Planning Where, When and How to Monitor

This section will show you how to:

- Choose an appropriate site(s) within your chosen waterbody to monitor.
- Create a detailed plan to carry out the sampling of your chosen parameters.

Mapping out your monitoring journey

By now you have established your "why," "what" and "who" questions (*Section 2*); chosen appropriate parameters to monitor (*Section 3*); and decided how to analyze your samples and apply QA/QC goals for each parameter chosen according to your data user(s) needs (*Section 4*). The next steps are to choose a sampling site and outline your methodologies for sampling. In this Section, you will document the "where," "when" and "how" of your program to take it from start to finish.

Guidelines for monitoring lakes, streams and rivers and wetlands

Sampling equipment

Sampling equipment needs for the various parameters are included in the detailed methodologies referenced throughout this Guide and also in *Appendix C*. Equipment and supply vendors are included in *Appendix D.*

Safety and liability considerations

Selecting the exact location to monitor requires consideration of many factors. Take into account some of these questions before selecting the exact location for sampling:

- Is the site easily accessible?
- How long will it take to get to/from the site on a regular basis? How will weather affect travel/sampling time?
- Is the site historically monitored by state/federal agencies?
- Is the site where recreational uses occur (i.e., swimming, fishing, boating)?
- Does the site represent the variety of conditions in the watershed (e.g., located near typical land uses, influenced by point or nonpoint discharges)?
- Is this location safe?

For lake, river, wetland or any other type of monitoring, you will want to be sure that the site you are monitoring is appropriate and relevant to your question, purpose, and goals.

Site safety

In any monitoring activity, you run the risk of injury, which might carry legal risks. Never put yourself at risk to obtain a measurement or observation. Part of your monitoring plan should cover safety and safety precautions should always be covered in any training provided.

Take the following suggestions into account when developing the safety portion of your monitoring plan (these should only be used as a guide and not be construed as a comprehensive safety plan):

- Describe the safety issues and risks involved with your particular type of monitoring.
- Describe the safety precautions for your particular type of monitoring. For example, in stream monitoring, describe the flow velocities and depths at which volunteers should not enter the stream.
- Include emergency contact information for all volunteers.
- Include locations and directions to local emergency care providers.

Additional safety considerations are covered in Section 2.3 of *Volunteer Stream Monitoring: A Methods Manual,* by U.S. EPA 1997 (Document Number EPA 841-B-97-003).

Poultney-Mettowee Watershed Partnership Learns There is Safety in Numbers

Collecting samples can take you to some interesting places. Just ask members of the Poultney-Mettowee Watershed Partnership who quickly learned that when taking a water quality sample from a stream in a cow pasture, it is best to have two people. The first person is the one that takes the sample, the second person stands on watch (behind the fence) and makes sure that the bull doesn't get any closer!

Buddy system

It is a good idea to implement a "buddy system" policy where certain field efforts require two or more people to be present. Monitors should also make sure someone knows where they are sampling, when they plan to return and who to contact if they don't return when expected.

Liability waivers

Organizations that coordinate volunteers may want to use liability waivers and/or have some coverage for liability and possibly for injuries. You may be able to cover volunteers with worker's compensation or by obtaining insurance through funding agencies or partners. Liability waivers are essentially signed documents (i.e., contracts) in which the signers promise not to sue. A carefully worded waiver, signed by an adult, can protect you if you are sued for negligent (unintentional) acts. Waivers often fail because they do not adequately describe the risks of the activity and the consequences of signing. Everyone signing a waiver must be clearly informed about the dangers so they can make informed decisions about signing.

Additional information is available from the Nonprofit Risk Management Center, 1130 Seventeenth Street, NW, Suite 210, Washington, DC 20036. Phone: 202-785-3891 or online at **www.nonprofitrisk.org**.

Selecting a monitoring location

Carefully selecting the best site for monitoring physical, chemical and biological parameters is important to ensure the data you collect are representative of the waterbody and the conditions you are analyzing. Remember, *many of Vermont's water resources are bordered by private property. Always contact the landowners and receive permission before entering or crossing private property.* You may also want to have a liability waiver, signed by volunteers, to present to landowners to make them more comfortable about allowing access to their land.

Biological monitoring of rivers, streams and lakes in your monitoring plan

Sampling methods, including the equipment needed and the suggested level of classification, are detailed in the manuals available from the resources identified in *Appendix C*, and throughout this Section. See also Table 5-1 for minimal and desirable designs for biological monitoring for lakes, streams and wetlands.

