Curriculum Ratings for Macroinvertebrate Monitoring

Submitted to Cairn & Associates by
Tricia Mangold Heiser
June 30, 2002

Table of Contents:

Background

Each of the ten curricula was rated according to how well it covered nine biological monitoring topics. The rating system used is described below:

N/A = This topic was not addressed at all by the curriculum
1 star = poor
2 stars = fair
3 stars = good
4 stars = excellent

The "average rating" at the bottom of each curriculum's chart is simply an average of the numerical ratings but does not include the "N/A" ratings. For example, if the curriculum received 5 numerical ratings and 4 "N/A" ratings, I simply added up the five numerical ratings and divided that number by five to obtain the average.

I provided a rather detailed "Notes" section for each curriculum. I hope this will help save teachers' precious time by steering them to the most useful activities.

The context was for use by classes of high school students who will be doing macroinvertebrate monitoring. Therefore, when looking at a summary chart of a curriculum that received low ratings, one should keep in mind that those do not reflect a poor quality environmental curriculum overall. It simply reflects the fact that this curriculum will not be very useful to high school students doing macroinvertebrate monitoring.

Other Recommendations:
EPA Volunteer Stream Monitoring: A Methods Manual (EPA) provides good coverage of most of the 9 monitoring topics.
Minnesota Rivers: A Primer (Water Resources Center, University of MN, 1999) provides good overview of river system functions, stream ecology, land use practices in MN, etc.
The Living Waters (River Watch/ River Network, Montpelier, VT). I don't have a copy of this myself, and I know a new edition has been printed since I looked at it. However, I remember it having lots of good basic stream ecology, macroinvertebrate life cycle information, etc. as well as easy to follow directions on how to monitor.

	Title	Source	Date	Grade	# Pages
1	The GLOBE Program, Hydrology Unit (online)	GLOBE Program, 1315 East-West Hwy. Rm#10600, Silver Spring, MD 20910-3282, or email: info@globe.gov, MN contact is Dr. Tony P. Murphy at Hamline University: (651) 523-2945, http://www.globe.gov	1995*	K-12	125**
2	Investigating Streams and Rivers	GREEN Program, Earth Force, Inc., 1908 Mount Vernon Avenue, 2nd Floor, Alexandria, VA 22301, #703-299-9400, http://www.green.org	1996	6-12	97
3	Rivers Curriculum Guide: Biology	The Rivers Project, Southern Illinois University, Box 2222, Alumni Hall, Edwardsville, IL 62026-2222, #618-650-3788, http://www.siue.edu/OSME/river	1998	7-12	242
4	Rivers Curriculum Guide: Chemistry	The Rivers Project, Southern Illinois University, Box 2222, Alumni Hall, Edwardsville, IL 62026-2222, #618-650-3788, http://www.siue.edu/OSME/river	1997	7-12	238
5	Rivers of Life (online)	Center for Global Environmental Education, Hamline University Graduate School of Education, 1536 Hewitt Ave., St. Paul, MN 55104-1284, #651-523-2480, http://cgee.hamline.edu/rivers	1997*	3-12	122**
6	Save Our Streams Teacher's Manual	Izaak Walton League of America, 707 Conservation Lane, Gaithersburg, MD, 20878-2983, #800-BUG-IWLA, http://www.iwla.org/SOS/index.html	1995	1-12	216
7	Water, Water, Everywhere	HACH Company, PO Box 389, Loveland, CO 80539-0389, #800-227-4224, http://www.hach.com	1991	7-12	144
8	The Water Sourcebook	Water Environment Federation, 601 Wythe St. Alexandria, VA, 22314-1994, #800-666-0206, http://www.wef.org	1997	9-12	885
9	Watershed Science for Educators	Cornell University/Media & Technology Services Resource Center, 7 Cornell Business & Technology Park, Ithaca, NY 14850 or Dist_Center@cce.cornell.edu # 607-255-2080, http://www.cce.cornell.edu/publications/catalog.html	1999	7-12	213
10	Water Quality High School Unit	Adopt-A-Watershed, P.O. Box 1850, Hayfork, CA 96041, #530-628-5334, http://adopt-a-watershed.org	1995	10-12	140

*Publication dates given for online curricula represent the year the core activities were written. However, please note that they are regularly updated online.
**Number of pages for online curricula is approximate and will vary according to monitor size and printer format.

