VII. Appendices

1. Feedback
2. Contacts and Resources
3. Utah Science Core Curriculum Matrix
4. A Note to Volunteers
5. Sampling Directions and Data Sheets (Masters)
6. Overhead Masters
7. Funding Your Monitoring Program
8. Purchasing Supplies
9. Making Your Own Monitoring Equipment
10. Monitoring in the Classroom
11. Conversion Charts
12. Glossary
13. Index

Appendix 1. Feedback

Utah Stream Team Evaluation Form

Thank you for participating in the Utah Stream Team Program. We hope that you and your participants benefited from the activities, and that the program was a success. To help us better maintain and update the Utah Stream Team Manual, please complete the following evaluation form.

Have you used the Utah Stream Team Manual before?

What size group did you have?

How often do you use the program?

During which season did you use the program?

Which stream or which type of waterway (i.e. river, lake, pond, etc.)?

Do you plan to use the Utah Stream Team Program again? Why or why not?

Please rate the following from 1 to 10, 1 being the lowest, and 10 being the highest.

Organization of the Manual	1 2 3 4 5 6 7 8 9 10
Ease of obtaining materials	1 2 3 4 5 6 7 8 9 10
Completeness and accuracy of information	1 2 3 4 5 6 7 8 9 10
Ease of bringing community issues into the program	1 2 3 4 5 6 7 8 9 10
Connections to Core Curriculum	1 2 3 4 5 6 7 8 9 10
Ease of implementing program	1 2 3 4 5 6 7 8 9 10
Overall rating of the Utah Stream Team	1 2 3 4 5 6 7 8 9 10

1. Do you feel that the Utah Stream Team Program was beneficial for the participants? Was the manual appropriate to your group's ages and abilities?

2. Was the Utah Stream Team Manual easy to use, identifying enough resources and activities for your program?

3. Using the Utah Stream Team Manual, do you feel comfortable facilitating a water quality investigation with your students or group?

4. Is there anything that you would like to see expanded upon in the manual, or is there anything that you feel was not useful in the manual?

5. Any other comments you may have regarding the Utah Stream Team Program.

Please return to Nancy Mesner, Department of Geography and Earth Resources, Utah State University, Logan, UT 84322-5240 or fax to (435) 797-4048 or email comments to nancym@ext.usu.edu.

Appendix 2. Contacts and Resources

Resources

Monitoring Publications

Adopt-A-Watershed – Adopt-A-Watershed supports student monitoring through an impressive k-12 continuum of 15 sequential curriculum units covering all elements of watersheds (wildlife, water geology, etc.). Among the curriculum units are: The Streamside Community for primary grades, focusing on interdependence in natural systems, a study of amphibians, a streambank restoration project and a community display. Another is Wildlife, a 16-lesson middle school unit that focuses on the concept of natural selection, and involves various population studies leading towards a wildlife enhancement project. Both units are multi-disciplinary, comprehensive and very teacher-friendly. Contact: Adopt-A-Watershed, PO Box 1850, Hayfork CA 96041, (530) 628 5334, www.tcoe.trinity.k12.ca.us/aaw

Educating Young People About Water - Three guides developed by the U.S Dept. of Agriculture Cooperative State Research and Extension Service: A Guide to Program Planning and Evaluation walks program planners through the steps in setting up and evaluating a youth water education program- bringing together the key components that can lead to an effective, sustainable program; A Guide to Unique Program Strategies tells the story of 37 program coordinators from around the country. Discover how they integrate community water education issues and youth development needs into unique program designs; A Guide to Goals and Resources, 2nd ed., provides the program coordinator with 100 water education curricula summaries, environmental education topics and goals, and multimedia resources. Contact: http://www.uwex.edu/erc/ywc/

Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools (6th edition) by Mitchell, Mark and William Stapp, 1992. The basic text used by Project GREEN programs worldwide. Instructions for eight chemical and physical water quality tests plus fecal coliforms and macroinvertebrates; also chapters on heavy metals testing, cross-cultural partnerships, and computer networking. Contact: William Stapp, 2050 Delaware, Ann Arbor, MI 48103. Spanish edition (titled Manual de Campo del Proyecto del Rio) also available for $9 from Project GREEN, 216 S. State St., Ste. 4, Ann Arbor, MI 48104; 313-761-8142.

A Guide to Goals and Resources – This guide provides summary descriptions of about 120 water education curricula. The web site is searchable by grade level or by topic, and each entry also includes information about how to obtain the materials. A less up-to-date printed version, containing 100 entries, is also available for $5. Contact: 800-276-0462 and ask for, 2nd ed www.uwex.edu/erc/ywc/.

Monitor's Guide to Aquatic Macroinvertebrates by Kellogg, L.L. 1994. 60 pages. A pocket-sized guide including a key (with some important fly families), descriptions of major invertebrate groups, sampling protocols for both rocky bottoms and muddy bottoms, and sample data sheets. Excellent illustrations. Contact: Save Our Streams, Izaak Walton League of America, 707 Conservation Lane, Gaithersburg, MD 20878; 800-BUG-IWLA. $5.

Sourcebook for Watershed Education – Provides detailed guidelines for the development of watershed-wide education programs, focusing on program goals, funding and school-community partnerships. It contains a rich set of interdisciplinary classroom activities and outlines GREEN's education philosophy. Contact: GREEN, 721 E. Huron Street, Ann Arbor, MI, 48104, 313-761-4951, web: www.igc.apc.org/green

Streamkeepers Field Guide: Watershed Inventory and Stream Monitoring Methods by Tom Murdoch, Martha Cheo, and Kate O'Laughlin (2nd Edition). Section on understanding watersheds, conducting field inventories, water quality monitoring programs, keys to plant and animal life, methods of analyzing and presenting your data and how to effect changes in attitude and policy. Manual is adaptable for use by students ages 12-adult. Companion video also available. Contact: Adopt-A-Stream Foundation, 600-128th St SE, Everett, WA 98208, 425-316-8592; www.streamkeepers.org

The Volunteer Monitor - The National Newsletter of Volunteer Water Quality Monitoring
The Volunteer Monitor newsletter facilitates the exchange of ideas, monitoring methods, and practical advice among volunteer environmental monitoring groups (including school groups) across the nation. You can obtain this free biannual publication by mail or via the EPA's web site. Contact: Elanor Ely, Editor, 1318 Masonic Avenue, San Francisco, CA, 94117; 415-255-8409. www.epa.gov/OWOW/volunteer/vm_index.html

The Volunteer Monitor's Guide to: Quality Assurance Project Plan (QAPP) – The QAPP is a document that outlines monitoring procedures for those who want to ensure that the data they collect and analyze meets EPA requirements. It is an invaluable planning and operating tool that outlines the project's methods of data collection, storage and analysis. It serves not only to convince skeptical data users about the quality of the project's findings, but also to record methods, goals and project implementation steps for current and future volunteers and for those who may wish to use the project's data over time. Contact: Alice Mayio at USEPA (4503F), 401 M St. SW, Washington, DC 20460; 202/260-7018; mayio.alice@epamail.epa.gov. www.wa.gov/ecology/wq/wow/wdw/monlevel.html

Volunteer Stream Monitoring: A Methods Manual - This 210-page manual is the third in a series of methods manuals published by Environmental Protection Agency (the first and second covered lakes and estuaries). It takes the reader through an introduction to streams and discussion of watershed survey methods, then proceeds to offer in-depth, step-by-step approaches to monitoring macroinvertebrates, habitat, water quality, and physical conditions. The manual concludes with a chapter on managing and presenting data. Several volunteer monitoring programs assisted EPA in developing this manual by sharing their protocols and expertise.
For a free copy of the manual, contact Alice Mayio at USEPA (4503F), 401 M St. SW, Washington, DC 20460; 202-260-7018; mayio.alice@epamail.epa.gov. Also available on the web: www.epa.gov/owow/monitoring/vol.html.

Monitoring Programs

Adopt-A-Stream Foundation – The mission of Adopt-A-Stream Foundation is: "To teach people to become stewards of their watersheds." They achieve their mission through two focus areas: Environmental Education and Habitat Restoration. The long term goal of AASF is to ensure the protection and care of every stream by encouraging schools, community groups, sports clubs, civic organizations and individuals to adopt their streams, and to become Streamkeepers. The Foundation publishes the Streamkeepers manual (see the "Curriculum" section), offers other educational materials and opportunities, and technical support. Contact: The Adopt-A-Stream Foundation at the Northwest Stream Center, 600-128th Street SE Everett, WA 98208-6353 425-316-8592; Fax: 425-338-1423; E-mail: aasf@streamkeeper.org; www.streamkeepers.org

The Global Rivers Environmental Network (GREEN) – GREEN is affiliated with the School of Natural Resources and Environment at the University of Michigan in Ann Arbor. GREEN is an international network of active schools and communities in over 50 nations and every state in the United States. The Central Office is also a clearinghouse of teaching and monitoring strategies to study water quality. GREEN provides materials and ideas for people interested in evaluating and improving local water quality through hands-on monitoring and problem-solving. Contact: GREEN, 721 E. Huron Street, Ann Arbor, MI, 48104, 313-761-4951, web: www.igc.apc.org/green>

Nature Mapping Program – The goal of Nature Mapping is to help students and communities create a biodiversity report card on which to base future land use decisions in their area. Volunteers help wildlife biologists amass reliable information about habitats, wildlife and invasive species. In support, Nature Mapping provides monitoring guidelines at their web site (currently for wildlife and water, with more modules to come), data entry software, teacher-training workshops, a video, posters, a field kit, preparatory activities for middle school classes, and final report cards. Contact: The Nature Mapping Program, University of Washington, Washington Cooperative Fish and Wildlife Research Unit, School of Fisheries, Box 357980, Seattle WA 98195-7980, 206-543-6475, http://salmo.cqs.washington.edu/~wagap/nm

Project GLOBE – Global Learning and Observations to Benefit the Environment (GLOBE) is an international hands-on environmental science and education program that uses scientific instruments and state-of-the-art technology to make science relevant to K-12 students. The water quality section, one of the many monitoring opportunities, offers lots of background information and classroom and field testing directions. Globe will store and graph data for each class. Students can share their data on the web site with schools from around the world and ask scientists for help interpreting the significance of their data. Contact: **www.globe.gov/**

The River Watch Network – The multi-faceted River Watch Network provides middle/high schools and community groups with an array of water monitoring services designed to yield high quality data and effective community partnerships. They help many groups develop their own programs; provide workshops for teachers, including a week-long summer institute; and help organize student workshops such as Clean Water Congresses. Among the Network's publications are *Testing the Waters: Chemical and Physical Vital Signs of a River* (211 pp., $25) and *Benthic Macroinvertebrate Monitoring Manual* (200 pp., $25). For those establishing monitoring programs, there is a *Program Organizing Guide* (24 pp., $10) and a *Study Design Workbook* (39 pp., $10). Contact: Education Coordinator, River Watch Network, 153 State St., Montpelier, VT 05602, 802-223-3840, http://www.riverwatch.org

Monitoring Supplies

Acorn Naturalists – Acorn Naturalists is a clearinghouse for environmental education resources, including material specific to water quality monitoring. In their catalog, published yearly, you will find descriptions and ordering information for books, puzzles, field guides, monitoring equipment, field investigation tools and much more. Contact: 800-422-8886; www.acornnaturalists.com

Chemetrics - Chemeterics offers a wide variety of water quality monitoring test kits, supplies and replacement materials. Customer service and educational materials support volunteer monitors. Contact: Chemetrics, Rt 28, Calverton, VA 20138; 800-356 3072; fax 504-788-4856; email: prodinfo@chemetrics.com; web: http://www.chemetrics.com

Hach Company – Hach offers a wide variety of water quality monitoring test kits, supplies and replacement materials. Customer service and educational materials support volunteer monitors. Contact: Hach Co., PO Box 389, Loveland, CO, 80539; 800-227-4224; www.hach.com

LaMotte Company – LaMotte offers a wide variety of water quality monitoring test kits, supplies and replacement materials. Customer service and educational materials support volunteer monitors. Contact: LaMotte Company, P.O. Box 329, 802 Washington Ave., Chestertown, Maryland, 21620 800-344-3100; fax 410-778-6394; www.lamotte.com

Nasco Science – Nasco offers a wide variety of water quality monitoring test kits, supplies and replacement materials. You will also find other science supplies and equipment. Contact: Nasco Science, 4825 Stoddard Rd, Modesto, CA 95356-9316; 800-558-9595; fax 209-545-1669; email: info@nascofa.com; web: http://www.nascofa.com

Water Quality Sampling Equipment and Homemade Sampling Equipment by theTennessee Valley Authority, 1988. Two 16-page booklets, designed to be used as a set. The first describes professional sampling equipment and tells how to obtain it; the second contains instructions for making low-cost facsimiles of the same equipment (Secchi disks, plankton samplers, artificial substrates, nets for macroinvertebrate sampling, and more). Contact: Carol A. Davis, 311 Broad St., Chattanooga, TN 37402-2801; 615-751-7338. Free (one set only).

Curricula

The Comprehensive Water Education Book. This curriculum guide seeks to promote water literacy amongst grades K-6. Topics include: Physical and Chemical Properties, The Hydrologic Cycle, All Things are Dependent on Water to Maintain Life, Water is Essential for Human Activities, and Fun and Games. Each one is supported by background information for the teacher and dozens of well-designed activities and lesson plans. Contact: International Office for Water Education, Utah Water Research Laboratory, Utah State University, Logan, UT 84322-8200, 435-797-3182, 800-922-4693.

Hands On Save Our Streams: The Save Our Streams Teachers Manual - A 215-page curriculum for grades 1-12. It contains classroom and field activities relating to watersheds, pollution sources, stream monitoring, and the relationship between land use and water quality. Also included is a science project guide with ideas for turning stream study into a science fair or community project. Contact: 800-BUG-IWLA; www.iwla.org.

The Indoor River Book by : The Complete Guide of Integrated Activities for Building and Maintaining a Model Watershed inYour Classroom by Jim Higgins, Martin Kemple Foods Works (1994). This is a simple step-by-step teacher's guide for building an indoor aquatic habitat modeled after the local watershed. For grades 4 and up, includes lists of materials and activities across the curriculum – science, math, social studies, language arts, creative arts,and design technology. Adaptable for teachers with little or no experience conducting an environmental/community-based activity in school. Includes diagrams, illustrations, and photos of the process.

Project Aquatic Wild Education Activity Guide. Project Aquatic Wild is an interdisciplinary, supplementary conservation and environmental education program emphasizing aquatic wildlife and the natural and human forces that affect them. Dozens of activities address topics such as "Awareness and Appreciation," "Management and Conservation," and "Responsible Human Actions." Activities address grades K-12 and may be easily integrated into existing courses of study, or the entire set of activities may serve as the basis for a course a study. Educators in non-school settings will also find the materials of use. Contact: Project Wild, 707 Conservation Lane, Suite 305, Gaithersburg, MD 20878, 301-527-8900, fax 301-527-8912, E-mail: info@projectwild.org, web: www.projectwild.org

Project WET. This curriculum and activity guide is an education program for educators and young people, grades K-12. Its goal is to facilitate and promote awareness, appreciation, knowledge and stewardship of water resources through the development and assimilation of classroom-ready teaching aids and through the establishment of state and internationally sponsored Project WET programs. Project WET activities incorporate a variety of formats, such as large and small group learning, whole-body activities, laboratory investigations, discussion of local and global topics, and involvement in community service projects. The guide is available to formal and informal educators through workshops. Contact: Project WET, 201 Culbertson Hall, Montana State University, Bozeman, MT 59717-0570, p: 406-994-5392, fax 406-994-1919, email: rwwmb@montan.edu, web: www.montana.edu/wwwwet

Rivers Curriculum Project – The Illinois Rivers Project developed this river curriculum series. The river is the central theme that binds together six teacher resource books – and six content areas – in this interdisciplinary high school curriculum. Students learn to work together to make a difference in their own community while exploring vital topics. The Rivers Curriculum units work together to form a complete, interdisciplinary program, or stand alone as supplements to your existing curriculum. Topics include Chemistry, Geography, Mathematics, Biology, Earth Science, and Language Arts. Contact: Rivers Project, Southern Illinois University, Box 2222, Edwardsville, IL, 62026-2222, 618-692-2466, www.siue.edu/OSME/river

The Stream Scene: Watersheds, Wildlife and People. The Stream Scene looks at watersheds from many perspectives. The arrangement of the curriculum will guide the user from the broad spectrum of watershed systems, riparian areas and their respective components to the specific nature of streams and the aquatic life they support. Materials – background information, activities and activity extensions, and bibliographies – can stand alone but are designed to prepare students to perform field investigations (e.g., water quality monitoring, fish sampling). Sampling directions, data collections sheets, equipment lists and more support the field investigations. Materials are designed for grades 6-12 but, are adaptable for younger students. Contact: Oregon Department of Fish and Wildlife, PO Box 59, Portland, OR 97207.

Utah Nonpoint Source Education Activities for Grades 1-12. This activity booklet includes directions for ten hands-on activities demonstrating nonpoint source pollution concepts, a glossary, and a correlation to the 1994 Utah Core Curriculum for Science. Contact: Contact: Your local [county] Cooperative Extension Service – or – Utah State University Extension, 1500 N 800 E, ASTE Dept, Utah State University, Logan, UT 84322-2300, 435-797-3389. extension.usu.edu/natres/wq/

Water Conservation and Nonpoint Source Pollution – This activity book features hands-on, minds-on activities for elementary grades. The booklet incorporates the activities in the *Utah Nonpoint Source Education Activities for Grades 1-12* and the *Groundwater Flow Demonstration Model Activities for Grades 6-12* and includes new materials on water conservation. It was developed to provide inservice training to teachers on water quality and quantity issues. Contact: Your local [county] Cooperative Extension Service – or – Utah State University Extension, 1500

N 800 E, ASTE Dept, Utah State University, Logan, UT 84322-2300, 435-797-3389. extension.usu.edu/natres/wq/

Water Education…with emphasis on Deer Creek Reservoir – Provo River Drainage Area. This manual is a compilation of lesson plans for grades 5 to 8. It is designed to integrate water resources, conservation, management, and environmental education into the regular school curriculum (Utah State Core Curriculum connections are identified). A multi-disciplinary, activity oriented approach is used. Each lesson plan provides *Background Information for the Teacher* and *Activities.* Although emphasis is placed on Deer Creek Reservoir, you'll find plenty of applicable and useful information about water – especially Utah water. You'll also find a *Utah Water Education Speakers Bureau Organizational Listing* (with phone numbers). Contact: Mountainland Association of Governments, 2545 North Canyon Road, Provo, Utah 84604

Watershed Science for Educators - Cornell Center for the Environment's new 213-page manual is designed for high school and middle school science classes and after-school science clubs. It covers biological, chemical, and physical monitoring and the use of topographic maps and aerial photographs. Each of the 15 activities includes a teachers page with background information and preparation suggestions. Clear instructions and photo-copyable data forms make the manual easy to use. Contact: Cornell University Media and Technology Services Resource Center, 6 Business & Technology Park, Ithaca, NY 14850; 607-255-2080; publications@cce.cornell.edu.

Teaching Resources

Diatomaceous Earth Model – By pouring colored water over a silt-like material and various "accessories" you can demonstrate how rivers form watersheds and how land development affects overland flow. Lots of fun! Contact: Utah State University Extension, 1500 N 800 E, ASTE Dept, Utah State University, Logan, UT 84322-2300, 435-797-3389. extension.usu.edu/natres/wq/

Enviroscape – This is a large, plastic model that illustrates the major natural and human features of a watershed. Spray the model with water to simulate rain and surface flow, add food coloring to trace pollution flow, and manipulate land uses to affect water quality. The model is an excellent interactive tool for teaching a variety of watershed and water quality concepts. Comes with guides (User and Resource) and added components that facilitate investigations of Watersheds, Riparian areas, Groundwater, Wetlands, and Hazardous waste. Contact : Your local [county] Cooperative Extension Service – or – Utah State University Extension, 1500 N 800 E, ASTE Dept, Utah State University, Logan, UT 84322-2300, 435-797-3389. extension.usu.edu/natres/wq/ To purchase one: JT&A, inc., 4 Herbert Street, Alexandria, VA 22305, 703-519-2180, Fax 703-519-2190, email: jtainc@gnn.com, web: Http://www.jtainc.com

The Groundwater Flow Demonstration Model – These models are used to demonstrate groundwater movement principles. The model is constructed of clear plexiglass which allows viewers to watch how the water within a groundwater system moves. The model is ideal for classrooms, children's (and adult's) festivals and Scout and 4-H groups. There are 14 models throughout Utah that can be used free-of-charge for educational purposes. An activity book with directions for hands-on lessons accompanies. Cooperative Extension County staff are often available to provide demonstrations using the model. Contact: Your local [county] Cooperative Extension Service – or – Utah State University Extension, 1500 N 800 E, ASTE Dept, Utah State University, Logan, UT 84322-2300, 435-797-3389. extension.usu.edu/natres/wq/

CD-Rom

Utah Groundwater – This IBM-compatible software program discusses ground water concepts including the hydrologic cycle, types of aquifers, and ground water contamination. It is designed to be self-pacing and interactive by using hyper-text and computer graphics. Contact: Your local [county] Cooperative Extension Service – or – Utah State University Extension, 1500 N 800 E, ASTE Dept, Utah State University, Logan, UT 84322-2300, 435-797-3389.

Utah Residential Water Conservation Techniques – This IBM-compatible software program discusses water conservation techniques in and around the home. It is designed to be self-pacing and interactive by using hyper-text and computer graphics. Contact: Your local [county] Cooperative Extension Service – or – Utah State University Extension, 1500 N 800 E, ASTE Dept, Utah State University, Logan, UT 84322-2300, 435-797-3389.

Watershed – This IBM-compatible software program uses a multi-media format to explain what a watershed is and the water quality issues facing land users. Provides a quick overview of various watersheds being monitored in Utah, and a simulation gaming format for youth to make decisions on land use and the consequences of those land use decisions. Contact: Your local [county] Cooperative Extension Service – or – Utah State University Extension, 1500 N 800 E, ASTE Dept, Utah State University, Logan, UT 84322-2300, 435-797-3389.

Web Sites

Adopt Your Watershed - This EPA web site is a national catalog of groups involved in local watershed protection efforts. Thousands of watershed alliances, volunteer monitoring groups, cleanup efforts, and advocacy organizations are listed. A great way to form partnerships and learn from other monitoring efforts. www.epa.gov/surf/adopt

Index of Watershed Indicators – This EPA web site compiles information on the condition and vulnerability of watersheds in Utah and the nation. Fifteen indicators are used, including: ability of waters to meet designated uses, fish consumption advisories, and aquatic/wetland species at risk. These indicators are combined to determine an overall index score for every watershed in the nation. Find out how your watershed scores! www.epa.gov/surf/iwi/

Project Green - The Global Rivers Environmental Education Network (GREEN) middle and high school-aged youth to understand, improve and sustain their watersheds and the water quality within. Youth learn how to use the proper tools and then undertake projects to improve environmental quality based on otheir findings. Water monitoring equipment, resource and action guides and a network of support are just some of the key elements GREEN provides its participants. Their website now offers a Hands-On Center where you can take your findings and learn more about the background behind your chemical water monitoring tests. They will also show you how to begin to take action on your research. http://www.earthforce.org/green/

Science in Your Watershed – The U.S. Geological Survey's Science in Your Watershed web site can help you find scientific information organized on a watershed basis. This information, coupled with observations and measurements made by watershed groups, provides a powerful foundation for characterizing, assessing, analyzing, and maintaining the status of a watershed. The web site has information on using GIS, active projects, case studies, and more. www.water.usgs.gov/wsc/

Surf Your Watershed – This web site is designed to help users locate, use, and share environmental information about a watershed or community. You can find out about protection efforts and volunteer opportunities in your watershed, and even build, view, and download a customized map of your area including such things as roads, streams, and EPA-regulated facilities. www.epa.gov/surf

Utah Environmental Hotline Web Page – The Utah Environmental Hotline 1-800-CLEANUP and website, is a public/private partnership designed to empower Utah residents with proactive environmental information and programs through a single network. As this program continues to grow, it will expand to include even more community specific information. New links to community specific environmental information and programs will be highlighted here, designed to make it easy for anyone, inside or outside the state, to access information about our state's environmental pollution prevention programs. www.1800cleanup.org/StatePrograms/States/Utah/ut.htm

Utah*Link* – This exhaustive site for Utah Educators links to many other sites and resources relevant to water quality monitoring. You'll find information on aquatic wildlife and ecosystems, water chemistry, funding sources, curriculum, and much, much more. A great place to learn how to make water quality monitoring a successful component of the school experience. www.uen.org/utahlink/

Water Pollution - This web site is an excellent starting point when looking for water- and water quality-related information on the web. You'll information on water pollution, monitoring, education, sewage and plumbing, wastewater treatment and much more. Sampling parameters (ex. nitrate) are described along with sampling techniques. You'll also find an exhaustive list of links (with abstracts) to other water education and water quality monitoring sites. www.geocities.com/RainForest/5161/wwlinks.htm

State Monitoring Agencies

Adopt-A-Waterbody – This Utah Department of Agriculture program recognizes and assists volunteer groups that provide stewardship to a body of water in Utah. Contact: Shelly Quick, 350 N Redwood Rd, PO Box 1465000, Salt Lake City, UT 84114-6500, (801)538-7100; www.ag.state.us/divisns/mkt&cons/aaw.htm

4-H – 4-H is a youth education program administered by the Cooperative Extension Service. The "National 4-H Environmental Stewardship" program helps youth learn how to turn a concern for the environment into action. Educational experiences guide youth toward a balanced approach to community problem solving, protecting the environment, managing resources, and taking appropriate action. For information on 4-H programs in your area, contact your state or county Cooperative Extension Office (see Utah State Cooperative Extension Service below for contact information). For information on the National 4-H Council in Maryland - 301-961-2866 or 301-961-2833.