Macroinvertebrates

For macroinvertebrate sampling from rivers and streams, it is important to recognize that the type, number and diversity of organisms will vary considerably among habitats. Different organisms are naturally found in different aquatic habitats, such as rocky-bottomed riffle areas, sandy pool areas and woody debris areas. This subsection only addresses macroinvertebrate monitoring in streams because currently this type of biological monitoring is best understood for streams and not so for lakes.

It is important to take the proper type of sample based upon the habitats available and your sampling goals. If you want to collect a quantitative riffle sample, then the stream you are sampling should have riffle-run-pool morphology with ample flow, characteristic of the habitats in which riffle-dwelling organisms are present. If you want a quantitative multihabitat sample, take a composite sample that represents different habitats present in the stream. Typically, macroinvertebrates are collected from riffle areas since these are generally the most diverse and productive areas of a stream and thus yield the greatest amount of information.

Macroinvertebrate monitoring methods range from streamside surveys where organisms are collected and identified entirely in the field to bringing organisms back to the lab for more detailed processing and identification. In general, macroinvertebrates are collected by wading into streams or wetlands and using nets to capture the organisms. The specific collection method depends on the purpose of the study and the habitat type being sampled.

Dip nets are useful in sampling multiple habitats (rocks, woody debris, vegetation) from fast-flowing, rocky streams; slow-moving sandy streams; and wetlands. Kick nets are often used when sampling is directed specifically at shallow, rocky substrates in streams. You can also use artificial substrates (multi-plate, bag or screen-cage samplers) to collect invertebrates where conditions prevent efficient sampling by hand (e.g., due to depth of the stream or wetland), where adequate invertebrate habitat is lacking or when a consistent quantitative sample is desired.

When conducting macroinvertebrate sampling, it is important to remember to tread lightly on streambanks and aquatic habitats to limit the amount of environmental disturbance. You also need to consider that these are living organisms that you are disturbing or removing from their habitat. If your program does not call for preservation and laboratory analysis, it is best to return the macroinvertebrates to the stream environ-

Table 5-1: Minimal and Desirable Designs for Biological Monitoring Programs

Sampling Season	Stream macroinvertebrates
Minimal design	One multihabitat or one riffle sample per year during spring emergence periods (April-May) or base flow conditions (mid-August - early October), family level identification.
Desirable design	Genus or species level identification verified by a professional taxonomist.
Comments	Sampling during base flow conditions can give a better indicator of stress; spring samples should not be compared to fall samples.
	Qualitative stream habitat and related chemical and physical parameters
Minimal design	One habitat assessment done at the same time and place as macroinvertebrate assessment.
Desirable design	Supplemental habitat information with flow, total phosphorus, nitrate, total suspended solids, dissolved oxygen and temperature.
	Wetland plants
Minimal design	One survey per year during period of maximum flowering/fruiting (late June - early August), species level identification.
Desirable design	Species level identification verified by a professional taxonomist.
Comments	Sampling outside of this index period will lead to a larger proportion of plants that are difficult for volunteers to identify due to the absence of visible reproductive structures.
	Aquatic plant survey
Minimal design	One survey per year during maximum growth (late June - early August), species level identification.
Desirable design	Species level identification verified by a professional taxonomist, continuous monitoring by shoreline landowner/volunteers and/or at public boat access area for invasive/exotic plants.
	***E. coli* monitoring**
Minimal design	One sample per week from areas of concern between Memorial Day and Labor Day.
Desirable design	For swim areas, sampling on Tuesdays allows one to take a retest before the weekend if results come back high. Sample from the locations in the water where people swim and plunge bottle to eight inches depth.

Table 5-2: Minimal and Desirable Designs for Eutrophication (Nutrient Enrichment) Monitoring Programs

Sampling Season	Stream monitoring	Lake monitoring
Minimal design	One year	One year (May - September)
Desirable design	Five to ten years	Five to ten years
Flow Monitoring		
Minimal design	Daily or with each sample collection	N/A
Desirable design	Continuous monitoring	
Water Quality Parameters		
Minimal design	Flow, turbidity, total phosphorus, total nitrogen, total suspended solids, dissolved oxygen and temperature	Secchi transparency, total phosphorus, chlorophyll-*a*
Desirable design	Add: ammonia nitrogen, chloride and turbidity	Profile sampling: collecting samples at discrete depths throughout the water column for diagnostic or comprehensive studies Add: total nitrogen, dissolved oxygen and temperature
Sampling Frequency		
Minimal design	10 samples per site per season	8 samples per site per season
Desirable design	15 to 20 samples per site per season, precipitation monitoring, either weight at high flows or supplement with rain event sampling	10-12 samples per season

ment after looking at them. Remember streamside surveys that are conducted entirely in the field can provide a reasonable assessment based on relative abundance and richness.

