

5

Volunteer-Based Wetland Monitoring

Introduction to Monitoring Wetlands

Importance of Wetland Monitoring

The purpose of this chapter is not to recommend a particular purpose or type of monitoring, but rather to discuss reasons for monitoring, things to consider, and to introduce various types of monitoring and related resources in which to obtain further information. Think of this chapter as serving as a “launching pad” to help get you started with wetlands monitoring, saving you valuable time and energy!

“People who monitor wetlands become more intimately knowledgeable about the place in which they live and the ecological processes that influence it” (EPA, 2001, December). Wetland monitoring builds and fosters stewardship among those that participate, by creating more informed and knowledgeable citizens, who can then become stewards and advocates for not only wetlands, but for more sustainable approaches to land and water management overall (EPA, 2001, December).

Government funds alone cannot support all the monitoring needed to assess the quality and quantity of our natural resources. Volunteer monitors across the nation have helped fill this void in part by generating extremely useful data that has been used by state, Federal and local agencies to meet reporting requirements, make management decisions and assess various impacts. For example, chemical and biological water quality data collected by volunteers is used by the DEQ for their biannual water quality assessment report, contributing to the assessment of the status and trends of surface waters within the Commonwealth. (For more information about the Water Quality Assessment Reports, visit the DEQ’s Water Quality Assessment web page at <http://www.deq.virginia.gov/wqa/>).

In addition to assessing existing natural resources, monitoring is essential towards measuring progress towards the intended ecological goals of wetland enhancement, restoration or creation. The Interagency Workgroup on Wetland Restoration commented on the great need for post activity monitoring: “A common misconception about wetland restoration, creation, and enhancement is that once a project is implemented, nature will just do the rest. In reality, many wetland projects need mid-course corrective actions such as re-planting seedlings that were washed away by a storm, digging more channels to get water to remote parts of the site, or plugging ditches missed during the initial site survey. Monitoring provides the information for this adaptive management. Monitoring can also give information on routine maintenance that may be necessary to keep the site functioning well. Broken sprinkler heads, non-native weed growth, and holes in fences are just a few of the routine maintenance items that are easily observed during monitoring” (EPA, n.d.).



Top to Bottom: Alliance volunteer measuring pH from stream sample; Volunteer measuring salinity within estuary; Bottom photos: Virginia Save Our Streams Volunteers at Macroinvertebrate Training (top photo by Davis; others courtesy Alliance)



Why Monitor Wetlands?

There can be many reasons for monitoring wetlands. Some of the most common include:

- Basic wetlands education
- Wetland type identification
- To study wetland plants
- To study wetland animals
- To determine the health of a wetland, or trends in wetland health (improvement or decline)
- To determine the need for wetland protection, such as the presence or absence of rare, threatened or endangered plant or animal species or natural communities
- To determine if a restored, enhanced or created wetland is *successful* in terms of meeting the three basic criteria for a wetland (keeping in mind that for created wetlands, it could be years before hydric soil has developed)
- To determine if the voluntary wetland activity has been *successful* in terms of meeting the intended functions and values

Two Main Categories of Voluntary Wetland Monitoring

For the purposes of this ToolKit, the monitoring methods discussed below are referring to monitoring associated with voluntary wetland activities; monitoring methods associated with compensatory mitigation as a result of a permit must be approved by the regulatory agency issuing the permit.

We have divided wetlands monitoring into two main categories, *Visual-based monitoring* and *Hands-On Monitoring* for ease of discussion and to benefit the many interests and goals of those who want to pursue wetland monitoring. *Visual-based monitoring* refers to observational type monitoring in which samples are not collected whereas *Hands-On Monitoring* refers to more in-depth monitoring in which samples are often collected or measurements are made. *Visual-based monitoring* includes the gathering of the same tools necessary for identifying potential sites for voluntary wetland activities and is the necessary prior to any hands-on type of monitoring. It is recommended that individuals and organizations phase their monitoring project, first performing visual observations prior to any hands-on types monitoring.

