (CA)
4. After one year in the program, volunteers get a red Florida Lakewatch cap.-Florida Lakewatch
5. We held a posh formal banquet that was both a fundraiser and an awards ceremony. Paying guests included local politicians and business people. Our 14 Stream Action Award recipients were honorary guests.-Maryland Save Our Streams
6. Right after an event, I write personal letters appreciating the importance of the volunteers' contribution. It is easy to write them at that time because I feel motivated and the words come easily.-Huron River Watershed Council
7. Each month we invite a local expert to give a "Tuesday Talk." We tried scheduling some "lighter" topics but found that the volunteers really pushed for the more technical talks.-Community Creek Watch (CA)
8. We interviewed a dozen or so volunteers, then interspersed quotes from them throughout an issue of our newsletter.- Adopt a Beach (WA)
9. We have a section called "Volunteer Alert" in our quarterly newsletter. In each issue we profile one volunteer.-Maryland Save Our Streams
10. We have a series of appreciation awards. The "basic" award is a certificate that we give all our volunteers on the day they bring in their last sample. After three years, we give volunteers a handmade Secchi disk pin, and after five years, we give them a Secchi disk medallion/refrigerator magnet.-Rhode Island Watershed Watch
11. Our Christmas parties were famous for our "Sampler Christmas Carols," featuring such favorites as "Randolph the Weak-Kneed Sampler" and "O Fecal Plate."-Stillaguamish Volunteer Water Quality Monitoring Program (WA)
12. We give scholarships to our annual Meeting of the Monitors conference, and we are developing a scholarship fund to send volunteers to national conferences related to monitoring.-Texas Watch
13. For our annual statewide volunteer monitoring conference we put together a slide show featuring the work of many groups around the state.-Maine's Clean Water Program
14. We held a "Volunteer Appreciation Day" and invited representatives from all the monitoring groups we work with throughout the state. Before the event, we asked each participant to submit three questions for discussion. During the morning DMR staff addressed all the questions. Then we served a buffet lunch prepared by DMR staff.-Maine Department of Marine Resources
15. In addition to our twice-a-year volunteer newsletter, we send out a very informal memo called "Notes to Volunteers" every three or four weeks. This memo serves as an update and reminder, and also is an excellent place to acknowledge any volunteer who's gone above and beyond the call of duty.-Beach Watch (CA)

16. After we finished our survey of the Napa River, we took all the participants on a rafting and kayaking trip. In addition, everyone received a cup with our "River R.A.T.S." (River Assessment Team Survey) logo.-Napa County Resource Conservation District (CA)
17. When we surveyed our volunteers, they told us that rewards like mugs or pins were not important to them. They said they were more interested in "doing good." So this year we're planning to try something new: an event at which each volunteer can plant a tree honoring his or her volunteer contribution.-King County Surface Water Management (WA)
18. Sometimes you get a chance to make a difference to volunteers on a one-on-one basis. For example, I knew that two volunteers wanted to be fisheries biologists. I was able to arrange for them to volunteer as assistants on a three-day backcountry data-collection trip with a team of fisheries biologists.-Community Creek Watch (CA)
19. The agenda for our annual meetings includes a "Distinguished Service Recognition Flyer" listing volunteers' names under the "50 Club," "100 Club," etc., in recognition of their total number of sampling trips.-New Hampshire Lakes Lay Monitoring Program
20. Whenever volunteers send in their data, we immediately send a postcard acknowledging that we received it and thanking them for their hard work.-Texas Watch
21. This might not seem like an obvious "reward," but we find that volunteers really respond positively to being put in charge of a specific project. We tell them, "Do it your way." This gives them a real sense of ownership-Beach Watch (CA)
22. Every summer we offer a 4- to 6-week advanced training course, open to any volunteer monitor in Rhode Island. Attendees can get Continuing Education units.-Rhode Island Watershed Watch
23. Our annual "Volunteer Appreciation Evening" is a dance with a live band and catered buffet. The staff arranges everything--the volunteers aren't allowed to do any of the work.-Beach Watch (CA)

Many of these ideas are quite easy to implement. One way of assuring that your states' volunteers needs are being met and are being rewarded efficiently is by establishing a Volunteer Monitoring Coordinator position. The Volunteer Monitoring Coordinator is the state's key person for relations between the agency and volunteers.

VOLUNTEER MONITORING COORDINATORS

A Volunteer Monitoring Coordinator is valuable to volunteers as well as to the states. Coordinators play a major role with communications between the state and volunteers as well as with making sure proper procedures are being used and followed by the volunteer monitors. Volunteer Coordinators assist the volunteers by coordinating and providing education, technical training, equipment loans, answering questions, and on site assistance.

States can benefit from Volunteer Monitoring Coordinators. The states that presently have a Volunteer Coordinator have increased their use of volunteer data for various state reports as well as the required 305(b) report submitted to EPA. With a Volunteer Coordinator, the agency is reassured that Quality Assurance/Quality Control (QA/QC) and Quality Assurance Project Plan (QAPP) protocols are followed by the volunteers.

The two core volunteer monitoring programs in New Hampshire are the Volunteer Lake Assessment Program (VLAP) and the Volunteer River Assessment Program (VRAP). Both of these programs have very active volunteer coordinators. Since these positions have been developed by the state the amount of volunteer data used has increased.

Volunteer monitoring is cost-effective, but it is not free. A well-coordinated and quality-controlled program requires dedicated professional staff support. At least one person should be identified to have responsibility to oversee the volunteer monitoring programs. The Volunteer Coordinator ensures the agency that the volunteers are collecting data of the highest quality. This can result in tremendous cost savings for the agency/organization. By having volunteers collect samples during part or all of the year, the agency does not need to allocate as much of their own personnel/resources to collect samples.