If macroinvertebrate samples are to be brought back to a laboratory for processing, typical procedures may include:

- Rinsing and preparing the sample.
- Picking and sorting a subsample of the macroinvertebrates.
- Preserving samples in 75% ETOH (ethyl alcohol), archived in labeled vials, so they can be further processed or rechecked at any time.

Macroinvertebrate monitoring is typically conducted in late summer and early fall. During this time, water levels are low and safer for sampling. Also, this time is when organisms are more mature and therefore easier to identify. High water temperatures and low flows can cause stressful conditions for the macroinvertebrates as well.

Detailed methodologies for macroinvertebrate monitoring are available from:

- *Volunteer Stream Monitoring: A Methods Manual,* by U.S. EPA 1997 Document U.S. EPA 841-B-97-003 available at **www.epa.gov/owow/monitoring/vol.html**.
- *Living Waters*, by River Network, available in print and online at **www.rivernetwork.org/lw**.

Aquatic plants

Conduct surveys of aquatic plants along the shoreline of the entire waterbody by recording observations about the species present, their abundance and site conditions. You also may want to travel straight out from the shoreline towards the center of the lake to find the depth at which rooted aquatic plants are no longer found.

Aquatic plants can be sampled by identifying plants in the field using a key and quantifying the abundance of each plant found in a particular area. If you are unsure of the identification of an aquatic plant, you may want to place it in a plastic bag and bring it off the water with you to study in detail later. Once you have identified a particular plant, it may be helpful to press a specimen for later reference. As mentioned earlier, aquatic plants also may be sent to the Water Quality Division for identification by a professional.

Aquatic plant surveys should be done when the plants are vigorously growing, generally July–August. However, some plants (most notably curly-leaf pondweed, *Potamogeton crispus,* an invasive plant) die off part way through the summer. In this case, a survey should be done in June when the plant is growing vigorously and again later in the summer after the die-off is complete.

Information and detailed methodologies for plant sampling/surveys are available from the following sources:

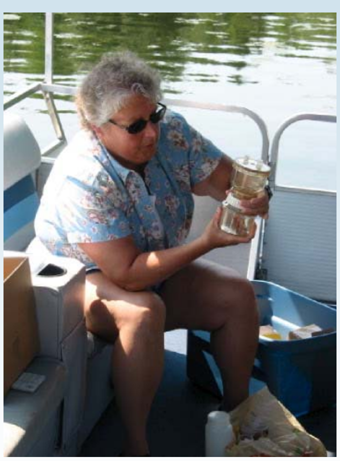

Photo submitted by the LCC

Lake Champlain Committee Teams with UVM to Monitor Toxic Algae in Missisquoi Bay

Missisquoi Bay is an area in northern Lake Champlain where toxic algae blooms have been occurring in recent summers. Volunteers with the Lake Champlain Committee (LCC) collect algae samples at various locations in the Bay to assess the differences in toxin production between nearshore and off-shore sites.

The Bay is visually monitored in early summer (June-July) and once a bloom starts, samples are taken weekly and analyzed under the direction of UVM Professor Dr. Mary Watzin at the Rubenstein Lab in Burlington. When dangerous levels of toxins are detected, the Department of Health is notified, beach warnings are posted, and warnings are posted on the LCC web site (see address below).

Other areas of Lake Champlain are also being monitored for toxic algae by volunteers in the Lay Monitoring Program. Samples are collected from Thompson's Point off Charlotte south to Button Bay in Vergennes and Larrabee's Point in Shoreham.

- For more information on the Lake Champlain Committee algae monitoring program, visit www.lakechamplaincommittee.org.