Utah Department of Natural Resources (UDNR) - The Utah Division of Water Rights is an agency of Utah State Government within the Department of Natural Resources. Their web site provides information on water rights, wells and groundwater, dams, stream alterations, geographical information (you can download topographical maps of your area), water-related publications, and streamflow data. Contact: http://nrwrt1.nr.state.ut.us/; nrwrt.bclayton@state.ut.us; or call 801-538-7240.

Utah Division of Water Resources (UDWR) – The UDWR, a department of the Utah Division of Natural Resources, implements water education and conservation programs that encourage wise municipal, industrial, agricultural and environmental water use. They also maintain accurate and current water supply and land use data for each watershed in the state. Check out their Water Conservation Web Site to learn about water use in Utah, and how we can protect and conserve our clean water supplies. You can also request UDWR publications (e.g., Utah Water Facts brochure). http://www.nr.state.ut.us/WTRRESC/water/Cons/cons.htm

Utah Division of Water Quality (UDWQ) – A department of the **Utah Department of Environmental Quality**. Their mission is to protect, maintain and enhance the quality of Utah's surface and underground waters for appropriate beneficial uses; and to protect the public health through eliminating and preventing water related health hazards which can occur as a result of improper disposal of human, animal or industrial wastes while giving reasonable consideration to the economic impact. Their Utah Water Quality Project Assistance Program (WQPAP) was created by the State Legislature in 1983 to provide financial assistance and state participation with the needs and requirements associated with conserving, developing, treating, restoring and protecting the waters of the State. Contact: State of Utah, Department of Environmental Quality, Department of Water Quality, PO Box 144870, Salt Lake City, UT 84114-4870, 801-538 6146, http://www.eq.state.ut.us/eqwq [Alan Daly, Head of State Program for Water Education - nrwcs.adaly@state.ut.us; Monitoring Section - Richard Denton 538-6055]

Utah Division of Wildlife Resources (UDWR) - The UDWR manages the state's fish resources, primarily for recreational use (sport fishing) and aquatic ecosystem health. To help them do this they have developed the Aquatic Resource Education (ARE) program which educates the public about the state's aquatic resources. Through ARE you will find many different educational resources as well as opportunities to be involved in or partner with habitat enhancement programs. The UDWR can also provide resource specialists to help you with your aquatic studies. Contact: UDWR, Box 146301, Salt Lake City, UT 84114-6301; 801-538-4774.

Utah Natural Resource and Conservation Service (NRCS) - The mission of the NRCS is to provide leadership in a partnership effort to help people conserve, improve, and sustain our natural resources and environment. They provide water conservation materials for teachers and students as well as technical assistance to stream and wetland monitoring groups. Contact: Utah State Office, 125 South State Street, Salt Lake City, Utah 84138, PO Box 11350, Salt Lake City, UT 84147-0350, 801-524-4550, fax: 801-524-4403, www.nrcs.usda.gov

Utah State Cooperative Extension Service - The Extension Water Quality Program at Utah State University offers up to date, unbiased, research-based information and assistance to Utah citizens about the quality of surface and ground water, best management practices to reduce pollution to our waters, and the function and protection of watersheds. In addition they provide information and assistance with hands-on activities for schools, 4-H, and other youth groups. Contact: Nancy Mesner, Water Quality Extension Specialist, 4900 Old Main Hill, Utah State University, Logan, UT 84322-4900; (435)797-2465, Fax: (435)797-2443; nancym@ext.usu.eduwww.ext.usu.edu/natres/wq/index.htm

Federal Monitoring Agencies

Bureau of Land Management (BLM) – The BLM, which administers most of the public land in Utah and the West, is an important resource for water quality monitors. They can provide maps, up-to-date information on streams and watersheds, staff expertise, volunteer opportunities, partnership information, teacher resources, and more. Check out their web site for contact information on your local District and a link to their Environmental Education Home Page. You can also reach the Utah State Office to find contact information for your local district. Contact: Bureau of Land Management, Utah State Office, PO Box 45155, Salt Lake City, Utah 84145-0155, (801) 539-4001, fax: (801) 539-4013, web: www.blm.gov

Soil Conservation Service – The Soil Conservation Service, US Department of Agriculture, has offices in nearly every county to assist the nation's private landowners to conserve, improve and sustain all natural resources through conservation programs and practices. Most SCS education and volunteer activities are locally based. Youth and leaders should contact their local SCS office for assistance, opportunities and materials. Check you local telephone directory under US Government, Department of Agriculture, Soil Conservation Service, for the address and phone number of you nearest Soil Conservation Service office.

US Environmental Protection Agency (EPA) – The EPA supports the volunteer monitoring movement in a number of ways. It sponsors national and regional conferences to encourage information exchange between volunteer groups, government agencies, businesses, and educators; publishes sampling methods manuals for volunteers; produces a nationwide directory of volunteer programs; and through its ten regions, provides some technical assistance (primarily on quality control and lab methods) and regional coordination. Grants to States that can be used to support volunteer monitoring in lakes and for nonpoint source pollution control are also managed by the EPA Regions. Contact: www.epa.gov/ow (Office of Water Homepage). Numerous links extend from there.

US Forest Service (USFS) – The environmental education branch of the USFS, the Conservation Education program, provides structured educational experiences and activities targeted to varying age groups and populations. Conservation Education enables people to realize how natural resources and ecosystems affect each other and how resources can be used wisely. The Conservation Education's Home Page includes information on specific programs and activity dates, as well as on curricular resources for teachers and others. Programs are listed by target audiences, and include information on locations, costs, and who to contact. Also included are contacts for Conservation Education in each state. Reach the Region 4 Office (Utah's region) to find contact information on your local district. Contact: Region 4 Administration, Federal Building 324, 25th Street, Ogden, UT 84401; Hours 8:00 to 4:15 MT, 801-625-5608, Fax: 801-625-5127, E-mail: mailroom/r4@fs.fed.us, web:www.fs.fed.us/intro/directory/rg-4.htm

US Geological Survey – The Water Resources Division of the USGS offers hydrology data, water quality and water education publications, technical resources and water quality programs. The USGS is also an excellent place to look for maps of your watershed. Contact the Utah office of the USGS at: Kimball Goddard, 1745 West 1700 South, Rm 1016 Administrative Building, Salt Lake City, UT 84104, (801) 975-3350, Fax: (801) 975-3424; dc_ut@usgs.gov; http://www.water.usgs.gov/

Non-Governmental Organizations

Ducks Unlimited - The mission of Ducks Unlimited (DU) is to fulfill the annual life cycle needs of North American waterfowl by protecting, enhancing, restoring and managing important wetlands and associated uplands. DU offers educational resources for teachers and often serves as a partner in restoration projects. Contact: Ducks Unlimited, Inc., One Waterfowl Way, Memphis, TN 38120; http://www.ducks.org/

Izaak Walton League – The Izaak Walton League promotes protection and preservation of natural resources, encourages conservation education, and defends America's soil, air, woods, waters and wildlife. Izaak Walton League chapters can provide valuable information about local environmental issues and conservation projects. The League's Save Our Streams (SOS) program encourages participants to adopt a stream by conducting water and habitat quality monitoring and completing appropriate restoration activities. Contact: Izaak Walton League of America, 1401 Wilson Blvd, Level B, Arlington, VA 22209 (800)BUG-IWLA

Trout Unlimited (TU) – Trout Unlimited is the nation's leading non-profit coldwater fisheries conservation organization and has over 75,000 members in 435 chapters across the country. TU's mission is to conserve, protect, and restore coldwater fisheries and other watersheds. TU chapters work at the local level to restore trout and salmon waters degraded by pollution, clean up litter on streams and rivers, and teach the public about the ecological and economic importance of healthy streams. An excellent organization to partner with on monitoring or restoration projects. Trout Unlimited, PO Box 11861, Salt Lake City, UT 84147; email: tudtrout@aol.com

Appendix 3. Utah Science Core Curriculum Matrix

VII-8. Utah State Science Core Curriculum Connections

"X" identifies sections of the manual that address (directly or indirectly) Science Core Curriculum standards and objectives.

5th Grade	stream survey	streamflow	stream shape	turbidity	temperature	pH	dissolved oxygen	nitrogen	phosphorus	macroinvertebrates	riparian vegetation	illustrating data	reflecting on data	stewardship	water cycle	watersheds	water pollution	water regulations	classroom monitoring
Standard 3050-01 **physical features of Earth**	**X**	**X**	**X**	**X**							**X**			**X**	**X**	**X**		**X**	
Obj. – 3050-0102 natural resources	X	X	X								X			X	X	X		X	
Standard 3050-02 conservation of natural resources	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
Obj. – 3050-0201 identify natural resources	X	X	X	X	X	X	X	X	X	X	X				X	X	X		X
Obj. – 3050-0202 analyze conservation and pollution														X			X		
Obj. – 3050-0203 form opinion on human influences	X	X	X	X	X	X	X	X	X	X	X		X		X	X			X
Obj. – 3050-0204 aware of natural resource issues														X	X	X	X	X	
Standard 3050-03 **water characteristics, management**				**X**	**X**	**X**	**X**	**X**	**X**			**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Obj. – 3050-0301 properties of water				X	X	X	X	X	X										
Obj. – 3050-0302 uses of water														X	X	X	X	X	X
Obj. – 3050-0303 amounts of water used												X		X					
Obj. – 3050-0304 opinions on water management													X		X	X	X	X	

	stream survey	streamflow	stream shape	turbidity	temperature	pH	dissolved oxygen	nitrogen	phosphorus	macroinvertebrates	riparian vegetation	illustrating data	reflecting on data	stewardship	water cycle	watersheds	water pollution	water regulations	classroom monitoring
6th Grade																			
Standard 3060-06 technology and the living world		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**						**X**
Obj. – 3060-0601 scientific development																			X
Obj. – 3060-0602 conduct experiment		X	X	X	X	X	X	X	X	X	X	X	X						X
Standard 3060-07 Microorganisms in the living world										**X**									**X**
Obj – 3060-0702 interactions of microorganisms										X									X

	stream survey	streamflow	stream shape	turbidity	temperature	pH	dissolved oxygen	nitrogen	phosphorus	macroinvertebrates	riparian vegetation	illustrating data	reflecting on data	stewardship	water cycle	watersheds	water pollution	water regulations	classroom monitoring
7th Grade																			
Standard 3200-05 classification schemes					**X**					**X**	**X**								**X**
Obj. – 3200-0501 classify matter from observations					X														X
Obj. – 3200-0502 living, dead and non-living matter										X	X								

	stream survey	streamflow	stream shape	turbidity	temperature	pH	dissolved oxygen	nitrogen	phosphorus	macroinvertebrates	riparian vegetation	illustrating data	reflecting on data	stewardship	water cycle	watersheds	water pollution	water regulations	classroom monitoring
Obj. – 3200-0504 classify taxonomic levels										X									

	stream survey	streamflow	stream shape	turbidity	temperature	pH	dissolved oxygen	nitrogen	phosphorus	macroinvertebrates	riparian vegetation	illustrating data	reflecting on data	stewardship	water cycle	watersheds	water pollution	water regulations	classroom monitoring
8th Grade																			
Standard 3240-01 **chemical and physical change**		**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**			**X**							
Standard 3240-0101 differentiate common changes		X	X	X	X	X	X	X	X										
Obj. – 3050-0102 analyze factors of change		X	X	X	X	X	X	X	X			X							
Standard 3240-02 **investigate biological energy**										**X**	**X**								**X**
Obj. – 3240-0201 plant, animal energy requirements										X	X								X
Obj. – 3240-0202 analyze energy of food webs										X	X								X
Standard 3240-03 **relate forces and energy to motion**		**X**	**X**									**X**							
Obj. – 3240-0301 demonstrate results of forces		X	X									X							
Obj. – 3240-0302 identify role of energy in motion		X																	
Standard 3240-05 **Earth's crust and climate**		**X**	**X**								**X**					**X**			
Obj. – 3240-0501 model changes in Earth's surface		X	X																
Obj. – 3240-0502 changes caused by climate																X			
Obj. – 3240-0503 analyze rock formation processes																X			
Obj. – 3240-0504			X								X					X			

Relate biology & Earth changes																			

Appendix 4. A Note to Volunteers

Utah Stream Team

Thank you for being a volunteer with the Utah Stream Team Program! We appreciate your time and effort in helping make this experience a success. The following is an overview of our program to give you some background information before heading into the field.

The Utah Stream Team has provided a hands-on program for all ages. Due to the fact that all the measurements are done in the field, volunteers should exercise caution, and be aware of the always-changing environmental conditions. The participants will gain an appreciation for our natural resources through hands-on activities in natural settings.

The goal of the Utah Stream Team program is to promote water quality monitoring through physical, chemical and biological testing. The information obtained will help us to better understand how our activities effect water quality, determine the overall health of our water, and identify specific water quality problems.

Physical Measurements

a. Stream flow is the amount of water that flows past a specific point over a specific period of time. We measure stream flow by determining the average velocity (how fast an object moves in the stream) and multiplying that by a cross sectional area of the stream. Participant will wade into the stream to take several depth measurements.
b. Stream shape refers to the physical structure of the stream. The stream channel may be meandering (making many tight "s-turns"), straight, or braided (continually splitting and rejoining). The stream may contain riffles (areas where the water is flowing over rocks and gravel), runs (long smooth areas), or pools (deep slow moving areas). We also measure substrate, which is the material that makes up the streams channel. Substrate is divided into six categories based on size. The participants will pick up, measure and record the size of the rocks on the stream bottom.

Chemical Measurements

a. pH is the measurement of how acidic or basic the water is. We measure pH on a scale from 1 to 14, with 1 being acidic, 7 being neutral, and 14 being basic. Water with extremely high or low pH is deadly to plants and animals. We sample pH using colored litmus strips which are dipped into the water. The color strips react with the water and are then compared with a chart to determine the pH. The allowable range of pH is 6.5 to 9.0 in the State of Utah.
b. Dissolved oxygen is a measurement of the amount of oxygen molecules in the water (the oxygen is invisible to our eyes; bubbles contain oxygen that is not dissolved). To test for dissolved oxygen, stream water is mixed with chemicals in a small glass ampoule, which then change color depending on the amount of oxygen present in the water. The darker blue, the more oxygen

dissolved in the water. The minimum concentration for Utah is 6.5 mg/liter for coldwater fish, and 5.5 mg/liter for warmwater fish.

c. Nitrogen (we measure nitrate and ammonia) is used in building proteins, and is therefore an essential nutrient for plant and animal growth. Too much nitrate in a stream however, may cause too many plants to grow, which may cause problems when they die and decay. Both nitrate and ammonia can also be poisonous. The nitrate and ammonia tests are color tests, where the amount of color change is proportional to the amount of pollutant being measured. The State of Utah considers nitrate concentrations of 4 ppm(mg/liter) to be an indicator of pollution problems. Ammonia is much more toxic in warm water or at higher pH levels.

d. Phosphorus is another important plant nutrient. Phosphorus is often the nutrient that limits how much plant growth occurs in a stream, lake or reservoir. We also measure phosphorus with a color test. The State of Utah considers a total phosphorus concentration of 0.05 ppm(mg/liter) in a stream or river an indicator of possible pollution problems.

e. Turbidity is a measurement of the amount of suspended solids present in a stream. This affects how deeply light can penetrate. We measure turbidity with a turbidity tube. Fill the tube with stream water, then release the water until you can see the black and white disk at the bottom. The depth in the tube to this point is then converted into turbidity units (NTU's). The higher the NTU's, the cloudier the appearance.

f. The temperature of the water is influenced by seasons, the geographic area of the stream, the source of water and the channel shape or shading from plants on the bank. We sample temperature with a field thermometer. The maximum temperature allowed for warm water fish and aquatic wildlife is 27 degrees Celcius. The maximum temperature allowed for cold water fish and aquatic wildlife is 20 degrees Celcius.

Biological Measurements

a. The tiny animals that live in the streams are called aquatic macroinvertebrates. The types and abundance of macroinvertebrates found in a stream are important for two reasons. One, they indicate water quality. Different macroinvertebrates tolerate different types of stream conditions. Two, they are important parts of the aquatic and terrestrial food chain. We sample macroinvertebrates directly from the stream by dislodging them from the rocks they cling to and collecting them in a net. They can be observed with a magnifying glass or counted for a water quality index.

b. The riparian zone is the green ribbon of life alongside a stream. The riparian zone connects the uplands zone to the aquatic zone. Well-functioning riparian zones are critical to a healthy watershed. All riparian measurements are taken by walking a transect and recording the plants with each step. We measure the types of plants that grow at the waters edge (the green line) to tell if these are plants which can hold on to the banks. We sample the canopy cover to see how shady the riparian area is. We sample the plants from the streams edge upward to see how extensive the riparian area is.

Appendix 5. Sampling Directions and Data Sheets (Masters)

General Stream Survey

Site and Sampling Date Information

Stream name________________________ Date _________________________

Time of Day __________________________ Watershed name___________________

School/group name ___________________ Teacher/leader ____________________

Group members ___________________________ ________________________________

___________________________ ___________________________

___________________________ ___________________________

Location of stream section ____

____

____

Weather in past 24 hours:
- storm (heavy rain)
- rain (steady rain)
- showers (intermittent rain)
- overcast
- clear/sunny

Weather now:
- storm (heavy rain)
- rain (steady rain)
- showers (intermittent rain)
- overcast
- clear/sunny

Air Temperature

____

degrees F
degrees C

Water and Watershed Information

Water appearance:
- clear
- brown
- multi-colored sheen
- foamy
- milky
- scummy
- muddy/cloudy
- orange/red
- green
- other ___________

Smell:
- rotten egg (sulphurous)
- musky
- chlorine
- other _____________

Land use around site:
- factories
- pavement
- agriculture
- logging
- grazing
- homes
- mining
- wildlands
- water treatment plant
- stream modifications
- unpaved roads/trails
- other ________

NOTES

____

Field Data Sheet

Stream Flow

STOP If your stream is too deep to wade into disregard the following directions. You can obtain accurate, up-to-the-hour data from the US Geological Survey – www.ga.water.usgs.gov

Time – 45 minutes
Persons - 4
Materials:
- Measuring tape (at least 50 feet)
- 8 surveyor's flags
- stopwatch or watch with a second hand
- float (ping pong ball, bobber, orange)
- 2 sets of waders
- Physical Data Collection Sheet

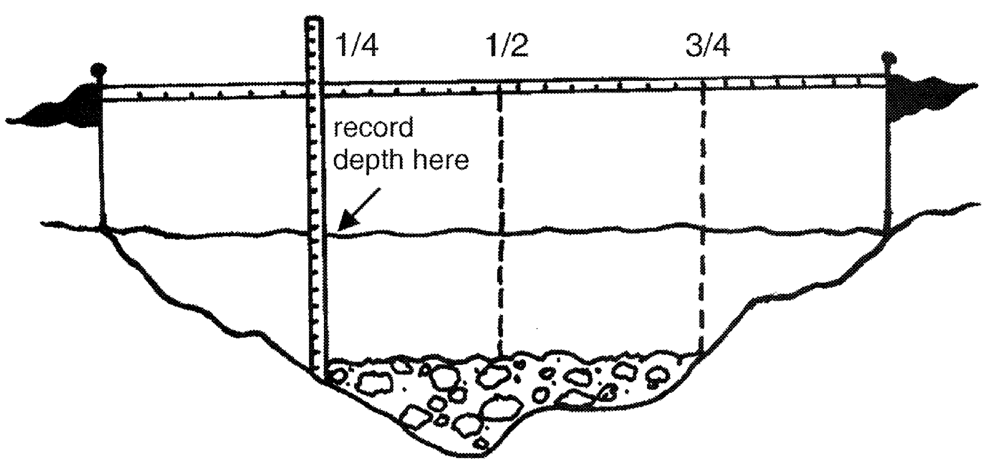
Step 1 - Measure length of stream section

1. Choose a fairly straight section of stream.
2. Use the tape measure to measure a 50 foot section. Place flags at both ends (next to the water's edge).
3. Record the length stream section as "50 feet" in Step 1 of the Physical Data Collection Sheet.

Step 2 - Measure cross-section area

a. Measure width of stream section (see Figure IV-2 for help)

1. Stretch a tape across the stream between two flags.
2. Record your width in Step 2a of the Data Collection Sheet in inches.
3. Keep holding the tape measure between the two flags. You will need it for the next step.



b. Measure average depth of stream section (see Figure IV-2 for help)

1. With the tape measure strung between the two zero ft flags, have a third person move one-fourth of the way across the width of the stream. To find this distance divide your width by 4. For example, if your stream is 20 feet, you would move 5 feet across.

2. At this one-quarter mark, *rest* your yard stick on the stream bottom (do not dig) and record the depth in Step 2b of the Physical Data Collection Sheet. Record depth in inches.

3. Move the same distance out along your tape measure (you will now be one-half way across the stream). Record the second depth measurement in Step 2b.

4. Record the depth at three-fourths of the way across the stream.

5. Add the three depths and divide by three to get an average depth for your stream section.

c. Calculate cross-section area

Fill-in the boxes in Step 2c – "Cross-section Area" – on the Physical Data Collection Sheet. Multiply the width times the depth. You now have cross sectional area in square inches. Divide that value by 144 for cross sectional area in square feet.

Step 3 – Measure velocity [see Figure IV-3 for help]

a. Calculate average travel time – the time it takes an object to travel your 50 foot section

1. Drop a floating object (ping pong ball) in the main channel upstream of your zero flag. Start the stopwatch when the object passes the zero flag (the "starting line").

2. Yell to stop the clock when the object passes the 50 ft flag (the "finish line").

3. Collect the object and record the time on the data sheet.

4. Repeat steps 1-3 two more times. Throw out any tests where the float gets stuck in rocks or debris.

5. Add all three travel times and divide by 3 to get an average. Record on data sheet.

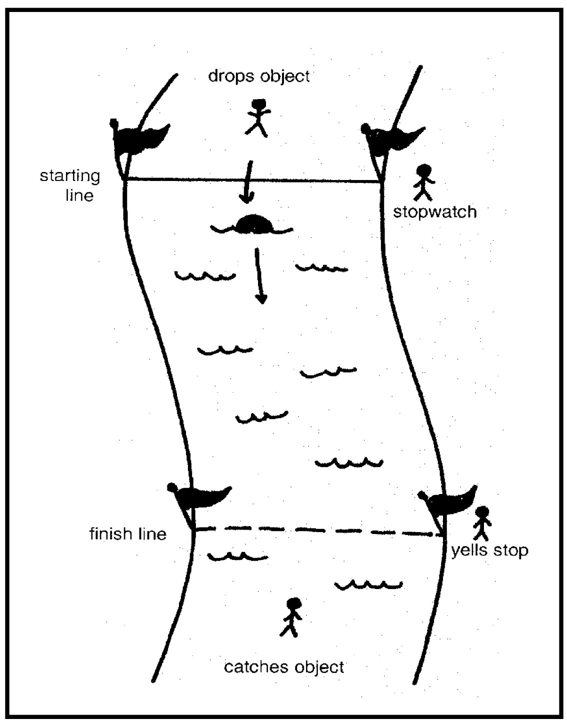


Illustration: Holly Broome-Hyer Figure IV-3

Calculate velocity

Divide stream section length by average travel time.

This will give you velocity in feet per second (feet/sec).

Step 4 – Calculate stream flow

Multiply the average cross-section area times the average velocity to determine stream flow for your section. Your flow will be in cubic feet per second.

Stream Shape

Stream channel pattern

Determine your stream's channel pattern with the help of the Physical Data Collection Sheet.

Time – 2 minutes
Persons - 1
Materials –
- Physical Data Collection Sheet

- Check the box next to the pattern that best describes the overall channel shape of your stream section.
- The fourth selection is an "unnatural" channel shape – it has been altered by humans. Include any altered channels, regardless of shape, in this category.

Substrate types

Determine the percentage of each type of substrate in your stream by doing a "pebble count." Follow the procedure below to perform a pebble count.

Time – 15 minutes
Persons – 3 (or more)
Materials –
- Physical Data Collection Sheet
- rulers

- To simplify calculating percentages, take exactly 50 samples. Two students can count pebbles (each one counts 25) while one student records data on shore.
- Record your totals on the Physical Data Collection Sheet.

Procedure

1. When instructed by the Recorder, have the Pebble Counters take one step into the stream towards the opposite bank.
2. After that step, reach down and touch the sediment at the tip of your toe. Important: do not look at the stream bottom while doing this, as this may bias your choice.
3. Pick up the sediment and measure the longest side with a ruler (in inches).
4. Tell the length to the Recorder. Make a mark next to the correct substrate size in column A of the Physical Data Collection Sheet. Refer to the "Substrate Sizes" table for help.
5. Repeat this until you reach the other shore. Then take 30 steps upstream and return back across the stream. Continue until 50 samples are recorded.
6. Calculate the percentage of each substrate type.
    1) Add up the marks for each row in column A. Write these totals in column B.
    2) Multiply the number in column B by "2" and record in column C. This will give you the

Substrate sizes

Bedrock (solid rock)

Boulder >12" (anything larger than a volleyball)

Cobble 3–12" (golf ball to volleyball size)

Gravel 1/4–3" (pea size to golf ball size)

*Sand <1/4" (smaller than a pea but large enough to be seen with the naked eye)

*Silt/clay (individual particles very hard to see with the naked eye)

* If having trouble determining the difference between silt and sand, pick up a handful of sediment. Silt will feel smooth, like mud. Sand will feel rough.

percent of each substrate type. For example, if you recorded 31 cobbles then, (31 X 2) = 62. This means that 62% of the substrate in your stream section are cobbles.

