Macroinvertebrate Mayhem

Grade Level:
Upper Elementary, Middle School

Subject Areas:
Ecology, Environmental Science, Mathematics

Duration:
Preparation time:
Part I: 20 minutes
Part II: 50 minutes

Activity time:
Part I: 50 minutes
Part II: 50 minutes

Setting:
Large playing field

Skills:
Gathering information (researching); Organizing (categorizing); Interpreting (relating, drawing conclusions)

Charting the Course
Orient students to stream ecology prior to this activity. The **Extension** of "Stream Sense" provides a variety of streamside investigations. Students can learn how nonpoint source pollutants accumulate in a stream in "Sum of the Parts." Treating polluted water is addressed in "Sparkling Water" and "Reaching Your Limits."

Vocabulary
macroinvertebrate, biodiversity

How does the phrase "appearances can be deceiving" apply to the water quality of a sparkling, crystal-blue stream?

Summary

Students play a game of tag to simulate the effects of environmental stressors on macroinvertebrate populations.

Objectives

Students will:

- illustrate how tolerance to water quality conditions varies among macroinvertebrate organisms.
- explain how population diversity provides insight into the health of an ecosystem.

Materials

- *Samples of macroinvertebrate organisms* (optional)
- *Resources* (texts, field guides, encyclopedia)
- ***Identification labels** for macroinvertebrate groups, one per student* (Divide the number of students by 7 and make that number of copies of each macroinvertebrate picture. One side of each label should have a picture of one of the seven macroinvertebrates. The other side of each label [except those for midge larvae and rat-tailed maggots] should have a picture of either the midge larva or rat-tailed maggot. For durability, the cards may be laminated. Use clothespins or paper clips to attach labels to students' clothing.)
- *Pillowcases or burlap bags*
- *Chart paper or a chalkboard*

NOTE: To adapt this activity for your area, call the state Department of Land and Natural Resources or Fish and Wildlife Service for information.

Making Connections

People may be able to assess the water quality of a stream by its appearance and smell. Sometimes, however, a polluted stream looks and smells clean. Students may have already learned certain ways to test water quality and may have conducted macroinvertebrate stream studies. Simulating how environmental stressors affect macroinvertebrate populations helps students relate the concept of biodiversity to the health of aquatic ecosystems.

Background

Macroinvertebrates (organisms that lack an internal skeleton and are large enough to be seen with the naked eye) are an integral part of wetland and stream ecosystems. Examples of macroinvertebrates include mayflies, stoneflies, dragonflies, rat-tailed maggots, scuds, snails, and leeches. These organisms may spend all or part of their lives in water; usually their immature phases (larvae and nymphs) are spent entirely in water. Larvae do not show wing buds and are usually very different in appearance from the adult versions of the insects. (Maggot is the term used for the larva of some flies.) Nymphs generally resemble adults, but have no developed wings and are usually smaller.

A variety of environmental stressors can impact macroinvertebrate populations. Urban and/or agricultural runoff can produce conditions that some macroinvertebrates cannot tolerate. Sewage and fertilizers added to streams induce the growth of algae and bacteria that consume oxygen and make it unavailable for macroinvertebrates. Changes in land use from natural vegetation to a construction site or to poorly protected cropland may add sediment to the water. Sedimentation destroys habitats by smothering the

rocky areas of the stream where macroinvertebrates live. The removal of trees along the banks of a river and alteration of stream velocity can both alter normal water temperature patterns in the stream. Some organisms depend on certain temperature patterns to regulate changes in their life cycles. Other stressors include the introduction of alien species and stream channelization.

Some macroinvertebrates, such as the mayfly and stonefly nymphs and caddisfly larvae, are sensitive (intolerant) to changes in stream conditions brought about by pollutants. Some of these organisms will leave to find more favorable habitats, but others will be killed or will be unable to reproduce. Macroinvertebrates (e.g., rat-tailed maggots and midge larvae) that may thrive in polluted conditions are called tolerant organisms. Other organisms, called facultative organisms (e.g., dragonfly and damselfly nymphs) prefer good stream quality but can survive polluted conditions.