Planning Your Monitoring Program

Much like planning your voluntary wetland activity, taking time to plan for wetlands monitoring is important and will depend on your goals, interests, and resources. Before jumping right into monitoring a wetland, you first need to think about what questions you hope to answer and what you want to gain from the monitoring program. The [Virginia Citizen Water Quality Monitoring Program Methods Manual](#), although specific to chemical and biological water quality monitoring

for streams and rivers, contains basic helpful information for planning a volunteer monitoring program that can easily be applied to a wetlands monitoring program. Appendix 10 of the manual contains worksheets intended to help you focus your planning efforts. (See the last part of this chapter for more information about the manual). Questions to ask while planning your monitoring program include:

- **What are your main monitoring goals?** Do you want to educate yourself, your organization, or others? Do you want to protect an existing threatened wetland? Do you want to develop baseline data for a site where no prior information exists in case of potential future development? Do you want to monitor wildlife or plants?
- **What resources, such as time, money, and volunteers are available?**
- **How can your monitoring project be most beneficial to others interested in preserving wetlands?** What data is most needed by local governments or nongovernmental organizations? Are there particular sites that need to be monitored? If so, what type of monitoring do these agencies need?
- **What about access and permission to the wetland site?** Do you also have permission to collect samples, install wells, etc.?

(Firehock et al., 1998)

Your goals will guide your monitoring project plan and monitoring objectives should follow accordingly (Firehock et al., 1998). For example, if your goal is to protect a wetland site that is threatened, one objective may be to perform water quality monitoring upstream and downstream of a wetland in order to establish that the wetland improves water quality and therefore should be protected (Firehock et al., 1998).

Other monitoring considerations

The below questions are examples of considerations when narrowing down the focus of your monitoring plan:

- What seem to be the most important functions and values of the particular wetland to the community?
- What parameters should you monitor in order to learn about these functions and values?
- Will you measure water chemistry, hydrology, wildlife, plants, or a combination of these?
- What are your technical needs? Do you have technical expertise within your organization or can you partner with someone or recruit the volunteers with necessary skills?
- Who will collect data? Volunteers? Students? Volunteers with special skills, such as volunteer birders?
- How will monitoring participants be trained to collect consistent data?
- Who will use your data and how will you report data findings?

(Firehock et al., 1998)

Developing a Quality Assurance Project Plans to ensure Use and Validity of Data

Once you have developed your project plan and have determined the types of monitoring to perform, parameters to monitor, and the like, you should also prepare a Quality Assurance Project Plan (QAPP) in order to add credibility of your project. A QAPP is a written document that explains how your project ensures that the data collected and analyzed meets project requirements (Firehock et al., 1998). **Quality Assurance** refers to an overall quality management system including organization, planning, data collection, documentation, and reporting. **Quality Control** refers to steps that you will take to assure the quality of the data for error control (Firehock et al., 1998). A QAPP documents the quality of your data and lends itself to increased use by others due to this documentation.

Getting to Know Your Wetland: Visual-Based Wetland Monitoring

"To see a wren in a bush, call it "wren," and go on walking is to have (self-importantly) seen nothing. To see a bird and stop, watch, feel, forget yourself for a moment, be in the bushy shadows, maybe then feel "wren"—that is to have joined in a larger moment with the word."~ Gary Snyder, Language Goes Two Ways, 1995.

Getting acquainted with your wetland is a critical first step prior to any voluntary wetland activity such as enhancement or restoration as well as prior to any type of hands-on monitoring. After all, how can you determine what parameters you might want to measure if you don't first know some basic information about your site? Visual-based monitoring is oftentimes all that many individuals and groups perform, due to time and other constraints. This type of monitoring can still be extremely valuable, leading to activities such as wetlands preservation.

Gathering Background Site Information

As many informational tools (introduced and discussed in Section Four, *Informational Tools*) as possible should be gathered and reviewed as background information for your site prior to ever stepping foot on the property. These tools include topographic maps, NWI maps, soil surveys, aerial photographs, additional information obtained through GIS, if possible as well as tools such as tax maps, and information concerning the presence of cultural resources and rare, threatened or endangered species. This information should be well organized so it can be easily accessed and understood by other members of your organization and the interested community (Firehock et al., 1998).

Once you have gathered and reviewed these tools, you can already begin to learn a lot of useful information about your site that can then be confirmed in the field through site visits. This information includes:

- **Studying the wetland location relative to its watershed**
– By using your topographic map, you can determine the drainage area that drains into your wetland site as well as what larger watershed your wetland is a part of. Confirm your mapped observations by walking the area and comparing it to the actual landscape.