The GLOBE Program, Hydrology Unit

MONITORING TOPIC	RATING	NOTES
A. Designing an experiment	***	"How to help your students design their own investigations" provides useful information (p.18).
B. Getting to know your stream site	***	"Water Walk" (p.75) includes visual survey, mapping, recording wildlife and plants. No data sheet provided. "Model your watershed" (p. 77) has students build a 3-D model of sampling site, simulate pollution flow, and discuss human impact. Appendix (p.88) has a good one page visual introduction on how to read contour lines on topographic maps.
C. Exploring stream ecology	N/A	
D. Collecting organisms in the field	**	"Macroinvertebrate Discovery" (p.84) covers this topic, but with directions that lack details. Does include information on how to make kick nets and D-nets.
E. Sorting and identifying organisms	*	"Macroinvertebrate Discovery" (p.84) has students sort organisms that "look alike" but no name identification is necessary (to calculate simple diversity index). Poor illustrations of common macroinvertebrates are included.
F. Analyzing and interpreting results	**	Above protocol for calculating diversity index is not state agency protocol. Most useful part of "Macroinvertebrate Discovery" is the charts showing typical pH, temperature and dissolved oxygen levels for specific macroinvertebrates. Web site has some tools for analyzing and exploring patterns in data.
G. Making the link between land use and water quality at your site	**	"Water Walk" (p.75) asks students to note type of land use and think about how it influences water quality. "Model your watershed" discussed above also gets students thinking about land use's effect on water quality.
H. Reporting and presenting stream data	*	Seasonal trends and anomalies in data are discussed, but all in context of chemical monitoring.
I. Taking action based on results	*	Encourages it, but provides few details.
AVERAGE RATING:	1.9	

Investigating Streams and Rivers, G.R.E.E.N.

MONITORING TOPIC	RATING	NOTES
A. Designing an experiment	****	With respect to designing an action project Activities 6-12 take you from start to finish, including: identifying problems, visualizing the future, selecting a specific project, contacting stakeholders, developing an action plan, taking action, and evaluating the project.
B. Getting to know your stream site	****	Part I: "Getting to Know the River" includes analyzing maps of the local watershed (Activity 1), mapping and recording basic site information during a stream walk (Activity 2), and interviewing people about local river history (Activity 3).
C. Exploring stream ecology	N/A	For topics C, D, E, and F this book provides an overview, but refers us to use W.B. Stapps' Field Manual for Water Quality Monitoring, or a similar manual.
D. Collecting organisms in the field	N/A	See above
E. Sorting and identifying organisms	N/A	See above
F. Analyzing and interpreting results	N/A	See above
G. Making the link between land use and water quality at your site	**	Activity 1 asks students to identify major land uses and how they affect the river. Activity 2 includes a checklist of land uses on stream walk data sheet.
H. Reporting and presenting stream data	**	Small groups report findings to class throughout many activities but no detailed advice on how to do this (except information on compiling interviews into a booklet for Activity 3). Web site has graphing tools for student data, data sheets to fill out, & online conferences.
I. Taking action based on results	****	Activities 6-12 take you from start to finish, including: identifying problems, visualizing the future, selecting a specific project, contacting stakeholders, developing an action plan, taking action, and evaluating the project. Pages 74-75 list over 10 possible actions to take.
AVERAGE RATING:	3.2	* The curriculum promotes the negative perspective that all rivers have problems and none are healthy. Very few positive examples.

Rivers Curriculum Guide, Biology

MONITORING TOPIC	RATING	NOTES (SA=Student Activity, SI=Student Information sheet)
A. Designing an experiment	**	Introduction (p. xi) includes good checklists of what to do before and after field monitoring including getting permission, gathering equipment, time estimates, etc. Field safety guidelines are found on page 12.
B. Getting to know your stream site	***	Page ix describes how to use community resources to find out about your site. SA 1.5 involves students doing research on local waterways. Habitat assessment activity (p. 91 and p.105) helps students examine field site in detail.
C. Exploring stream ecology	****	Some coverage in SI 1.1 and SI 1.4. Lesson 2 "River and Stream Ecology" covers energy flow, food webs, adaptations. SI 4.1 covers human influence on stream ecology. SI 4.3 describes riverine habitats.
D. Collecting organisms in the field	****	SI 4.2 and SA 4.4 gives detailed directions for both rocky and muddy bottom field sites.
E. Sorting and identifying organisms	***	Great macroinvertebrate flashcards with good illustration on one side and detailed information on reverse helps students practice recognition (p. 45-50). SI 3.3 provides pictures of macroinvertebrates sorted by pollution tolerance level. No keys included or hints on identification work.
F. Analyzing and interpreting results	****	Lesson 3 provides detailed information on what indices are and how they are used. Describes four different indices including pollution tolerance index and diversity index. Students use these indices directly in SA 4.6 and SA 4.4.
G. Making the link between land use and water quality at your site	***	Some discussion of land use in SI 4.3. SA 4.5 habitat assessment just looks at field site area, and does not examine watershed for bigger picture. Lesson 7 "Environmental Assessment" involves students in examining land use and other factors.
H. Reporting and presenting stream data	**	SA 7.4 involves a mock or real public meeting (depending on teacher preference) for students to present their ideas. Curriculum also encourages sharing student information on the web site.
I. Taking action based on results	***	Lesson 7 "Environmental Assessment" can be applied to a real life proposal on your stream, and include students in public meetings on the topic.
AVERAGE RATING:	3.1	*Note that although the majority of language used is balanced, the curriculum sometimes promotes the negative perspective that all rivers have problems and none are healthy.