DEVELOPING A COOPERATIVE AGREEMENT

A Cooperative Agreement (CA) is an essential part of the solution to use a volunteer monitoring program's data. A CA is a contract between the agency and a volunteer program. The CA is similar to a Memorandum of Agreement (MOA) or a Memorandum of Understanding (MOU). The contract describes the type of work to be performed and the means of collecting data. If the agency wants to use a volunteer program for a specific reason then a CA can provide the necessary criteria. The CA works hand and hand with QA/QC or a QAPP. By sitting down with volunteers the state is able to describe the exact data which are needed and the CA assures the state that data will be collected in a manner that is useable. An example of a Cooperative Agreement can be found in Appendix B.

DEVELOPING QA/QC OR A QAPP WITH A VOLUNTEER MONITORING GROUP

One of the most difficult issues facing volunteer monitoring programs is data credibility. An essential tool in breaking down this barrier of skepticism is the Quality Assurance/ Quality Control (QA/QC) or Quality Assurance Project Plan (QAPP). The QA/QC and QAPP are documents that outline the procedures to be followed by those who conduct monitoring projects to ensure that the data collected and analyzed meet the project requirements. Developing QA/QC is a dynamic process that should ideally involve quality assurance experts, potential users, and members of the volunteer monitoring team. These documents are designed to encourage and facilitate the development of volunteer QA/QCs and QAPPs by clearly presenting explanations and examples.

The following quality goals clarify the uses for the data and how rigorous the monitoring must be in order to satisfy the needs of the users.

- *Meets legal, regulatory and scientific peer review requirements.* This is the most rigorous level of monitoring. It provides data that can be used in court cases, regulatory proceedings, or reporting research results in scientific journals. Meeting this goal will require that monitors document a high degree of precision, accuracy, and sensitivity in their methods and that they undertake a rigorous quality control program.
- *Meets evaluation and assessment requirements of state and federal agencies.* Data in this category may be used in State Water Quality Assessments (305(b) reports) to determine if water quality standards are being met, evaluate effectiveness of pollution control programs and projects, and other water quality planning activities. Meeting this goal will require that monitors use methods and quality control measures that are similar to those of state and federal agencies.
- *Meets requirements for evaluation, assessment, and management at the community or watershed level.* Town boards, landowners, the public, regional planning agencies, and other organizations and agencies may use this data in their resource management decisions. Methods may be geared toward identifying gross pollution problems, rather than detecting subtle trends or deviations from water quality standards.
- *Data quality sufficient to increase awareness and knowledge of resource values and conditions.* These relatively simple and low cost programs can help groups and the public understand how watersheds function, the condition of a local water body, and how human activities can affect watershed health. These programs do not require rigorous sampling and analysis methods, but should follow sound scientific principles of investigation.

Quality assurance is an invaluable planning and operating tool that should be developed in the early stages of any volunteer monitoring program. The coordinating group should always consider developing QA/QC or a QAPP. It is of utmost importance if information is to be used by federal, state, or local resource managers. Some states will not even consider volunteer data without QA/QC or a QAPP. Massachusetts, for example, accepts volunteer data if the program has an established Quality Assurance/Quality Control plan (QA/QC) and if the data have been analyzed by a state-certified lab; otherwise the state will not use the data.

Few water quality agencies will use volunteer data unless methods of data collection, storage, and analysis can be documented. Clear and concise documentation of procedures also allows newcomers to the project to continue monitoring using the same methods as those who came before them.

States can assist volunteer monitoring programs by developing a guidance manual on how to develop a QA/QC plan or QAPP. In addition, the state can assist the groups with development of their QA/QC or QAPP through training and technical assistance.

This will benefit the agency that will be assured that any QA/QC or QAPP developed will allow for the collection of useful data. An example of a QAPP can be found in Appendix C.

TRAINING VOLUNTEERS

Training is an essential component of any volunteer monitoring project, yet volunteer training is rarely given the time and attention that it deserves. Program coordinators wear many hats and work hard to hone their skills as environmental scientists, media specialists, community organizers, and data analysts. Equal attention should be paid to working on training skills.

When training volunteers, many objectives can be achieved. The primary objective is to teach volunteers the scientifically correct way to perform monitoring tasks. During the training, volunteers learn the ecological concepts behind the monitoring tasks. They are given the tools and information they need to do the job right and to explain their activities to their family and friends. Good training is the first component of a monitoring program's quality assurance process. Training sessions also build essential connections between program volunteers and the program staff. Training sessions are important social events, providing volunteers with an opportunity to meet staff and other volunteers in the program. For many volunteers, training sessions are an important reward for participating in the program.

Good training takes planning. The first step is delineating a target audience. For monitoring programs, the audience is the volunteers, but the main need is to understand who they are and what their needs are as adult learners. The next step is to write clear, measurable, and reasonable training objectives that acknowledge constraints on time and staff. Third, the training session is designed, and finally, in step four, it is evaluated.

Step one: Understanding adults as learners
Professional educators understand that there are certain ways that children learn, and classroom curricula are designed with these concepts in mind. Similarly, a good volunteer monitor trainer needs to appreciate the learning process for adults and design training programs to take advantage of these characteristics.

Four pertinent characteristics of adult learners are listed below. Accompanying each characteristic are suggested ways to address adult learning during the training process.

1. Adults are mature and need to control their learning. Traditional classroom learning gives the teacher the power while the student is passive. Adult training should allow the students to have an essential role in directing the learning process.
    - When beginning a training session, present your training objectives and session agenda to the volunteers. Give them an opportunity to discuss and adjust the plan for the day.

- Get to know your volunteers before or during the training. Find out why they are participating in the monitoring program and try to design their "job" to satisfy their interests.