Riffle/run/pool ratio

The riffle/run/pool ratio is a measure of the kinds of habitat in your stream for fish, macroinvertebrates and other aquatic life.

Time – 15 minutes
Persons – 3
Materials –
- Physical Data Collection Sheet

Notes

- Use Figure 6 below to help you correctly identify *pools*, *riffles* and *runs*. Practice identifying in the field before sampling.

- The "Riffle/Run/Pool Procedure" can be done at the same time as the "Substrate Sampling Procedure." Record both measurements each time you take a step across the stream.

Procedure

1. Walk along the edge of your stream, using even paces. Stop after each step and look across the stream. Determine whether the stream is a riffle, pool or run at this point in the river. Note: If there are several habitat types, choose the most common type.
2. Mark the correct habitat type in column A on the Pool/Run/Riffle chart on the Physical Data Collection Sheet.
3. Continue for exactly 50 paces (this simplifies calculating the percentage).
4. Add your marks for each row in column B.
5. Multiply the number in Column B by 2 to find the percentage of pools, runs and riffles in the stream. For example, if you sampled 31 riffles then 31 X 2 = 62. This tells you that 62% of your stream section consists of riffles.

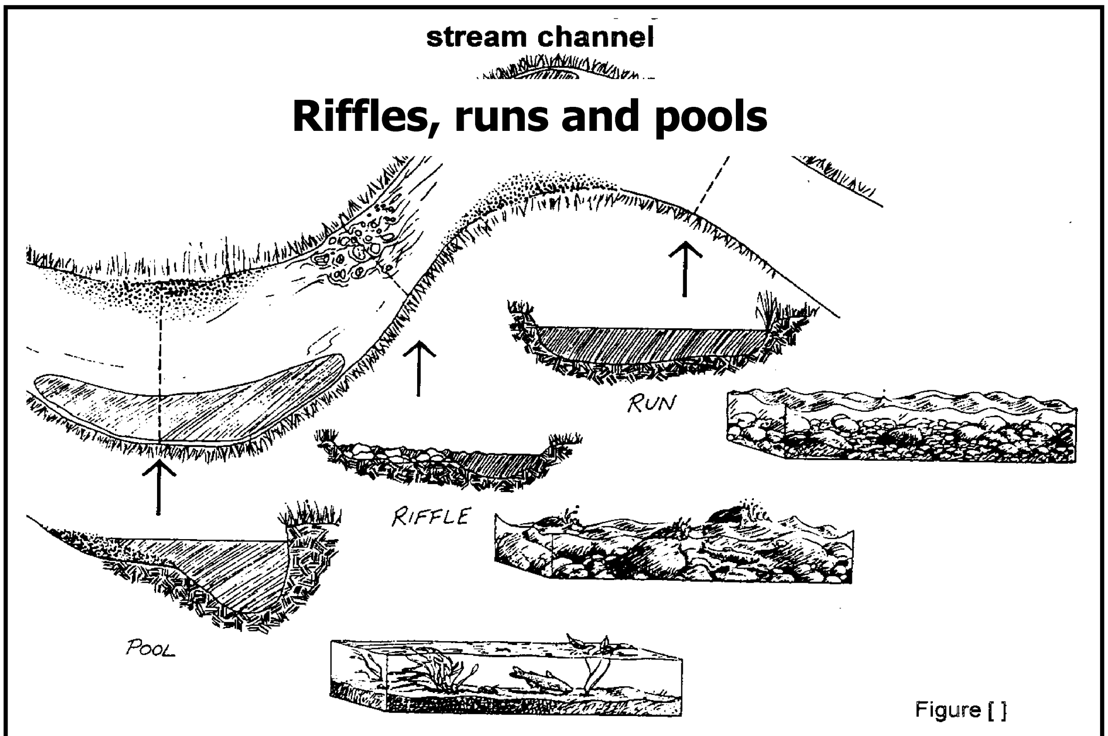


Figure [ ]

Date:____________________ Recorder:________________________________

Streamflow

Step 1 - length of stream section

[ ] feet

Step 2 - cross-section area (width x depth)

a) width ________ (inches)

b) depth **1.** __________ (inches)

2. __________ (inches)

+ 3. __________ (inches)

= __________ (inches)

÷ 3 = ________ (inches)

C) cross section area

________ **width** (inches)

x ________ **depth** (inches)

= ________ (square inches) **÷ 144**

= [ ] **cross section area** (square feet)

Step 3 – velocity

a) travel times

1. __________ (sec)

2. __________ (sec)

+ 3. __________ (sec)

= __________ (sec)

÷ 3 = _________ **average travel time** (sec)

b) velocity

____________ length (feet)

÷ ____________ average travel time (sec)

= [ ] **velocity** (feet/sec)

Step 4 – stream flow

__________ **cross section area (square feet)**

x ____________ **velocity (feet/sec)**

= [ ] **stream flow (feet³/sec)**

Stream Shape

Channel Pattern

Substrate Type

Substrate type	A. Record each observation	B. Total number of observations	C. Percent substrate type (column B x 2)
Silt (individual particles very hard to see with the naked eye)			
Sand 1/4” (smaller than a pea but large enough to be seen with the naked eye)			
Gravel ¼” – 3” (pea size to golf ball size)			
Cobble 3” – 12” (golf ball to volleyball size)			
Boulder >12” (anything larger than a volleyball)			
Bedrock (solid rock)			

Riffle/Run/Pool Ratio

Feature	A. Number of observations	B. Total number of observations	C. Percent feature type (column B x 2)
Riffle			
Run			
Pool			

pH

Time – 2 minutes
Persons – 1
Materials
- pH strips

Step 1
Dip one strip of indicator paper in to the stream and pull out.

Step 2
Wait 1 minute.

Step 3
Compare the color of the litmus paper to the pH color key on the pH box.

Step 4
Record the number associated with the correct color match on the Chemical Properties Field Data Sheet.

Remember: Take pH readings directly in the stream. If this cannot be done safely, collect water in a bucket and take the pH reading of this water immediately.

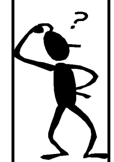
The allowable range of pH is 6.5 to 9.0 in the State of Utah.

Dissolved Oxygen

- **This test detects dissolved oxygen concentrations of 0 to 12 mg/L (ppm)**
- Collecting and handling of the water should be done with as little shaking as possible. Shaking may cause oxygen from the air to dissolve into the water sample and produce a inaccurate measurement.

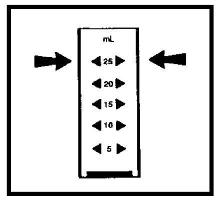
Time – 3 minutes
Persons - 1
Materials -
- CHEMets DO Sampling Kits

STOP Sunlight can damage the ampoules in your DO kit. Keep them shaded at all times.



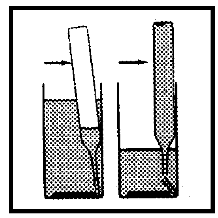
Step 1

1. Pre-rinse collection bottle with stream water.
2. Fill the sample cup to the 25 mL mark with your sample.



Step 2

1. Place the CHEMet ampoule in the sample cup.
2. Snap the tip by pressing the ampoule against the side of the cup.
3. The ampoule will fill, leaving a small bubble that will help you mix the contents of the ampoule.



Step 3

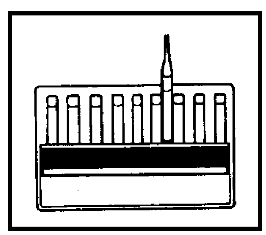
1. Mix the contents of the ampoule by turning it up and down several times, allowing the bubble to travel from end to end each time.
2. Wipe all liquid from the outside of the ampoule.

Step 4

1. Wait **2 minutes** for color development.

Step 5

1. With the sun (or another light source) shining on the comporator – rack of colored tubes – from directly above, place the dissolved oxygen ampoule between the color standards for viewing. It is important that the ampoule be compared by placing it on both sides of the color standard tube before deciding that it is darker, lighter or equal to the color standard.
2. Record the concentration of the best color match.



In Utah:
The minimum concentration for coldwater fish is 6.5 mg/L
The minimum concentration for warmwater fish is 5.5 mg/L.

Nitrate

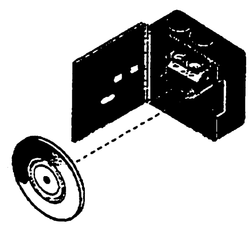
Time - 15 minutes
Persons - 1
Materials
- Hach nitrate kit

NOTE: These directions are for concentrations less than 1 mg/liter. More detailed instructions can be found in the kit.

Detection limit = 0.02 mg/liter

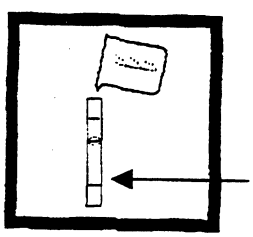
Step 1 - assemble color viewer

1. Add color wheel.



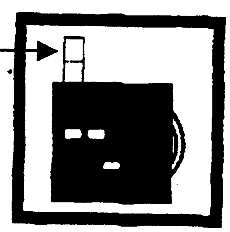
Step 2 – pour the blank

1. Rinse two test tubes with stream water. Fill both tubes with stream water to the 5 ml mark – the lowest mark. Place one tube in the top left opening this is your *blank*.



Fill to this mark

blank



Step 3 - add the first reagent

1. Add contents of Nitra Ver 6 Reagent packet to the second tube (the *sample* tube).
2. Stopper the tube and shake for 3 minutes.

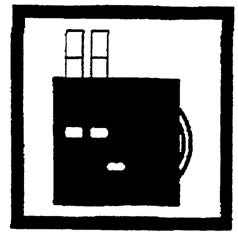
Step 4 – develop color

1. Add contents of Nitra Ver 3 Reagent packet to the sample tube.
2. Stopper the tube and shake for 30 seconds.

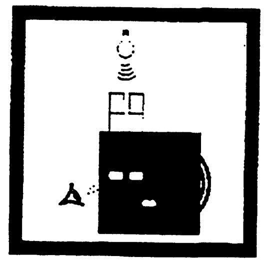
NOTE: Wait at least 10 minutes but not more than 20 minutes before proceeding to Step 5.

Step 5 - Read concentration

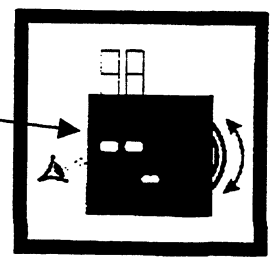
1. Place sample tube in the top right opening of the view



2. Hold the viewer so that your light source (sun, lamp) is behind the viewing window

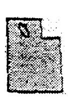


3. Rotate the color disc until the color on the disc matches the color in the sample tube. Read the number in the scale window.



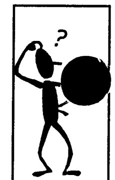
Step 6 –Record your results

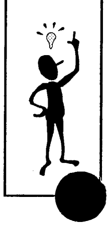
1. The number in scale window is the nitrate-nitrogen concentration (mg / liter) of your sample. Record this on your Chemical Properties Field Data Sheet.



In Utah:
The maximum concentration of nitrate allowed in drinking water is 10 mg/liter.

The State of Utah considers nitrate concentrations of 4 mg/liter to be an indicator of pollution problems.



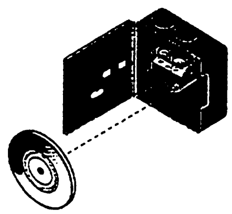


Ammonia

NOTE: These directions are for concentrations less than 3 mg/liter. More detailed instructions can be found in the kit

Detection limit = 0.10 mg/liter

Time - 5 minutes
Persons - 1
Materials
- Hach ammonia sampling kit



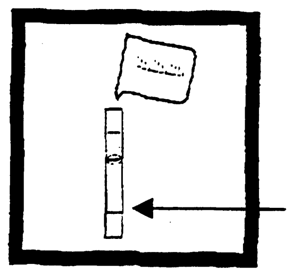
Step 1 - assemble color viewer

Add color wheel to color comparator.

Step 2 – place blank in viewer

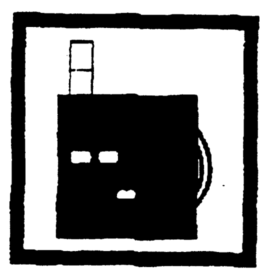
1. Pre-rinse two tubes with sample water

2. Fill one tube to the 5 ml mark with sample water.



Fill to this mark

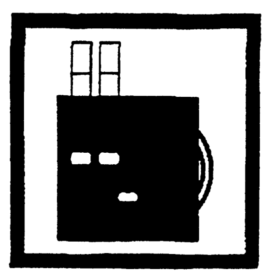
3. Place the tube in the top, left opening of the viewer. This will be your blank to control for natural water color or turbidity.



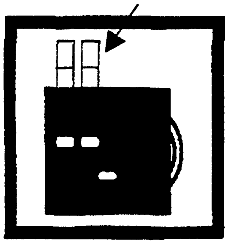
Step 3 – prepare the sample

1. Add three drops of Nessler Reagent to one tube
2. Swirl to mix.

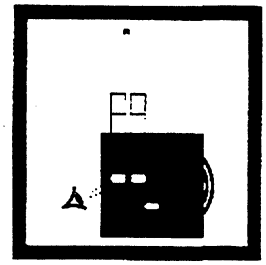
NOTE: Wait at least 1 minute but not more than 5 minutes before proceeding to Step 4



Step 4 - read concentration

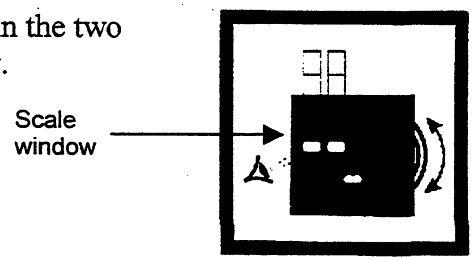


1. Place the tube with the reagent in the top right opening of the viewer.



2. Hold the viewer so that your light source (sun, lamp) is behind the viewing window.

3. Rotate the color disc until the color matches in the two openings. Read the number in the scale window.



Step 5 – Record your results

The number in the scale window is the ammonia-nitrogen concentration (mg/liter NH3-N) of your sample. Record this on your Chemical Properties Field Data Sheet.

> In Utah:
> The maximum allowable concentration of a ammonia depends on the pH and temperature of the water.
>
> Please refer to the Utah Stream Team manual for more information.

Phosphorus (phosphate)

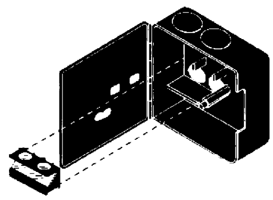
NOTE: These directions are for concentrations less than 0.3 mg/liter PO_4 - P. More detailed instructions can be found in the kit.

Detection limit = 0.01 mg / liter

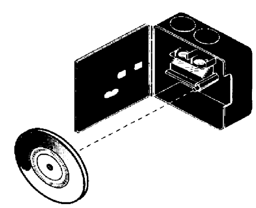
Time – 5 minutes
Persons – 1
Materials
- Hach phosphorus sampling kit

Step 1 - assemble color viewer

1. Add Long Path Viewing Adaptor.



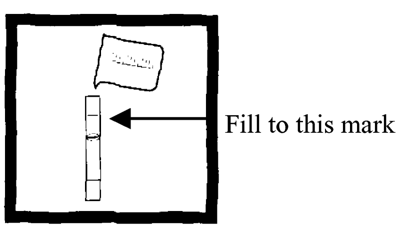
2. Add color wheel.

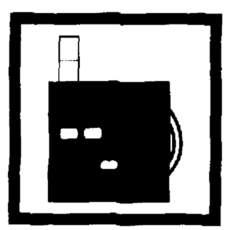


Step 2 - pour the blank

1. Pre-rinse 1 test tube with stream water and fill to top mark with sample water.

2. Place this tube in the left top opening of the viewer. This is your blank.



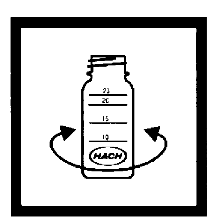


Step 3 – develop color

1. Fill square bottle to the 20 ml mark with stream water.

2. Add contents of Phosphorus Reagent packet into bottle.

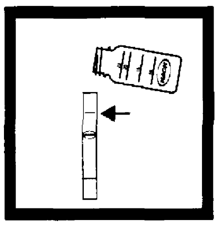
3. Swirl until the powder is dissolved.



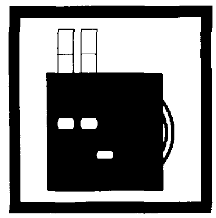
NOTE: Wait at least 8 minutes but not more than 10 minutes before proceeding to Step 4.

Step 4 - read the color (concentration)

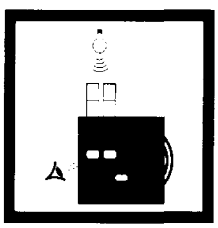
1. Fill 2nd tube to the top mark with prepared sample from Step 3.



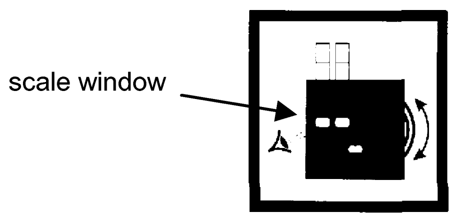
2. Place in top right opening of viewer.



3. Hold the viewer so that the top of the tube points toward a light source.



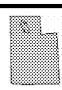
4. Rotate the color disc until the color matches in the two openings. Read the # in the scale window.



Step 5 – Calculate and record your results

Divide the number in the scale window by 150.

This is the phosphate-phosphorus concentration (mg / liter of (PO_4^{3-} -P) .



> The State of Utah considers a total phosphorus concentration of 0.05 mg/liter in a stream or river to be an indicator of pollution problems. A concentration of 0.025 mg/liter in lakes is considered a potential problem.

Turbidity

Detection limit = 6 NTU

Time – 2 minutes
Persons - 1
Materials –
- Turbidity tube

Step 1 – collect your sample

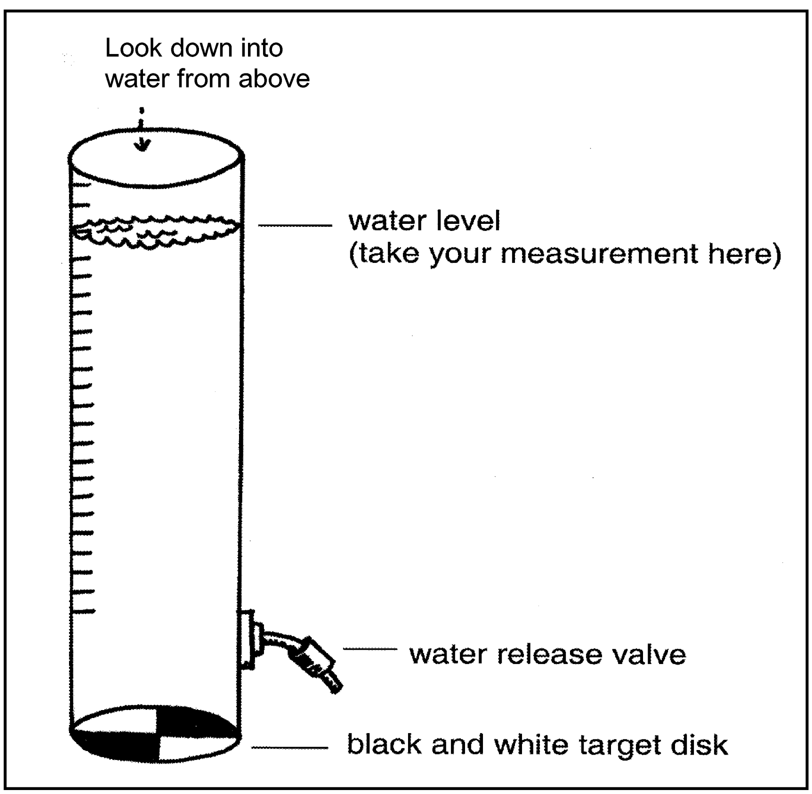
1. Dip the tube into the water at your sampling site and fill to the top. Be careful to sample flowing water and not the stream bottom.

Step 2 – Take your measurement (see figure below for help)

1. Take your filled turbidity tube to a shaded spot. If there is no shade around, use your body to block the sun from shining on the tube.
2. With your hand over the opening, shake the tube vigorously. This will help to re-suspend any sediment that has settled to the bottom.
3. Look down through the tube toward the target disk on the bottom of the tube.
   - If the disk is visible, record the water level in centimeters (cm).
   - If the disk is not visible, slowly release water from the release valve, until the disk becomes visible. Record the water level in centimeters (cm) on the Chemical Data Collection Sheet.

Step 3 – Convert from centimeters (cm) to turbidty units (NTU's)

1. Match your turbidity measurement in centimeters to the corresponding NTUs using the conversion chart on the back of this page. Record on the Data Collection Sheet.



Turbidity Conversion Chart	
Distance from bottom of tube (cm)	**NTU's**
< 6.25	> 240
6.25 to 7	240
7 to 8	185
8 to 9.5	150
9.5 to 10.5	120
10.5 to 12	100
12 to 13.75	90
13.75 to 16.25	65
16.25 to 18.75	50
18.75 to 21.25	40
21.25 to 23.75	35
23.75 to 26.25	30
26.25 to 28.75	27
28.75 to 31.25	24
31.25 to 33.75	21
33.75 to 36.25	19
36.25 to 38.75	17
38.75 to 41.25	15
41.25 to 43.75	14
43.75 to 46.25	13
46.25 to 48.75	12
48.75 to 51.25	11
51.25 to 53.75	10
53.75 to 57.5	9
57.5 to 60	8
Over the top	6

- Utah standards state that an **increase** of more than 10 NTUs is unacceptable for most waters.
- This increase can be over natural levels or from one location to another nearby downstream location.

Temperature

Time – 2 minutes
Persons – 1
Materials –
- Thermometer

Step 1

1. Dip the thermometer into a moving part of the stream or river.
2. Wait for the temperature to stop changing (at least 1 minute).

Step 2

1. Read the temperature and record on the data sheet. Be sure to record your temperature in degrees Celsius.
2. Use the equations below to convert between degrees Celsius to degrees Fahrenheit.

Converting Fahrenheit to Celsius: $°C = (5/9) \times (°F - 32)$

Converting Celsius to Fahrenheit: $°F = [(9/5) \times °C] + 32$

The maximum temperature allowed for warm water water fisheries and aquatic wildlife is 27° C (81° F).

The maximum temperature allowed for cold water fisheries and aquatic wildlife is 20° C (68° F).

Date:____________________ Recorder:___________________

Your Results	Compare your results to Utah's requirements
Water Temperature _______ °F (or) _______ °C	The maximum temperature for: • warmwater fisheries is 27° C (81° F) • coldwater fisheries is 20° C (68° F).
pH (Value of the color match) ________________	The allowable range for most waters in Utah is 6.5 to 9.0
Dissolved Oxygen (Value of the color match) _____________ mg / liter	The minimum concentration for: • warmwater fisheries is 5.5 mg/liter • coldwater fisheries is 6.5 mg/liter.
Nitrate (Value of the color match) _____________ mg / liter Nitrate-nitrogen	The maximum concentration for drinking water is 10 mg/liter. The concentration which indicates a possible pollution problem for streams and rivers is 4 mg/liter.
Ammonia (Value of the color match) _____________ mg / liter Ammonia-nitrogen	The maximum allowable concentration depends on the water's pH and temperature. Please check the Ammonia section in the manual.
Phosphate (Divide value of the color match by 150) ____________ mg / liter Phosphate-phosphorus	The concentration which indicates a possible pollution problem: • in streams and rivers is .05 mg/liter • in lakes is .025 mg/liter
Turbidity (Use chart to convert target distance to NTUs) ________________ NTUs	The maximum *increase* over natural levels in most streams and rivers is 10 NTUs.

Macroinvertebrate Sampling

Time - 40 minutes
Persons - 2
Materials -
- 1 kick net
- 1 plastic pan
- transfer pipettes
- plastic4 petri dishes
- magnifying glasses
- dichtomous key

OPTIONAL
- paint brushes (for transferring)
- 5 gal plastic bucket (for decanting)
- waders (for sampling in cold or deep water)

Step 1 - Choose your sample site

- Select sampling reaches that are safe and easily accessed by everyone in your group. A riffle will offer the best variety of organisms.
- You may also want to collect samples from other habitats such as pools, aquatic vegetation and stream margins. Compare the different results you obtain from these areas and discuss why (think about Functional Feeding Groups, different flows, or available oxygen).

Step 2 – Collect your sample.

Note: Follow these directions if you are sampling in *flowing* water.

1. Wade into the stream and place your net so the mouth of the net is perpendicular to and facing the flow of water.
2. Stand upstream of the net and disturb the stream bottom with your feet and hands.
3. Carefully pick up and rub stones directly in front of the net to remove attached animals. The stream bottom material and organisms will be carried by the current into the net. If the rocks are lodged in the stream bottom, rub them vigorously, concentrating your effort on any cracks or indentations.
4. After removing all large stones, disturb the sand and gravel to a depth of about 3 inches by raking and stirring with your hands.
5. Continue this process until you can see no additional animals or organic matter being washed into the net.

Note: Follow these directions if you are sampling in *pools or highly-vegetated* areas.

1. Scoop material from the stream bottom.
2. Push and pull the net through aquatic vegetation.
3. Hand pick organisms from sticks and other structures.

Step 3 – Empty your sample

1. Hold your sampling net over a plastic pan and use a bucket of stream water to wash the material into the pan.
2. If your sample contains a lot of rocks or debris, stir the sample in the pan to suspend the animals, then pour the suspended material back into your net. Rinse the debris from the pan, then wash the animals in the net back into the pan.

