Macroinvertebrate Mayhem

(45 minute activity)

Objectives

Students will be able to:

1) Illustrate how tolerance to water quality conditions vary among macroinverebrate organisms
2) 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 (Figure 3) 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 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 a clothespin 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 Natural Resources or U.S. 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 are an integral part of wetland and stream ecosystems. Examples of macroinvertebrates include mayflies, 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 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. Both the removal of trees along the banks of a river and alteration of stream velocity can 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, stonefly, and caddisfly larvae, are sensitive (intolerant) to changes in the 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 that may thrive in polluted conditions (e.g., rat-tailed maggots and midge larvae) are called tolerant organisms. Other organisms, called facultative organisms (e.g., dragonflies, damsel flies, nymphs) prefer good stream quality but can survive polluted conditions.

Background
continued

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, traces of contaminants). If, on the other hand, the sample contains a diversity of organisms, the stream conditions are 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 temperature conducive to growth all characterize a healthy stream.

Procedure

1. Review the conditions that are necessary for a healthy ecosystem.

2. 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?

3. 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 answer the following questions:
   What land use practices are visible in this 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?

4. 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.

5. Review the many types of plants and animals, including insects, that live in the streams. How might environmental stressors affect these organisms? Would all organisms be affected in the same way? Why or why not?

Procedure
continued

Part1

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.

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

Part2

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.

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

Macroinvertebrate Mayhem is used with the permission from The Watercourse/Montana State University and the Council for Environmental Education (CEE) from Project WET Curriculum and Activity Guide. For further information about Project WET (Water Education for Teachers), contact the national office at (406)994-5392.

3. Divide the rest of the class into the 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.

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 MacroinvertebratesandHindrances). These obstacles symbolize sensitive organisms' intolerance to pollutants. Have students practice their motions.

IntolerantMacroinvertbratesandHindrances

ORGANISM	HINDRANCE	RATIONALE 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 their gills.

* Caddisfly larvae build cases and attach themselves to rocks for protection and stabilization.

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

Procedure
continued

6. Assemble the macroinvertebrate groups at one end of the playing field and the environmental stressor(s) at mid-field. 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.

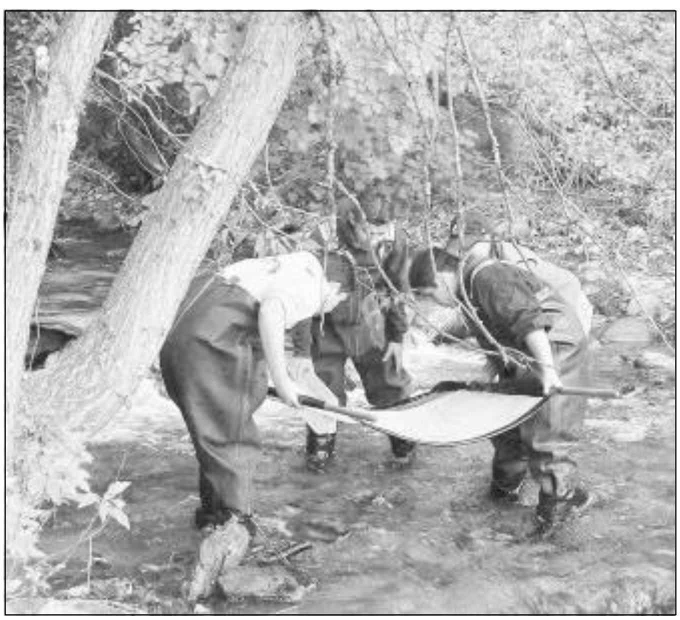
9. Complete two more rounds, with all tagged players rejoining the macroinvertebrates who successfully survived the previous round. Record the number of members in each species of macroinvertebrates at the conclusion of each round. Because some players will have flipped their identification labels, there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

ASampleofDataFromMacroinvertebrateMayhem

		NUMBERS (AT START AND AFTER EACH ROUND)			
ORGANISM	TOLERANCE	START	ROUND 1	ROUND 2	ROUND 3
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

Wrap Up

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.



Ask students to investigate a nearby stream. What types of macroinvertebrates live there? Graphics of Aquatic Insects Tolerant and Sensitive to Water Pollution (Figures 4 & 5) and A Key to Immature Aquatic Insects (Figure 2) may prove helpful for identification. 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.
- ✈ Describe macroinvertebrate organisms and identify what stream conditions they need to survive.
- ✈ Explain how some organisms indicate stream quality.
- ✈ Interpret stream quality based on the diversity and types of organisms found there.

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.
- ✈ 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.

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