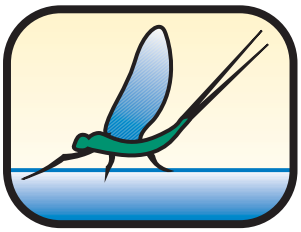

Lessons from the Bay

Stream Creatures: Clues to Stream Health

What are freshwater macroinvertebrates, and how can they tell us whether the water in which they live is polluted or clean?

Objectives

Students will

- study the adaptations of some macroinvertebrates that enable them to spend part or all of their life cycle in a stream ecosystem
- compare the role of herbivores, carnivores, detritivores, and omnivores and note the interdependence of plants and animals in a stream
- observe the effects of erosion and other pollution on stream macroinvertebrates and infer pollution's effects on the entire Chesapeake Bay watershed
- collect information from fact sheets and guidebooks and use a classification key to identify macroinvertebrates
- analyze and graph data from a stream-monitoring simulation.

Background

Freshwater macroinvertebrates are organisms that have no backbone (*invertebrate*), are large enough to be seen without a microscope (*macro*), and live underwater in streams, rivers, ponds, and lakes (*freshwater*). Many stream invertebrates are insect larvae. While such macroinvertebrates as dragonflies, mayflies, black flies, stoneflies, and caddis flies spend the adult stage of their lives on land and in the air, all of these insects spend the larval—and some the pupal—stage of their lives totally underwater. They have special adaptations, including gills, as larvae to help them live underwater. Other stream macroinvertebrates live their entire life underwater. These include crustaceans such as crayfish, scuds, and sowbugs; arachnids such as water mites; mollusks such as snails, clams, and mussels; and worms such as leeches, flatworms, and aquatic earthworms.

Scientists have discovered that certain macroinvertebrates are sensitive to pollution and can survive only in clean or slightly polluted water. Others are somewhat sensitive and can live in clean water or water with a moderate level of pollution. Still others are tolerant of pollution and can live in any water condition, even heavily polluted water. A clean, healthy stream ecosystem will have many sensitive organisms as well as somewhat sensitive and tolerant ones. The unpolluted stream ecosystem will likely exhibit biodiversity, meaning

Related Standards of Learning

Science:
3.1.h; 3.1.j; 3.5.b; 3.5.c; 3.6.a; 3.8.b; 3.10.a; 3.10.b; 3.10.c; 4.1.a; 4.5.a; 4.5.e; 4.5.f; 4.9.a; 5.1.a; 5.1.g;; 5.7.f; 5.7.g; 6.1.a;; 6.1.g; 6.5.c; 6.5.f; 6.7.g

Mathematics:
3.3; 4.3.a; 3.17; 3.17.c; 4.2; 3.3.c; 4.3; 4.14; 5.8.d; 5.8.e; 5.2.a; 5.15; 6.2.d; 6.7; 6.14.a; 6.14.b

English:
3.1; 3.2; 3.6; 3.8; 3.11; 4.1; 4.24.6; 4.7.b; 4.7.d; 4.8; 5.1; 5.4; 5.6; 5.7; 5.8; 6.2; 6.4.a; 6.4.b; 6.4.c; 6.4.d; 6.4.e; 6.6

History and Social Science:
3.10; VS.1.b; VS.1.d; VS.1.h; USI.1.e; USII.2.b; USII.9.b

Time Required

Three 45-minute sessions

Materials

- SOS: Save Our Streams *presentation (included with CD, and available on the Web; see Resources)*
- *computer with large monitor or projection device*
- *Internet access*
- *enlarged picture of each of the macroinvertebrates online at* The Stream Study *(see Resources)*
- *calculators*

For each student:

- *Macroinvertebrate Fact Sheet (handout, page 39)*
- *Schoolyard Stream Simulation Cards, cut apart (handout, page 43)*
- *Schoolyard Stream Simulation Data Sheet (handout, page 47)*
- *graph paper*
- *clipboard (optional)*

a great variety of organisms will be found. A stream in fair condition with some pollution will have more tolerant organisms but also some somewhat sensitive and a few sensitive species. A polluted stream ecosystem will have mostly tolerant organisms and a few somewhat sensitive ones. The polluted stream will not exhibit much biodiversity, because fewer organisms are able to survive in its poor conditions.

Professional scientists and certified *Save Our Streams* volunteers monitor stream health by collecting and identifying samples of the macroinvertebrates living there. The data is analyzed using several different counts. For this lesson, the analysis has been simplified so that students will compare the health of three simulated streams by looking only at the percent of tolerant macroinvertebrates.