2. Adult learning requires a climate that is collaborative, respectful, mutual, and informal. Adults bring a vast personal experience to the learning process. It is essential that the trainer recognize and use this experience.
    - Minimize lectures. Studies have shown that learning retention is increased when we become actively involved in the learning process. Monitoring training sessions should be paced to allow time for volunteers to hear about the monitoring program, perform the monitoring techniques themselves, and then reflect on the learning by asking and answering questions.
    - Provide opportunities for group work. Use your experienced volunteers to mentor newer volunteers. Reinforce your instruction by designing problem-solving exercises for groups to work on. Design role plays to reinforce the learning. Learning styles are very individualized, and group exercises can be designed to provide a variety of learning environments.
    - Encourage volunteers to share experiences and expertise. Provide volunteers with additional learning materials.
3. Adults need to test their learning as they go along, rather than receive background theory and general information. Adults need clear connections between content and application so they can anticipate how they will use their learning.
    - Start your training session with kits and techniques, and save the lecture on ecology for later.
    - During the training, work with your volunteers to devise an action plan for using their data.
    - Provide time in the training to discuss how the volunteers will use their new knowledge.
    - Use volunteers as trainers. Provide other opportunities for volunteers to take on new challenges.
4. Adults need to expect performance improvements to result from their learning. Adult learning needs to be clearly focused in the present and be "problem centered" rather than "subject centered."
    - Help volunteers evaluate the training and their own performance.
    - Train volunteers in groups. Encourage them to set goals for themselves and then mentor each other to achieve those goals.

Step two: Preparing training objectives

Before beginning a training program, carefully consider what you are trying to teach. Monitoring programs focus on skills. It is essential that volunteers learn how to perform monitoring tasks with skill and accuracy. However, we are often interested in teaching more than just skills. We want to enhance volunteers' knowledge of safety, scientific methods, and basic ecological concepts. Identify what you are trying to teach then design a training program that moves from the simple topics to the more complex.

Training should be designed to achieve training objectives. A training objective is a brief, clear statement of what the participant should be able to do as a result of the training. Usually, a training objective includes three parts:

1. A statement of the participants' ultimate behavior. Try to write this with an action verb so you can design ways to evaluate your success.
2. A statement of the standards that the trainee is expected to attain. Include information on quantity and quality, and make the standard time-bounded.
3. A statement of the conditions under which the trainee is expected to perform.

For monitoring skills, it is often necessary to conduct a task analysis before writing training objectives. Monitoring manuals often contain task analyses. A task analysis provides the logical sequence of all the steps needed to perform a monitoring job and also identifies potential problems that could occur. The task analysis can be used to identify prerequisite skills and knowledge. Once the monitoring tasks have been analyzed, training objectives are written to identify the steps that are to be learned and the standards and conditions under which they are to be performed.

Step three: Designing a training session

Skill training takes time. Monitoring trainers frequently try to teach too much in too little time, and do not give volunteers the opportunity to understand unfamiliar techniques. A carefully planned skill session has three parts:

Introduction. This should be a short introduction to the skill, not an introduction to the monitoring program or to ecological concepts.

Body. The body of the skill session should include four sections:

- Show: The skill should be demonstrated to the volunteers. The demonstration should accomplish the learning objective you have written for the volunteers.
- Show and tell: Repeat the demonstration a second time, explaining the technique as you proceed. It is not important to accomplish the learning objective this time. This demonstration is shown slowly, step by step, allowing the volunteers to follow along with their own equipment.
- Check of understanding: Ask volunteers to review the steps and the points you have emphasized.
- Practice: Provide volunteers with adequate time to practice.

Conclusion. Review the steps and key points. Answer the volunteers' questions. Find out what steps they found difficult, and critique your task analysis. Training sessions should provide a full skill session for each technique that is being taught.

<u>Coordinating the training program</u>

Planning a training session requires attention to detail. The following list provides a reminder of things to check as you plan and conduct the training.

Before the training:

1. Communicate with volunteers. Give them the time, place, and duration of the training. Send directions. Tell them what to bring (pen, paper, lunch), how to dress, what to do in case of rain. Provide them with the name and telephone number of someone to contact with questions about the training. Outline the training content and provide them with pre-training readings.
2. Arrange guest speakers. Provide them with the same information you are providing the volunteers attending the training.
3. Prepare materials (sampling kits, manuals, data sheets, overheads, slides, and food).

During the training:

1. Arrive early to set up and prepare. Volunteers will often arrive early, and you want to be there to greet them.
2. During the first hour:
    - Introduce yourself to each volunteer as they arrive.
    - Introduce volunteers to each other.
    - Try to have a key person in your organization open the program.
    - Cover basic administration.
3. Ask volunteers to jot down personal objectives for the training and for participation in your program. Take time to listen to these and, when possible, adapt the training plan to achieve volunteers' objectives.
4. With guest speakers:
    - Make sure they are still available immediately before the date of their presentation.
    - Introduce them personally.
    - Do not leave the training room during their remarks. They may need your assistance.
    - Make sure all handouts are ready.
5. When closing a program:
    - Review objectives and ask volunteers if those objectives have been met.
    - Briefly review each major session.
    - Ask volunteers to complete an evaluation.
    - Thank volunteers for attendance and interest.

After the training, take care of administrative details:

- Clean up the training room and return materials.
- Store all handouts and materials. Retain a master copy.
- Pay bills.
- Write thank-you letters.
- Note and file suggestions for improvement.

Step four: Evaluating a training program

Evaluation is an essential part of any training program, and it is an essential part of training for volunteer monitors. Evaluations allow trainers to assess whether they have met their training objectives. For training designed to teach monitoring techniques,

evaluations are conducted to assess the competency of the volunteers. Coordinators need to be sure that volunteers can collect data that meet the data requirements established by the program.