- *How to Conduct an Aquatic Plant Survey* by the VTDEC available at **www.vtwaterquality.org/lakes/docs/ans/lp_plantsurvey.pdf**, or by calling the Water Quality Division at (802) 241-3777.
- *Citizen Lake and Watershed Survey* by the VTDEC available by request from the Water Quality Division.
- *Key to Common Aquatic Plant Species* by the VTDEC available by request from the Water Quality Division.
- *Volunteer Lake Monitoring: A Methods Manual* 2002 by U.S. EPA Document number EPA 440-4-91-002 available at **www.epa.gov/owow/monitoring/volunteer**.

E. coli monitoring

For *E. coli* monitoring, where, when and how to collect samples will depend on your monitoring purpose. Some general guidelines to follow are:

- Be consistent with your monitoring location over time.
- Collect samples in the morning, if possible, as sunlight degrades the *E. coli* present. If morning collection is not possible, be consistent in the time of day you collect samples.
- Collect samples at sites where elevated bacteria levels are of most concern (e.g., the location and depth at which swimmers commonly recreate, upstream and downstream from an agricultural area).

More information and detailed methodologies for *E. coli* sampling, are available from:

- *Citizen's Guide to Bacteria Monitoring in Vermont Waters* by the VTDEC available online at **www.anr.state.vt.us/dec/waterq/lakes/docs/lp_citbactmonguide.pdf**.

Chemical and physical monitoring of lakes

In many lakes in Vermont, it is sufficient to sample chemical parameters at one primary site, typically where the lake is the deepest. Lakes with complex basin morphologies (with numerous bays and inlets, like Lake Champlain) require chemical monitoring at multiple sites.

Temperature and dissolved oxygen are frequently taken as a depth profile (i.e., taken at

Table 5-3: Lake Monitoring Parameters and Frequency of Sampling between Memorial Day and Labor Day

Parameter	Primary site	Secondary site	Priority	Cost	Frequency Minimum	Recommended
Nutrients -total phosphorus -total nitrogen	 X X	 X X	 High High	 Moderate Moderate	 Every 10 days Every 10 days	 Every 5-7 days Every 5-7 days
Secchi disk	X	X	High	Very Low	Every 10 days	Every 5-7 days
Chlorophyll-*a*	X	X	High	Moderate	Every 10 days	Every 5-7 days
General Chemistry - total suspended solids, pH, alkalinity, conductivity, turbidity, total nitrogen	X		Moderate	High/Low	Monthly	Weekly
Dissolved oxygen and temperature profiles	X	X	Moderate	High/Low	Monthly	Weekly
Field Observations -Precipitation -Lake level			 Moderate Moderate	 Low Low	 Each Storm Weekly	 Weekly
Rooted aquatic plants (macrophytes)	Shoreline		Moderate	Low	Every 2-3 years	Annually*
E. coli	X		Moderate	high	Weekly	Twice per week

* More often (2-3 times during the summer) if community changes throughout the season or continually if monitoring for invasive species

intervals from the surface to the bottom) and used to assess stratification and vertical mixing of the lake. Other lake parameters such as total phosphorus can be collected from the euphotic zone, which is the depth that light can penetrate through the water, and determined by twice the Secchi transparency reading. See Tables 5-1, 5-2 and 5-3 for tips on designing a lake monitoring program.

The VTDEC has also developed a lake and watershed survey for organizations and concerned individuals to learn about what kinds of problems or activities may be affecting a lake and to aid decisions about what to do to protect or improve a lake's water quality. Lake watershed surveys include in-lake, shoreland and watershed observational surveys to identify in-lake conditions that indicate potential problems and land uses and watershed conditions that might be the cause.

Lake sampling in Vermont is usually done during the summer, from Memorial Day through Labor Day. More detailed monitoring plans may involve sampling year-round, even during the winter through holes cut in the ice.

Detailed sampling methodologies for lakes are available in:

- *Citizen Lake and Watershed Survey Instructions*, available from the Water Quality Division at (802) 241-3777.
- *The Vermont Lay Monitoring Program Manual*, by the VTDEC available at **www.vtwaterquality.org/lakes/docs/lp_lmp-manual.pdf**, or by calling the Water Quality Division at (802) 241-3777.
- *Volunteer Lake Monitoring: A Methods Manual* 2002 by U.S. EPA Document number EPA 440-4-91-002 available at **www.epa.gov/owow/monitoring/volunteer**.

Chemical and physical monitoring of rivers and streams

River and stream water chemistry sampling should be done at a point where the water is well mixed and is most likely to represent the water quality of the stream segment that is to be assessed. The goal is to get a sample that represents the overall characteristics of the stream at that site.