Water quality researchers often sample macroinvertebrate populations to monitor changes in stream conditions over time and to assess the cumulative effects of environmental stressors. Environmental degradation will likely decrease the diversity of a community by eliminating intolerant organisms and increasing the number of tolerant organisms. If the environmental stress is severe enough, species of intolerant macroinvertebrates may disappear altogether. For example, if a sample of macroinvertebrates in a stream consists of rat-tailed maggots, snails, and dragonfly nymphs, the water-quality conditions of that stream are probably poor (i.e., low oxygen level, increased sediment, contaminants). If, on the other hand, the sample contains a diversity of organisms, the stream conditions are

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likely good. However, baseline data is essential because some healthy streams may contain only a few macroinvertebrate species. A variety of food sources, adequate oxygen levels, and temperatures conducive to growth all characterize a healthy stream.

Procedure

▼ *Warm Up*

Review the conditions that are necessary for a healthy ecosystem. Ask students to describe what could happen to an ecosystem if these conditions were altered or eliminated. What clues would students look for to determine if an ecosystem was healthy or not?

Remind students that a stream is a type of ecosystem. Ask them how they would assess the health of a stream. Students may suggest conducting a visual survey of the surrounding area and answering the following questions: What land use practices are visible in the area? How might these practices affect the stream? Is there plant cover on the banks of the stream or are the banks eroded? What color is the water? What is living in the stream?

Identify several environmental stressors (e.g., urban and agricultural runoff, sedimentation, introduction of alien species) and discuss how they can affect the health of a stream. Review the many types of plants and animals, including insects, that live in streams. How might environmental stressors affect these organisms? Would all organisms be impacted in the same way? Why or why not?

▼ *The Activity*

Part I

1. **Introduce the practice of sampling macroinvertebrate populations to monitor stream quality.** Show students pictures or samples of macroinvertebrates used to monitor stream quality.

2. **Divide the class into seven groups and assign one macroinvertebrate (from *Macroinvertebrate Groups*) to each group. Have group members conduct library research to prepare a report for the class about their organism.** The report should include the conditions (e.g., clean water, abundant oxygen supplies, cool water) the organism must have to survive.

Macroinvertebrate Groups
Caddisfly larva
Mayfly nymph
Stonefly nymph
Dragonfly nymph
Damselfly nymph
Midge larva
Rat-tailed maggot

3. **Have students present their reports to the class and compare each organism's tolerance of different stream conditions.**

Part II

1. **Tell students they are going to play a game that simulates changes in a stream when an environmental stressor, such as a pollutant, is introduced. Show students the playing field and indicate the boundaries.**

2. **Have one student volunteer to be an environmental stressor (e.g., sedimentation, sewage, or fertilizer). Discuss the ways that a stream can become polluted and how this can alter stream conditions.** With a large class or playing field, more students will need to be stressors.

3. **Divide the rest of the class into seven groups to play the game. Each group represents one type of macroinvertebrate species listed in *Macroinvertebrate Groups*. Record the number of members in each group, using a table similar to *A Sample of Data From Macroinvertebrate Mayhem*.**

NOTE: Try to have at least four students in each group. For smaller classes, reduce the number of groups. For example, eliminate the

Intolerant Macroinvertebrates and Hindrances

ORGANISM	HINDRANCE	RATIONAL FOR HINDRANCE
Caddisfly	Must place both feet in a bag* and hop across field, stopping to gasp for breath every five hops.	Caddisflies are intolerant of low oxygen levels.
Stonefly	Must do a push-up every ten steps.	When oxygen levels drop, stoneflies undulate their abdomens to increase the flow of water over their bodies.
Mayfly	Must flap arms and spin in circles when crossing field.	Mayflies often increase oxygen absorption by moving gills.

*CADDISFLY LARVAE BUILD CASES AND ATTACH THEMSELVES TO ROCKS FOR PROTECTION AND STABILIZATION.