Evaluations also allow trainers to assess the strengths and weaknesses of their training programs. Good trainers are always revising and improving their training sessions in response to participant comments.

Proper training of your agency's/organization's volunteers will prove to be valuable. Training volunteers works hand in hand with the development of a QAPP. Knowing the types of training the volunteers have had can assure the agency that proper methods of data collection are being followed. Maine's Volunteer Lake Monitoring Program (VLMP) is an excellent example of how the state stresses the importance of proper training. The state requires volunteers to attend training to become certified to collect data. This ensures the state of Maine that the data collected was properly done with the most up-to-date techniques. Training is an inexpensive way of keeping your volunteers informed of current technologies and innovations. There are many parameters, for a variety of waterbody types, which you can train volunteers to sample. Some of the parameters include; pH, temperature, dissolved oxygen, nutrients, biological indicators (macroinvertebrates), transparency, salinity, aquatic vegetation, as well as habitat assessments and identification of pollution sources.

DESIGNING A DATA MANAGEMENT SYSTEM

At some point in any monitoring program, the problem of data management will inevitably arise. Naturally, the larger the project, the more data management tasks there can be. However, even in smaller programs, data can be difficult to keep under good control. Data management can be relatively easy, however, with the right software, dedication, and some preliminary research.

Today, with reasonably priced computers and software available, a simple yet effective data management system can be developed to fit the needs of most monitoring programs. However, many headaches await those who charge blindly into the task. Advance planning will smooth the process considerably.

Why Computerize Data?

Simply put, a good data management system provides efficient storage of information, wherein any piece of that information is accurately retained and readily accessible. A computerized data management system does offer many advantages, especially if collecting data from many sites or over a long period. With the right computer program:

- a great amount of information can be stored in a small amount of space
- data can be viewed in many different ways (e.g., by site, by sampling date, in order from highest to lowest value)
- relationships can be detected between data points that otherwise could not easily be seen

- conversions, calculations (e.g., salinity from hydrometer and temperature data), and statistics can be automatically computed in a fraction of the time required for manual calculation
- data can be automatically graphed, arranged in a chart or table, or in other ways illustrated for purposes of analysis or presentation
- large amounts of data can be readily shared with other users

Spreadsheet vs. Database

Once it has been decided to use a computer for managing data, the next step is deciding between a spreadsheet program or a database. These two types of software are not as different as they once were. Still, each system has its own particular strengths and weaknesses.

In general, spreadsheets (e.g., Lotus 123, Excel, and Quattro Pro) can perform a much wider array of mathematical and statistical manipulations than databases, and are better at graphing. Database programs (e.g., dBASE, FoxPro, Paradox, Filemaker Pro, and Access) can store a larger volume of data and are better at finding or retrieving information. Furthermore, the more sophisticated database programs are relational, meaning that you can extract information from two or more separate database files at the same time.

Another advantage of databases is that they can easily be programmed to catch errors in data entry. If someone tries to enter data that does not conform to a specified range or style, the program will not accept it. Databases are also better equipped to handle different types of data, including nonnumeric data, within a single file, whereas spreadsheets are primarily designed to handle quantitative data that is all of a kind; dollars, inches, or pounds.

Even with all the advantages offered by databases, many volunteer monitoring programs are still using spreadsheets. Perhaps the main reason is that historically, spreadsheets were easier for novices to use. Older versions of database software required a thorough knowledge of programming commands and offered little or no on-screen help, whereas spreadsheets have been menu-driven since the early days of Lotus 1-2-3. Today's database programs are much more user-friendly.

Software

When a volunteer group considers what brand of software to buy, cost may be the first factor that comes to mind. Cheaper spreadsheet programs are often limited in their mathematical, statistical, and data-sorting capabilities. Inexpensive databases may not be relational, and will not have the wide assortment of retrieval capabilities found in more sophisticated programs. In addition, less expensive programs may be weak in graphing capabilities and printing options, and effective data presentation is often extremely important for monitoring groups.

Another important consideration when purchasing software is how easily data files can be translated by another software program. Ask others which software programs they are using and what problems they may be encountering with file conversion. Check with any groups or government agencies with whom you plan to share data, and make sure the software being considered will easily convert to the file formats they require. If you have data analyzed by an outside lab that provides you the results in electronic format, you will also want to check compatibility with their system.

Basic System Design

When designing any data management system, begin by asking, "What do we need this system to do?" Analyze what information flows through the organization and what needs to be done with it. Make a list of all the tasks that the system should be able to accomplish. What types of output will be needed? Reports? Graphs? What data will need to be in the system to support these outputs?

It is especially important for a volunteer monitoring group to think about who will input the data and make the reports. If the system will be used mainly by just one person, it can be designed primarily for speed and power. However, if it will be used by a large number of volunteers, ease of use becomes the paramount goal. Speed would be sacrificed in favor of features like data validation, onscreen help, and user-friendly forms for data input.

Ease of data entry is always an important element to consider. Ideally, the spreadsheet or database input screen should be set up to look like the field or lab data forms filled out by the monitors. The person keying should not have to spend a lot of time hunting for information on field forms or searching back and forth across the computer screen for some place to input a data item.

Plan Ahead

You will also want to design a data management system that will be flexible enough to meet future needs that may arise. This sounds tough, and it is. Take something as simple as site numbering, for instance. Suppose you are conducting 10 sampling projects, each having 10 sampling sites. One possible coding scheme might consist of a simple letter designation for each project, followed by a number for the site location (A1, A2, A3; B1, B2, and so on). This is fine until you ask the computer to sort your data by site number. The computer will place A10 ahead of A2, since it considers each digit individually from left to right. "Okay," you say, "we'll change the numbering scheme to A01, A02, etc." This is fine, too, as long as your database remains small.