Where to go for more help with developing a Monitoring Plan and a QAPP

- The *Virginia Citizen Water Quality Monitoring Program Methods Manual* contains information on developing a quality assurance project plan and contains QAPP template:
<http://www.deq.virginia.gov/cmonitor/guidance.html>
- The *Volunteer Monitor's Guide to Quality Assurance Project Plans*, developed by EPA, is available at <http://www.epa.gov/owow/monitoring/volunteer/qappcovr.htm>.

Safety Tips To Protect You and The Wetland

Safety First! – Safety is an important element of any volunteer monitoring program. Monitors should never put themselves at risk to perform wetlands monitoring. No data is more important than safety!

- Always obtain permission from the landowner (whether private or public) to enter and monitor a wetland site.
- Dress properly for the weather. Don't forget to wear blaze orange during hunting season!
- Sample in teams or with partners.
- Inform someone where you are going and when you plan to return.
- If you drive to the monitoring site, park in a safe location
- Watch out for poisonous plants and wildlife. Dress appropriately for protection against ticks.
- Minimize impact to the wetland you are monitoring – This can mean limiting the number of people, choosing a single entrance path, or sometimes not even entering a wetland at all. Some wetlands may be so ecologically fragile that they should only be monitored by knowledgeable scientists.
- Clean equipment, including boots after each monitoring visit to avoid transporting plant seeds and introducing them to other places.
- Collection of plant and animal samples – Make sure to follow regulations concerning the collection of plants and animals. Many parks and wildlife refuges have additional rules and regulations regarding the collection of plants or animals. Always make sure that the plant or animal you are collecting is not a rare, threatened or endangered species. For more information about wildlife procession (including nests, feathers, etc.):
<http://www.dgif.virginia.gov/wildlife/scp.html>.

Adapted from *Volunteer Wetland Monitoring, An Introduction and Resource Guide* (EPA, 2001), the *Chesapeake Bay Citizen Monitoring Manual* (Alliance for the Chesapeake Bay [Alliance], 2002) and the *Virginia Citizen Water Quality Monitoring Program Methods Manual* (DEQ, 2003).

- **Determining the size and type of wetland** – By using the NWI map as well as other tools, you can determine the size and type of your wetland and then confirm it in the field.
- **Studying Hydrology** – Several of your tools, including your topographic map and your NWI map, provide information about sources and types of water inputs or outputs related to your wetland, such as streams or springs. You can then visit the site to look for field observations of hydrology. Signs of wetland hydrology include drainage patterns and watermarks on trees (See Section One, *What Makes it a Wetland?* for more information about field indicators of wetland hydrology.)
- **Studying Types of Vegetation** – Your NWI map as well as aerial photographs should give you a clue prior to your site visit as the major dominant types of vegetation your site may contain. Site visits are necessary to confirm and to study vegetation in greater detail.
- **Wildlife Habitat Observations** – Background information gathered from resources including DGIF’s Virginia Fish and Wildlife Information Service and Virginia Natural Heritage Program’s Online information of Virginia’s natural communities, rare, threatened and endangered species will provide information as to the likelihood of wildlife on and around your site. Site visits can help to confirm the potential presence of wildlife. Although you will not set up monitoring stations for wildlife or collect samples of signs of wildlife (such as feathers, nests or bones), as a part of visual-based monitoring you can still observe for potential habitat and also note any wildlife sightings at the time of your visits. Sightings include animals actually observed or heard as well as signs such as animal tracks, feathers, fur, scat and nests.
- **Studying Human Impacts to the Wetland Site** – Human land uses within a watershed affect the health and functionality of a wetland. Wildlife within a wetland can also be affected by disturbances such as roads or populated places. Therefore, it is important to study and document human impacts, including the presence of existing land uses as well as changes observed with future monitoring visits such as vegetation clearing, dumping, land disturbance and off-road vehicle damage. Topographic maps and aerial photographs provide some information about land use. Additionally, local state and Federal government agencies also have general land use data, much of which is becoming available in digital format. However, the most detailed and current land use information will be gathered by your on site monitoring. Be sure not to trespass on private property when studying land uses in the vicinity of your site. Much information can be gathered simply by driving around the area.

(Adapted from Firehock et al., 1998).

Other types of Visual-Based Monitoring

- **Establishing a Photographic Record** – Photographs are an easy way to record site conditions and to visually document change at the site. For photographs to be useful over time, it is important to take photographs at the same location and direction.