For general chemical and physical parameters such as temperature, collect samples over a range of conditions to represent a variety of flows and seasons. You may want to complete annual habitat surveys at the sampling location to track long-term trends. Generally, stream monitoring is done during the “open water” season, roughly from March to November.

See Table 5-2 for guidance as to a minimal and desirable sampling program design for stream eutrophication monitoring.

Detailed sampling methodologies for streams are available in:

- *Volunteer Stream Monitoring: A Methods Manual* 1997 by U.S. EPA Document number EPA 841-B-97-003 available at **www.epa.gov/owow/monitoring/vol.html**.

Lewis Creek Association Turns 15 in 2005

Since 1990, the Lewis Creek Association (LCA) has been actively working "to protect, maintain and restore ecological health while promoting social values that support sustainable community development in the Lewis Creek watershed region and Vermont."

With dozens of active and hard-working volunteers, the LCA has engaged in numerous monitoring activities. Water quality monitoring on the Lewis Creek began in 1992, with volunteers monitoring *E. coli* levels.

Today, they participate in the VTDEC's LaRosa Lab Analytical Services Partnership and have samples analyzed for total phosphorus, pH and nitrogen in addition to *E. coli*. The results are used to establish baseline data for stream conditions, identify "hot spots" (localized elevated levels of pollutants) and target areas in need of improved stream buffers.

During 2001 and 2002, the VTDEC River Management Program and the Vermont Department of Fish and Wildlife partnered with the LCA on a pilot project to develop and test geomorphic assessment protocols. Volunteers attended numerous trainings, conducted assessments and worked along side professionals to gain a better understanding of ways to protect river corridors, manage stream bank erosion and phosphorus loading to Lake Champlain and focus ongoing river restoration efforts. Participation in the geomorphic assessment project has allowed the LCA to analyze the effects of various land uses on water quality and prioritize specific reaches in need of further assessment and/or restoration.

Photo submitted by the Lewis Creek Association

- For more information on the Lewis Creek Association, visit: www.lewiscreek.org.

- *Testing the Waters: Chemical and Physical Vital Signs of a River* by Sharon Behar for the Riverwatch Network, Kendall/Hunt Publishing Company, 1997.

- *Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools, Eleventh Edition* by Mark K. Mitchell and William B. Stapp for GREEN (Global Rivers Environmental Education Network), Kendall/Hunt Publishing Company, 1997.

- *Healthy Water, Healthy People: Water Quality Educator's Guide,* by The Watercourse - National Project WET, available from the Vermont Water Quality Division at (802) 241-3777, or online at **www.healthywater.org**.

Geomorphic assessment

Geomorphic assessments take place in three phases.

The Phase 1 assessment is a watershed-scale exercise that to a large degree relies on remote sensing techniques. A GIS (Geographic Information System) program has been developed by the Agency of Natural Resources to facilitate analysis of remote sensing data. Remote sensing data sources include topographic maps, geologic surveys, land use and land cover maps, hydrology records, orthophotos, and river management specialists.

In the field component of the Phase 1 assessment, you will conduct a watershed orientation and "windshield survey" (general observations made from a car as you and a partner drive about the watershed). The information gathered in this Phase will provide an overview of the general physical characteristics and fluvial processes of the watershed and provide a context for understanding specific physical processes that will be identified during the Phase 2 assessment.

Phase 2 involves making qualitative and quantitative field observations and measurements of the stream channel, riparian corridor and aquatic habitat. The Phase 2 assessment helps verify Phase 1 stream geomorphic data and provides more specific information about stream segments of interest. Phase 2 assessments can be used to compare stream reaches within the same watershed to each other and/or to regional reference conditions.

In Phase 3, you will be following detailed protocols for making quantitative observations and measurements. Survey equipment will be used to get precise data on "reference" equilibrium reaches and selected degraded sites to quantify physical channel form and processes in detail. Phase 3 assessments can be used to verify Phase 1 and Phase 2 data; provide scientifically sound information that can be used for stream corridor restoration and watershed planning; and provide more detailed characterization of aquatic habitat, erosion, and flood hazards.

Recently, there has been an increased interest in conducting geomorphic assessments in Vermont. Due to the complexity and technical aspects of geomorphic assessments, volunteers are *strongly encouraged* to contact the VTDEC River Management Program before attempting to initiate this type of monitoring. Volunteer training may be available from the VTDEC as well as grant money for volunteer groups to hire a consultant to perform the three phases of a geomorphic assessment. Handbooks for all three geomorphic assessment phases are available online at **www.vtwaterquality.org/rivers/htm/rv_geoassesspro.htm**.