A Sample of Data From Macroinvertebrate Mayhem:

ORGANISM	TOLERANCE	NUMBERS (AT START AND AFTER EACH ROUND)			
		START	ROUND ONE	ROUND TWO	ROUND THREE
Caddisfly larva	Intolerant	5	2	2	2
Mayfly nymph	Intolerant	5	4	1	0
Stonefly nymph	Intolerant	4	4	4	2
Dragonfly nymph	Facultative	5	5	4	4
Damselfly nymph	Facultative	4	4	4	3
Midge larva	Tolerant	4	6	7	9
Rat-tailed maggot	Tolerant	4	6	9	11
TOTAL		31	31	31	31

stonefly nymph and the damselfly nymph groups.

4. **Distribute appropriate identification labels to all group members.** The picture of each group's macroinvertebrate should face outward when labels are attached.

5. **Inform students that some macroinvertebrates have hindrances to crossing the field.** (See *Intolerant Macroinvertebrates and Hindrances.*) These obstacles symbolize sensitive organisms' intolerance to pollutants. Have students practice their motions.

6. **Assemble the macroinvertebrate groups at one end of the playing field and the environmental stressor(s) at midfield. When a round starts, macroinvertebrates will move toward the opposite end of the field and the stressor will try to tag them. To "survive," the macroinvertebrates must reach the opposite end of the field without being tagged by the environmental stressor.** The environmental stressor can try to tag any of the macroinvertebrates, but will find it easier to catch those with hindered movements.

7. **Begin the first round of the game. Tagged macroinvertebrates must go to the sideline and flip their identification labels to display the more tolerant species (i.e., rat-tailed maggot or midge larva). Tagged players who are already in a tolerant species group do not flip their labels.**

8. **The round ends when all of the macroinvertebrates have either been tagged or have reached the opposite end of the playing field. Record the new number of members in each species.**

9. **Complete two more rounds, with all tagged players rejoining the macroinvertebrates who successfully survived the previous round. Record the number of members in each species of macroinvertebrates at the conclusion of each round.** Because some players will have flipped their identification labels, there will be a larger number of tolerant species in each successive round.

▼ *Wrap Up and Action*

The game is completed after three rounds. Discuss the outcome with students. Emphasize the changes in the distribution of organisms among groups. Have students compare population sizes of groups at the beginning and end of the game and provide reasons for the changes. Review why some organisms are more tolerant of poor environmental conditions than others. Have students compare the stream environment at the beginning of the game to the environment at the end.

Have students investigate a nearby stream. What types of macroinvertebrates live there? How would students describe the diversity of organisms? Do students' findings provide insight into the quality of the stream? What other observations can students make to determine stream quality? They may want to report their findings to local watershed managers or water quality inspectors.

Assessment

Have students:

- analyze a stream based on a visual assessment (*Warm Up*).
- describe macroinvertebrate organisms and identify what stream conditions they need to survive (*Part I*, steps 2 and 3, and *Wrap Up*).
- explain how some organisms indicate stream quality (*Wrap Up*).
- interpret stream quality based on the diversity and types of organisms found there (*Wrap Up*).

Upon completing the activity, for further assessment have students:

- develop a matching game in which pictures of streams in varying conditions are matched with organisms that might live there.

Extensions

Supplement the students' macroinvertebrate survey of a stream with chemical tests and analyses. (See **Resources.**)

Have students design their own caddisfly case.

Have students study aspects of biodiversity by adding another round to the game. For example, add a fourth round in which all organisms are caddisflies. This round will demonstrate how a few intolerant species or a single species can be quickly eliminated.

Resources

Ancona, George. 1990. *River Keeper*. New York, N.Y.: Macmillan.

Cromwell, Mare. 1992. *Investigating Streams and Rivers*. Ann Arbor, Mich.: Global Rivers Environmental Education Network (GREEN).

Delta Labs. 1987. *Adopt-A-Stream Teacher's Handbook*. Rochester, N.Y.: Delta Laboratories, Inc.

Edelstein, Karen. 1993. *Pond and Stream Safari: A Guide to the Ecology of Aquatic Invertebrates*. Ithaca, N.Y.: Cornell University.

Ellet, K. K. 1988. *An Introduction to Water Quality Monitoring Using Volunteers*. Baltimore, Md.: Citizens for the Chesapeake Bay, Inc.