Step 4 – Sort out the bugs

1. Use plastic transfer pipettes, small paint brushes or your fingers to remove bugs from pans. For easier observation, place the animals into smaller water-filled containers (plastic ice cube trays or petri dishes work well).
2. Use the keys provided in this section to identify the bugs.

Macroinvertebrate Indices

Subsample to simplify EPT Value or Water Quality Rating Index

Time - 60+ minutes
Persons - 3 or more
Materials -

- Macroinvertebrate sample
- 1 plastic pan
- transfer pipettes
- plastic petri dishes or ice cube trays
- magnifying glasses
- ruler for subsampling
- dichotomous key
- Macroinvertebrate Index Data sheet

To calculate either index, you need to sort approximately 100 animals. It is very difficult to "randomly" select animals from a large sample, because we tend to choose the most obvious, largest or most active animals. This will bias the results. Subsampling gives you a representative selection from your larger sample.

1. Place entire macroinvertebrate sample into flat plastic pan.
2. Pour off most of the water from the pan, so material and animals are no longer floating. Distribute material evenly on the bottom of the pan.
3. Distribute material evenly on bottom of pan. Take a ruler and divide the material in the pan in half. Remove one half of the material from the pan.
4. Redistribute the material again over the bottom of the pan and divide this material again with a ruler.
5. Continue this process until you have a sample with about 100 total organisms.
6. Add some stream water back into the pan for easier sorting.

EPT Value

1. Find all the mayflies, stoneflies and caddisflies in your subsample using the identification key.
2. Separate these into as many distinct species by looking for differences in body shape, color and markings. Place all members of each species into separate containers.
3. Count the total number of species of mayflies, stoneflies and caddisflies. This total is the EPT Value.

Remember: A separate "species" in this case refers to animals that are related (e.g. all mayflies) but have enough different physical characteristics that they can be easily divided into separate groups.

Water Quality Rating Index

1. Separate each different type of macroinvertebrate in your subsample into a different container.
2. Use the identification key to identify each different type. Look at the body shape, color and markings.
3. Separate these different types into pollution tolerance categories, using picture guides on data sheet.
4. Multiply the number in each category by the pollution sensitive weighting found on the data sheet.
5. Sum the number of animals in each category and the weighted values for each category. Add up the total number of animals, and the total weighted values.
6. Divide the total weighted values by the total number of animals. This will give you the Water Quality Rating Index.

	EPT Value	Water Quality Rating Index
Time -	45 minutes	60 minutes
Persons -	3+	3+

Materials (needed for either sampling method)

- 1 plastic pan
- 4 plastic petri dishes
- 4 transfer pipettes
- 1 kick net
- 4 magnifying glasses
- dichotomous keys
- 1 pair waders (for cold and/or deep water)

EPT VALUE

Aquatic invertebrate Group	Number of different "species" found
MAYFLIES	
STONEFLIES	
CADDISFLIES	
TOTAL	

Total "species" equals EPT Value

[ ] >10 not affected (excellent water quality)

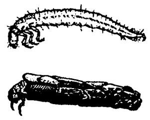
[ ] 6 – 10 slightly affected (good water quality)

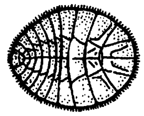
[ ] 2 – 5 moderately affected (fair water quality)

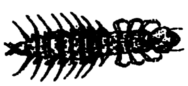
[ ] < 2 severely affected (poor water quality)

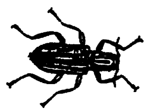
Water Quality Rating Index
(Circle each category found)

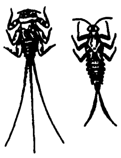
Group 1: Pollution Sensitive


Caddisfly larva


Water penny


Dobsonfly larva adult


Riffle Beetle


Mayfly nymph

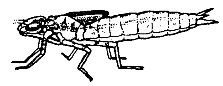

Gilled Snail

Group 3: Fairly Tolerant

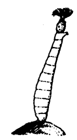

Scud


Clams, Mussels

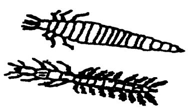

Crayfish nymph

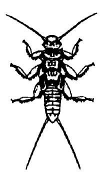

Dragonfly

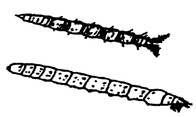

Damselfly nymph


Blackfly larva

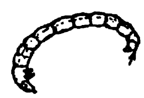
Group 2: Slightly Tolerant


Beetle larva

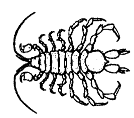

Stonefly nymph

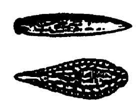

Cranefly larva

Group 4: Very Tolerant


Midge larva


Pouch (left hand) Snail


Sowbug


Leech

Total # categories of Pollution Sensitive Group 1	______	X	100	=	__________
Total # categories of Slightly Tolerant Group 2	______	X	80	=	__________
Total # categories in Fairly Tolerant Group 3	______	X	60	=	__________
Total # categories in Very Tolerant Group 4	______	X	30	=	__________
COLUMN TOTALS	______	(a)			__________ (b)

Divide (b) by (a) __________ / __________ = Water Quality Rating Index ______________

Water Quality Rating Value:

[ ] > 79 Excellent [ ] 60-79 Good [ ] 40-59 Fair [ ] < 40 Poor

Riparian Zone

Greenline

Time – 30 minutes
Persons – 2
Materials –
- Flagging
- Tape measure
- Riparian Zone Data Collection Sheet
- Plant guide (optional)

NOTE: The "greenline transect" can be done at the same time as the "canopy cover transect." To save time have your directions and data sheets ready for both.

1. Measure a 100 ft stretch along your stream. Place a flag near the water at the beginning and end points.

2. Standing at the first flag, look toward the water. Note the vegetation type that is closest to the water and record it in row (1) of the data sheet.

3. Take one pace toward the other flag and stop. A pace is a normal stride you would take while walking. Look toward the water and record the vegetation type closest to the water.

4. Repeat these steps until you reach the other flag.

5. Add up the total number of steps you took and record in row (2).

6. Sum up all the observations and record in row (3)

7. For each vegetation category, divide the number in row (2) by the number in row (3), multiply by 100 and record in row (4). This will give you the percentage of the greenline that is made up of that vegetation category. For example, if you took 50 steps and found grass at 20 of them then 40% of your greenline consists of grasses.

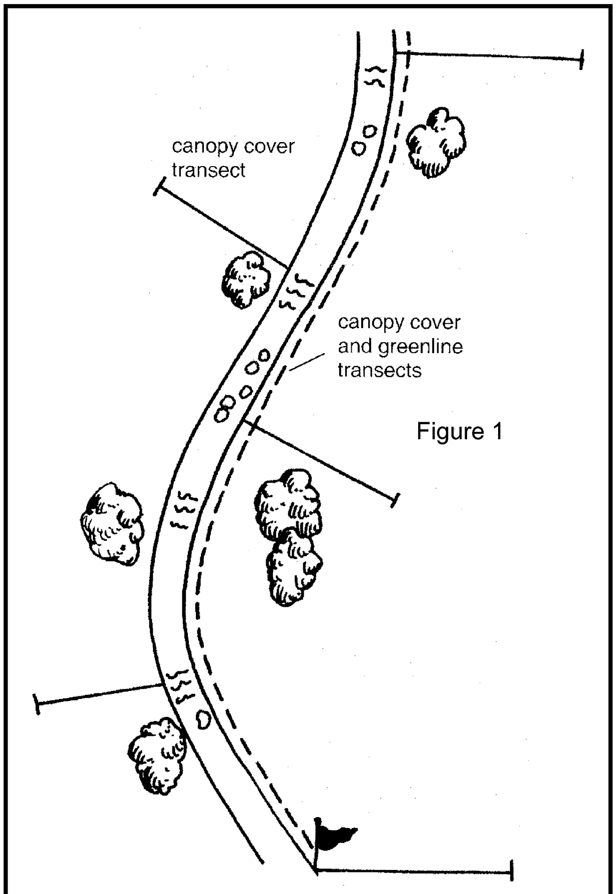


Figure 1

8. For each vegetation category, multiply the number in row (4) by the factor in row (5) and record in row (6). This will give you the "site score" for each vegetation category. Because sedges and rushes have the strongest roots and prevent erosion the best they receive the highest factor - "9." Bare ground doesn't prevent erosion so it receives the lowest factor – "1."

9. Add the individual site scores in row (6) together to get the "total site score" for that stretch of stream.

Canopy Cover

Time – 30 minutes
Persons – 2
Materials –
- ocular tube
- measuring tape
- Riparian Zone Data Collection Sheet

Note: At each point where you record greenline data you will also record canopy cover data.

1. Point the ocular tube straight up in the air (90 degree angle) and look through it with one eye. Your partner who is recording data can help you adjust the tube until it is as straight as possible.
2. Tell the recorder whether the “X” at the end of the tube points at sky (a “miss”) or a part of a tree or bush (a “hit”). Record this on your “canopy cover data chart.”
3. Repeat these steps for the rest of the greenline.
4. Add up the total hits and misses and record in the second row.
5. Add the two scores recorded in row 2. This will tell you the “total number of steps” you took along the transect (the greenline). Record this total in row 3.
6. Divide the number of “hits” in row 2 by the total observations in row 3 and multiply by 100. This will give you the percent canopy cover for the transect.

Ground Cover

Time – 35 minutes
Persons – 2
Materials –
- Measuring tape
- Riparian Zone Data Collection Sheet

Note: Riparian ground cover transects start at the stream edge and extend 15 paces away from the stream, into the riparian vegetation. A pace is a normal stride you would take while walking.

1. You will collect data along five separate transects in your stream stretch, spaced out at approximately equal distances along your stream reach. If possible, you should run two transects on one side of the stream and three on the other to get a better picture of the total riparian zone. Refer to the figure on page 1 of these instructions for help locating these transects.
2. Starting at the stream’s edge take one pace away from the stream. Touch your finger to the ground at the tip of your front foot.
3. Note the ground cover type that your finger touches. The categories are: bare ground, live vegetation, litter (dead vegetation or sticks) or rock. Record the type with a slash in the appropriate box on the “ground cover data chart.” Note that each column on the data chart is for a separate transect.
4. Repeat steps 2 – 3 for 15 paces. Then move on to the second transect. Repeat.
5. When you’ve finished with all five transects, add the totals for each row or cover type. Record your totals for each ground cover category in the category total column. In the next column, divide the categoy total by 75 (your total number of steps) and multiply by 100. This will give you a percentage of ground cover for each type in the riparian zone. To check your math, add up your percentages for each ground cover type. They should total 100%.

* The percentage of each ground cover type provides a measure of ground cover that can be compared to other sites or to compare changes over time (between different years or seasons). As a general rule, though, a healthy riparian zone will be covered by a mixture of litter, rock and vegetation. An important exception to this are desert streams, which have very sandy banks.

Greenline

	Vegetation Categories				
	Deep Rooted Plants		Shallow Rooted Plants		
	Sedges and Rushes	Shrubs and Trees	Grasses	Forbes	Bare Ground
Row 1: Record each observation as a slash mark in the appropriate box.					
Row 2: Total # of observations for each category					
Row 3: Total number of observations for the entire greenline (sum of all observations in Row 2):					
Row 4: % of each category (divide row 2 values by total in row 3. Multiply by 100)					
Row 5: Multiply each value in row 4 by this factor.	X 9	X 8	X 6	X 3	X 1
Row 6: Site score for each category					

Total Site Score (add up all site scores in Row 6)**:**______________________

The higher your score the stronger your plant roots are and the more your stream banks will resist erosion.

Notes:

____

____

____

____

____

Canopy cover

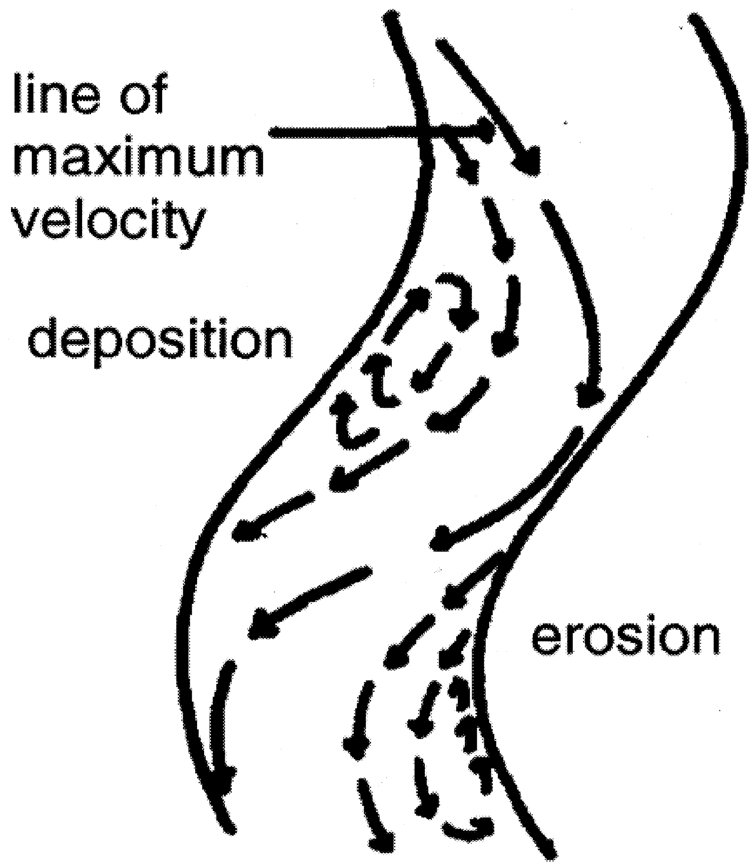
	"Miss" (Open sky)	"Hit" (Vegetation)
At each step along green line, record with a slash whether you see a "miss" (open sky) or a "hit" (vegetation) in your ocular tube.		
Total # of slash marks for each category		
Total number of observations		
% Canopy cover: Divide total "hits" by total observations and multiply by 100		

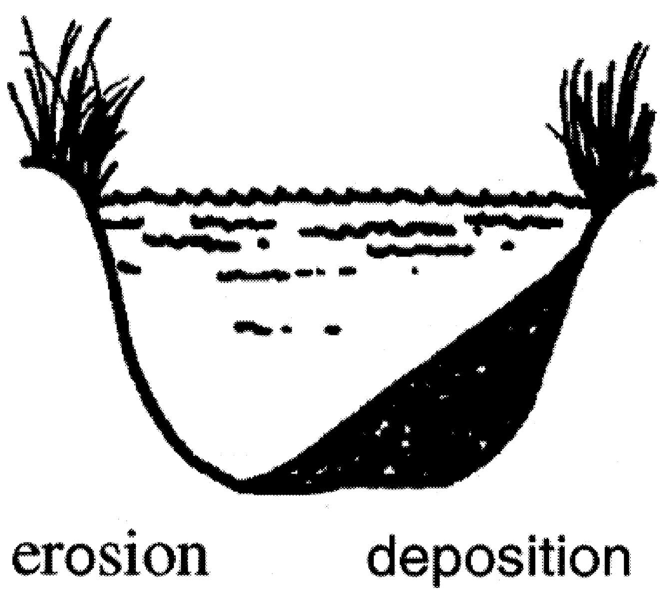
The more "covered" area you have the more shading your stream receives (this keeps the water cool and provides food for aquatic organisms).

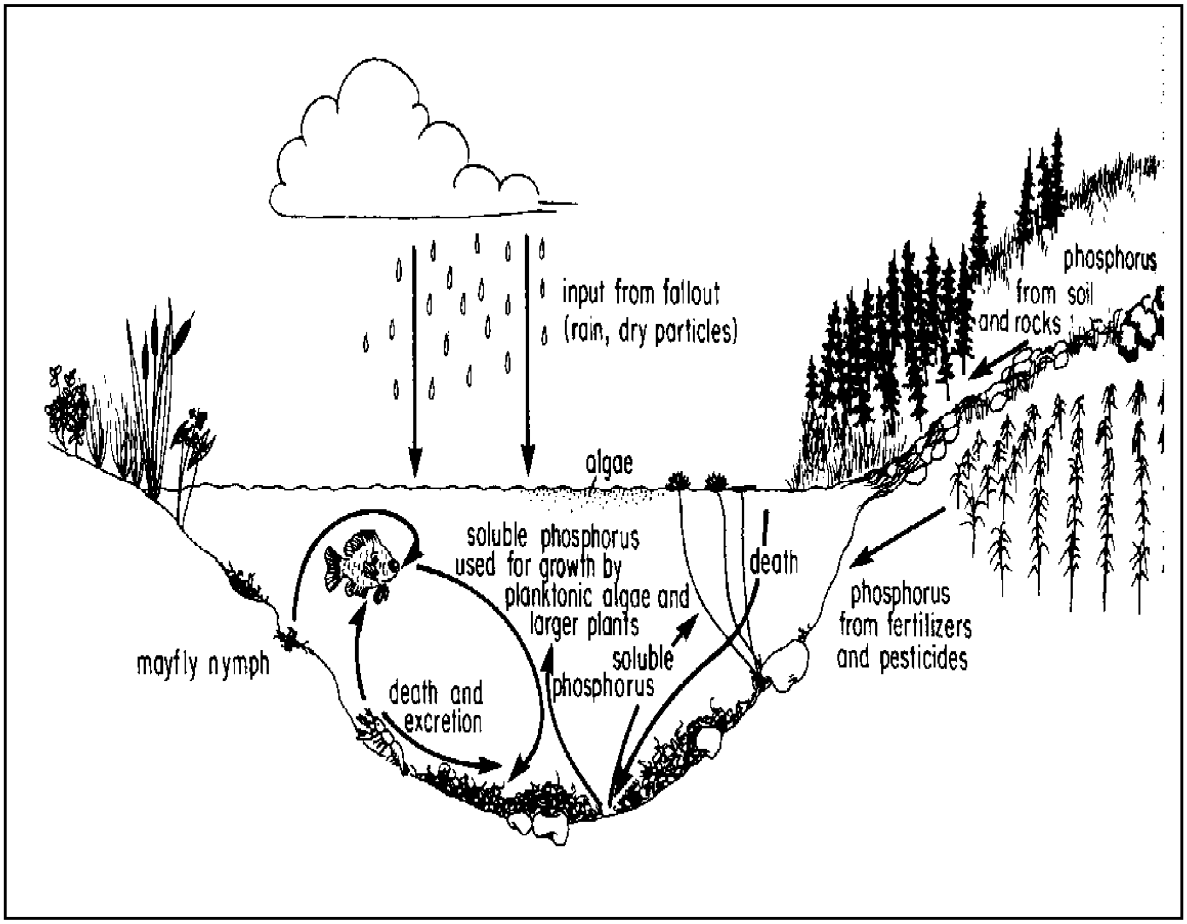
Ground cover

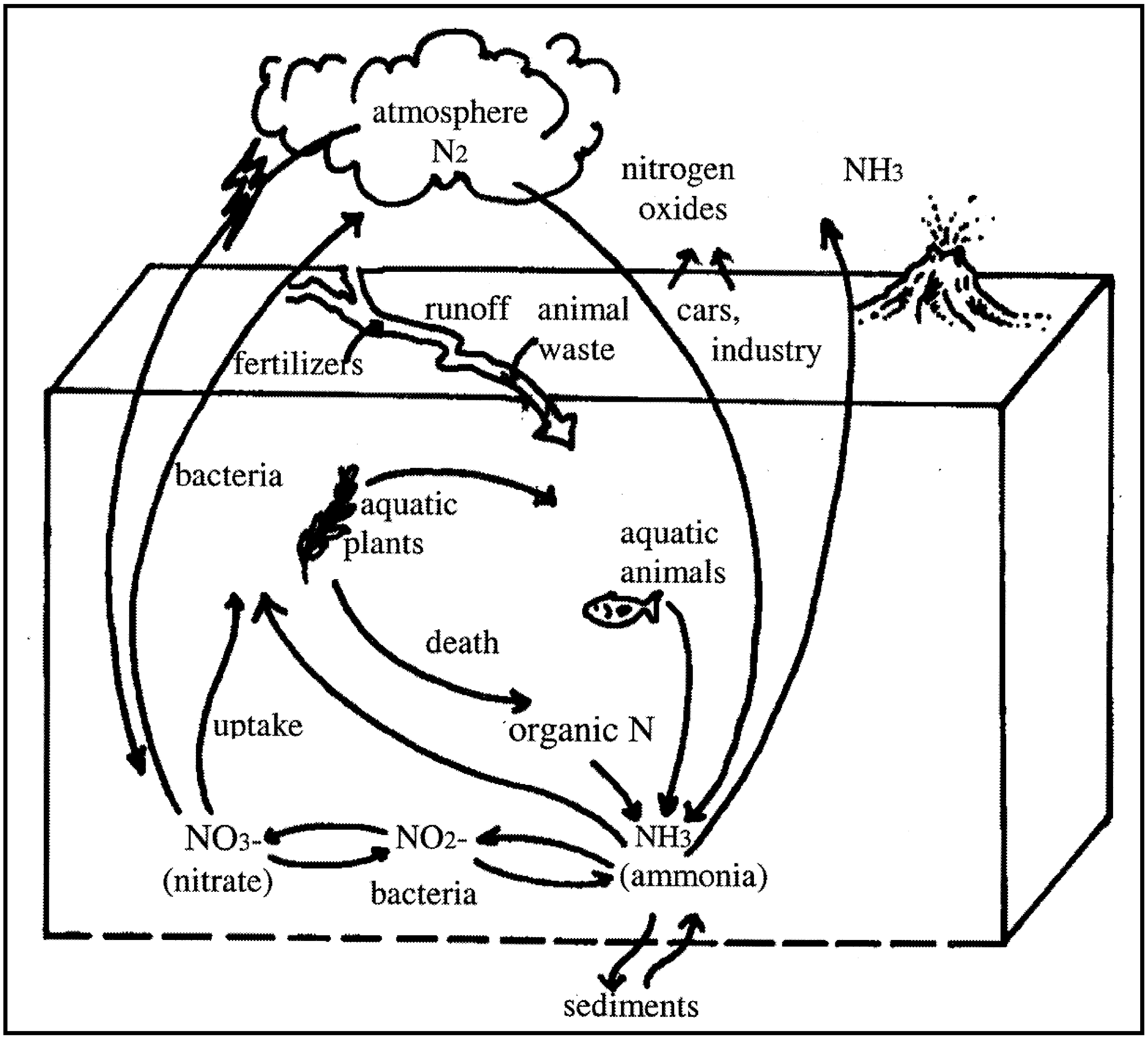
	Transects Perpendicular to the Greenline						
	1	2	3	4	5	Category Total	**Percent of each category** (divide category total by 75 and multiply by 100)
Live vegetation							
Litter							
Rocks							
Bare ground							

Appendix 6. Overhead Masters


line of
maximum
velocity
deposition
erosion


erosion
deposition

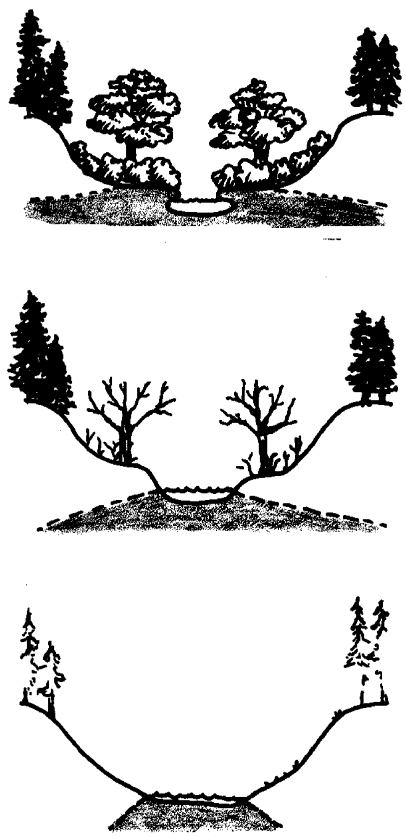

input from fallout
(rain, dry particles)
phosphorus
from soil
and rocks
algae
soluble phosphorus
used for growth by
planktonic algae and
larger plants
death
phosphorus
from fertilizers
and pesticides
mayfly nymph
soluble
phosphorus
death and
excretion


atmosphere
N2
nitrogen
oxides
NH3
runoff
animal
waste
cars,
industry
fertilizers
bacteria
aquatic
plants
aquatic
animals
death
uptake
organic N
NO3-
(nitrate)
NO2-
bacteria
NH3
(ammonia)
sediments

pH Scale

	Common substances		Biological effects
	Stomach acid	1	
	Lemon juice		
		2	
	Vinegar	3	
			All fish die
	Soda	4	
	Tomatoes		Caddis and may flies die
	Carrots	5	
	Normal rain		Salmon eggs and alevin die
		6	Bass and trout begin to die
ACIDIC	Milk		Snails and tadpoles begin to die
NEUTRAL		7	
	Human blood		Optimum for most fish
BASIC	Egg whites	8	
	Baking soda	9	
			All fish die
		10	
	Ammonia		
		11	
	Bleach	12	
	Lye	13	
		14	

Changing channel shape resulting from loss of riparian vegetation



Temperature Scales		
Celsius	**Fahrenheit**	
100	**212**	Boiling point of water at sea level
90	194	
80	176	
70	158	
60	140	
50	122	
40	**104**	38°C (98.6 °F) – average human body temperature
30	86	
20	**68**	Average room temperature
10	50	
0	**32**	Melting (freezing) point of ice (water) at sea level
-10	14	
-20	-4	
-30	-22	
-40	-40	
-50	**-58**	-50°C (-59°F) – 2nd lowest recorded temperature in continental US (near Logan, UT)
-60	-76	
-70	-94	
-80	-112	
-90	**-130**	-67°C (-89°F) – lowest recorded temperature - Antarctica, July, 1983
-100	-148	

Converting Fahrenheit to Celsius
°C = (5/9) x (°F-32)