Maryland's Save Our Streams Project Heartbeat, each site is identified by a three-letter code representing the name of the monitoring project, followed by three digits designating the particular site within the project. Thus, station number SHA001 designates site number 1 (001) of the State Highways Administration project (SHA). One could potentially create thousands of project codes, with up to 999 sites per project - far

more than sufficient for most needs. With this coding system, sampling data from many different projects can be pulled together and easily identified which samples pertain to which project.

Using Templates

Try to keep the data files as uncomplicated as possible. The more a file is loaded up with equations and fancy cell formatting, the larger it becomes and the more storage space it requires. If there is a need to perform complicated calculations in a spreadsheet and there are problems with disk space or computer memory problems, try using a series of "template" files instead of expecting one spreadsheet to do everything.

Many things need to be considered when designing a monitoring data management system. First and foremost, it must be known what is wanted out of the system before design features are built into it. Without good planning in the beginning, you could find yourself going back months or years later and repeating all your efforts. So, before purchasing any software, take the time to assess the needs of the program thoroughly, to ask questions of other monitoring groups, and to consider how to build flexibility into the system.

FUNDING SOURCES

Volunteer monitoring programs are funded through a variety of sources. In some cases, state water quality or natural resource agencies may actually sponsor the volunteers and contribute staff, equipment, and services such as data analysis. City and county governments do the same. Some programs are supported by federal agencies such as the EPA (primarily through pollution control grants to the States), the National Park Service, and the U.S. Forest Service.

In addition, many volunteer programs receive private support through foundations, universities and other research centers, or corporate sponsors. This support may include funding for a full or part time organizer, equipment, training workshops, or data analysis. In many programs, volunteers themselves also help pay for monitoring by purchasing their own equipment and hosting training sessions.

Connecticut encourages volunteer monitoring programs through Section 319 funding. There are three principal sources of funding for state-managed and private volunteer monitoring programs: federal grants, state funds, and private in-kind contributions.

Volunteer programs may use grant money awarded from Federal and State governments under Sections 104(b)(3) (Research Grants); 106 (Grants for Pollution Control Programs); 205(j) (grants for Water Quality Management Planning); 314 (Clean Lakes Program); 319 (Nonpoint Source Management Programs); and 320(g) (National Estuary Program) of the Water Quality Act of 1987 to initiate citizen monitoring programs. There are also many other short-term funding resources to be found from Federal and State Governments.

General state revenues have been used to establish volunteer monitoring programs. General revenues may also be supplemented with innovative state funding sources through taxation. States have also distributed funds to local governments or agencies to implement volunteer monitoring programs.

Individuals or organizations participating in a volunteer monitoring program have successfully solicited funds, in-kind services, and equipment from private sources. Also, non-profit organizations are able to obtain funds by collecting dues and charging fees.

No individual source of funding is guaranteed to persist and sustain a volunteer monitoring program. Therefore, long-term program stability depends upon a diversity of funding sources. Program planners should investigate all potential sources of funding.

CONCLUSION

This summary has been developed to assist states and organizations with the utilization of volunteers and to improve the states' current use of volunteers and volunteer programs. Increasingly, state, local, and federal agencies are finding that volunteers are valuable partners in programs to monitor our water resources. Volunteer programs are an important tool for many states. There are a variety of methods and ways to involve volunteers to accomplish your goals. Volunteers can learn to identify sensitive areas, collect baseline data, monitor various locations, and overall become a beneficial part of a state's program.

Always give the volunteers praise and feedback. Your volunteers are important; keep a direct line of communication open at all times, develop a volunteer newsletter for your state, recognize the volunteers' ownership of the program, and recognize their accomplishments with awards and other means of recognition. Never discourage the volunteers. Do encourage QA/QC or QAPP development so their data can be used, and increase their responsibilities, where appropriate.

Volunteers play an important role in assisting states to accomplish their water-quality monitoring goals. Planning, implementing, and maintaining a volunteer monitoring program requires organization, time, resources, and dedication. However, the payoffs are great. By assisting the program from the beginning, you can be assured that you will receive quality data and dedicated volunteers. Agencies can draw on the enthusiasm, expertise, and commitment of those interested citizens to monitor and protect our valuable water resources.

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APPENDIX A

KEY TO ACRONYMS

ABN	Ambient Biomonitoring Network
BASU	Biomonitoring and Aquatic Studies Unit
BMP	Best Management Practices
BOD	Biochemical/Biological Oxygen Demand
BWM	Bureau of Water Management
CA	Cooperative Agreement
COD	Chemical Oxygen Demand
CT DEP	Connecticut Department of Environmental Protection
CT DPH	Connecticut Department of Public Health
CWA	Clean Water Act
DDT	DichloroDiphenylTrichloroethane
DEP	Department of Environmental Protection
DES	Department of Environmental Services
DHHS	Department of Health and Human Services
DMR	Department of Marine Resources
DO	Dissolved Oxygen
DOH	Department of Health
DOW	Division of Water
DWM	Department of Watershed Management
EDAS	Ecological Data Application System
EPA	Environmental Protection Agency
FWS	Fish and Wildlife Service
IBI	Index of Biotic Integrity
MA DEP	Massachusetts Department of Environmental Protection
ME DEP	Maine Department of Environmental Protection
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MWI	Massachusetts Watershed Initiative
NEIWPCC	New England Interstate Water Pollution Control Commission
NH DES	New Hampshire Department of Environmental Services
NPDES	National Pollutant Discharge Elimination System
NWQSS	National Water Quality Surveillance System
NYS DEC	New York State Department of Environmental Conservation

KEY TO ACRONYMS (cont'd)