- For more information on Geomorphic Assessments, contact the Water Quality Division River Management Program at (802) 241-3777, or visit their web site at **www.vtwaterquality.org/rivers.htm**.

Wetland monitoring

Unlike lake and river monitoring, assessing wetland conditions incorporates some of the monitoring and assessment techniques used for forests, meadows, and other upland areas. Wetlands require a broad spectrum of surveying and monitoring techniques because they are transitional areas between aquatic and upland environments and exist in a variety of types.

Each type of wetland hosts a distinct community of plants and animals. Since physical and chemical conditions in wetlands create such a variety of biological conditions in wetlands, measuring nutrients, pH, dissolved oxygen, turbidity and solids gives a limited picture of a wetland's health. Any wetland monitoring program should include a combination of physical, chemical and biological parameters.

Purple Loosestrife Biological Control Program: Volunteers Help Combat Invasive Species

Purple loosestrife is an invasive plant introduced to the U.S. from Europe and Asia in the early 1800's. It has no natural predators in this country, spreads rapidly through wetlands and along roadsides and chokes out native plants, which reduces food and shelter for native animals. In 1996, the VTDEC Wetlands Section launched the Purple Loosestrife Biological Control Program (PLBCP) in an effort to reduce the spread of this plant through the introduction of an "imported" predator, the *Galerucella* spp. beetle.

Each spring since the PLBCP began, volunteers throughout the state have worked with VTDEC staff to raise, release and monitor beetles and to hand pull and dispose of the plants. The PLBCP also works with school groups to provide education about the program, wetlands and water quality through games and activities, and participation in releasing and monitoring the beetles.

To date, the PLBCP has released over 425,000 beetles in 67 towns across Vermont. The results of this program are evident, as in 2004, 22 percent of the 139 release sites, on nearly 211 acres of land, showed at least a 25 percent defoliation of purple loosestrife by the *Galerucella* spp. beetles, and a significant reduction in flowering.

- For more information or to volunteer with the Purple Loosestrife Biological Control Program, contact the Wetlands Section at (802) 241-3770 or visit their web site: www.vtwaterquality.org/wetlands/htm/wl_purpleloosestrife.htm.

You may want to consider monitoring:

- Dominant vegetation type- Requires some training; is often conducted using sample plots located on transects and is a principal means of detecting change in a wetland.
- Adjacent impervious surface (e.g., pavement, roofs)- Estimated using maps or visual observations in the field; can be an important indicator of stresses to wetlands.
- Hydrology- Water fluctuations can be measured by installing and reading a staff gauge or monitoring shallow wells; timing, frequency and duration of water inputs can be crucial to wetland health.
- Exotic/invasive plant species encroachment- Uses some of the same methods used for measuring dominant vegetation types; can identify the need for exotic species control.
- Amphibian counts- A variety of methods are used to count amphibians; counts can provide insight into the effects that land use or other stressors might have on wetland health.
- Physical and chemical parameters- Nutrients, pH, dissolved oxygen, turbidity and total suspended solids.
- Macroinvertebrates- Wetland macroinvertebrate monitoring is a new and developing science; protocols have been developed and are available for the New England region, however, they may need to be modified for specific application to Vermont environments.
- Bird sightings- Recognizing and counting birds and their calls takes training; it can be a good screening mechanism to assess risk or determine a wetland's connection to migratory corridors.

- Wetland appearance/footprint (through photographs or maps)- This very simple information-gathering method is not scientifically rigorous but can help supplement other data and "freeze" a picture of a wetland's condition at a certain time.

Find this and additional information on wetland monitoring from:

- *Volunteer Wetland Monitoring: An Introduction and Resource Guide* 2002 by U.S. EPA Document number EPA 843-B-00-001, available at **www.epa.gov/owow/monitoring/volunteer**.
- *Methods for Evaluating Wetland Condition*, U.S. EPA modules at **www.epa.gov/waterscience/criteria/wetlands**.
- U.S. EPA's Biological Assessment of Wetlands website at **www.epa.gov/owow/wetlands/bawwg**.
- *Handbook for Wetlands Conservation and Sustainability, 2nd ed.*, by the Izaak Walton League of America, available for purchase at **www.iwla.org**.
- *New England Freshwater Wetlands Invertebrate Biomonitoring Protocol: A Manual for Volunteers*, by Anna Hicks, available for purchase at **www.umassextension.org/Merchant2/merchant.mv**.