- **Journals for recording observations** – Journals are invaluable for recording observations and impressions of wetlands. After all, most of what we know about the natural world prior to the early 1800s is based on information obtained largely from journals. Think of the notebooks by Charles Darwin or the journals of Lewis and Clark and how much less we would know about our natural history without these documents. Journals can be strictly narrative, such as diaries, or can include sketches, photographs, or even sound recordings. Keeping a nature journal forces you to be more observant about your surroundings. It is a good idea to make journal entries with each visit to your wetland. “Day to day, season to season, year to year, you will begin to amass a collection of observations and important information about the area” (Thomson & Luthin, 2004). **Keeping a nature journal can be highly satisfying for volunteers**, many of which are drawn to volunteer monitoring due to their naturalist tendencies, whether or not they have been self-realized.

*“What I have not drawn, I have never really seen”
~Fredereic Franck, The Zen of Seeing*

Hands-On Wetland Monitoring

Once you or your organization has gathered background information and performed some visual-based monitoring, you may become more interested and prepared to begin *hands-on monitoring*, in which samples are often collected or measurements are made.

How to Measure and Sample Wetlands?

OK, so now you’re ready to go out into your wetland and start taking some measurements, right? How and what exactly should you measure?

Well, there’s not a straight answer because there is no one “correct way” to monitor wetlands. This can be a confusing and daunting realization for volunteers and professionals alike. As wetlands are the interface between land and water, compounded by their variability, deciding how and what to monitor can be daunting. Additionally, because wetlands often contain such a variety of biological conditions, typical water monitoring parameters such as pH, dissolved oxygen or temperature give a limited picture of the overall health of the wetlands. It is therefore often necessary to also study wetland plants and animals to order to obtain a better picture of how healthy the wetland is and how it is functioning (EPA, December 2001).

Types of Hands-On Wetland Monitoring

In general, wetland monitoring methods can be categorized into four broad types: (1) functional assessments, (2) habitat assessments, (3) wetland inventories and characterization, and (4) biological assessments (Danielson, 1998).

Functional assessments

For volunteers that measure water quality along streams and rivers, the idea of a “functional assessment” may seem new and unfamiliar. Instead of measuring water chemistry or macroinvertebrates, functional assessments attempt to estimate

the ability of a wetland to perform different “functions,” such as surface water storage, water filtration, and serving as habitat for plants and animals (Danielson, 1998).

Habitat assessments

“Habitat assessment methods are based on the assumption that if the habitat is there, then the animals will be there”(Danielson, 1998). A well-known method is the *Habitat Evaluation Procedure* (HEP), developed by the FWS to answer questions such as “Is this site potentially good habitat for ducks?” (or any particular wildlife of interest). Using the HEP method, biologists visit a wetland and judge its ability to support the species in question (Danielson, 1998).

Wetland inventories and characterization

Wetland inventories and characterization are the most common types of wetland monitoring among volunteer monitoring groups. Some monitoring projects inventory just one or a few types of plants or animals. For example, volunteers with the Bird Studies Canada/Long Point Bird Observatory Marsh Monitoring Program monitor birds and amphibians (Danielson, 1998).

Biological assessments

“In a biological assessment, investigators evaluate the condition of one or more biological “assemblages” (examples of assemblages are macroinvertebrates, plants, or fish). Since plant and animal assemblages reflect the cumulative effects of chemical, physical, and biological disturbances to a habitat, scientists can use them much the same way as a doctor would use a thermometer, blood pressure gauge, and other instruments in a physical exam” (Danielson, 1998).

This is different than simply inventorying types of plants or animals, as described in the previous section. Instead, by evaluating the composition, diversity, and condition of plant or animal assemblages, wetland scientists are then able to determine the overall “health” of a wetland (Danielson, 1998).

A **bioassessment** is a relatively new term used to describe a way of performing a more rapid biological assessment rather than a comprehensive assessment (Danielson, 1998). Wetland bioassessment methods are based on a combination of surveys of the different types of plants and animals within a wetland, often including the collection of some physical and chemical data. EPA, December 2001). For more information on wetland bioassessment, visit the EPA’s Biological Assessment of Wetlands web page: <http://www.epa.gov/owow/wetlands/bawwg/>.

Wetland Parameters for Hands-On Monitoring

The below information introduces various wetland “parameters” that may be measured as part of one of the four main monitoring types discussed above. Remember to revisit your monitoring goals and objectives in order to focus your monitoring so that it will be most valuable to you and other intended users of your data. As a volunteer program, it is a good idea to start slowly with a narrowed down list of monitoring parameters.