Procedures

Session 1 (45 minutes)

Conduct this session in the classroom.

1. Show students the *Save Our Streams* presentation. Stop throughout to discuss such concepts as:
   - watershed
   - definition of *macroinvertebrate*
   - insect life cycles
   - water pollution and its effect on different stream macroinvertebrates
   - ability to determine water quality from a stream's macroinvertebrate population.
2. Have students, working in pairs at computers with Internet access, go to the Stream Study home page (http://www.people.virginia.edu/~sos-iwla/Stream-Study/StreamStudyHomePage/StreamStudy.HTML), and help them find the Web site's Identification Key for common stream-bottom macroinvertebrates.
3. Hold up one of the enlarged pictures of a macroinvertebrate (unlabeled). Ask students to make observations about the organism. Then show the students how to use the key to identify the macroinvertebrate. Repeat with other macroinvertebrates as time allows, and share results.
4. Discuss the benefits of an identification key, including its function of narrowing one's choices and eliminating the need to look at pictures of every organism.

Session 2 (45 minutes)

Conduct this session in the classroom.

1. Provide each student with a copy of the Macroinvertebrate Fact Sheet.
2. Divide the class into five groups, and assign two macroinvertebrates to each group. Give each group enlarged pictures of their macroinvertebrates, labeled with the organisms' names.
3. Discuss the headers on the fact sheet as well as scientific vocabulary that students will encounter while reading about their macroinvertebrates. Some things to discuss may include
   - the difference between common and scientific names
   - classification levels (i.e., Kingdom, Phylum, Class, Subclass, Order, Family, Genus, and Species)
   - definitions of *sensitive*, *somewhat sensitive*, and *tolerant* of pollution on fact sheet
   - definitions of *herbivore*, *carnivore*, *detritivore*, and *omnivore*
   - definitions of *adaptation* and *ecosystem*
   - insect life stages (i.e., egg, larva, pupa, and adult).
4. Have each group read and discuss the characteristics of their two macroinvertebrates. Tell them to add diagrams, drawings, labels, and notes to the pictures of their macroinvertebrates based upon what they read. So that others might learn about the macroinvertebrates, the diagrams should be as clear and informative as possible. The exercise will also help them organize their information. Tell them to look for similarities and differences between their two macroinvertebrates.
5. When students are ready, call on each group to pick two or three important facts about both of their macroinvertebrates to share orally with the class. Ask them to provide one similarity and one difference between their two macroinvertebrates.
6. Next choose a few characteristics by which to sort the macroinvertebrates. Students might sort by
   - *herbivore*, *carnivore*, and *omnivore*
   - the part of life cycle spent in stream or length of life cycle

- *phylum*, *class*, *subclass*, and *order*
- *sensitive*, *somewhat sensitive*, and *tolerant*.

Session 3 (45 minutes)

Conduct this session in the schoolyard.

1. Tell students that in this session the class will be acting out three plays: one for each of three streams being monitored. In each play 20 students will be needed to play the roles of the stream macroinvertebrates. If you have more than 20 students, the extras may play the parts of water or other stream inhabitants; if fewer, some students may take on two roles.
2. Provide each student with a Schoolyard Stream Simulation Data Sheet and a piece of graph paper. In addition, students should bring their Macroinvertebrate Fact Sheet. (If available, give each student a clipboard to hold each of the items.)
3. Hand out Schoolyard Stream Simulation cards for Stream 1. Instruct the students that as actors they must consult their fact sheets to study the character indicated on their simulation card. The fact sheet will provide students with clues for imitating their character. For example, the actor portraying a crayfish might use his or her hands as claws and make shredding motions; the leech might make sucking noises; the mayfly might pretend to crawl out of his or her skin; the aquatic worm might wiggle.
4. Direct the actors to start uphill, if possible, and to move downhill, as if they were flowing, until they reach you, who, playing the scientist, will collect them in your net.
5. Once you catch the macroinvertebrates, direct all the tolerant ones to get into a group. Count these, and instruct students to record the number on Data Sheets.
6. Next tell students to group themselves according to the type of organism they portray. As a class, count and record the number of different organisms on the Simulation Data Sheet. This number will indicate the level of diversity in the stream ecosystem.
7. Repeat steps 2–6 for the Stream 2 and Stream 3 Simulation Cards.
8. Find a shady spot or return to the classroom, and have students fill in the rest of the data sheet, discussing how the fraction of tolerant organisms is determined and how that is converted to the percent tolerant.
9. Instruct students to draw two graphs on their graph paper: one showing the percentage of tolerant macroinvertebrates in each stream, and the other showing the biodiversity in each stream. Use the graphs to compare the streams. (See "Preparing Graphs and Charts" on page 69 of the **Project Action Guide**.) Discuss what the graphs communicate about the health of each stream. Speculate about what could be happening on the land of each stream's watershed to affect the water quality.