Rivers Curriculum Guide, Chemistry

MONITORING TOPIC	**RATING**	**NOTES** (SA=Student Activity, SI=Student Information sheet)
A. Designing an experiment	**	Introduction (p. xii) can apply to macroinvertebrate monitoring. Provides checklists of what you need to do to prepare to monitor, and what to do afterwards. Much of field safety guidelines (p.9) apply to macroinvertebrate monitoring as well.
B. Getting to know your stream site	*	Encourages use of local organizations to gather information that's already known about your site (p. xi).
C. Exploring stream ecology	**	First SI of most chapters covers a little ecology (typically how the water quality parameter discussed in that chapter affects aquatic plants and animals).
D. Collecting organisms in the field	N/A	
E. Sorting and identifying organisms	N/A	
F. Analyzing and interpreting results	N/A	Only on chemical topics.
G. Making the link between land use and water quality at your site	*	First SI of most chapters discusses land use as it affects the parameter discussed in that chapter. No specific discussion on macroinvertebrates.
H. Reporting and presenting stream data	N/A	
I. Taking action based on results	*	Students debate whether or not to stencil storm drains (p.111). Students develop action plan to reduce turbidity (p. 63), which affects macroinvertebrates.
AVERAGE RATING:	1.4	

Rivers of Life (online)

MONITORING TOPIC	RATING	NOTES (R=Rivers Through Time, S=Steamer Trunk, F=Chasing the Flood, E=Energy Odyssey)
A. Designing an experiment	**	R Activity #1 goes through process: students read questions about watershed, note what they already know and what they are most interested in investigating, small groups brainstorm what is needed to answer questions, then entire class ranks according to interest. Also in S#3.
B. Getting to know your stream site	***	More social science rather than based on environmental science. In S, students use artifacts to document their watershed's traits in a culture box that is exchanged with another school. In R, students examine past and current view of a local river. Preparation Activity #2 involves mapping your watershed. E#11 involves mapping your watershed's energy resources.
C. Exploring stream ecology	N/A	
D. Collecting organisms in the field	N/A	
E. Sorting and identifying organisms	N/A	
F. Analyzing and interpreting results	N/A	
G. Making the link between land use and water quality at your site	**	Explores land use, but doesn't always link to water quality. If flooding is an issue at your site, F helps students explore relationship between precipitation, land use, and flooding. Preparation Activity #2 examines land use. S and R may explore land use questions depending on student interest and research topics.
H. Reporting and presenting stream data	*	Encourage students to submit work to the web site, but nothing specific to macroinvertebrate monitoring.
I. Taking action based on results	**	Some action projects are included, but none are based on monitoring data (see R#9, R#10). Interactive Youth Expedition projects may include monitoring action project, depending on student interest.
AVERAGE RATING:	2.0	