- **Vegetation** – Plants are good indicators of wetland health and stability because they are restricted to one location for their entire lifetime. Some plants are more tolerant of human-induced stressors than others and can serve as indications of disturbance, whereas the presence of mainly less tolerant plants may indicate a healthier ecosystem (Firehock et al., 1998). Vegetation sampling is a common monitoring activity after an enhancement, restoration or creation activity has occurred in order to determine plant survival and vigor. Terrestrial vegetation sampling can include monitoring dominant vegetation types as well as the amount of invasive plants. In subaqueous wetlands, algae and submerged aquatic vegetation can be measured. There are many methods for sampling vegetation. Common methods include measuring plant species and percent cover using sample plots along either transects or within each vegetation community. Plot types and sampling methods vary based on the dominant vegetation type and specific goals and objectives.
- **Soil Investigation** – Soils often received the least attention by volunteer monitors. Soils can be measured for signs of wetland hydrology, for texture or color.
- **Hydrology** – the duration, timing and frequency of water inputs as well as outputs are critical to wetland health. Water fluctuations can be measured in wetlands, including groundwater and surface water levels as well as stream flow, precipitation and tides. Examples of ways hydrology can be measured include:
 - Surface water levels (inundation) – staff gauge installation and monitoring
 - Ground water levels (saturation) – **Piezometer** installation and monitoring
 - Stream flow – **Stream flow**, also referred to as discharge, is the volume of water that moves over a point for a period of time. Stream flow is directly related to the amount of water moving off a watershed into a stream channel. Stream flow may be measured using a flowmeter or by measuring crosssectional area and measuring stream velocity.
- **Water Chemistry** – can include collecting water samples and measuring water chemistry parameters such as dissolved oxygen, pH, water temperature and salinity.
- **Wildlife** – Volunteers who monitor wetlands often focus on living things, in part because they are so tangible and appealing. “If a citizen group wants to raise community awareness of wetlands, they’ll do better to talk about songbirds and frogs than groundwater recharge and water storage capacity (as quoted by John Kusler in Danielson, 1998). Types and methods of wildlife monitoring include:
 - Birds – visual sightings, bird calls
 - Amphibians and Reptiles –visual surveys including terrestrial, trapping and egg masses as well as frog call surveys
 - Macroinvertebrate surveys – typically performed at least annually, possibly four times a year. Survey methods will

differ depending on the habitat type and variability.

- Fish – seining and shocking
- Mammals – more scientific surveys than simply incidental observations, best performed within seasonally, at different times of the day and within each habitat type.

Monitoring Resources for Visual and Hands-On Wetland Monitoring

The Monitoring Resources listed and described below contain information on methods that are appropriate for volunteers for many types of visual-based and hands-on wetlands monitoring. Each resource varies in terms of its focus, rigor, objectives and often the geographic setting (EPA, 2001, December). Remember, you will probably still need to write your own protocols and QAPP, using these resources as a reference. This is not a comprehensive list but rather a list of resources to help get you started in your monitoring journey.

Please note: Contact and pricing information were current as of October 2005. Websites and pricing may change after than time — we are providing these listings as a source of information only.