Resources

Amos, William H. *Life in Ponds and Streams*. Books for Young Explorers. Washington, D.C.: National Geographic Society, 1981. ISBN 0870444042.

Bour, Laura. *The River*. First Discovery Book. Paris: Gallimard Jeunesse, 1992. New York: Cartwheel Books-Scholastic, 1993. ISBN 0590471287.

Carle, Eric, ed. *Animals, Animals*. New York: Scholastic, 1989. ISBN 0590436406. (A collection of poems including Dorothy Aldis' "Every Insect," p. 18, that teaches basic insect body parts, and a dragonfly haiku by Chisaku, p. 82.)

Engel, Sarah. "Bottom-dwellers Tell Stories about the Water Above." *Virginia Water Central* 21 (April–June 2002): 11–17. (See <http://vwrrc.vt.edu/>.)

Kellogg, Loren Larkin. *Monitor's Guide to Aquatic Macroinvertebrates*. Save Our Streams. 2nd ed. Isaak Walton League of America, 1994. (See <http://openagricola.nal.usda.gov/Record/CAT10857771>.)

"Life of a Stream." *Let's Explore and Research Nature (LEARN)*. (Environmental education lesson plans for field trips to Lake Anna State Park. Contact Lake Anna State Park: 540-854-5503.)

"Macroinvertebrate Mayhem." Poster. Project WET. The Watercourse, 1995. (See <http://www.projectwet.org/watercourse>.)

Classroom Assessment Suggestions

- *Correctly identifying macroinvertebrates, using online classification key*
- *Group notes, diagrams, and labels on their Macroinvertebrate pictures*
- *Understanding demonstrated during discussions*
- *Correctly recording data, calculating percents, and graphing results of Schoolyard Stream Monitoring Simulation*

Extensions for Students

- *Make a computer database of macroinvertebrates.*
- *Research other stream animals and plants. (See "Using the Library Media Center for Project Research" and "Using the World Wide Web for Project Research" on pages 55–58 of the* ***Project Action Guide****.)*
- *Read related poetry (see Resources) and write your own stream poem.*
- *Learn more about the* Virginia Save Our Streams *program at http://www.sosva.com, and monitor a stream near your school four times a year. If one person is trained and becomes a certified monitor, then your class' data will be included in a database used by scientists across the state.*
- *Take a field trip to Lake Anna State Park or another state park to learn more about stream flow and ecosystems, as in the activities "Life of a Stream" and "Mainstream" (see Resources).*
- *See "Conducting a Stream Quality Survey" on page 19 of the* ***Project Action Guide****.*

"Mainstream." *Let's Explore and Research Nature (LEARN).* (Environmental education lesson plans for field trips to Lake Anna State Park. Contact Lake Anna State Park: 540-854-5503.)

McGovern, Ann, ed. *Arrow Book of Poetry*. New York: Scholastic, 1965. ISBN 0590336711. (A collection of poetry that includes Rachel Field's "Grandmother's Brook," p. 79.)

Ramsay, Helena. *Rivers and Lakes.* London: Children's Press of Grolier Publishing, 1997. ISBN 0516202375.

Stream Study, The. Dept. of Environmental Sciences, University of Virginia. <http://people.virginia.edu/~sos-iwla/Stream-Study/StreamStudyHomePage/StreamStudy.HTML>.

Telford, Carole, and Rod Theodorou. *Down a River.* Amazing Journeys. Heineman Library, 1998. ISBN 157721538.

"Using the Library Media Center for Project Research." Project Action Guide. *Lessons from the Bay*. 55–56.

"Using the World Wide Web for Project Research." Project Action Guide. *Lessons from the Bay*. 57–58.

Virginia Save Our Streams. <http://www.vasos.org/>.

Voshell, J. Reese, Jr., and Amy Bartlett Wright. *A Guide to Common Freshwater Invertebrates of North America.* Blacksburg: McDonald and Woodward, 2002. ISBN 0939923874.

Woodard, Kathy. *SOS: Save Our Streams.* 2002. Microsoft PowerPoint presentation. (See the Virginia Department of Education Web site at <http://www.doe.virginia.gov/instruction/science/elementary/lessons_bay/lesson_plans/stream_creatures/SOS.ppt>. Also provided with the *Lessons from the Bay* CD.)