NYS DOH	New York State Department of Health
OWR	Office of Water Resources
PIN	Penobscot Indian Nation
PMN	Primary Monitoring Network
PWL	Priority Waterbody List
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RBP	Rapid Bioassessment Protocol
RIBS	Rotating Intensive Basin Studies
RI DEM	Rhode Island Department of Environmental Management
STORET	STOrage and RETrieval
UNH	University of New Hampshire
URI	University of Rhode Island
USGS	United States Geological Survey
VLAP	Volunteer Lake Assessment Program
VLMP	Volunteer Lake Monitoring Program
VRAP	Volunteer River Assessment Program
VT DEC	Vermont Department of Environmental Conservation
WMA	Water Management Act

APPENDIX B

COOPERATIVE AGREEMENT
between
THE RIVER ADVISORY COMMITTEE
hereinafter called the RAC
and
THE RIVER WATERSHED COUNCIL
hereinafter called the RWC
and
ENVIRONMENTAL SERVICES
hereinafter called the ES

Whereas the purpose of this agreement is to cooperate in the initiation, development, and maintenance of a Citizen Volunteer Water Quality Monitoring Project (hereinafter called the Project) for the _____River, from the confluence of the _____ and _____ Rivers at _____ to _____ in _____ hereinafter known as the segment.

Whereas it is the intention of the parties to this Agreement that such cooperation shall further the future and health of the segment, improve overall environmental quality, and promote community education about the _____ River and its watershed.

Whereas the RAC has named this project as a key action in the Water Quality section of its *Management and Implementation Plan* for the _____ River, and has the membership and local contacts to initiate and maintain the Project.

Whereas the RWC under its *Clean Waters* program has the technical expertise, ability and experience through working with other volunteer monitoring projects to maintain the Project, and through the _____ River Initiative Volunteer Network (VN) is committed to assisting groups in monitoring.

Whereas the ES has a commitment to maintaining water quality through the *Clean Water Act* and is responsible for administering state laws and standards aimed at maintaining and enhancing existing water quality in the _____ River, and has the equipment and expertise to provide technical support and assist in the collection of water quality data and training of volunteers.

Now therefore the parties hereto agree to work cooperatively in designing, establishing, and implementing an effective and lasting volunteer water quality monitoring program for the _____ River under the following stipulations:

A. The RAC agrees:

1. To establish and maintain municipal endorsement, provide findings, and recommend actions to the communities as well as assist in the implementation of recommendations.
2. To recruit volunteers from within the committee for this Project.
3. To fully participate in the administration of the Project.

B: The RWC agrees:

1. To provide technical assistance in the shoreline survey, study design, and training for the Project.
2. To assist in coordinating volunteers.
3. To provide assistance in writing the final reports.
4. To fully participate in the administration of this Project and to integrate it into the VN.

C: The ES agrees:

1. To provide collection and measuring equipment including rock baskets and dissolved oxygen, temperature, salinity, conductivity, and pH meters to the Project when not otherwise in use by the ES.
2. To provide training in the use of metering equipment and macroinvertebrate collection and identification techniques.

D: It is mutually understood and agreed:

1. That the RAC has been established under _____ and has clearly defined duties under this statute, its *Management and Implementation Plan* and its federal study capacity.
2. That the Project and its implementation will be administered through the partnership and an Advisory Committee made up of the parties. The Monitoring Project Advisory Committee, hereinafter known as MPAC shall consist of the following: 2 RAC members, 2 RWC members, 1 ES member, 1 member of the business community and 1 member of the public.
3. That the parties involved may extend monitoring beyond the segment.
4. That all parties will coordinate public relations to enhance the visibility of the Project.
5. That this Cooperative Agreement may and should be modified as necessary to ensure the lasting effectiveness of the Project and that each party will have an opportunity to review and comment on all plans to modify the Project.
6. That this agreement may be terminated by any of the parties to this Agreement with 30 days written notice to the other parties.

_____	_____
Chairperson River Advisory Committee	Date
_____	_____
President River Watershed Council	Date
_____	_____
Commissioner Environmental Services	Date

APPENDIX C

Quality Assurance Project Plan
State of Maine Volunteer Lake Monitoring Program
funded through the State of Maine Department of Environmental Protection (DEP), and United States Environmental Protection Agency (EPA)

Prepared by
DEP, Land and Water Bureau
Water Resources Survey Unit
State House Station 17
Augusta, ME 04345
(207) 287-3901
September 4, 1996

US EPA Project Officer	Date
US EPA QA Office	Date
VLMP Executive Director	Date
DEP Project QA Officer	Date

Project Description:

In 1971, the Maine State Legislature authorized a Volunteer Lake Monitoring Program (VLMP) to provide Maine citizens with continuously updated information regarding the quality of Maine's lakes and ponds. In 1976, the State of Maine Department of Environmental Protection (DEP) took over the VLMP. Since 1974, approximately 600 lakes have been sampled by DEP-trained volunteers.

Data collections are performed bi-weekly over a minimum of 5 months during the open water seasons; however, many monitors collect data for six months. Transparency data give an indirect measure of water quality. By observing transparencies over a long period of time (years), a general trend develops. Many monitors also collect dissolved oxygen (DO) data from their respective lakes. In addition, the DEP samples lakes for baseline data (dissolved oxygen and temperature profiles, color, alkalinity, pH, chlorophyll, and total phosphorus) on a rotating basis.

In 1992, the State Legislature decided not to fund the Lake Restoration and Protection Fund (LRPF) for 1993 and beyond. The LRPF was the source of monies used to run the program. The DEP solicited monitors who would help create a revised program by becoming volunteer regional coordinators, data entry coordinators, and Board of Directors members. The Board of Directors voted to become a not-for-profit organization called the Maine Volunteer Lake Monitoring Program (VLMP). The DEP has entered into a long term agreement with VLMP. The VLMP will be responsible for the administration of the program, while the DEP will manage the data and provide data quality assurance quality control (QA\QC) and technical expertise.