Davis

Alliance volunteer measuring water clarity with a turbidity tube

General Wetland Monitoring Resources

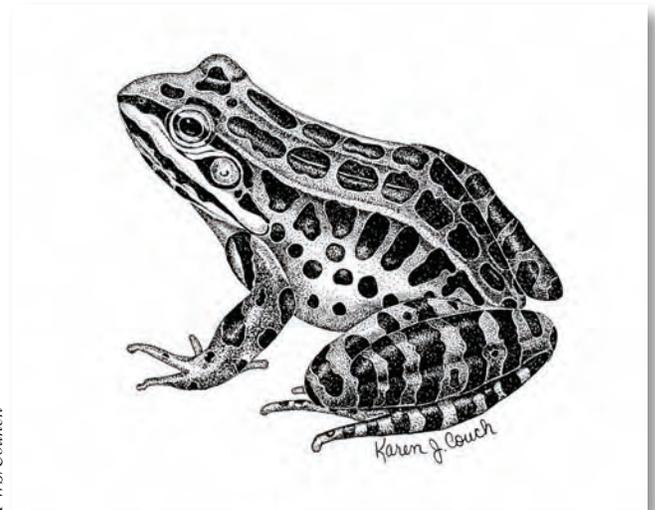
- *An Introduction and User's Guide to Wetland Restoration, Creation, and Enhancement.* Developed by the Interagency Workgroup on Wetland Restoration (EPA, Corps, FWS, NRCS, National Oceanic and Atmospheric Administration). This document is designed specifically for individuals, community groups, municipalities, or others who have little or no experience in the restoration field. Chapter 6 contains monitoring information. Available for download at: <http://www.epa.gov/owow/wetlands/pdf/restdocfinal.pdf>
- *Handbook for Wetlands Conservation and Sustainability.* 1998 (Second Edition). Firehock, K., Graff, L., Middleton, J.V., Starinchak, K.D. & Williams, C. The Izaak Walton League of America (IWLA). 288 pp. Softcover. The handbook is an excellent resource for wetland education, citizen action and monitoring. Contains protocols and resources for establishing monitoring transects and for the monitoring of vegetation, soil, and surface and groundwater hydrology (including chemical water quality). The manual also contains protocols and resources for wildlife monitoring including amphibians, birds, fish, macroinvertebrates, and mammals. Methods are very easy to understand and the manual contains many datasheets for reproduction. For a table of contents of this manual go to: <http://www.iwla.org/SOS/handbook/index.htm>. The manual is available for purchase from the McDonald and Woodward Publishing Company at www.mwpubco.com or 1-800-233-8787 \$39.95 (0941675 05-X)
- *Maine Citizens Guide, to Evaluating, Restoring, and Managing Tidal Marshes.* 1997. Bryan, R., M. Dionne, R. Cook, J. Jones, and A. Goodspeed Maine Audubon Society, Falmouth, Maine. 87 pages plus appendices. This guide contains methods for assessing salt marshes for their overall ecological health as well as for functions and values. The document is geared toward collecting observational data that can be used to guide local planning efforts. Although the manual is quite technical and detailed, it is very methodical and includes clear definitions and explanations. Although the orientation of the manual is for tidal wetlands in Maine, much is applicable elsewhere. To obtain electronic copies (hardcopies are no longer available): contact the Maine Audubon Society, P.O. Box 6009, Falmouth, ME 04105-6009; Contact Becca Wilson 207-781-6180 ext. 222 or via email: bwilson@maineaudubon.org
- *A Manual for Salt Marsh Evaluation: Narragansett Bay Method.* 1996. Lipsky, A. Save the Bay, Providence, RI. 22 pages. This manual is based on the New Hampshire Coastal Method and outlines a visual-based evaluation of salt marshes and adjacent uplands. The manual is short and informal (photocopied), and was designed for use by Rhode Island volunteers to help gauge the restoration potential of altered and degraded salt marshes in Narragansett Bay. Although the orientation of the manual is for tidal wetlands in Rhode Island, much is applicable elsewhere. Contact Save the Bay, 434 Smith St., Providence, RI 02908-3770, Tel. (401) 272-3540. Available online: <http://www.savebay.org/Habitat/SaltMarsh/NarragansettMethod.asp>