Converting Celsius to Fahrenheit
°F = [(9/5) x °C] + 32

Overhead and cross-section views of physical characteristics of a stream channel

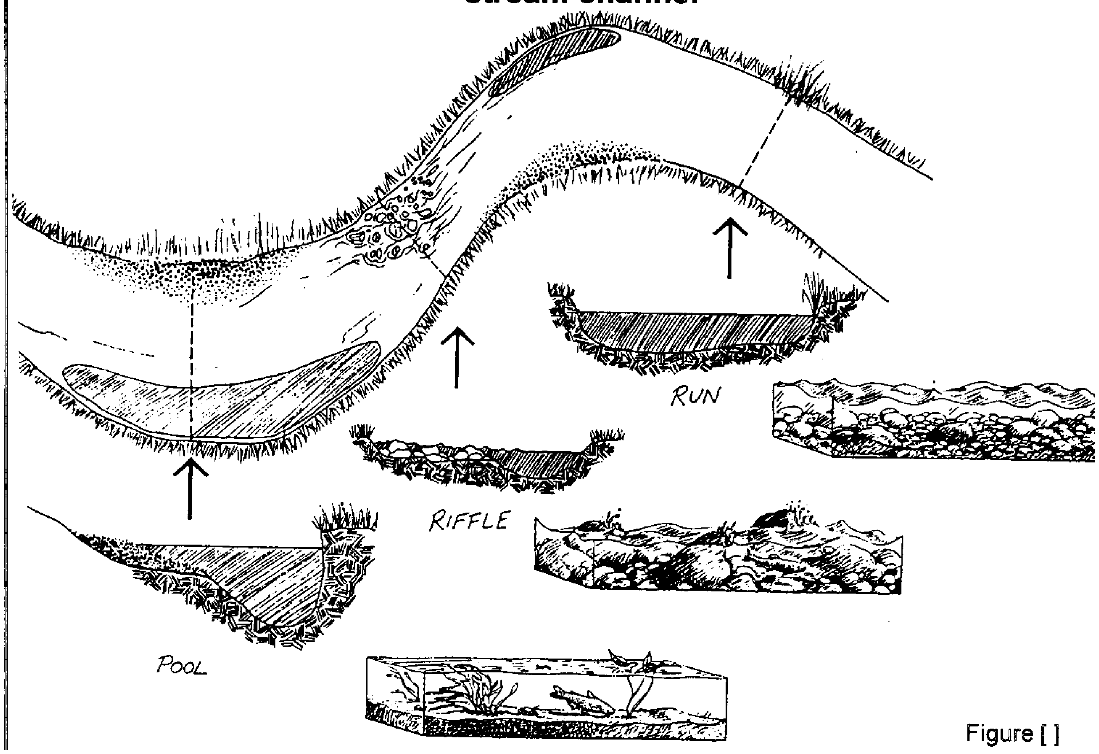
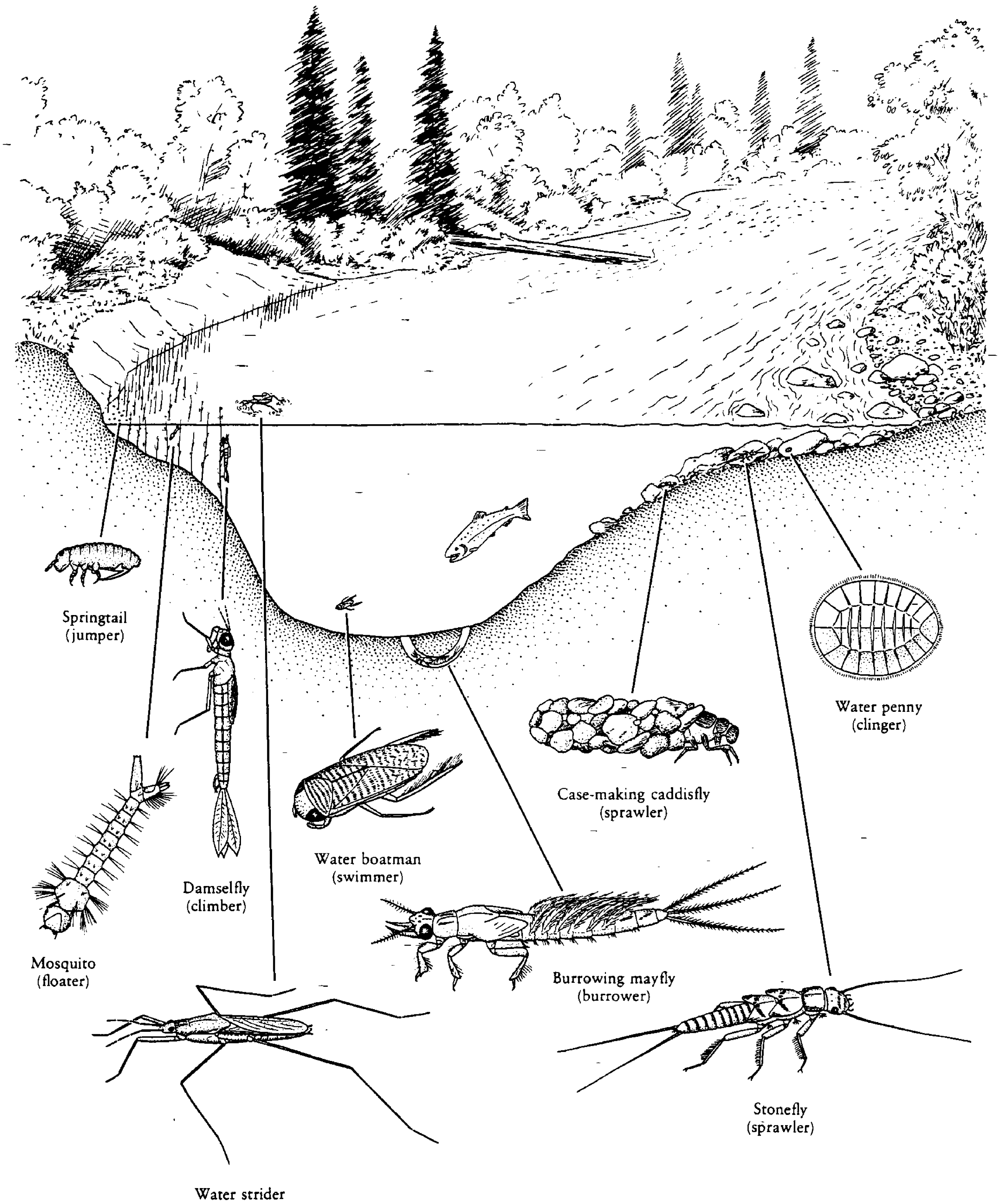


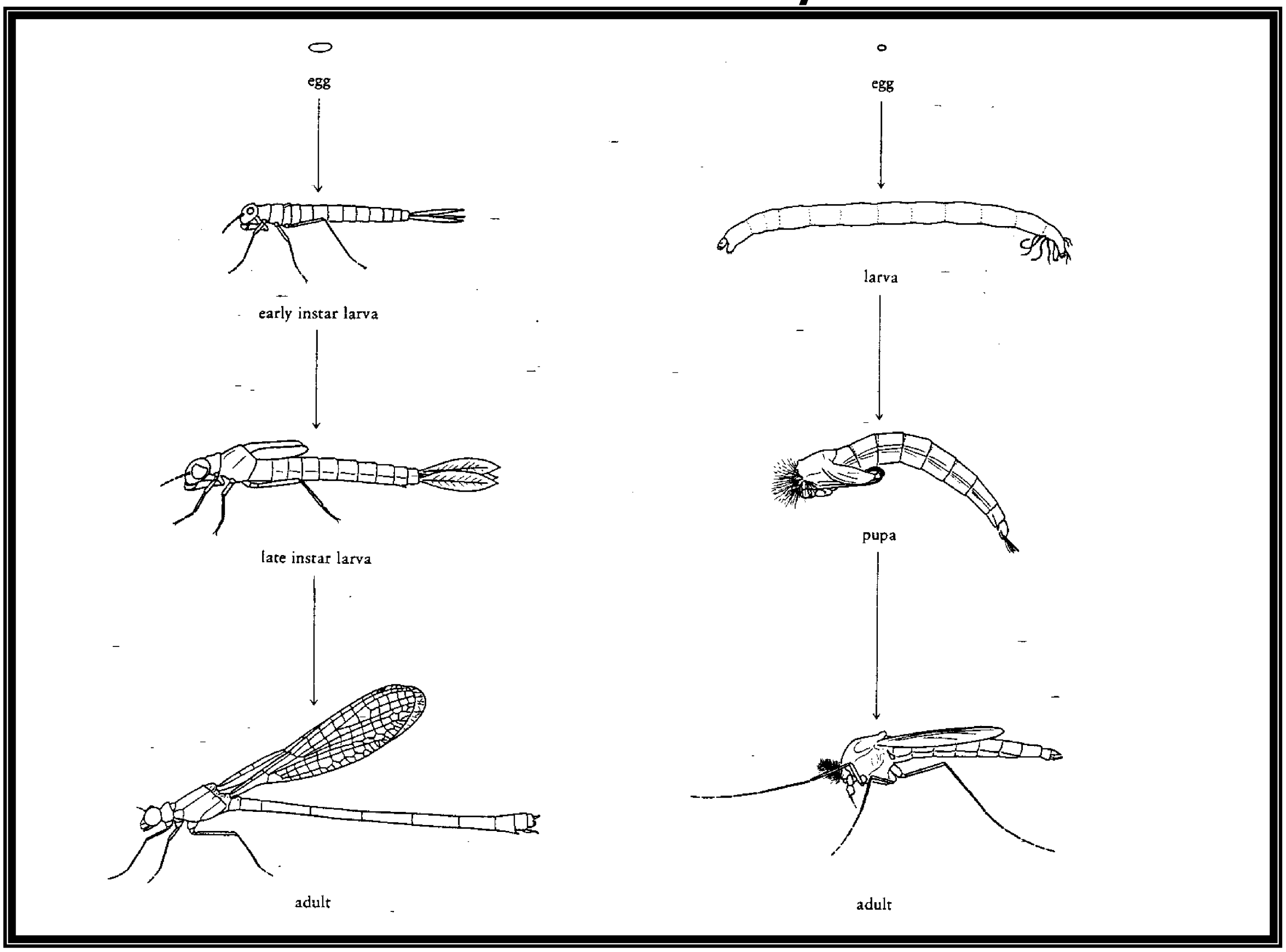
Figure [ ]

Macroinvertebrates in your stream



Provonsha in McCafferty, Aquatic Entomology, 1998: Jones and Bartlett Publishers, Sudbury, MA. www.jgſub.com. Reprinted with permission

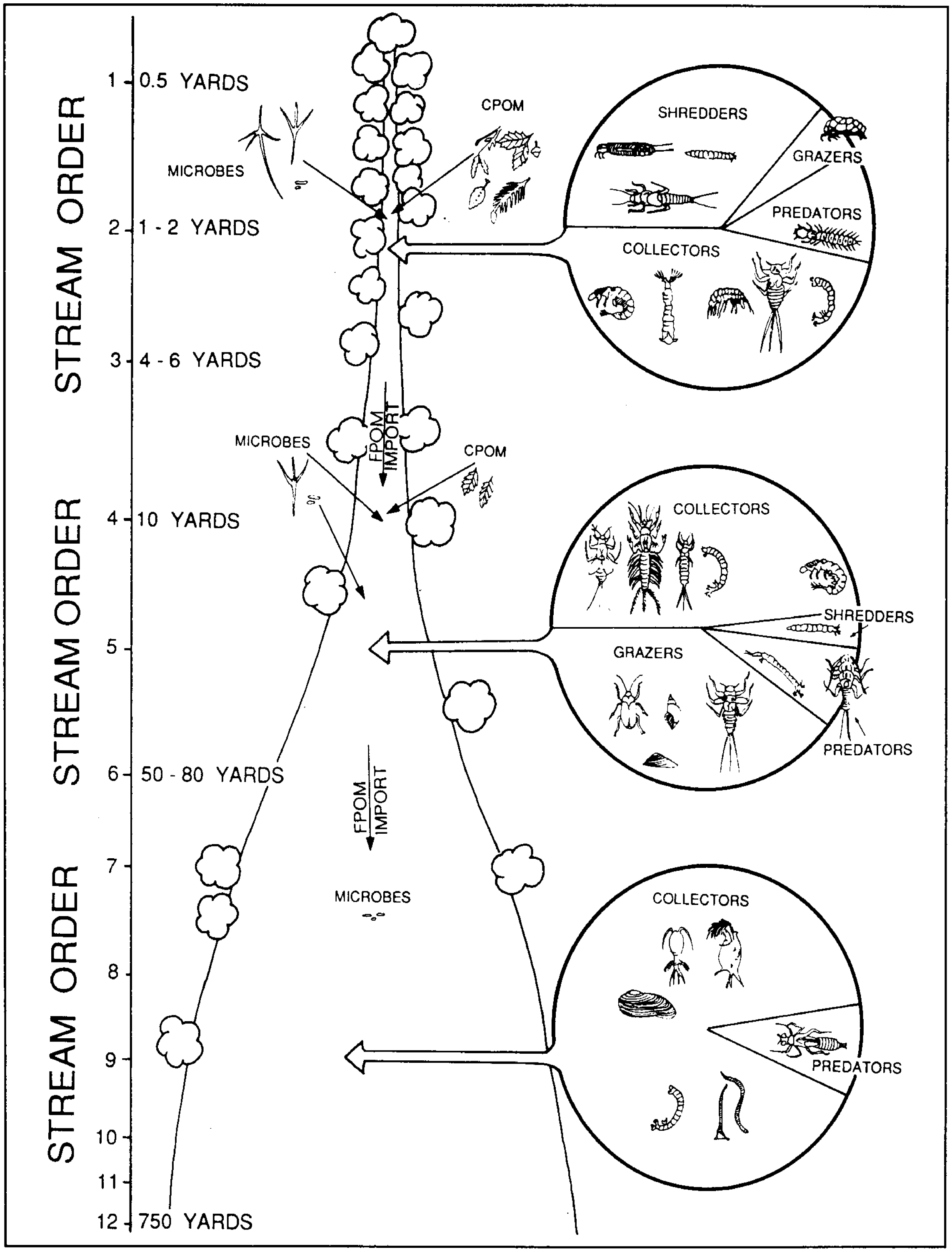
Macroinvertebrate Life Cycle



Provonsha in McCafferty, Aquatic Entomology, 1998: Jones and Bartlett Publishers, Sudbury, MA.
www.jg[ub.com. Reprinted with permission

D

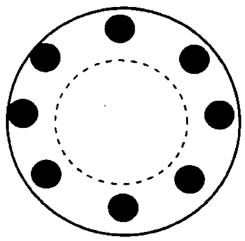
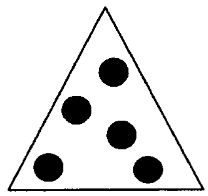
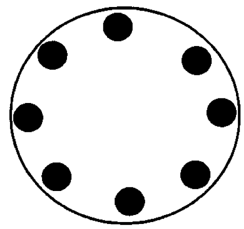
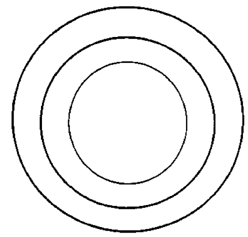
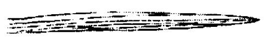
Functional feeding groups

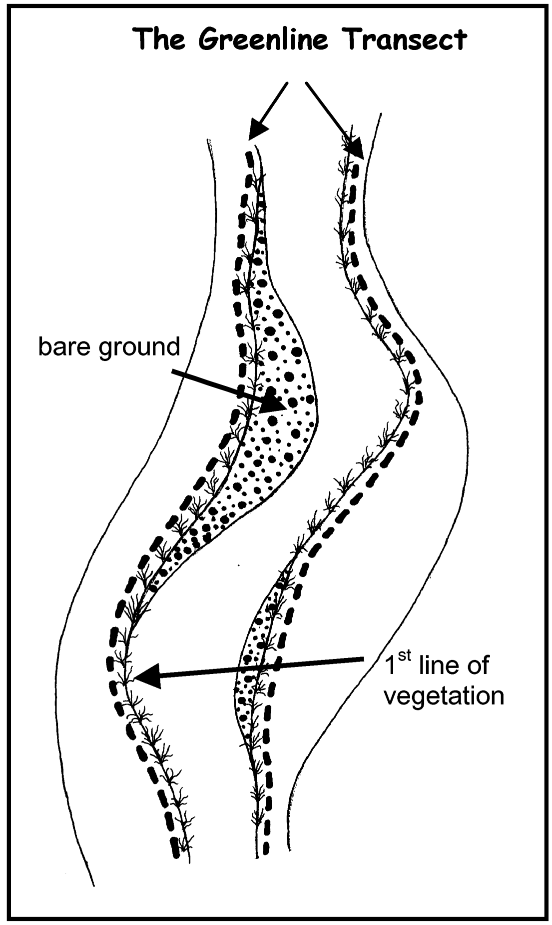


Source: Ken Cummins, "From Headwater Streams to Rivers," *The American Biology Teacher*.

CPOM (coarse particular organic matter) – plant material (leaves, needles and wood)
FPOM (fine particulate organic matter) – feces and tiny bits of plant materials

Vegetation Types

	Grasses	Grasslike sedges	Forbes	Shrubs
Stems	 Hollow or Pithy	 Solid, not Jointed	 Solid	 Growth rings Solid
Leaves	 PARALLEL VEINS		 "VEINS" are NETLIKE	
	 LEAVES on 2 sides	 LEAVES on 3 sides		
Example				


The Greenline Transect
bare ground
1st line of vegetation

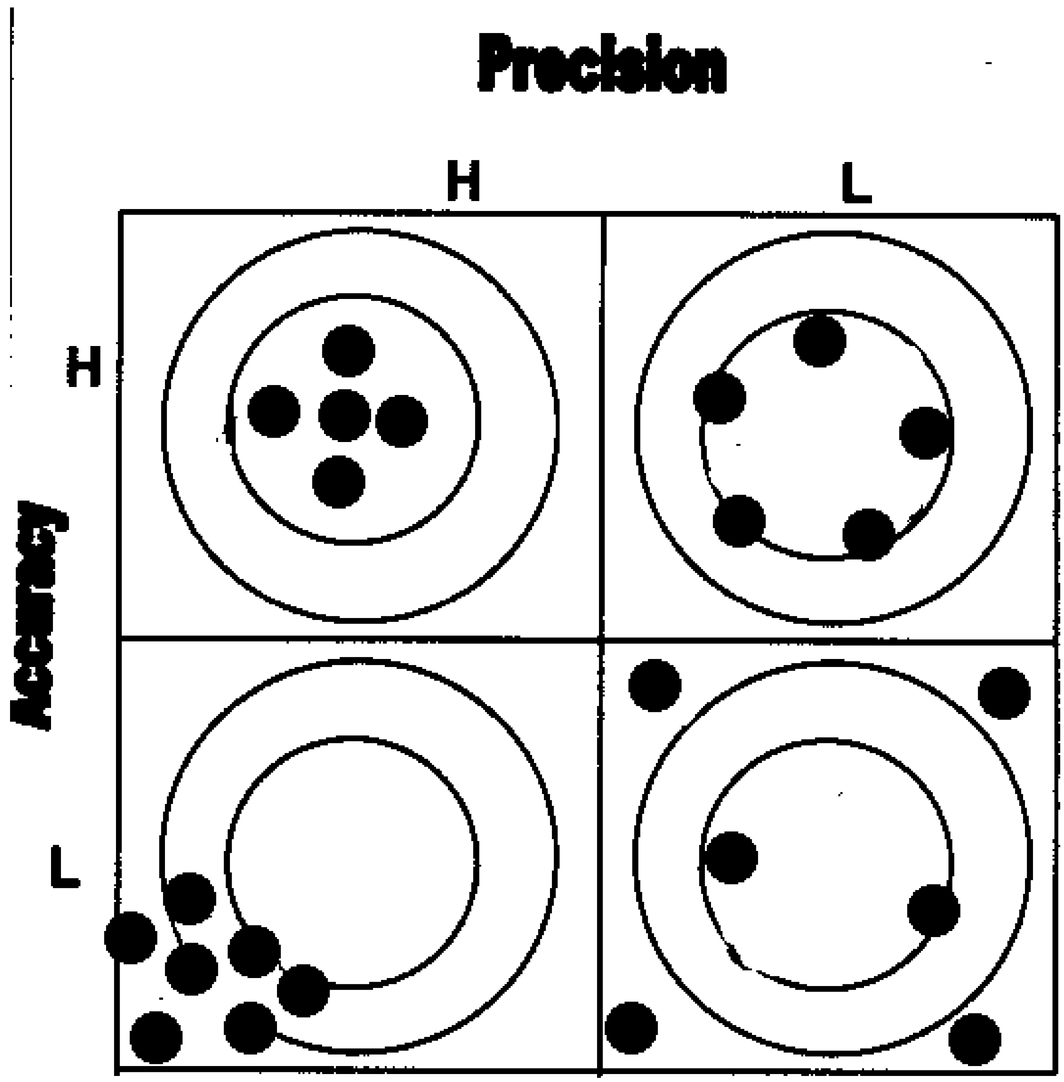
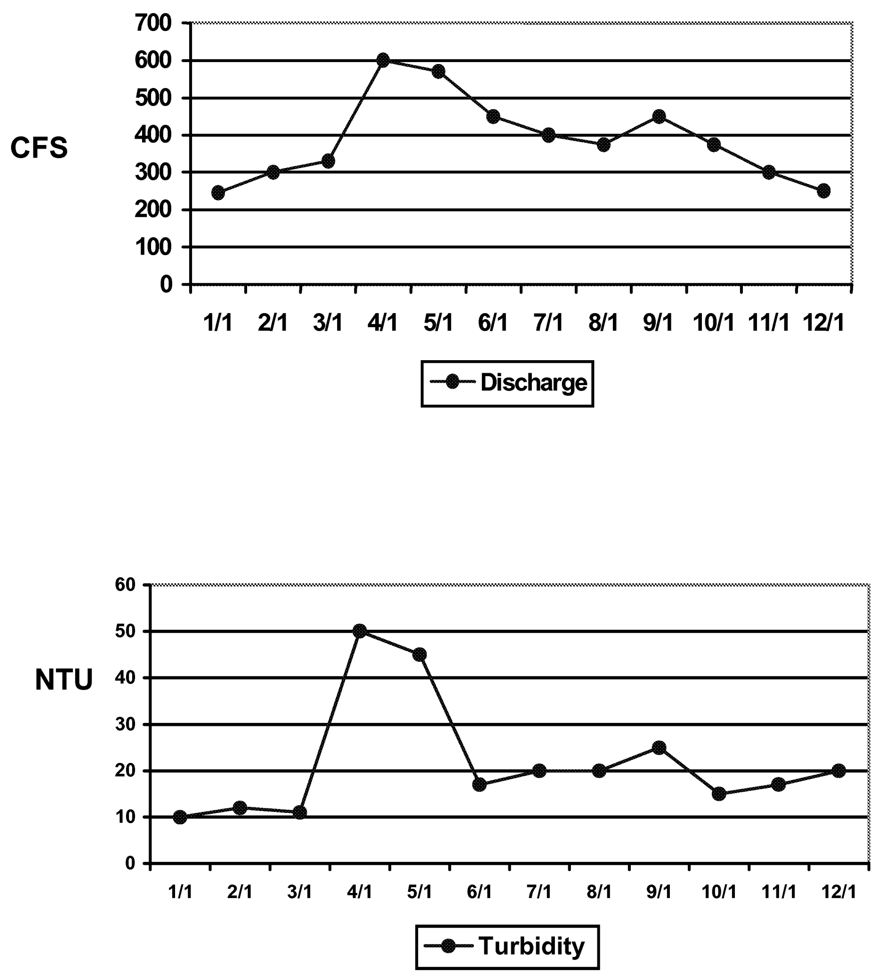