Save Our Streams Teacher's Manual

MONITORING TOPIC	RATING	NOTES (S=Project Guide for Students, T= Teacher's Manual)
A. Designing an experiment	****	S p.6-11: "Designing a Science Project" covers gathering info. about stream, visiting the site, and forming a hypothesis on topic you want to investigate. T p.56-58 and p.63: Info. on where and when to monitor. Safety guidelines found on S p.41 and T p.165.
B. Getting to know your stream site	****	Stream Walks to get to know your site found on S p. 7, 19 and T p.30. Watershed Walk involves looking for impacts on stream (T p.37). Map a Watershed involves delineating watershed boundaries on topographic maps (T p.22). Time Travel activity has students do research and interviews to learn stream history (T p.134).
C. Exploring stream ecology	***	S p.4-6: Ecology of Streams provides good basics. S p.11-13 has more on macroinvertebrates and their life cycles. T Chapter 1 has a little basic ecology. T p.49-50 has overview of fish, macroinvertebrates and plant roles in determining water quality.
D. Collecting organisms in the field	****	S p.25-28 and T p.61-68 and Appendix F describe in detail how to collect organisms. Both volumes include info. on how to build a kick net and a D-net.
E. Sorting and identifying organisms	***	S p.29 and T p.180 include tips on ID to order level, and 2 page illustrated key of macroinvertebrates grouped by pollution tolerance level. It is not state agency accepted protocol, but it is easy to follow.
F. Analyzing and interpreting results	***	T p.49 shares differences between chemical and biological monitoring and when each is appropriate. S p.14 shares tips on not jumping to conclusions when interpreting macroinvertebrate data. Stream Quality Survey Form includes simple calculation that reveals basic water quality ratings (S p.34 and T p.157).
G. Making the link between land use and water quality at your site	****	T Chapter 3 "The relationship between land use and water quality" provides excellent coverage of 10 land use topics including construction, agriculture, wetlands, forests, and dams. S p.23 includes alternatives to homeowner land use practices that degrade streams. Map a Watershed and Watershed Walk mentioned above also has students examine land use at their site.
H. Reporting and presenting stream data	****	S p. 15 provides good tips on presenting macroinvertebrate results. Also see newsletter and news articles below.
I. Taking action based on results	****	S p. 16 lists examples of possible action projects including displays, planting projects, and stream clean ups. Good detailed instructions on how to create a newsletter (T p. 135) and how to write a press release (S p.43 and T p. 138).
AVERAGE RATING:	3.7	

Water, Water, Everywhere

MONITORING TOPIC	RATING	NOTES
A. Designing an experiment	**	Page 14 "Teacher's Guide to Field Testing a Local Water Source" focuses on chemical testing, so all of it is not directly applicable. Page 3 covers safety considerations, some of which apply to macroinvertebrate monitoring.
B. Getting to know your stream site	*	All lab work, except curriculum encourages one field trip to collect samples from local waterbody.
C. Exploring stream ecology	***	Water Quality Factors Reference Unit: For each physical and chemical attribute of water, it discusses effects on aquatic life. Student Reading Unit covers stream ecology as relates to irrigation, pollution (thermal, sediment, toxins, sewage, fertilizer, etc.), and dams.
D. Collecting organisms in the field	N/A	
E. Sorting and identifying organisms	N/A	
F. Analyzing and interpreting results	N/A	Nothing on macroinvertebrates.
G. Making the link between land use and water quality at your site	**	Student Reading Unit discusses different types of pollution (thermal, sediment, toxins, sewage, fertilizer, etc.) but no discussion of effects on macroinvertebrates.
H. Reporting and presenting stream data	**	Teacher's Guide and Experiments shares tips for reporting your results to peers in a presentation (p.21), directions for writing reports (p.22), and directions for writing a speech (p.23). Again, focus is on chemical water quality parameters.
I. Taking action based on results	*	Encourages it once, but provides no details. "This is first and foremost a learning experience. Whatever you find out about the quality of the river is secondary (p. 15 Teacher's Guide)."
AVERAGE RATING:	1.8	* I would not recommend the Student Reading Unit due to the use of alarmist language and overgeneralizations at times. Teacher's Guide and Experiments includes some typographical errors and several confusing directions.

The Water Sourcebook, Grades 9-12

MONITORING TOPIC	RATING	NOTES
A. Designing an experiment	N/A	
B. Getting to know your stream site	***	3-1: Students write biographies of local rivers. Not a lot of coverage on this topic, but this one activity is a quality one.
C. Exploring stream ecology	****	Good coverage of this topic, but little mention of macroinvertebrates. 3-11: Stream flow and ecology. 3-37: Floods and some ecology. 3-34: Streams and logging projects. 3-53: Stream flow affecting pollution concentrations. 3-71: Turbidity and aquatic life. 3-83: Mining can degrade streams. 3-89: Thermal pollution and stream macroinvertebrates. 5-19: Rivers carry non-point source pollution to lakes. F-9, F-10, and F-41 discuss ecology of aquatic ecosystems.
D. Collecting organisms in the field	*	3-31: includes a very brief description of collecting organisms that lacks details.
E. Sorting and identifying organisms	**	3-35: provides one page picture key to order level, but no tips on how to identify.
F. Analyzing and interpreting results	**	3-29: includes brief discussion of macroinvertebrates as indicator species of pollution. 3-31 discusses how to calculate a general diversity index.
G. Making the link between land use and water quality at your site	***	2-33: students examine potential pollution sources in watershed. 2-123: focuses on storm water pollution of streams, includes good info. sheets describing Best Management Practices. F-8 and F-45 include info. on land use impact on water quality.
H. Reporting and presenting stream data	*	About 15 activities involve some type of presentation to peers or community, but none focus on stream data, and none give specific tips for creating presentations.
I. Taking action based on results	*	No action projects directly related to macroinvertebrate monitoring. Some activities have students brainstorm how to conserve water resources. 1-125: involves students in a realistic scenario where they create a proposal for decreasing trash in a waterbody.
AVERAGE RATING:	2.3	