Future plans include increased sampling by monitors to include more detailed data collection, education for both monitors and the public, and expansion of the program both in number of lakes and breadth of sampling (possibly into exotic species monitoring and watershed nonpoint source surveys). Through the use of volunteers, these detailed data can be collected from a large number of lakes. In addition, lake residents and users will be educated regarding lake and watershed ecology. Any expansion of the program, however, will not take place until there are adequate funding mechanisms to support it.

Quality control checks have also increased in the recent past. Previously, volunteers were trained when first joining the program. After this training, only data discrepancies led to future quality control checks. Starting in 1992, and continuing into 1993, transparency quality controls checks were performed on 70 + monitors. In 1994, quality control checks for transparency and dissolved oxygen measurements were performed on every monitor. Future quality control checks will be held bi-annually for monitors performing transparency sampling, and annually for monitors performing DO testing.

Data Usage:

The data collected by monitors, along with baseline data, are of great value to the DEP and the State of Maine. The data are integrated into a pre-existing long term monitoring data base. The data are used for determining trends, water quality assessment, and lake management. In addition, data from each lake are included in an annual report that is distributed to monitors, state and federal agencies, and others interested in the water quality of Maine's lakes. These data are also one basis for determining attainment of Maine's classification requirements and the assigned uses as reported in 305(b) reports.

Technical Design:

Sampling is designed to monitor lake transparency, which indirectly measures lake productivity. In Maine, Secchi disk transparency is affected by water color, suspended sediments, and algae. Algal populations are usually the most dominant factor. Secchi disk data are therefore used to provide an indirect measure of algal production. Periodic baseline monitoring, which includes dissolved oxygen and temperature profiles, and integrated total phosphorus, chlorophyll a, alkalinity, and color samples, supplement transparency readings.

Frequency of collection:

Transparency readings will be conducted bi-weekly for at least five months during the open water season. Sampling locations will be located at the deepest part of the sampled lake, with one exception. On larger lakes, or lakes with more than one distinct basin the DEP can add additional sampling stations.

Dissolved oxygen readings are performed at least once per month during the same five month open water season. At DEP discretion sampling could be increased or decreased. Sampling will occur at the same station as transparency monitoring. DEP occasionally

devises custom monitoring programs for monitors with different objectives. Sampling procedures will follow those of Pearsall (1996).

Project Organization and Responsibilities (VLMP, DEP and Boards):

The project is managed jointly by the non-profit organization (status pending) VLMP and the DEP. VLMP is responsible for the administration of the program, while the DEP is charged with the program's data management, technical assistance, training, and data quality assurance quality control. VLMP also assists to the extent possible in training, QA\QC.

A Board of Directors composed of representatives from the volunteer regional coordinators, data entry coordinators, monitors, and citizens at large will direct and oversee the program. The Board will draw guidance from a three year action plan developed by a Board appointed Strategic Planning Committee. The action plan will be updated every two years. Table (1) lists the contact persons for various aspects of the VLMP.

Table 1
VLMP Organizational Contacts
Position Contact

Project Coordinator (VLMP) (207) xxx-xxxx
(207) xxx-xxxx Fax
Data Management (DEP) (207) xxx-xxxx
(207) xxx-xxxx
QA Officer (DEP) (207) xxx-xxxx
(207) xxx-xxxx Fax
Chairperson Board of Directors (207) xxx-xxxx

Project Organization and Responsibilities (Regional Coordinators) :

An integral part of the program is the utilization of volunteer regional coordinators and data entry coordinators. The volunteer coordinators are the first contact with the monitors. All coordinators receive 3-4 hours of instruction along with a procedure manual. In addition, coordinators are required to attend an annual meeting, part of which consists of updating pertinent information and training. Table (2) lists the responsibilities of the regional coordinators.

Table 2
Regional Coordinator's Responsibilities

1) Keep extra disks, tapes, scopes, field forms, log sheets, and envelopes.
2) In order to remain current of program's goals and progress you must attend yearly Coordinators' meetings.
3) Response to inquires (know who to refer to)

Keep your opinions to yourself (Be objective; know VLMP's positions on issues)
Know your limitations
Be responsive
Be courteous
Watch for hidden agendas

4) Be prepared for complaints of program procedures or policy, refer to co-coordinators.
5) Be informed on environmental laws (see training workshops). Coordinators are not expected to know the laws, only to provide background information and know what agency or bureau to refer to.
6) Keep log of questions.
7) Keep log of time worked.
8) Keep telephone usage log.
9) Keep log of problems, or suggestions to improve the program.
10) Think about future training topics at annual meeting.
11) Consider joining the Board of Directors (meets semi- annually).
12) Keep in contact with data entry personnel.
13) Check with delinquent monitors.
14) Know your limitations! Saying, "I don't know," is much better than guessing.
    A: All questions from the media should go to program coordinator.
    B: All questions regarding permits should go to the appropriate DEP Bureau, Land Use Regulation Commission (LURC), Inland Fish and Wildlife, or Town.
    C: All questions regarding policy should go to the VLMP coordinator.

Project Organization and Responsibilities (Data Entry Coordinators)

Volunteer data entry coordinators' main function is to key punch data on time-share software package developed by the DEP. Data entry coordinators receive 3-4 hours of instruction, including hands-on use of the data entry program. After keypunching, the data are proof-read, and sent to DEP. All data will be proof-read by DEP staff. This system has produced the earliest annual VLMP report. Table (3) lists the responsibilities of the data entry volunteers.