Figure VI-2.1

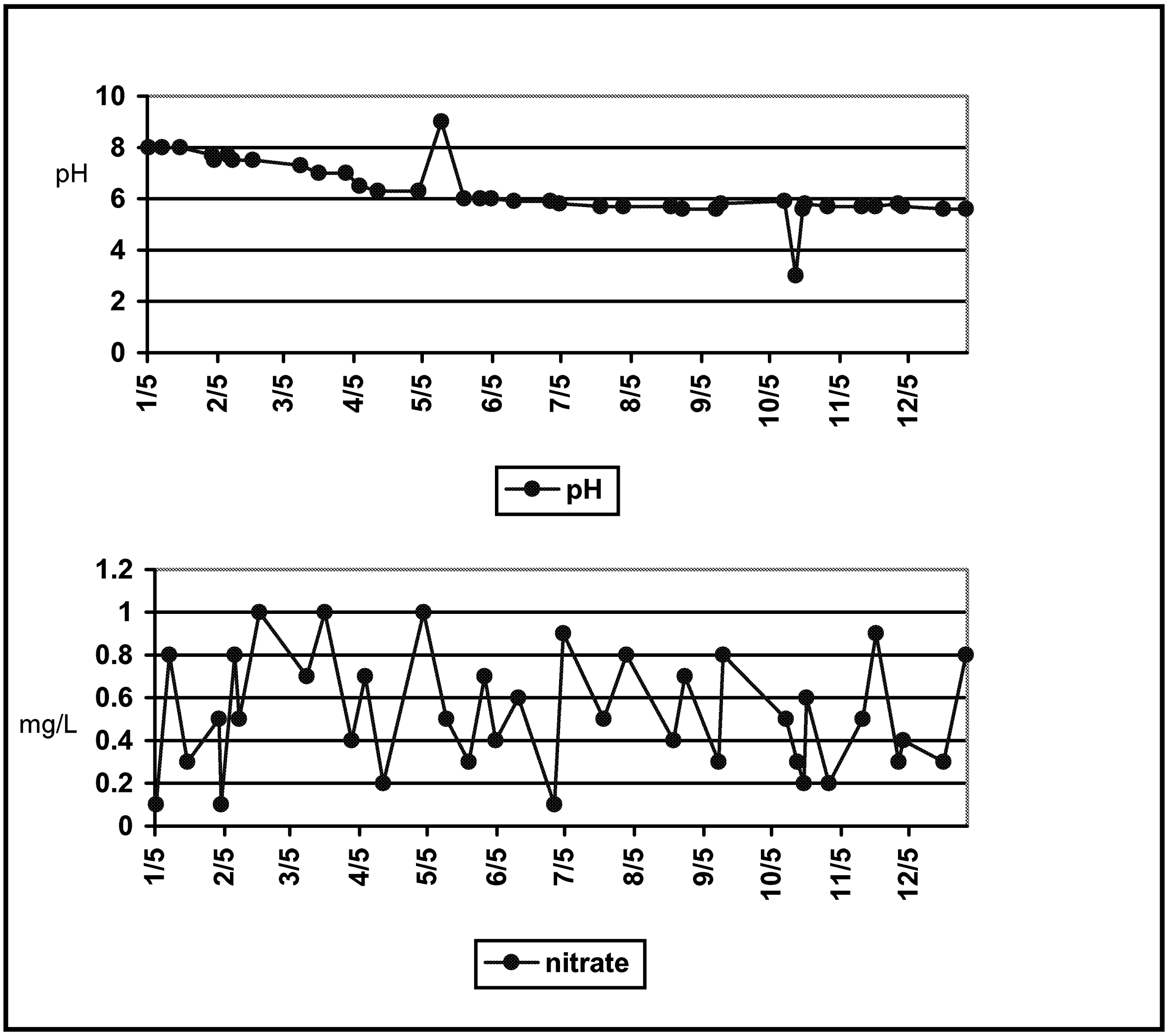
Adapted from: Volunteer Monitor's Guide to Quality Assurance Project Plans

Graph set 1



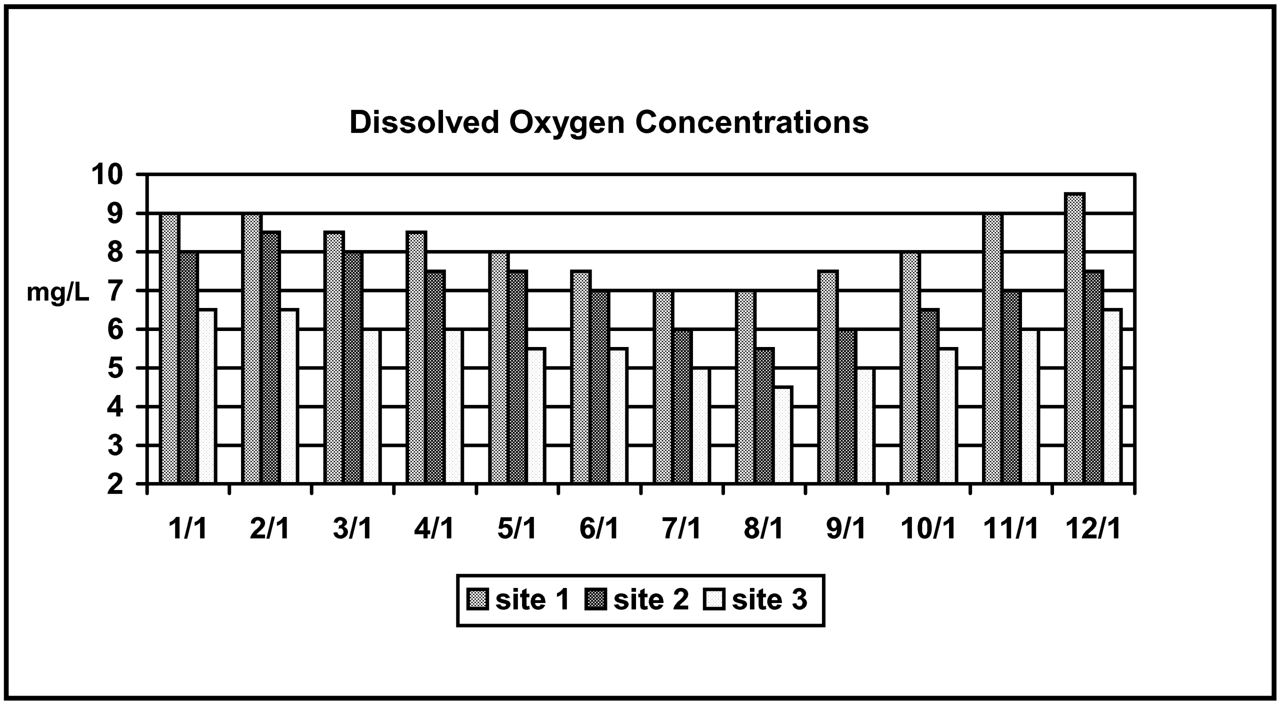
CFS
700
600
500
400
300
200
100
0
1/1 2/1 3/1 4/1 5/1 6/1 7/1 8/1 9/1 10/1 11/1 12/1
Discharge
NTU
60
50
40
30
20
10
0
1/1 2/1 3/1 4/1 5/1 6/1 7/1 8/1 9/1 10/1 11/1 12/1
Turbidity

Graph set 2

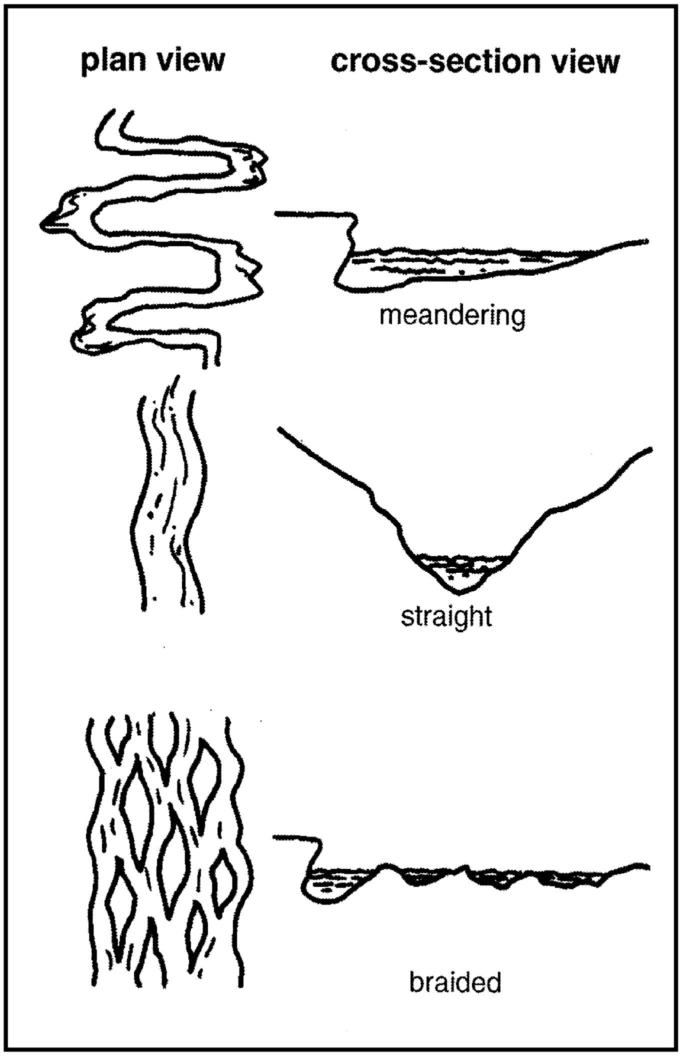


1. and precise nature of the data points suggests sampling error is not a factor. Contact a water quality specialist to investigate further.

Graph 3



Dissolved Oxygen Concentrations
10
9
8
mg/L 7
6
5
4
3
2
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
11/1
12/1
site 1
site 2
site 3


plan view
cross-section view
meandering
straight
braided

Appendix 7. Funding Your Monitoring Program

Funding Your Monitoring Program

Why do we need funding?

Funding presents one of the biggest obstacles to any field monitoring program. An on-going program needs money to purchase supplies and new equipment. Money also secures transportation which means more field time and better water quality assessments. Unfortunately, most school and community groups lack monetary support. This section will help you to overcome this obstacle by providing strategies and sources for obtaining funding.

Where do we obtain funding?

Support for your program can come from many sources:

- fundraisers (sales, special events)
- grants (foundation, government, and corporate)
- solicitations (local businesses, community groups, PTA, school board)
- partnerships (resource management agencies, community groups, non-profit environmental organizations)

> The *Utah Stream Team* suggests monitoring groups obtain their own monitoring tubs. Tubs are available on loan for free (see "The *Utah Stream Team* Monitoring Kit," section III-6). However, supplies are limited. Having your own tub allows you to monitor whenever you wish and to tailor your equipment to fit your specific monitoring objectives. For example, if you are interested in acidity levels, you may want to purchase a pH meter, which gives more accurate and precise measurements than pH strips provided by the Utah Stream Team.

How do we obtain funding?

Your available time, commitment, and resources will determine which of the previous sources, you target. Regardless of your approach, follow these general principles:

- Diversify! You will have more success if you approach a variety of funding sources.
- Most funding sources like to give to new programs: finding support for a continuing program will prove more difficult. Since monitoring is, by nature, an ongoing process, you may try adding a new wrinkle to your program to attract interest.
- If your data is benefiting someone – a land owner, municipality or agency – ask them to help share the cost.
- Businesses are always looking for strategic ways to give away money and gain publicity. Monitoring programs make excellent recipients. Contact corporations with offices or stores in your town. When you approach them to ask for money, include ways you will recognize the company's contributions.
- Remember, in-kind support (equipment, volunteers, technical assistance, laboratory analysis, training) can be just as valuable as money, if not more so. A great many sources can be of help, including: natural resource management agencies, local government agencies, non-profit organizations, universities, community groups, and more.
- Collaborate! Work with other teachers in your school, school district and beyond to create a watershed level approach to water quality monitoring. Integrated programs are more likely to receive funding than individual programs.

Grantwriting Tips

[adapted from: Nancy Light, "Proposal Writing Made Simple(r)," The Volunteer Monitor. 5(2) Fall 1993]

- Believe in your program and your confidence will shine through in your application. Be honest.
- Know your grantmaker and tailor your request to the foundation's specific interests.
- Follow proposal guidelines to a tee.
- Don't limit yourself to environment-specific grants. Be creative in how you address grant requirements.
- Define your water quality program precisely and concisely. You should be able to summarize your program in one or two sentences.
- State very clearly the nature of the water quality problem and why you are addressing it. Leave out the hyperbole.
- Tell the grantmaker how you are going to fix the problem (it does not necessarily need to be fixed through monitoring). If you are monitoring, explain exactly what will be done with the data after you have collected it.
- Provide a line-by-line budget if possible.

What are some specific funding sources?

The organizations and programs described below provide consistent opportunities for obtaining money or in-kind support. Of course, these are but a few of the hundreds of potential funding sources available. Consult the next section "Grant Clearinghouses" for publications and web sites that list other state and national funding sources.

Cooperative Extension Service

The Cooperative Extension Service is a national organization that seeks to extend research-based knowledge into the community. In Utah, that mission has included support for school monitoring programs. Extension provides in-kind support in the form of technical expertise, equipment, supplies and training. Contact your local Cooperative Extension Agent or the State Water Quality Coordinator Nancy Mesner, Extension Specialist, 435-797-2465, Fax: 435-797-2443; E-mail nmesner@cc.usu.edu.

> Consider forming a relationship with a local water treatment plant. Often, plants will run back-up tests of samples, analyze difficult parameters for you (e.g., bacteria), provide training, and give tours of the plant. In the process, students see another real-life application for water quality monitoring.

Adopt-A-Waterbody

This program coordinates the efforts of volunteer groups around the State to "adopt" portions of rivers, lakes, wetlands and groundwater. Adoption may include cleaning up, monitoring, mapping, educating, restoring and more. Small grants are made available to volunteer groups to help supply materials for their project. For more information about grants and a copy of the funding review criteria contact Shelly Quick, Utah Division of Water Quality, 288 N. 1460 W. SLC, UT 84116; 801-538-6516.

School Foundations

Many counties, cities, and school districts in Utah have foundations who's purpose is to support school programs. Support comes in the form of money, transportation, volunteers and in-kind support. Consult you local School District Office or Board of Education to locate a foundation in your area.

Toyota USA Foundation

This foundation has a primary interest in K-12 math and science education programs which are broad in scope, incorporate interdisciplinary curricula, and have "real world" application. Schools may not directly apply to the Foundation but may be the recipient of an independent nonprofit agency's funding request. Grants are used to support the development and implementation of programs. Contact: Foundation Administrator, Toyota USA Foundation, A404, 19001 S. Western Ave., Torrance, CA 90509

Toyota USA also supports the *Toyota TAPESTRY Grant Program* which offers grants to K–12 science teachers. Grants are awarded in two categories: Environmental Education and Physical Science applications. The Environmental Education category funds projects that emphasize the efficient use of natural resources and protection of the environment. Students participating in these projects should gain an increased awareness of the terrestrial, aquatic, and/or atmospheric environment and an understanding of their own interdependence with the natural world. Contact: National Science Teachers Association, 1840 Wilson Boulevard, Arlington VA 22201-3000, 703-243-7100; www.nsta.org

Environmental Protection Agency - Environmental Education Grants

The Environmental Education Grants program supports projects that enhance the public's awareness, knowledge, and skills to make informed decisions that affect environmental quality. Any local or tribal education agency, college or university, state educational or environmental agency, nonprofit organization, or noncommercial educational broadcasting entity is eligible for these grants. The majority of grants are for under $5,000. To receive a solicitation of notice, mail a request, including your name, organization, address, and phone number, to: Environmental Education Grants – [year], U.S. EPA (A-107), 401 M Street, SW Washington, DC 20460

Chevron Corporation Grants

Chevron currently focuses its giving in the areas of K-12 math and science education ($1.7 million in '98), and environmental conservation ($1.6 million in '98), with an emphasis on habitat preservation, wildlife protection, and environmental education programs. Contact: http://www.chevron.com/community/grants/main.html

American Honda Foundation Grants

Grants are made for projects that focus on math, science, and environmental education. Eligibile groups include nonprofit organizations, K-12 schools and districts, education institutions, nonprofit scientific and education organizations. If the staff receive preliminary proposals a month before the deadline, they can provide feedback in time for applicants to make changes and still meet the deadline. Contact person: Kathy Carey, American Honda Foundation, 1919 Torrance Blvd, Bldg 100, Torrance, CA 90501 310-781-4090.

Resources to help you find grants

The Catalog of Federal Domestic Assistance Programs (CFDA) - This government-wide compendium of all 1,424 federal programs, projects, services, and activities that provide assistance or benefits to the American public. These programs provide grants, loans, loan guarantees, services, information, scholarships, training, insurance, and more. http://aspe.os.dhhs.gov/cfda/index.htm

EE Link – One section of EE Link is devoted to helping teachers and administrators obtain funding for science and environmental education programs. You'll find links to sites that offer strategies and techniques to develop funding for EE programs, and information on education-related grants that may be applicable to EE. http://eelink.net/grants-generalinformation.html

The Foundation Center – The Foundation Center, an independent national organization established by foundations, produces numerous publications on foundations and fundraising and also maintains library collections that are free to the public. To find out about Foundation Center publications, call 800-424-9836.

National Science Teachers Association (NSTA) – This web site offers dozens of national science education-related grants. Use the "search" option to find a grant that fits your program. www.nsta.org/

ScienceWise – This website has a user-friendly education and research funding search component. Check out *Federal Opportunities* for the latest grant opportunities available from U.S. federal agencies and *Foundation & Corporate Opportunities* for grant opportunities from private corporations. http://www.sciencewise.com/grantscontracts/

U.S. Department of Education (USDOE) – This USDOE web site provides information on current grants (applications available on-line) and grant-writing help. http://www.ed.gov/funding.html

Utah State Office of Education (USOE) / Planning and Project Services – Go to the Grant Requirements and Application Forms section of the USOE web site for up-to-date information on grants that are specifically available to Utah schools. www.usoe.k12.ut.us/data/grants.htm

Resources to help you write grants

EPA Grant Writing Tutorial – This web-based software walks users through the grant-writing process and helps them learn to write more competitive grants. It has detailed information and tips on writing a grant proposal and completing a grant application package; sections on three EPA grant programs; examples of good, complete grant packages; and, a mock grant-writing activity. (available for download or on a CD-ROM); http://www.epa.gov/grtlakes/seahome/grants.html

Grant Funding for Your Environmental Education Program: Strategies and Options - By M. Archie. 1993, 30 pp. For those of us with limited resources, this book is packed with tips, advice, and resource suggestions to better target fundraising efforts and to hone proposal writing skills. Available via the NAAEE website - www.naaee.org/ - for $9 nonmember / $5 for NAAEE members.

"River Wealth" – This 40-page booklet produced by River Network contains ideas for more than 50 ways to raise money from local community sources. Most of the suggestions are illustrated by a specific example from a river protection group. Available for $7 (includes shipping) from River Network, P.O. Box 8787, Portland, OR 97207; 800-423-8747.

The Volunteer Monitor – This bi-annual EPA publication addresses all aspects of water quality monitoring, including those specific to school and youth groups. Volume 5 (2), Fall 1993 focuses on Funding Your Water Quality Monitoring Program. You can find this issue on the internet. www.epa.gov/volunteer/spring97

Bibliography

Bidlack, Cindy, and Robert Williams. "Grantwriting for Teachers," The Volunteer Monitor. 5(2), Fall 1993.

Environmental Protection Agency. EPA Grantwriting Tutorial. http://www.epa.gov/grtlakes/seahome/grants.html no date available.

Fabisch, Sue. Personal Communication. July, 1999.

Green, Jack. Personal Communication. June, 1999.

Green, Linda, and Jeff Schloss. "Cooperative Extension Support for Citizen Monitoring," The Volunteer Monitor. 5(2), Fall 1993.

Handley, Susan. "What Makes an Effective Fundraising Program?" The Volunteer Monitor. 5(2), Fall 1993.

Heacock, Craig. "Finding and Keeping Corporate Sponsors," The Volunteer Monitor. 5(2), Fall 1993.

Light, Nancy. "Proposal Writing Made Simple(r)," The Volunteer Monitor. 5(2), Fall 1993.

Appendix 8. Purchasing Supplies

Purchasing Supplies

- *Utah Stream Team* test kits and other equipment are obtained from the sources listed below. Additional monitoring supply sources are listed in the "Resources" appendix.
- Costs are estimates. Please check updated costs before purchasing.

Item	**Source**	**Cost**
calculator	Wal-mart	$3
pair chest waders w/ straps, belt	Wal-mart	$50-$100
garbage bags	Wal-mart	$1
tape measure (30m or 100')	Wal-mart	$10
clipboards	Wal-mart	$5
plastic tray	Wal-mart	$3
ping pong balls	Wal-mart	$1
small scissors	Wal-mart	$1
turbidity tube[1] (- #77107)	Forestry Suppliers	$35
survey flags	Bldg supply store	$4
plastic petri dishes (#D1151-PK20)	USU Chem Store	$2 (for 20)
transfer pipettes[2] (#Fisher 1371140)	USU Chem Store	$31 (for 100)
thermometer (#TO421)	USU Chem Store	$13
water collection bottle (#B0931)	USU Chem Store	$4
chemical waste bottles (#B0931)	USU Chem Store	$4
plastic gloves (#G0725)	USU Chem Store	$5 (for 100)
safety glasses (#G0151)	USU Chem Store	$4
box pH strips	USU Chem Store	$ 9
magnifying glasses (#SB18031M)	Nasco	$0.75
Nitrate-nitrogen test kit (#14161-00)	Hach	$46
- reagent refills		$42
Ammonia nitrogen test kit (#2241-00)	Hach	$46
- reagent refills		$31

Dissolved Oxygen test kit (#K-7512)	Chemetrics	$38
- reagent refills		$19
Phosphate Test Kit[3] (#PO-19)	Hach	$59
-reagent refills		$18
kick net	you make it	$7
occular tube	you make it	--
macroinvertebrate ID key	we will provide	--

---

[1] Attach a string from the tube to the bottom rubber piece to keep from losing it.
[2] Snip the end of the pipette to make it larger. Opening should be ¼" wide.
[3] Range 0 – 1 mg / liter

Contact Information

Hach Company
PO Box 389
Loveland, CO 80539
800-227-4224 (ph)
970-669-2932
email: orders@hach.com
web: www.hach.com

Forestry Suppliers, Inc.
PO Box 8397
Jackson, MS 39284-8397
800-647-5368 (ph)
800-543-4203 (f)
www.forestry-suppliers.com

Chemetrics
Rt 28
Calverton, VA 20138
800-356-3072 (ph)
504-788-4856 (f)
prodinfo@chemetrics.com
http://www.chemetrics.com

Nasco
4825 Stoddard Rd
Modesto, CA 95356-9316
800-558-9595 (ph)
209-545-1669 (f)
info@nascofa.com
http://www.nascofa.com

Utah State University
Chemistry Stores
Department of Chemistry
and Biochemistry
Widstoe Hall Room 129
Logan, UT 84322-0300
435-797-1616 (ph)
435-797-3390 (f)

Appendix 9. Making Your Own Monitoring Equipment

Make Your Own Monitoring Equipment

Stadia Rod

A stadia rod is used to take depth measurements in a stream channel. With this rod you can measure in both metric and English systems. You can also take length measurements in feet and tenths of feet at the same time. To measure, rest the rod on the bottom of the stream (do not dig in). Then read the depth on the downstream side of the rod (water piles up on the upstream side and will render a false measurement).

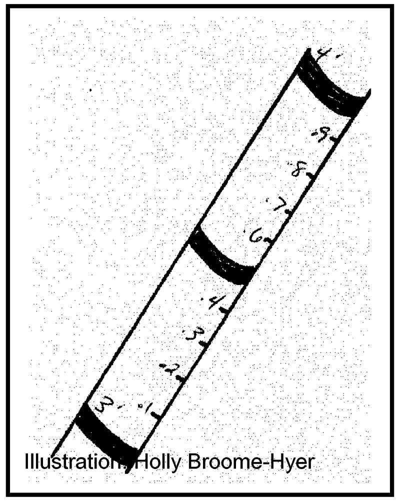


Illustration: Holly Broome-Hyer

Materials

- a 5 ft length of wooden dowel, rebar or PVC (¾ or ¼ in diameter)
- paint (red and white) / paint brush
- measuring tape

Directions

1. Paint the rod in either metric or English units (or both).
2. If you use English paint the rod with alternating 6 in long sections of bright red and white. Let dry. Then, paint black lines over the red and white, marking 0.1 foot intervals.

Occular Tube

An occular tube is used to sample canopy cover – see "The Riparian Zone – Canopy Cover Directions," section IV-4c. It is easy and cheap to make and easy to use.

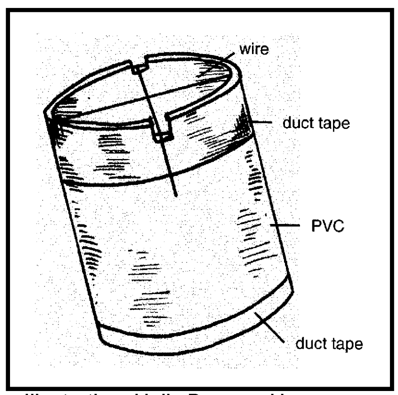


Illustration: Holly Broome-Hyer

Materials

- 6 in of 1 in wide PVC or other tubing material
- 2 paper clips
- Duct tape

Directions

1. Cut a 6 in length of PVC.
2. Make 4 notches every 90 degrees on one end.
3. Straighten paper clips and lay into notches. Bend excess length over the outside of the tube.
4. Duct tape around the ends of the paper clips to hold them in place.
5. Duct tape over the edges of the viewing end of the tube to make a smooth surface.

Staff/Crest Gauge

[source: Ken Pritchard, Vol Monitor, 7 (2), Fall 1995]

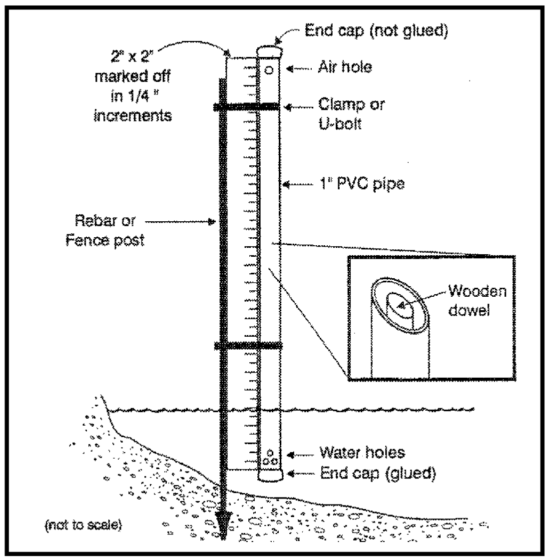
This combination gauge serves as both a staff gauge to measure the water level of a stream at the time of inspection, and a crest gauge to measure the highest level reached by that stream between the last inspection and the current inspection.

By taking successive staff and crest gauge readings and plotting them on a time graph, you can obtain a general picture of how a stream behaves in response to rain. For instance, a rapid rise and fall in stream level would denote the watershed's inability to slowly release water (probably due to a lack of vegetation). Long-term trends can also show a correspondence between stream levels and land use changes. For example, the data might show that runoff from a new shopping center has caused the stream to crest several inches higher after receiving the same amount of precipitation.