Watershed Science for Educators

MONITORING TOPIC	RATING	NOTES (BIS=Background Information Sheet)
A. Designing an experiment	****	Chapter 2, "Planning your watershed monitoring program" covers deciding why, where, what, how, and when to sample and includes safety tips. Encourages student involvement in planning process.
B. Getting to know your stream site	****	Chapter 4 "Topographic maps" provides great introduction to analyzing topo. maps and delineating watershed boundaries. Students also create a 3-D model of their watershed. Chapter 5 "Aerial photographs" examines land use by examining historic & current photos.
C. Exploring stream ecology	***	BIS 6.1 covers general stream ecology: food webs, macroinvertebrate life cycles, seasonal changes. BIS 7.1 discusses chemical parameters and includes effect on aquatic plants and animals.
D. Collecting organisms in the field	**	BIS 6.2 and Activity 6.1 coves collection methods but they are not detailed and not up to state agency standards. Appendixes show how to build a D-net and artificial sampler for macroinvertebrates.
E. Sorting and identifying organisms	**	Page 109 has a two-page macroinvertebrate identification sheet, to "order" level. No good tips on helping students identify.
F. Analyzing and interpreting results	***	Chapter 9 "Wrap Up" provides details on which kinds of graphs and charts are best for which data, hints for trouble-shooting contradictory results, and advice for data that do not fit with the rest. Not much detailed help interpreting macroinvertebrate results. Simplified coverage of indices. Activity 8.2 notes how discharge rate can affect macroinvertebrates.
G. Making the link between land use and water quality at your site	****	Activity 3.2 Watershed Field Trip has students identify land uses. Chapter 4 (topos) and 5 (aerial photos) examine land use in detail. Chapter 8 (Physical monitoring) relates physical monitoring to land use patterns.
H. Reporting and presenting stream data	****	Chapter 9 "Wrap Up" provides details on which kinds of graphs and charts are best for which data, hints for trouble-shooting contradictory results, and advice for data that do not fit with the rest.
I. Taking action based on results	*	Encouraged, but no detailed discussion.
AVERAGE RATING:	3.0	

Water Quality High School Unit, Adopt-a-Watershed

MONITORING TOPIC	RATING	NOTES
A. Designing an experiment	***	Lesson 1: Students look at GIS maps and visit site to decide what questions they want to investigate and what kind of data to collect. Encourages getting students to ask specific questions that can be answered through research, and thoroughly involved them in research design.
B. Getting to know your stream site	****	Lesson 1: Students share what they already know about watershed, learn mapping skills, then go on a field trip to gather more information about their site/watershed.
C. Exploring stream ecology	N/A	C, D, E, F, and G received ratings of "N/A" because the curriculum was designed to be used with the Rivers Curriculum Guides (see separate ratings sheets above). Based on issues students decide to investigate, teachers may choose to use different guides (such as Biology, Chemistry, Earth Science, Math, etc.) and therefore coverage on these topics will vary.
D. Collecting organisms in the field	N/A	See above
E. Sorting and identifying organisms	N/A	See above
F. Analyzing and interpreting results	N/A	See above
G. Making the link between land use and water quality at your site	N/A	See above. Refers you to lesson in Rivers Curriculum Guide Geography, which involves students in a role play activity to understand complexity of water quality issues and land use decisions that affect them.
H. Reporting and presenting stream data	***	Lesson 5 and 7: Students organize a symposium and watershed fair to present, compare, and discuss results with others. They use posters, slides, debates and other techniques. General tips, but not very detailed. There are a few additional tips on p. 70 and 106.
I. Taking action based on results	****	Lesson 6: In this student-directed lesson students write a project proposal, implement the project and write a report. Includes detailed write-ups on how to carry out four different action projects (such as public education or restoration work).
AVERAGE RATING:	3.5	