- *A Volunteer's Handbook for Monitoring New England Salt Marshes* (2002, May). Carlisle, B.K., Donovan, A.M., Hicks, A.L., Kooken, V.S., Smith, J.P. & Wilbur, A.R.. Massachusetts Office of Coastal Zone Management. Contains discussion of developing a monitoring plan and includes methods for monitoring vegetation, tidal hydrology, salinity, birds, fish, crabs and other invertebrates. The Handbook contains easy to understand instructions, data forms and nice illustrations. Available online: <http://www.mass.gov/czm/volunteermarshmonitoring.htm>
- *The Volunteer Monitor Newsletter*, a forum for citizen volunteer monitors of all types, not limited to wetland monitors. The document is issued twice yearly and electronic copies may be downloaded at: <http://www.epa.gov/owow/monitoring/volunteer/info.html>
 - *Monitoring Wetlands* The Volunteer Monitor, Vol. 10, No. 1, spring 1998. This issue is devoted entirely to volunteer wetlands monitoring and discusses common types appropriate for volunteers. The issue also discusses biological wetland assessment. <http://www.epa.gov/owow/monitoring/volunteer/newsletter/volmon10no1.pdf>
- *Volunteer Wetland Monitoring, An Introduction and Resource Guide*. EPA. December 2001. EPA 843-B-00-001. U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Wetlands Division, Washington DC. To order, call the EPA Wetlands Helpline at 1-800-832-7828 or email wetlands.helpline@epa.gov. Also available for download at: <http://www.epa.gov/owow/wetlands/monitor/volmonitor.pdf>
- *Wetland Bioassessment Fact Sheets*. Danielson, T.J. EPA. July 1998. EPA 843-F-98-001. U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Wetlands Division, Washington DC. 11 fact sheets developed based on recent efforts to measure the biological condition of wetlands. Available for download at: http://www.epa.gov/owow/wetlands/wqual/bio_fact/
- *Wetland Restoration Handbook for Wisconsin Landowners 2nd Edition*. Thomson, A.L. & Luthin, C.S. (2004). Madison, WI: Bureau of Integrated Science Services, Wisconsin Department of Natural Resources. Available for download: <http://www.dnr.state.wi.us/org/water/fhp/wetlands/resman.shtml> (Publication #SS-989 2004). This manual is intended primarily for private landowners and encourages responsible and effective wetland restoration. The manual contains nice graphics, colorful quotes and interesting side-bars. Chapter 2 contains information on visual-based monitoring, including journaling. Chapter 11 contains information on monitoring after restoration
- *Wetland Walk Manual: Guidebook for Citizen Participation*. 1996. EPA. Seattle: Office of Water. This 15 page manual with data forms provide instructions for citizens to easily determine the wetland type, observe human impacts to the wetland, observe signs of degradation in the wetland, and describe vegetative communities. Available for download at: <http://www.epa.gov/owow/wetlands/pdf/wetwalk.pdf>
- *WOW!: The Wonders of Wetlands, an Educator's Guide*. Environmental Concern. Kesselheim, A.S. & Slattery, B.E. (1995). An interdisciplinary curriculum guide for K-12 educators of grade levels focused on the three definitive wetland parameters: water, soil, and plants; there are wildlife-oriented exercises as well. Although geared for educators, much of the information is useful for volunteer wetland monitors. For more information, contact Environmental Concern Inc., <http://www.wetland.org/> P.O. Box P, St. Michaels, MD 21663-0480, Tel. (410) 745-9620

Nature Journaling

- *Keeping a Nature Journal: Discover a Whole New Way of Seeing the World Around You* C. W. Leslie & C. E. Roth (2000) North Adams, Massachusetts, Storey Books

Amphibian Monitoring

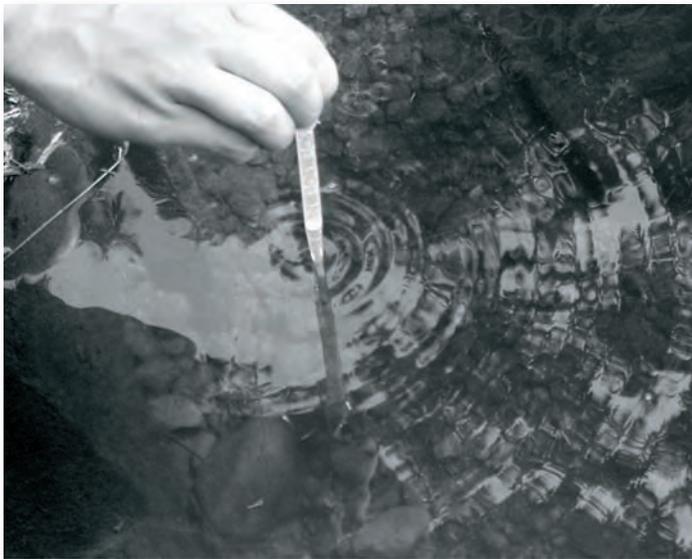


- *Frogwatch USA* is a volunteer frog and toad-monitoring program managed by the National Wildlife Federation (NWF) in partnership with the U.S. Geological Survey (USGS). Frogwatch USA volunteers monitor populations of vocal amphibians. The Frogwatch USA website contains all the basic information necessary to learn how and when to monitor, pick an appropriate monitoring site and enter results online. Although monitoring is recommended every two weeks throughout the breeding season, volunteers may participate on a less frequent basis. The Frogwatch USA program is set up mainly for individual participation but can easily be modified for organizations to participate. <http://www.nwf.org/frogwatchUSA/>
- *North American Amphibian Monitoring Program (NAAMP)* is a collaborative effort among regional partners, such as state natural resource agencies and nonprofit organizations, and the (USGS) to monitor populations of vocal amphibians. This is a "professional-grade" volunteer program with many data quality control procedures built into the monitoring protocols. After volunteers have collected sufficient data, it will be used to determine long-term amphibian population trends occurring across the nation. Recommended for volunteers