You can correlate your crest gauge readings (ft) to flow readings (CFS). Then, in the future, you will be able to determine stream flow based soley on your crest gauge readings.

Materials

- 6 ft fence post or rebar
- PVC pipe, 1in diameter (or wider), 4 or 5 ft long (length depends on anticipated change in stream level)
- 2 end caps for the PVC pipe
- 2 or 3 metal clamps or U-bolts
- Section of 2 in x 2 in wood, (about the same length as PVC pipe)
- Wooden dowel, ¼ in to ½ in diameter, to fit inside PVC pipe
- Granulated cork
- Permanent, waterproof marker
- Tape measure
- Drill
- Saws for cutting pipe and wooden dowel



Directions

1. Permanently mark 2 in x 2 in in 1/4 in increments. (Alternative: affix length of measuring tape to 2 in x 2 in.)
2. Glue end cap to bottom of PVC pipe. Drill three or four vent holes in section of pipe that will always be immersed in water. This will allow water to flow into pipe. Drill one vent hole near top of pipe, to allow air to escape.
3. Drive fence post or rebar into streambed in a location where water flows permanently and where you will be able to reach the gauge without getting wet.
4. Attach 2 in x 2 in to fence post or rebar using clamps or U-bolts.
5. Attach PVC pipe to 2 in x 2 in, aligning bottom of pipe with zero point marked on 2 in x 2 in.
6. Cut dowel to same length as PVC pipe (dowel should fit snugly so it won't float). Place dowel and granulated cork inside PVC pipe. Place end cap (DO NOT GLUE) on top end of pipe.

Calibrating the crest gauge

Calibrate the gauge by measuring the difference between the lowest point on the stream bed and the zero point on the scale marked on the 2 in x 2 in. (Note that the lowest point on the stream bed won't necessarily be the point where the gauge is located, but it must be along the same cross section.) This "depth-of-stream factor" must always be added to the gauge readings. Recalibrate the gauge yearly, and also after severe episodes of erosion or deposition.

Reading the crest gauge

To read the crest gauge, remove the top end cap and take out the dowel. Use the scale on the 2 in x 2 in to measure the level of the cork powder "ring." Don't forget to add the depth-of-stream factor (see "Calibration," above). After taking the reading, wipe off the cork powder and replace the dowel. Occasionally you may need to add more cork powder.

[For more information, contact Ken Pritchard, Special Projects Coordinator, Adopt a Beach, P.O. Box 21486, Seattle, WA 98111; 206-624-6013.]

Kick Net

Kick nets, which consist of screening material stretched between two poles, are used for sampling macroinvertebrates. Sampling is done by pushing the two poles into the substrate until the edge of the screen rests on the bottom. Organisms are dislodged by disrupting the substrate on the upstream side of the stream, allowing them to be carried by the current into the screen. For more information on sampling with a kick net, refer to “Macroinvertebrate Sampling Directions,” section IV-4b.

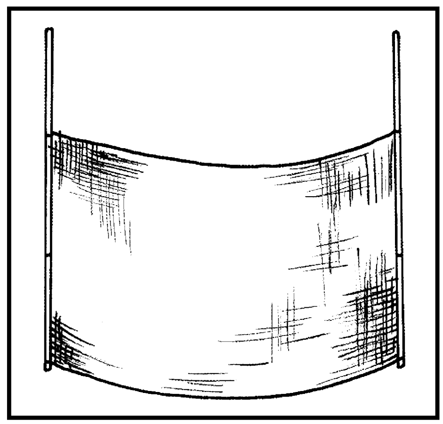


Illustration: Holly Broome-Hyer

Materials

- two 3 ft x 1.5 in sections of wooden dowel
- one 3 ft x 2 ft section of metal window screen
- duct tape
- staple gun

Directions

1. stretch window screen length-wise between dowels
2. attach window screen to dowels with staples and duct tape (wrap as much screen around dowel as possible to properly secure it)

Hester-Dendy sampler

A Hester-Dendy sampler is a fancy word for “bug hotel.” Aquatic macroinvertebrates will colonize the spaces between the rough-textured plates of the sampler. Anchor the sampler to the bottom of the stream or suspend in the water column (different placements will attract different populations). Allow at least 4 weeks to attract a sizable population. Wrap a fine mesh bag around the sampler when you remove it to investigate. This will catch any macros that float off of the squares. Also, remember to flag your sampler so you can find it later.

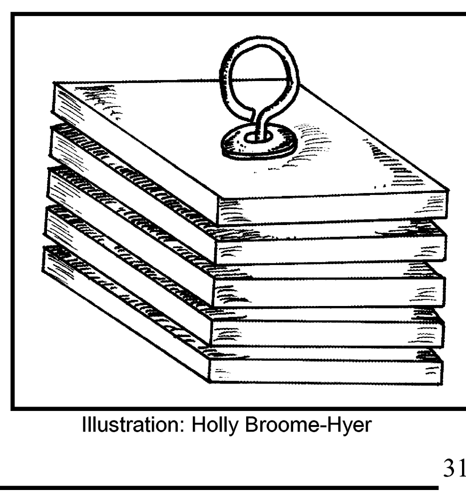


Illustration: Holly Broome-Hyer

Materials
- 8 large plates (made of wood, cement, unglazed porcelain or anything rough and durable) about 3 in square and 1/8 in thick.
- 7 smaller plates should be about 1in square and ¼ in thick.
- 1 eye bolt 6 in long
- 20 washers
- 2 nuts
- bailing wire (or similar wire)
- drill

Directions
1. Drill a hole through the middle of each plate the size of your eye bolt and washers.
2. Stack plates on the eyebolt and separate with washers. Place larger plates on bottom. Using the washers, vary the space between plates to provide for different habitats.
3. Secure the plates in place with a nut.
4. Using the bailing wire, anchor the sampler to the bottom substrate or suspend from above. Remember to flag the sampler to help you relocate it.

Secchi Disc
The Secchi disc is used to measure light penetration which tells us the level of turbidity in the water. Secchi discs work well for still bodies of water like lakes, wetlands and pools in streams. Slowly lower the disc into the water until it disappears; record this depth. Then, pull it back up until it is barely visible; record this depth. Average two measurements. This should be done in a shady area if possible.

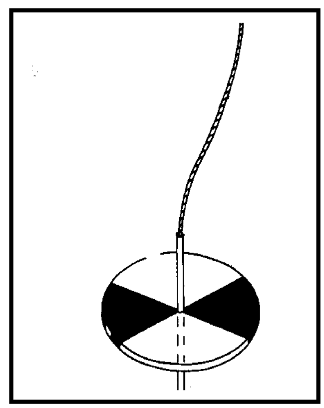


Illustration: Holly Broome-Hyer

Materials
- a lid from a ½ gallon paint can (or similar-size, stiff lid)
- black and white paint
- 6 ft of ½ in line
- drill

Directions
1. paint the lid, in alternating quarters, black and white
2. drill a hole through the middle of the lid
3. attach the line through the hole with knots

Underwater Viewer
An underwater viewer allows you to see what's happening under the surface with surprising clarity. In shallow riffle areas the viewer works well for investigating substrate and macroinvertebrate habitat.

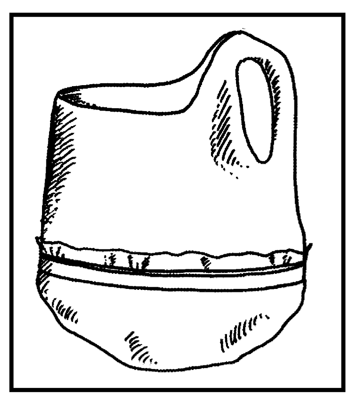


Illustration: Holly Broome-Hyer

Materials
- plastic ½ gallon milk jug
- thick plastic wrap

- heavy rubber bands

Directions

1. Cut off the top of the jug leaving the handle
2. Cut off the bottom of the jug
3. Wrap a piece of plastic wrap over the bottom of the jug, making sure there are no wrinkles. Secure the wrap to the jug with the rubber bands.

Using the underwater viewer

Press the viewer down into the water making sure not allow the water to rise over the rubber bands. Hold the handle and look through the top opening. The water slightly magnifies the objects you will see.

Resources for Further Investigation

Water Quality Sampling Equipment and Homemade Sampling Equipment by theTennessee Valley Authority, 1988. Two 16-page booklets, designed to be used as a set. The first describes professional sampling equipment and tells how to obtain it; the second contains instructions for making low-cost facsimiles of the same equipment (Secchi disks, plankton samplers, artificial substrates, nets for macroinvertebrate sampling, and more). Contact: Carol A. Davis, 311 Broad St., Chattanooga, TN 37402-2801; 615-751-7338. Free (one set only).

Appendix 10. Monitoring in the Classroom

Monitoring in the Classroom

This section will help you to create a rewarding classroom monitoring experience   If possible, combine your classroom monitoring with a field experience. If not, students lose an opportunity to connect with their local stream – to experience the beauty and complexity of a natural water body – and to see how scientific information is gathered in the field.

How do we monitor in the classroom?

The following are four approaches you can take to monitor in the classroom.

1. Water samples from your local stream can be brought back to the classroom for sampling. Classes without access to a water body will welcome this opportunity as will classes who wish to augment their field experience with additional monitoring. See "How do we sample water from the field?" which follows.

2. Classes can sample water brought in from various sources around the community (a pristine mountain stream, water near industrial, municipal or construction sites, ponds and lakes, anywhere you wish to sample from). These waters can be sampled periodically to assess changes over time or they can be compared with one another. See "How do we sample water from the field?" which follows.

3. Water samples with known concentrations of chemicals (common household substances or prepared samples) can be measured. Usually, classes sample in this manner in order to practice their sampling techniques or to perform controlled water quality experiments. Rely on the lesson plans found in the "Background Information" sections for each chemical parameter to help you design your experiments.

4. Classes can create **aquariums** as a way to perform on-going monitoring experiments that involve living, dynamic systems. Aquarium monitoring can be a simple or complex task, depending on your objectives. Detailed information on aquarium monitoring can be found at the end of the Classroom Monitoring section.

How do we sample water from the field?

Sampling water from your local stream or other areas of your community and watershed is a great way to connect the classroom with the outside environment. However, there are special considerations you must account for with each sampling parameter.

General Stream Survey

A General Stream Survey, section V-1, cannot be made from the classroom. However, students can complete the survey in one, short visit to the stream. Also, if you (the teacher) bring the samples in from your local stream you can perform the survey and then share the results with your class. This information will be helpful when interpreting the results of your classroom monitoring.

Stream Flow

Stream flow, V-2B, cannot be measured from the classroom. However, you can obtain this information from outside sources, such as the U.S. Geological Survey (see to the "Resources" section for contact information).

Stream Shape

Stream shape, V-2C, cannot be measured from the classroom. If you make only one visit to your stream, have students measure stream shape. It should not change much over a year's time. You can also obtain aerial photos of your stream from your local Soil Conservation District office (see the “Resources” appendix for contact information).

Turbidity

Turbidity, section V-2D, can be measured accurately in the classroom within 24 hours (if you wait longer algae may begin to grow and increase turbidity). Fill a large bucket with water from the field and bring it back to the class. Stir the bucket thoroughly to re-suspend the material in the water. Then, pour the water into a turbidity tube and record your measurement (just as you would in the field).

Temperature

The temperature, section V-2E, of your stream water will probably change considerably when you bring it from the field to the classroom. Take a minute to record temperature when you collect your water samples.

Nitrogen (nitrate, ammonia)

Nitrogen, section V-3D, can be measured in the classroom. Sample within 48 hours to obtain an accurate concentration. Your sample must be kept cool and dark from the time you collect until the time you sample (a cooler with ice or a refrigerator works well).

Phosphorus

Phosphorus, section V-3D, can be measured in the classroom. Follow the same procedures outlined for nitrogen.

pH

The pH of your stream water will probably change from the time you collect it until the time you sample in the classroom. Measure pH in the field when you collect your water samples.

Dissolved Oxygen (DO)

DO concentrations will change considerably from the field to your classroom. Sample DO yourself when collecting the water samples or obtain values for your water body from the Utah Division of Water Quality (see the “Resources” appendix for contact information).

Macroinvertebrates

Macroinvertebrates can be brought into the classroom and studied. Place them in a large container of water (5 gallon bucket) so the water remains cool and DO concentrations remain high. If you wish to keep them for an extended period, place an aquarium “aerator” in their container to maintain DO concentrations.

Aquarium monitoring

Monitoring aquariums provides unique opportunities to perform hands-on scientific investigations. In a controlled, accessible environment you can investigate water chemistry, aquatic food chains, water quality–plant interactions, sampling techniques and much more. These variables can be isolated and exaggerated in experiments to help you better see and understand science concepts.

How do we design a scientific investigation using aquarium monitoring?

There are many ways to perform scientific investigations using aquarium monitoring. This section outlines a fairly basic approach. Think how you might modify this activity to fit your group's specific interests and objectives.

Overview

By using classroom aquariums you can create different aquatic environments (ex. a turbulent environment, a heavily vegetated environment, an environment with critters). Demonstrate and measure the effects of changes in water quality (ex. high pH) in each aquarium.

Aquariums can be…
- Standard "pet store" aquariums (nice but expensive)
- Glass bowls (also available at pet stores)
- One gallon glass jars
- Plastic tubs
- Whatever you can find

* Make sure you sterilize your aquarium with boiling water before adding components.

Materials you may need

[] aquariums (this is your classroom stream)
[] stream water (to better mimic the field environment)
[] **substrate** from your stream (for aquatic plants and animals to live in)
[] aquatic plants (from your stream or pet store)
[] aquarium oxygenators (to maintain oxygen levels)
[] *Utah Stream Team* Materials Tub (for sampling kits)
[] *Utah Stream Team* Manual (to help you research your investigation and to provide sampling directions)
[] measuring devices and eye droppers (to add specific amounts of chemicals/materials)
[] one fish net (to transfer critters)
[] timer or watch (to make precise measurements)
[] aluminum foil (to cover aquaria from light when necessary)
[] fish or other stream critters (see "Be Respectful" at the end of this section).

Sample pH in the morning and at night to see changes that result from the photosynthetic activity of aquatic plants.

Nitrate levels in aquariums will rise over time as fish and other aquatic life convert food into waste. This presents a great opportunity to monitor changes over time. Why do nitrate levels continually rise in an aquarium but not in a well-functioning pond? Place aquatic plants in your aquarium to find your answer.

Procedure

1. Use the *Utah Stream Team* manual, other reference materials, and your field experiences to determine which aspects of water quality you would like to examine. Develop a guiding question(s) based on your research to structure the investigation. For example; "How will different pH levels affect the growth of aquatic vegetation?"
2. Divide students evenly into groups. Each group will maintain one aquarium.
3. Divide a sample of stream water evenly among the aquariums. Each aquarium should contain at least one gallon. These samples are called "split" samples; they have all come from the same source and are stored and treated in the exact same way throughout the experiment (except for the **variables** applied to each). Important: Sample your water in the field when you collect it. Then, sample again immediately after you have set up

your experiment. These initial measurements will serve as benchmarks to assess future changes. They will also ensure that each split starts with the same water quality.

4. To each container add the variables (e.g. acids and bases to raise and lower pH) you wish to experiment with. Make no changes to the control aquarium. A **control** sample, which has no experimental influences or variables applied to it, will be the standard of comparison for the other samples. Changes may occur in the control aquarium but they should not be due to any experimental activities.

5. Sample as often as you need to in order to track changes. Record and chart your information. A dry-erase or chalk board near the aquariums allows all students to see changes occurring in each aquarium.

6. Refer to "Ilustrating Your Data," section V-1, and "Reflecting On Your Data," section V-2, sections of this unit for help processing your activity.

How can we replicate real-life conditions in an aquarium?

Real-life influences, both human and natural, are described in the *Utah Stream Team m*anual for each sampling parameter (see Unit IV). The Dissolved Oxygen chart below provides examples of how to replicate these influences in your aquarium.

Dissolved Oxygen (DO)	
Natural Influence	**Classroom Equivalent**
Water Temperature	Use lamps, shading, fans or other devices to affect aquarium water temperature. Higher temperatures will decrease DO concentrations. Hint: Use real plants to mimic shading that would come from riparian vegetation.
Aquatic Vegetation	Place different amounts of aquatic vegetation in each aquarium. More vegetation will increase DO concentrations (until it dies; the effects will then be reversed). Hint: Start with the same amount and type of vegetation in each aquarium. Use nutrients (fertilizer) to create different amounts of vegetation. Sample the different DO levels that result. This will demonstrate how different water quality parameters influence each other.
Turbulence	Vary the amount of turbulence using an oxygenator or mechanical device (a small propeller). Turbulent water, like riffles, are more oxygenated than still areas, such as pools.
Human Influence	**Classroom Equivalent**
Organic wastes	Add different amounts of decayed material, such as manure, to the aquarium. Bacteria multiply and use up oxygen during decomposition. Hint: Increase water temperatures to enhance the decomposition process and rate of DO depletion.
Land uses	Using plants, differ the amount of shading each tank receives to see effects on water temperature and DO. This will mimic effects of loss of riparian vegetation. Add salt to mimic runoff from nearby salted roads. Add fertilizer to mimic runoff from lawns and agricultural areas.

What else should we know about classroom monitoring?

Be realistic

You can exaggerate variables (e.g. add extreme amounts of nutrients) to illustrate a point. However, students should be well aware of the amounts of material added to the aquarium relative to amounts that would be added in a real stream. To help students gain a better understanding of the relative amounts of pollutants affecting streams have them measure out the pollutants themselves and add. Refer to "A Drop in the Bucket," found in the "Water Pollution" section, for help determining realistic amounts of pollutants.

Know what you are monitoring

Nature is highly variable. Numerous factors besides "chemical pollution" affect the health of a stream or the aquatic species within. For example, most aquatic plants would die in drinking water due to lack of nutrients. It would be an error to interpret the water quality as "polluted by chemicals" because the plant died (the water was not polluted, only lacking nutrients). Make sure you know specifically what you are sampling for: Are you trying to determine whether the water is polluted by chemicals or that it can support plant life? Then, make sure you isolate the variable that you are testing: in this example, a lack of nutrients clouded the chemical pollution assessment.

Connect with the field

Use classroom activities to introduce or reinforce field work. For example, if you monitor the pH of your stream you probably want to investigate natural influences on it. If you read through "pH," section IV-3b, you will find that the photosynthetic activity of aquatic vegetation raises pH. Set up your aquariums with different amounts of vegetation and monitor the effects on pH. Ask your class: "How would our stream be affected if it had these different amounts of vegetation in it?" "How would the resulting pH levels affect the aquatic life in our stream?"

Be respectful

The *Utah Stream Team* strongly advocates against harming fish or other aquatic animals in your aquariums by "experimenting" with them. If you use live critters, then your monitoring should focus on maintaining a healthy environment for them.

Resources for further investigation

Aquatic Habitats: Exploring Desktop Ponds, by Katharine Barrett and Carolyn Willard. In this unique series of life-science activities for grades two through six, student groups set up and observe living, desktop models of a pond. Over a period of weeks, each group studies and adds one type of organism at a time to a small tank, transforming the containers into aquatic habitats. As the model ponds develop and change over time, students discover firsthand some of the complex interactions within a typical pond ecosystem. Contact: http://www.lhs.berkeley.edu./GEMS/GEMaquatic.html

"A Constructed Wetland," by Dan Kowal. The Green Teacher. Spring-Summer 1998, Issue #55. pp. 28-31. This article details how a Colorado school's water quality monitoring project evolved into an experiment using constructed wetlands to treat toxic mine runoff. You'll find information on mines, the filtering effects of wetlands, and instructions on how to build your own schoolyard wetland. Take classroom monitoring one step further! Note: This article is part of a larger issue on environmental monitoring (an excellent resource for any volunteer water quality monitor). Contact: http://www.web.ca/~greentea/

"Freshwater Studies Using Cattle Drinking Troughs," by Roger Lock and Nigel Collins. Journal of Biological Education, v.30, Autumn 1996, pp. 166-168. Cattle troughs are relatively cheap and very effective for studying a variety of water quality parameters. This article will inform and inspire you to develop a trough pond on your own school grounds.

"**Keeping Classroom Aquaria – A Simple Guide for the Teacher**." Project Wild Aquatic Education Activity Guide. pp.213-216. This short, to-the-point guide will get you started with a classroom aquarium. You'll find an equipment list, directions for making your own aquarium and tips on caring for animals. The rest of the activity guide is full of hands-on activities to support your water education and water quality monitoring program. Contact: Project Wild, 707 Conservation Lane, Suite 305, Gaithersburg, MD 20878, 301-527-8900 (p), 301-527-8912 (f), email: info@projectwild.org, web: www.projectwild.org

Trout in the Classroom – This extensive web site provides all the information you need to operate a classroom fish hatchery. You'll find curriculum materials, background information, life cycle and identification charts, and numerous links to fish hatchery resources. There is even a chat section to share information with other classrooms around the nation. Contact: http://www.newberg.k12.or.us/EY/HTML/trout.html

Bibliography

Barrett, Katherine and Carolyn Willard. Aquatic Habitats: Exploring Desktop Ponds. GEMS. Berkely, CA. 1993

Hershey, David R. "Evaluation of Irrigation Water Quality," The American Biology Teacher. 55(4), April, 1993.

LaMotte Company. The Pondwater Tour. LaMotte Company Chestertown, MD, no date.

Western Regional Environmental Education Council (WREEC). "Keeping Classroom Aquaria – Simple Guide for the Teacher," Aquatic Project WILD. Project WILD. Boulder, CO. 1987. pp. 213-215.

Appendix 11. Conversion Charts

Conversion Chart

If you know ⇨	Multiply By ⇨	To get
To get ⇦	Divide By ⇦	If you know
Length		
inches (in)	2.5	centimeters (cm)
feet (ft)	30.0	centimeters (cm)
yards (yd)	0.9	meters (m)
miles (mi)	1.6	kilometers (km)
Area		
square inches (in^2)	6.5	square centimeters (cm^2)
square feet (ft^2)	0.093	square meters (m^2)
square yards (yd^2)	0.84	square meters (m^2)
square mile (mi^2)	640.0	acres (acre)
acre (acre)	43,560	square feet (ft^2)
acre (acre)	4,047	square meters (m^2)
acre (acre)	0.405	hectacres (ha)
Mass		
ounces (oz)	28.35	grams (g)
pounds (lb)	0.45	kilograms (kg)
Volume		
teaspoons (tsp)	5.0	mililiters (ml)
tablespoons (tbs)	15.0	mililiters (ml)
fluid ounces (fl oz)	30.0	mililiters (ml)
cups (c)	.24	liters (l)
pints (pt)	.47	liters (l)
quarts (qt)	0.95	liters (l)
gallon (gal)	0.134	cubic feet (ft^3)
gallon (gal)	3.79	liters (L)
cubic feet (ft^3)	0.03	cubic meters (m^3)
cubic feet (ft^3)	28.32	liters (L)
acre-feet (af)	1.234	thousand cubic meters (m^3x10^3)
acre-feet (af)	325,850	gallons (gal)
acre-feet (af)	43,560	cubic feet (ft^3)
Flow		
cubic feet per second (cfs)	0.03	cubic meters per sec (m^3/s)
cubic feet per second (cfs)	1.98	acre-feet per day (af/day)
cubic feet per second (cfs)	448.8	gallons per minute (gpm)
cubic feet per second (cfs)	646,320	gallons per day (gpd)
Temperature		
degrees Celsius (C°)	(9/5 x °C) + 32	degrees Fahrenheit (°F)
degrees Fahrenheit (°F)	5/9 x (°F – 32)	degrees Celsius (°C)

Other water equivalents

1 cubic foot (ft^3) = 7.48 gallons (gal) = 62.4 pounds of water (lb/ft^3)
1 cubic foot per second (cfs) flowing for one year = 724 acre-feet (af)
1 gallon (gal) = 0.134 cubic feet = 8.34 pounds of water (lb/gal)
1 acre-foot = one and a half football fields 1 foot deep
1 acre-foot = a typical garden hose (5 gpm) flowing continuously for 45 days
1 acre-foot = approximately 3,475,700 12 oz. cans of soda

Appendix 12. Glossary

Glossary

For a more extensive listing of water quality definitions check out the Nevada Division of Water Planning's *Water Words Dictionary* at: http://www.state.nv.us/cnr/ndwp/dict-1/waterwds.htm.

Accuracy - A measure of how close repeated trials are to the desired target.
Acid – Any substance that has a pH level below 7, or that has more free hydrogen ions (H+) than hydrogen ions.
Acidity - A measure of the number of free hydrogen ions (H') in a solution that can chemically react with other substances.
Acre-foot – (AC-FT) is the quantity of water required to cover 1 acre to a depth of 1 foot and is equal to 43,560 cubic feet or about 326,000 gallons or 1,233 cubic meters.
Adaptation - The modification, over time, of the structure, function, or behavior of an organism, which enables it to be better suited to its environment.
Adhesion – The attraction of water molecules to other materials as a result of hydrogen bonding.
Aerobic – Able to live only in the presence of air or free oxygen; conditions that exist only in the presence of air or free oxygen.
Alkalinity - A measure of the negative ions that are available to react and neutralize free hydrogen ions. Some of most common of these include hydroxide (OH-), sulfate (SO), phosphate (POQ), bicarbonate (HCO') and carbonate (COQ).
Ambient - Pertaining to the current environmental condition.
Ammonia - A highly water-soluble, gaseous compound, NH3, usually produced by the direct combination of nitrogen and hydrogen gases.
Anaerobic – Able to live and grown only where there is no air of free oxygen; condition that exist only in the absence of free air and free oxygen.
Aquarium – A man-made aquatic environment.
Aquatic zone – The area of the stream channel covered by water.
Aquifer – A geologic formation, or group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.
Assemblage - The set of related organisms that represent a portion of a biological community (e.g., benthic macroinvertebrates).
Atmosphere – The layer of gases surrounding Earth; composed mainly of nitrogen and oxygen.
Backwaters – Areas of water to the side of a main stream channel usually formed by flooding.
Bacteria – Microscopic unicellular organisms, typically spherical, rod-like, or spiral and threadlike in shape, often, clumped into colonies. Some bacteria cause disease, while others perform an essential role in nature in the recycling of materials; for example, by decomposing organic matter into a form available for example, by decomposing organic matter into a form available for reuse by plants.
Bar graph - A graph using parallel bars of varying lengths, as to illustrate comparative data.
Base flow – The portion of the stream flow that is relatively consistent throughout the year.
Basic – Alkaline. Basic water contains high concentrations of hydroxyl ions (OH-).
Bed material – The rock, sediment and organic matter that comprises the bottom of a stream channel.
Beneficial use – The legal, designated uses for a water body including, drinking, recreation, fish and wildlife, etc. Water quality standards are designed to support a water body's beneficial use(s).
Benthic - Pertaining to the bottom (bed) of a water body.
Biochemical oxygen demand (BOD) – A measure of the quantity of dissolved oxygen, in milligrams per liter, necessary for the decomposition of organic matter micro-organisms, such as

bacteria.