Summary Chart of Ratings for All Ten Curricula

MONITORING TOPIC	The GLOBE Program	Investigating Streams and Rivers	Rivers Biology	Rivers Chem	Rivers of Life	Save Our Streams	Water, Water, Everywhere	The Water Sourcebook	Watershed Science for Educators	Water Quality High School Unit
A. Designing an experiment	3	4	2	2	2	4	2	N/A	4	3
B. Getting to know your stream site	3	4	3	1	3	4	1	4	4	4
C. Exploring stream ecology	N/A	N/A	4	2	N/A	3	3	4	3	N/A
D. Collecting organisms in the field	2	N/A	4	N/A	N/A	4	N/A	1	2	N/A
E. Sorting and identifying organisms	1	N/A	3	N/A	N/A	3	N/A	2	2	N/A
F. Analyzing and interpreting results	2	N/A	4	N/A	N/A	3	N/A	2	3	N/A
G. Making the link between land use & water quality at your site	2	2	3	1	2	4	2	3	4	N/A
H. Reporting and presenting stream data	1	2	2	N/A	1	4	2	1	4	3
I. Taking action based on results	1	4	3	1	2	4	1	1	1	4
AVERAGE RATING:	1.9	3.2	3.1	1.4	2.0	3.7	1.8	2.3	3.0	3.5

Recommendations for Chemical Monitoring

Because some teachers will choose to do chemical monitoring in addition to biological monitoring, I have included some recommendations of high-quality lessons to use.

Key to Curriculum Title Abbreviations:
AAW= Adopt-a-Watershed Water Quality High School Unit
BIO= Rivers Curriculum Guide: Biology
CHEM= Rivers Curriculum Guide: Chemistry
GLOBE= The GLOBE Program
ISR= Investigating Streams and Rivers
ROL= Rivers of Life
SOS= Save Our Streams Teacher's Manual
SOURCE= The Water Sourcebook
WWE= Water, Water, Everywhere
WSHED= Watershed Science for Educators

GLOBE	"Water, Water, Everywhere. How Does it Compare?" Students learn how to explain seasonal trends and anomalies in GLOBE data sets, then design a unique study to analyze their own data.
GLOBE	"Introduction: The Big Picture." Good introduction to physical and chemical parameters. Provides basic description, typical values, and effects on living things. Reading level is upper high school grades.
WWE	"Water Quality Factors Reference Unit." This volume (out of 3 in the series) describes 23 physical and chemical water quality parameters, and gives acceptable limits of each for various uses (such as drinking or swimming). The 23 factors include: ammonia, chloride, copper, mercury, oxygen, phosphates, sulfates, lead, and others. It provides a wealth of information to help put numeric water quality results into perspective, including pollutants' effects on aquatic and terrestrial life and the synergistic effects of multiple pollutants. *Note that I would not recommend using the Student Reading Unit due to the use of sometimes alarmist, biased language.
CHEM	"Activity 10.4: Calculating the Overall Water-Quality Index." In this culminating lesson, students use all data they have collected (on physical and chemical parameters) to determine the overall water-quality index for their stream.

CHEM	"Lesson 1.4: The Quality of Your River or Stream." Good introduction to Q-values, and overall water quality index.
CHEM	"Lesson 1.5: Accuracy and Precision of Data." Great introduction to statistical data analysis, including mean, standard deviation, and the proper way to report values.
CHEM	"Lesson 1.6: Should All Data Be Used?" Describes how to do a quotient test in order to determine whether to reject or include an outlier.
WSHED	"Background Information Sheet 7.1: Commonly Tested Water Chemistry Parameters." Good background information on physical and chemical parameters including a section called "Effect on aquatic ecosystem" for each. Parameters covered include: dissolved oxygen, pH, alkalinity, hardness, nitrate, phosphates, chloride, carbon dioxide, silica, turbidity, and temperature.
SOS	"Chapter 2, Measuring Stream Health." Subsection called "Monitoring Water Quality, p.49" provides good introductory discussion on differences between chemical and biological monitoring, and when they are most appropriate. Discusses a study that showed that biological monitoring detected the presence of water quality impairment in streams more often than chemical monitoring.
BIO/CHEM	"Lesson 1, Safety Guidelines and Contract." Covers both laboratory and field safety issues in a contract that students sign before participating in activities. Includes scenarios of unsafe behavior for class discussion and analysis.