who can commit to a long-term program and adhere to a strict monitoring schedule within the established monitoring time periods. For more information on NAAMP: <http://www.pwrc.usgs.gov/naamp/>. The Wildlife Diversity Division of the DGIF coordinates the NAAMP program in Virginia. If you're interested in becoming a Virginia Frog and Toad Surveyor: http://www.dgif.state.va.us/wildlife/frog_call_survey.html

- *NAAMP frog call quiz* – Online Frog Quizzes and Frog Call information available for the general public, trained NAAMP volunteers, Frogwatch USA volunteers and Professionals: <http://www.pwrc.usgs.gov/Frogquiz/>.
- *Virginia Frogs and Toads* – The Virginia Herpetological Society website contains an up-to-date listing of all of the Virginia frog and toad species, distribution maps and sound clips of their mating calls: http://fwie.fw.vt.edu/VHS/frogs_and_toads_of_virginia.htm

General Water Monitoring



Alliance

- *Chesapeake Bay Citizen Monitoring Manual*. Alliance for the Chesapeake Bay. (October, 2002). Basic chemical water quality monitoring manual geared for volunteers Available for download from the World Wide Web: <http://www.acb-online.org/pubs/projects/deliverables-206-1-2003.PDF> The Alliance coordinates a citizen monitoring chemical water quality program for Virginia citizens within the Chesapeake Bay watershed. For more information, contact the Alliance's Virginia office: phone: 804-775-0951, P.O. Box 1981, Richmond, VA 23218 <http://www.acb-online.org/project.cfm?vid=87>

- *The Monitor's Handbook*. Campbell and Wildberger. LaMotte Co. Provides the background necessary for volunteers to understand water quality monitoring purposes and procedures. Describes the physical, chemical and biological factors in water quality, analytical procedures, and the elements of a successful monitoring program. Contains a glossary of terms, conversions, and additional resources. Available for purchase from the LaMotte Co., P.O. Box 329, Chestertown, Md. 21620; or call (800) 344-3100. Reference No.1507. (\$12.95) <http://www.lamotte.com/pages/edu/monitor.html>
- *Volunteer Estuary Monitoring: A Methods Manual, Second Edition*. Ohrel, R.L., Jr. and K.L. Register. The Ocean Conservancy and U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds. This manual presents information and methodologies for estuarine water quality while stressing proper quality assurance and quality control techniques to ensure that data are useful to state agencies and other data users: <http://www.epa.gov/owow/estuaries/monitor/>
- *The Volunteer Monitor's Guide to Quality Assurance Project Plans*. EPA. 1996. EPA Office of Wetlands, Oceans, and Watersheds (4503F), Washington, DC 20460. EPA 841-B-96-003: <http://www.epa.gov/owow/monitoring/volunteer/qappcovr.htm>

Macroinvertebrate Monitoring

- *Guide to Common Freshwater Invertebrates of North America*. Voshell, J. R., Jr. 2002. Available for purchase from the McDonald and Woodward Publishing Company at www.mwpubco.com or 1-800-233-8787 Softcover \$32.95 (0-939923-87-4).
- *New England Freshwater Wetlands Invertebrate Biomonitoring Protocol: A Manual for Volunteers, 2nd Edition*. Hicks, A.L and Nedeau, E.J. Includes many illustrations of representative wetland invertebrates, and user-friendly field sheets and data forms. Designed for wetland scientists, environmental consultants, watershed associations, and volunteer monitoring groups. To order online: http://www.umassextension.org/Merchant2/merchant.mv?Screen=PROD&Product_Code=NC-WIBP&Category_Code=WETL&Product_Count=0 (\$25)
- *Virginia Save Our Streams (VASOS)* is a nonprofit organization that trains and certifies volunteers to perform macroinvertebrate monitoring throughout Virginia. Although VASOS monitoring protocols have been developed for use in flowing streams, not wetlands, the website contains basic information on freshwater macroinvertebrates that may be found in wetlands. Website: <http://www.sosva.com/index.htm>. To contact VA SOS: phone: 804-615-5036 or toll free at 888-656-6664, P.O. Box 8297, Richmond, VA 23226