Table 3
Data Entry Volunteer's Responsibilities

1) Know procedures of data entry and management.
2) Maintain contact with regional coordinators.
3) Answer questions regarding data entry and management (but not interpretation of data) know your limitations and refer to DEP.
4) All questions from media should go to Program Coordinator.
5) All questions regarding organizational or technical aspects of program should be referred to Regional Coordinators, or program's co-coordinators.
6) Keep log of time worked.

7) Keep log of problems.
8) Keep log of questions, or suggestions to improve the program.
9) Make backup copy of data disk before mailing to DEP.
10) Send DEP data disk and field forms in one envelope.
11) Consider joining the Board of Directors (meets semi-annually).

Project Schedule:

1) March through November: Monthly contact sheets and/or telephone checks by Regional Coordinators.
2) March: Board of Directors meeting.
3) April: Field forms and annual reports sent to regional coordinators, and monitors.
4) April: Annual report for all lakes in coordinator's area will be updated.
5) May: A\QC checks on dissolved oxygen meters and kits.
6) May through July: Bi-annual QA\QC checks on Secchi Disk transparency.
7) July: Board of Directors meeting.
8) July 15: First half of data sent to Regional Coordinators.
9) July 20: Data forwarded to Data Entry Coordinators.
10) July 20: Regional Coordinators will contact delinquent monitors.
11) Last week in July: Regional Coordinators annual meeting (Associated with COLA annual meeting, unless otherwise noted).
12) August 1: All data to DEP.
13) July: Follow-up QA\QC for dissolved oxygen meters and kits.
14) September: Fall letters sent by Regional Coordinators.
15) September: Board of Directors meeting.
16) November 10: All data to Regional Coordinators.
17) November 20: Data sent to Data Entry Coordinators.
18) November 20: Regional coordinators will contact delinquent monitors.
19) December 1: All data to DEP.
20) January: Board of Directors meeting.
21) February: Strategic Planning Committee meeting (bi-yearly noted).

Field Sampling Table:

Parameter	Method	Frequency	Sample Vol. (mL)	Container	Preservative	Holding Time
Transparency	Secchi Disk	2/month	-----	-----	-----	-----
Dissolved Oxygen	Meter Kit	Monthly*	-----	Glass	-----	8 Hrs. *
Total Phosphorus	Digestion	1/Year	-----	Plastic	Cool (4°C) dark, acid	8 Hrs. acid, 28 Days **
Chlorophyll a	Digestion	1/Year	50 Ml	Plastic Cube	Cool (4°C) Dark	24 Hrs. [1]
Alkalinity	Kit	1/Year	Low 23 mL High 6 mL	Plastic Cube	Cool (4°C)	24 Hrs.
Color	Kit	1/Year	Low 15 mL High 5 mL	Plastic Cube	Cool (4°C)	24 Hrs.

* minimum sampling, 2/month is recommended
** After acid has been added.
[1] Filter within 24 hours. Hold filter in freezer, wrapped in foil (no light) for up to 21 days. If cannot filter within 24 hours whole water sample can be held up to 14 days at 4 degrees Celsius in the dark. Do not freeze whole water sample.

Sampling Procedures and Chain of Custody:

All sampling will be performed at the deep hole of the lake, unless otherwise directed by DEP. Water craft will be anchored before sampling occurs. Sampling procedures will follow those described by Pearsall (1996).

Analytical Procedures:
The data will be reviewed for completeness, accuracy, and possible errors at the half way point and end of the field season. If any data problems are encountered, they will be identified and corrected. At least 80 percent of the data must be accepted for the project to be considered complete. EPA may conduct field or lab audits to assess the project. All analytical procedures will follow DEP (Pearsall 1996), and State of Maine Department of Human Services Health and Environmental Testing Laboratory (HETL 1994) guidelines.

Quality Control Samples:

Quality control checks for transparency data will be performed with each monitor on a bi-yearly schedule. DEP staff, or DEP-trained Mentors will conduct training workshops. The workshops will be composed of two parts, theoretical, and hands on. Detailed instructions on proper Secchi disk procedures will be reviewed. Monitors will then be observed performing the task on an individual basis. At this time the trainer will note any flaws in the monitor procedure and correct it. In addition, the trainer will obtain a reading at the same time for direct comparison of transparency readings. Acceptable accuracy for water transparency will be ±0.3 meter from the State standard, the VLMP's QA\QC officer. The QA\QC officer will be calibrated against two other DEP staff members to determine a valid state standard. The trainer will work with the individual monitor until the monitor's reading is within the acceptable range, or is consistent. It must be noted that if a monitor is consistently outside the acceptable limits their data will be flagged but

used. The reasoning for this; data collected are used in long term trend analysis. As long as the same monitor is consistent in procedures and ability to see the disk, long term comparison can be made even if the data is outside the acceptable range in terms of absolute readings.

Dissolved oxygen quality control checks will be performed by DEP staff or DEP trained mentors. Monitors will be checked once a year, unless it is deemed necessary by DEP that additional visits are warranted.

Procedures for checking quality control of monitor-owned dissolved oxygen meters will consist of an observation of general meter and probe condition, calibration steps and field procedures. Dissolved oxygen and temperature readings will be compared to a Winkler calibrated Yellow Springs Instrument dissolved oxygen meter.

Acceptable accuracy for LaMotte field kits will be a combination of ±10% for the field kits and the accepted accuracy of the individual calibrated meter. The LaMotte Company states that accuracy of their kits can be improved to ±5%. This is achieved by the use of a higher quality graduated cylinder for measuring samples, and extra care by the monitors.

Project Fiscal Information:

The VLMP will be funded by various sources. These include, but are not limited to, DEP (in-kind services, and general fund revenue), VLMP (in-kind services), USEPA 604B and 319 funds, and private foundations. Future sources could include corporations.

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