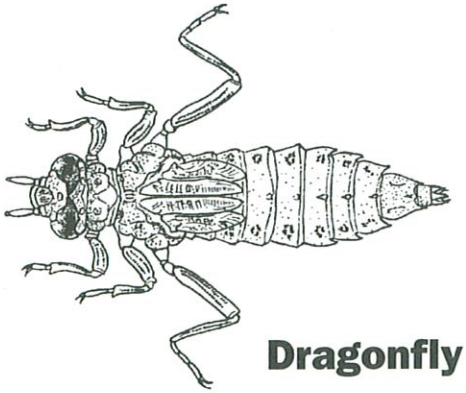
Mitchell, M. K., and W.B. Stapp. 1986. *Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools*. Dexter, Mich.: Thompson-Shore Printers.

Project WILD. 1992. Activity "Water Canaries." From *Aquatic Project WILD*. Bethesda, Md.: Western Regional Environmental Education Council.

Save Our Streams. Contact: Izaak Walton League of America, 1401 Wilson Blvd., Level B, Arlington, VA 22209.

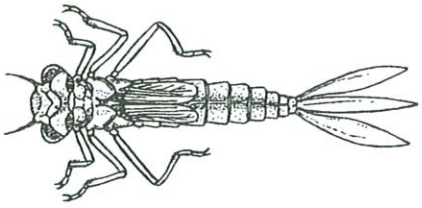
The Stream Scene: Watersheds, Wildlife and People. 1990. Portland, Oreg.: Oregon Department of Fish & Wildlife.

Identification Labels

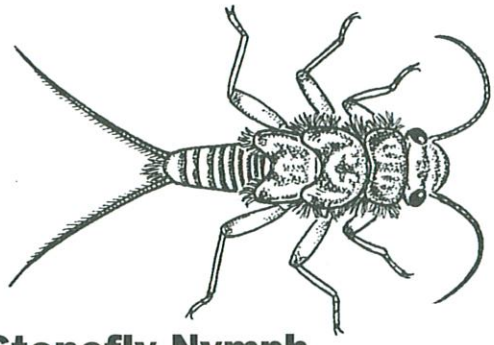


Dragonfly Nymph

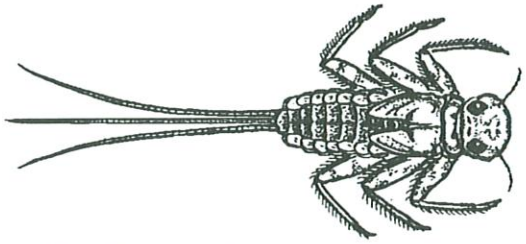
Caddisfly Larva



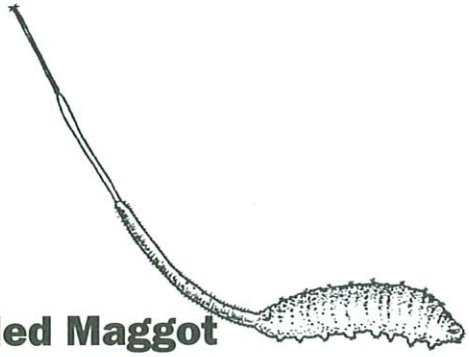
Damselfly Nymph



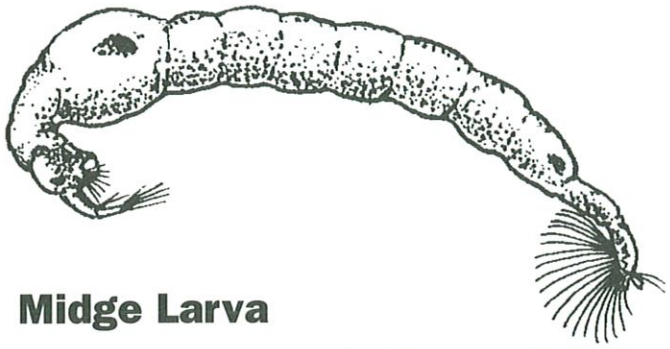
Stonefly Nymph



Mayfly Nymph



Rat-tailed Maggot



Midge Larva

Environmental Stressor