Wetland sampling is generally conducted throughout the summer and early fall in the shallow, near-shore area of the wetland, close to (or in) any vegetation. Vegetation monitoring generally occurs in midsummer (i.e., late June to early August).

Some information on wetlands monitoring was taken with permission from the article "A Wetlands Primer" by Matthew Witten: *The Volunteer Monitor*, Volume 10, No. 1, Spring 1998.

Document monitoring activities

Making sure data are credible depends on good documentation. It is extremely important to document all of your monitoring methods and activities. If you have a QAPP, be sure to provide detailed documentation of how you followed it so that your data user(s) can be sure your data are accurate and credible.

Use a well-designed field sheet

Field data collection sheets are an essential part of your monitoring plan. Many are available from existing methods manuals, so you may not have to design one yourself. *Appendix E* provides some examples of existing field sheets. If you plan on designing your own field sheets, see the side box to the right for tips.

Record data in the field

Once you leave the monitoring site, the field sheet) is the only record of your efforts. No matter how carefully the tests are performed, the data will only be as useful as what is written on the form. Therefore, be sure you understand instructions on how to carefully fill out the forms.

- Record any unusual conditions at the site (when in doubt, write it down).
- Record the presence of any tributaries, dams, bridges, or anything else that may affect results.
- Record all instrument or kit readings, including units, on the form.
- Do not report a value of zero for water chemistry parameters. Instead report "less than ____," filling in the blank with the lowest value that can be read with the equipment since trace amounts may be present. Example: If the range of a test is 0-1mg/L with the smallest measurable increment being 0.02 mg/L, and the test result is zero, report "less than 0.02 mg/L."

Designing a Good Field Sheet

Field sheets should include simple instructions, example calculations and ample space for the following:

- Waterbody name and city/town it is located in.
- Exact sampling location (including depth), site number (if more than one) and GPS location, if available.
- Date and time of sampling.
- Monitor's name and phone number.
- Weather conditions (recent and current).
- Parameters water samples were collected to test.
- Sample results for non-laboratory tests (i.e., Secchi disk reading or temperature).
- Site conditions, leave room to record anything unusual you see (spills, new construction, pollution, dead animals, etc.) as well as any problems you may have in performing the tests.
- Aquatic nuisance species observational monitoring.

If you are using field kits or meters, include spaces for:

- Recording calibrations.
- Name and model number of test kit or field meter.
- Actual readings, including duplicate readings.

- If calculations are performed, show all formulas, calculations and units.
- When reporting results of calculations, do not report excess decimal places. Use the following rule of thumb: look at all the values that were used in the calculation, and find the measured value with the fewest decimal places. The final answer should have that same number of decimal places.
- Be sure to state the number of sample replicates. This is likely to vary depending on the test and the data collected.

- Record observations on habitat, recreational suitability, and other characteristics, if that is part of your sampling routine.
- Record field procedures, including calibration and documentation procedures.
- Take extra field sheets, pencils, pencil sharpeners or replacement lead in the field with you.
- Consider purchasing waterproof field paper. It can be used with any laser printer and is tough enough to resist ripping even when wet.

Keep a copy

If data sheets are to be mailed in, keep a copy in case the originals are lost in the mail. Having a reference copy also comes in handy if the program coordinator calls with questions. Be sure to have another person check the numbers before you send them in.

Get ready to head to the field

Now that you have your monitoring plan completed, here are a few additional elements to consider and coordinate:

- Purchasing equipment. See *Appendix D* for a list of equipment vendors.
- Recruiting and organizing volunteers.
- Training. Whenever possible, a practice run is a good idea.
- Procuring a first aid kit and waivers, if used.
- Getting property owner permission.
- Timing for sample analysis. If you collect samples on a Friday or before a holiday, be sure you or your laboratory will be available over the weekend to accept samples and analyze the parameters with short holding times.
- Determining methods for data transfer and management.

There are a lot of things to remember. Using a checklist in addition to the field data collection sheets will help you organize data and ensure you have all your equipment before heading out to the field.

Now that you have finished reading *Section 5*, return to the Worksheet on pages 5-8 to answer the corresponding questions.