Biodiversity – A measure of the distinct characteristics, qualities, or elements of plant and animal life in a defined area; a measure of biological differences.

Biological integrity – The condition of the aquatic community inhabiting unimpaired water bodies as measured by community structure and function.

Buffer – To maintain high pH levels. Alkaline soils keep the pH of water from getting too low.

Capillary action – Forces of adhesion and cohesion help water to move through the soil from areas of greater concentration to areas of lesser concentration.

Cause – The producer of an effect.

Channel - The section of the stream that contains the main flow.

Channelization - The straightening of a stream; this often is a result of human activity

Climate – The meterological element, including temperature, precipitation, and wind, that characterize the general conditions of the atmosphere over a period of time at any one place or region of the Earth's surface. Earth has three climate zones: polar, temperate, and tropical. Climate zones are further classified into ecosystems and biomes.

Cobble - Medium-sized rocks (2-10 inches) that are found in a stream bed.

Cohesion – The attraction of water molecules to each other as well as a result of hydrogen bonding.

Collectors – Macroinvertebrates that collect bits of food from the water column.

Community - The whole of the plant and animal population inhabiting a given area. culvert – man-made construction that diverts the natural flow of water.

Comparability – The degree to which we can compare data between dates and locations.

Concentration – The amount of a specific substance dissolved in a given amount (volume) of another substance.

Condensation – The process by which a vapor becomes a liquid; the opposite of evaporation.

Confined aquifer – A water-saturated layer of soil or rock that is bounded above and below by impermeable layers.

Contaminant – Any substance that when added to water (or another substance) makes it impure and unfit for consumption or use.

Control - A standard for comparing, checking, or verifying the results of an experiment or activity.

Correlation – The mutual relation of two or more things.

Cubic foot per second (ft^3/s) – Units typically used in measuring streamflow that express rate of discharge. The measurement is equal to the discharge in a stream cross section one foot wide and one foot deep (or one meter wide and one meter deep), flowing with an average velocity of one foot (or meter) per second; 1 cfs = 44.8 gallons per minute (gpm); 1 cms = 1,000 liters per second.

Decomposition – The breakdown or decay of organic matter through the digestive processes of microorganisms, macroinvertebrates, and scavengers.

Deionized water - Water that has had al l of the ions (atoms or molecules) other than hydrogen and oxygen removed.

Density – The compactness or crowdedness of matter (ex. water molecules) in a given area.

Deposition – The process of laying down sediment or accumulating layers of material carried in suspension.

Designated beneficial uses - State-established desirable uses that waters should support, such as fishing, swimming, and aquatic life. Listed in state water quality standards.

Detection limit – The lowest point at which a particular piece of sampling equipment can accurately assess chemical concentrations.

D-frame net - A fine mesh net that is attached to a pole and used for sampling. It resembles a butterfly net.

Dichotomous key – A tool for identifying objects, such as macroinvertebrates. The key presents a series of "yes or no" questions to the observer; each question brings the observer closer to the identification.

Diffusion – The movement of a substance from an area of high concentration to an area of low concentration.

Discharge – The volume of water (or more broadly, volume of fluid plus suspended sediment) that passes through a cross-section of the channel within a given period of time.

Discharge limits – Any restriction on quantities, rates, and concentrations of chemical, physical, biological or other constituents which are discharged from point sources.

Dissolved - Solids are classified as "dissolved" if they pass through a standard glass-fiber filter with about one micrometer pore size.

Dissolved oxygen (DO) - Oxygen dissolved in water and available for living organisms to use for respiration.

Distillation – The purification of water. When water evaporates the vapor separates from impurities.

Distilled water - Water that has had most of its impurities removed.

Divide – The boundary between two watersheds.

Downstream – In the direction of a stream's current; in relation to water rights, refers to water uses or locations that are affected by upstream uses or locations.

Drainage basin – Part of the surface of the earth that is occupied by a drainage system, which consists of a surface stream or a body of impounded surface water together with all tributary surface streams and bodies of impounded surface water. See watershed.

Ecology – The study of the relationships of living things to one another and to the environment.

Ecoregion - Geographic areas that are distinguished from others by ecological characteristics such as climate, soils, geology, and vegetation.

Ecosystem – A community of living organisms and their interrelated physical and chemical environment; also, a land area within a climate.

Eddie – An area of water current that swirls or moves upstream. Eddies are usually formed as water flows past or over an obstruction, such as a boulder or log.

Effluent – Waste material discharged into the environment, including waters of the United States.

Embeddedness - The degree to which rocks in the streambed are surrounded by sediment.

Emergent plants - Plants rooted underwater, but with their tops extending above the water.

Engulfers – Macroinvertebrate predators that feed by swallowing their prey whole.

Environment – All of the external factors, conditions, and influences that affect an organism or a biological community.

Ephemeral – Occurs intermittently. Ephemeral streams flow only during and shortly after extreme precipitation or snowmelt events.

EPT Value – A index of water quality derived from the percent of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Tricoptera (caddisflies) in a 100-individual sample of macroinvertebrates.

Erlenmeyer flask - A flask having a wide bottom and a smaller neck and mouth that is used to mix liquids.

Erosion – The wearing down or washing away of the soil and land surface by the action of water, wind or ice.

Erosive – The power of wind or water to wear away sediment. Highly erosive water can wear away more sediment.

Eutrophic – A condition in which the water in a lake, pond, or reservoir is enriched with plant nutrients such as nitrogen and phosphorous which results in large amounts of plant and algal production. As the plants and algae die and sink to the bottom, an organic sediment is created which removes oxygen from the water as it decays.

Evaporation – The conversion of a liquid (ex. water) into a vapor (a gaseous state) usually through the application of heat energy; the opposite of condensation.

Evapotranspiration – The loss of water from the soil through both evaporation and transpiration from plants.
Excretion – The act or process of removing waste material from living organisms.
Fecal coliform bacteria – Bacteria that are present in the intestines or feces of warmblooded animals. They are often used as indicators of the sanitary quality of the water.
Floating plants - Plants that grow free floating, rather that being attached to the stream bed.
Flocculent (floc) - A mass of particles that form into a clump as a result of a chemical reaction.
Flood – Any relatively high streamflow overtopping the natural or artificial banks of a stream.
Floodplain – Any normally dry land area that is susceptible to being inundated by water from any natural source; usually lowland adjacent to a stream or lake.
Forbs – Plants with broad leaves and net-like veins; stems are solid and spongy and die back to the ground every year.
Friction – Resistance of a force. For example, rocks in a stream provide friction for the streamflow.
Functional feeding groups – Classification of macroinvertebrate groups according to their mode of feeding.
Gas (gaseous) – The state of water in which individual molecules are highly energized and mover about freely; also known as vapor.
Glide/run – A section of a stream with a relatively high velocity and with little or no turbulence on the surface of the water.
Gradient – A measure of degree of incline; the steepness of slope.
Graduated cylinder - A cylinder used to measure liquids that is marked in units.
Grass – Plants with hollow stems that are jointed and leaves with parallel veins. The leaves come off the stem opposite to each other.
Gravity – The natural force of attraction exerted by Earth on objects or materials on its surface that tends to draw them down toward its center.
Greenline – A line of vegetation that runs alongside the stream. It is the first line of vegetation you encounter as you move away from the water.
Groundwater – Water found in spaces between soil particles underground (located in the zone of saturation).
Habitat – The environment occupied by individuals of a particular species, population, or community.
Headwaters – The source of a stream.
Humidity – The degree of moisture in the air.
Hydrogen bond – A type of chemical bond caused by electromagnetic forces, occurring when the positive pole of one molecule (ex. water) is attracted to and forms a bond with the negative pole of another molecule (ex. another water molecule).
Hydrograph – A representation of water discharge over time.
Hydrology – The study of Earth's waters, including water's properties, circulation, principles and distribution.
Hydrophilic – Water-loving.
Hypoxia - Depletion of dissolved oxygen in an aquatic system. impairment - degradation.
Impaired waters – Waters that fail to meet applicable water quality standards or to protect designated uses (such as fishing or swimming).
Impermeable layer – A layer of material (ex. clay) in an aquifer through which water does not pass.
Impoundment - A body of water contained by a barrier, such as a dam. inert - not chemically or physically active.
Independent variable – A factor in a relationship that is not affected by the relationship. Time is a common independent variable.
Indicator – A gauge of water pollution: not legal criteria but, rather a sign that there may be a

problem. When an indicator level is exceeded, further studies are done.

Instream flow – The minimum amount of water required in a stream to maintain the existing aquatic resources and associated wildlife and riparian habitat.

Instream use – Uses of water within a stream's channel (ex. by fish and other aquatic life, or for recreation, navigation and hydroelectric power production).

Intermittent – A stream that does not flow year round.

Irrigation – The controlled application of water to cropland, hay fields, and/or pasture to supplement that supplied by nature.

Kick-net - A fine mesh net used to collect organisms. Kick-nets vary in size, but generally are about three feet long and are attached to two wooden poles at each end. land uses - activities that take place on the land, such as construction, farming, or tree clearing.

Lake-effect – A weather phenomenon that results from air currents passing over a large lake and then over a mountain range. The warm lake water warms the air, allowing it fill with moisture. As the air climbs up and over the mountains it cools and then drops its moisture.

Large woody material – Fallen trees and limbs in a stream.

Larva - The immature, wingless, feeding stage of an insect that undergoes complete metamorphosis.

Leach – The movement of dissolved particles by the percolation of water through soils.

Levee – An embarkment or raised area that prevents water from moving from one place to another.

Line graph – An illustration of data points where individual points are connected by a line. Line graphs show a continuous trend.

Litter – Dead plant material on the ground.

Macroinvertebrate - Organisms that lack a backbone and can be seen with the naked eye.

Mainstem – The primary path for waterflow in a watershed.

Mean - Average. The sum of all the measurement values divided by the number of measurements.

Meandering – The curving pattern of a stream channel.

Metabolism – The physical and chemical processes in an organism that produce energy and that result in the production, maintenance, or destruction of materials in the body. Many metabolic processes involve water.

Metal - An elementary substance, such as gold or silver, which is crystalline when solid and yields positively charged ions in aqueous solutions of its salts. Metals can be very toxic in streams at low concentrations.

Metamorphosis – A change in form from one stage to the next in the life history of an organism, as from the caterpillar to the pupa and from the pupa to the adult butterfly.

Minimum instream flow requirements – Regulations set by management agencies that determine the least amount of water a stream can hold. Requirements protect the aquatic ecosystem and balance competing out-of-stream uses.

Municipal water system – A network of pipes, pumps, and storage and treatment facilities designed to deliver potable water to homes, schools, businesses and other users in the city or town and to remove an treat waste materials.

Narrative criteria - Chemical, physical or biological concentrations in water that are expressed in words.

National Pollutant Discharge Elimination System (NPDES) - A national program in which pollution dischargers such as factories and sewage treatment plants are given permits to discharge. These permits contain limits on the pollutants they are allowed to discharge.

Nephelometer (turbidity tube) – A clear tube used to measure the turbidity of a stream or water body.

Nephelometric turbidity unit (NTU) – A unit used to describe turbidity measurements.

Neutral – A substance, such as distilled water, with a pH of 7.

Niche – The role, or combination of functions, that an organism holds in the environment.

Nitrate – A nitrogen compound (NO_3) that functions as a plant nutrient. An overabundance of nitrate is considered a water pollutant.

Nitrite – A combination of nitrogen, ammonia and oxygen (NO_2) that functions as a plant nutrient. An overabundance of nitrite is considered a water pollutant.

Nitrogen fixation – Changing nitrogen gas into ammonia. Some plants and algae fix nitrogen.

Nonconsumptive uses – Instream use of water that does not reduce the supply; or, removing water returning it to the source without reducing the supply.

Nonpoint source pollution – Refers to pollution sources that are diffuse and do not have a single pint of origin. Run-off from agriculture, forestry and construction sites are examples.

Numeric criteria – Chemical, physical or biological concentrations in water that are typically expressed as concentrations, such as milligrams per liter.

Nutrient – An element, such as nitrogen or phosphorus, or compound needed for the reproduction, survival or growth of plants and animals.

Nymph – The young of an insect that undergoes incomplete metamorphosis

Occular tube – A device used to measure canopy cover.

Organic - Of, related to, or derived from living organisms. Organic substances contain carbon.

Orthophosphate - Inorganic phosphorus dissolved in water.

Outlet – The point where water exits a watershed (flows into a larger watershed).

Outlier – A point on a graph that does not fit within the range of the rest of the data points.

Parameter – A distinguishing characteristic or feature. For example, nitrate is a water quality parameter.

Particle-size – The diameter, in millimeters (mm) of a particle in a stream bed.

Particulate phosphorus -

Parts per million (ppm)/parts per billion (ppb) - Units typically used in measuring the number of "parts" by weight of a substance in water; commonly used in representing pollutant concentrations.

Pathogen - A disease-producing agent, especially a microorganism.

Peak flow – The largest rate of flow during a certain time period.

Piercers – Macroinvertebrate predators that feed by injecting a sharp mouth part into their prey and sucking out body fluids.

Percent saturation – The amount of dissolved oxygen in water compared to the amount of dissolved oxygen the water can hold.

Percolation – Describes the action of water as it moves through spaces in the soil and rock.

Perennial – Occurs year-round. Perennial streams hold water throughout the year.

Permeable - Capable of transmitting water (e.g., porous rock, sediment, or soil).

Permeable layer - A layer of porous material (rock, soil, unconsolidated sediment); in an aquifer, the layer through which water freely passes as it moves through the ground**.**

Permit – Legal authority to carry out a regulated activity.

pH - A numerical measure of the hydrogen ion concentration used to indicate the alkalinity or acidity of a substance. Measured on a scale of 1.0 (acidic) to 14.0 (basic); 7.0 is neutral.

Phosphorus - A nutrient that is essential for plants and animals.

Photosynthesis - The chemical reaction in plants that utilizes light energy from the sun to convert water and carbon dioxide into simple sugars. This reaction is facilitated by chlorophyll.

Pipet - An eye dropper-like instrument that can measure very small amounts of a liquid.

Playa – The sandy, salty, or mud-caked flat floor of a desert watershed having interior drainage, usually occupied by a shallow lake during or after prolonged, heavy rains.

Point source pollution - Refers to pollution resulting from discharges into receiving waters from any discernible confined and discrete conveyance such as a pipe, ditch, or sewer.

Pool – A deeper portion of a stream where water flows slower than in neighboring, shallower portions.

Pore spaces – Open areas between grains of soil. Water and air exist in these spaces. Tiny grains have smaller pore spaces than large grains.

Precipitation - Water falling, in a liquid or solid state, from the atmosphere to Earth (e.g., rain, snow).
Precision - A measure of how close repeated trials are to each other.
Predator – An animal, such as a macroinvertebrate, that feeds on other animals.
Protocol - A defined procedure.
Reagent - A substance or chemical used to indicate the presence of a chemical or to induce a chemical reaction to determine the chemical characteristics of a solution.
Redds – A fish spawning area. Redds are usually round or eliptical areas of clean gravel about 1-3 feet long.
Representative – Accurately depicting the true characteristics of the stream.
Reservoir – A still, lake-like water body that forms upstream from a dam. Reservoirs store water and often provide for recreation.
Respiration - The act or process by which an organism exchanges gases with its environment; in animals with lungs, the process of inhaling and exhaling, or breathing. Cellular respiration involves the release of energy from food through chemical reactions. Restoration. The act or process of bringing something back to a previous condition or position.
Ridge lines - Points of higher ground that separate two adjacent streams or watersheds; also known as divides.
Riffle – A shallow area in a stream where water flows swiftly over gravel and rock.
Riparian zone - The vegetative area on each bank of a body of water that receives flood waters.
Riprap - Rocks used on an embankment to protect against bank erosion.
River system – The network of connecting streams. Smaller streams serve as tributaries for larger streams, forming a vein-like pattern.
Run/glide - See glide/run.
Runoff - Precipitation that flows overland to surface streams, rivers, and lakes.
Rushes – Similar to sedges but have round (verses triangular) stems and very small or no leaves. Rushes stabilize stream banks well and preventing erosion.
Salinization - The condition in which the salt content of soil accumulates over time to above the normal level; occurs in some parts of the world where water containing high salt concentration evaporates from fields irrigated with standing water
Saturated - Inundated; filled to the point of capacity or beyond.
Saturation concentration – The amount of dissolved oxygen a body of water can hold.
Scrapers – Macroinvertebrates that feed by scraping algae and other material from the surface of plants, wood and rock. Also known as grazers.
Season - A period of time during the year classified by length of day and weather conditions.
Secchi disk – A black and white disc used to measure the turbidity of a pond or lake.
Sedges – Sedges resemble grasses but have solid, triangular stems with no joints. The leaves have parallel veins and come off the stem in three directions. Sedges are effective at stabilizing stream banks and preventing erosion.
Sediment – Solid material that originates mostly from disintegrated rocks and is transported by, suspended in, or deposited from water; it includes chemical and biochemical precipitates and decomposed organic material such as humus. The quantity, characteristics, and cause of the occurrence of sediment in streams are influenced by the quantity and intensity of precipitation.
Sheen - The glimmering effect that oil has on water as light is reflected more sharply off of the surface.
Shredder – A macroinvertebrate that feeds by cutting or tearing on leaves and woody material that falls into the stream.
Shrubs – Plants with woody stems that remain alive all year. The leaves tend to have net-like veins. Shrubs rarely grow larger than 13 ft tall; if they do they may be considered "trees."
Siltation – An increased supply of fine sediments to a stream bottom or channel. Siltation can cover up and harm fish spawning areas and macroinvertebrate habitat.

Sinuosity – The degree to which a stream meanders, or curves.
Soil - The top layer of Earth's surface, containing unconsolidated rock and mineral particles mixed with organic material.
Solute – Any substance that is dissolved in water.
Solids - Water, a liquid, can contain quite a bit of solid material, both in dissolved and suspended forms. Solids captured on the filter are, by definition, "suspended" solids. Solids which settle out of a water sample on standing for a period of an hour are defined as "settlable."
Soluble – Able to be dissolved in water.
Solute - A substance dissolved in another substance (the solvent) create a solution.
Solvent - A material such as water that dissolves another subs (the solute) to form a solution.
Spreadsheet - A work sheet that is arranged in the manner of a mathematical matrix and contains a multicolumn analysis of related entries for easy reference on a single sheet.
Stomata - Tiny pores in the epidermis or surface of plant leaves or through which gases and water vapor are exchanged with the environment.
Storm drain - Constructed o a road system through which " runoff from the road surface into an underground sewer system.
Stratification – A natural process in which bodies of standing water become colder near the bottom and warmer near the surface. The two layers are separated by a thinner middle layer characterized by a rapidly changing temperature profile.
Stream - Any body moving under oaf running w gravity's influence through clearly defined natural channels to progressively 1 levels.
Streamflow – The discharge that occurs in a natural channel. Although the term "discharge" can be applied to the flow of a canal, the word "streamflow" uniquely describes the discharge in surface stream course. The term "streamflow" is more general than "runoff" as streamflow may be applied to discharge whether or not it is affected by diversion or regulation.
Stream order – A system used to classify and analyze streams.
Sub-basin – A smaller watershed that comprises part of a larger watershed.
Sublimation - The transition of a substance from the solid directly to the vapor phase, or versa, without passing intermediate liquid phase.
Submergent plants - Plants that live and grow fully submerged under the water.
Substrate - Refers to a surface. This includes the material comprising the stream bed or the surfaces which plants or animals may attach or live upon.
Surface runoff – Water that flows over the surface of the land or through the upper layer of soil.
Surface tension - The attraction among water molecules at the surface of a liquid; creates a skinlike barrier between air and underlying water molecules.
Surface water - Water above the surface of the land, including lakes, rivers, streams, ponds, floodwater, and runoff.
Suspended solids – Particles carried in water without being dissolved.
Swale – A low point on the surface of the land. Swales in riparian zones are usually filled with fine sediments and organic matter.
Taxon (plural taxa) - A level of classification within a scientific system that categorizes living organisms based on their physical characteristics.
Taxonomic key - A quick reference guide used to identify organisms. They are available in varying degrees of complexity and detail.
Temperature - The measurement of the average kinetic energy of moving molecules within a substance.
Temperature regulation - The processes through which an organism's temperature is adjusted to certain metabolic requirements or conditions in its environment.
Thalweg – The line of maximum velocity in a stream.
Titration - The addition of small, precise quantities of a reagent to a sample until the sample reaches a certain endpoint. Reaching the endpoint is usually indicated by a color change.

Tolerance - The ability to withstand a particular condition - e.g. pollution tolerant indicates that ability to live in polluted waters.
Topography – The shape of the land's surface.
Total dissolved solids – A measure of the amount of solid (generally inorganic) material carried in solution by a body of water.
Toxic – Poisonous or damaging.
Transpiration - The process by which water absorbed by plants (usually through the roots) is evaporated into the atmosphere from the plant surface (principally from the leaves).
Tributary - A body of water that drains into another, typically larger, body of water.
Turbidity - Murkiness or cloudiness of water, indicating the presence of some suspended sediments, dissolved solids, natural or man-made chemicals, algae, etc.
Turbidity tube (nephelometer) – A clear tube for measuring the turbidity of a stream or water body.
Unconfined aquifer - An aquifer in which the upper boundary is the top of the water table.
Uplands zone – The area of the watershed that does not receive regular flooding by a stream. The uplands zone borders the riparian zone.
Upstream – Toward the source or upper part of a stream; against the current. In relation to water rights, refers to water uses or locations that affect water quality or quantity of downstream water uses or locations.
Utah State Standard – The legally designated allowable concentration of an impurity in a water body. Concentrations over this state standard are considered as pollution.
Variable - A quantity or function that may assume any given value or set of values.
Velocity – The speed of water flow.
Volume – The amount of water in a stream.
Volumetric flask - A flask that holds a predetermined amount of liquid.
Wastewater - Water that contains unwanted materials from homes, businesses, and industries; a mixture of water and dissolved or suspended substances
Wastewater treatment - Any of the mechanical or chemical processes used to modify the quality of wastewater in order to make it more compatible or acceptable to humans and the environment.
Water (H2O) - An odorless, tasteless, colorless liquid made up of a combination of hydrogen and oxygen. Water forms streams, lakes, and seas, and is a major constituent of all living matter. The word water and important concepts related to water appear on almost every page of this text.
Water allocation - In a hydrologic system in which there are multiple uses or demands for water, the process of measuring a specific amount of water devoted to a given purpose.
Water cycle - The paths water takes through its various states-vapor, liquid, and solid-as it moves throughout Earth's systems (oceans, atmosphere, ground water, streams, etc.). Also known as the hydrologic cycle.
Water molecule - The smallest unit of water; consists of two hydrogen atoms and an oxygen atom.
Water pressure - The downward force of water upon itself and other materials; caused by the pull of gravity.
Water quality - The chemical, physical, and biological characteristics of water with respect to its suitability for a particular use.
Water quality criteria - Maximum concentrations of pollutants that are acceptable, if those waters are to meet water quality standards. Listed in state water quality standards.
Water quality rating index – An index of water quality derived from a 100-individual sample of macroinvertebrates. The more pollution-intolerant individuals found in the sample the better the water quality.
Water quality standard - Recommended or enforceable maximum contaminant levels of chemicals of materials (e.g. nutrients). In relation to water rights, refers to water

uses or locations that affect water quality or quantity of downstream water uses or locations.

Water right - A legal right to use a specified amount of water for beneficial purposes

Watershed – The land area from which surface runoff drains into a stream channel, lake, reservoir or other body of water; also called a drainage basin.

Water table - The top of an unconfined aquifer; indicates the level below which soil and rock are saturated with water.

Weather – The composite condition of the near-Earth atmosphere, including temperature, barometric pressure, wind, humidity, clouds, and precipitation. Weather variations in a given area over a long period of time create climate.

Wetlands – Lands where water saturation is the dominant factor determining the nature of soil development and the types of plant and animal communities. Other common names for wetlands are sloughs, ponds and marshes.

Xeriscaping – A form of landscaping that utilizes a variety of indigenous and drought-tolerant plants, shrubs, and ground cover.

Zone of aeration – The unsaturated surface layer of the ground in which some of the spaces between soil particles are filled with water and others are filled with air. Some of the water in the zone of aeration is lost to the atmosphere through evaporation.

Zone of saturation – The part of a ground water system in which all of the spaces between soil and rock material are filled with water. Water found within the zone of saturation is called ground water. The water table is the top of the zone of saturation.

Appendix 13. Index

INDEX