Lake Roosevelt Water Festival 2008

September 23 & 24 • 9:30am to 2pm • Lake Roosevelt Day Use Area

Macroinvertebrate Mayhem

The Watercourse and Council for Environmental Education (CEE)

Curriculum Objective

To teach students how tolerance to water quality conditions varies among macroinvertebrate organisms. To teach students how population diversity provides insight into the health of an ecosystem. Students play a game of tag to simulate the effects of environmental stressors on macroinvertebrate populations. This simulation exercise helps students to understand how environmental stressors affect macroinvertebrate populations and helps the students relate the concept of biodiversity to the health of aquatic ecosystems.

Washington State Essential Academic Learning Requirements (EALRs)

Science: 1.1 (basis of biological diversity BM 1,2 & 3)
Science: 1.2 (structure and organization of living systems BM 1,2&3)
Science: 1.3 (life processes and the flow of matter and energy BM 1& 2, biological evolution BM 1,2&3, interdependence of life BM 1,2 & 3, environmental and resource issues BM 1,2 & 3)
Science: 2.1 (questioning BM 1,2&3, explanation BM 1,2&3, communication BM 1&2)
Science: 3.1 (evaluating methods of investigation BM 1&2)
Science: 3.2: (careers and occupations using science, mathematics and technology BM 1&2)
Mathematics: 3.1 (analyze information BM 1,2&3)
Mathematics: 5.2 (relate mathematical concepts and procedures to real-life situations BM 1,2)
Health & Fitness:1.2 (safely participates in a variety of developmentally appropriate physical activities BM 1&2)

Links: macroinvertebrates | pollution | water quality testing | pollution tolerance in macroinvertebrates | adaptations to pollution | biomonitoring|

Course Description (50 minutes)

Students play a game that simulates changes in a stream when an environmental stressor, such as a pollutant, is introduced. They are shown a playing field and its boundaries.

A student volunteer is selected to become an "environmental stressor (e.g., sedimentation, sewage, or fertilizer). The group discusses ways that a stream can become polluted and how this can alter stream conditions (large groups will require more students to become stressors).

The class is divided into seven groups to play the game. Each group represents one type of macroinvertebrate species listed in Macroinvertebrate Groups. The number of members in each group is recorded, using a table as follows:

Organism	Tolerance	Numbers (at start/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

Note: Have at least four students in each group; for smaller classes, reduce the number of groups. For example, eliminate the stonefly nymphs and the damselfly nymph groups.

Group members receive appropriate

Prework

Students should be familiar with the words "macroinvertebrate" and "biodiversity." They should understand that people are able to assess the water quality of a stream by its appearance and smell. Sometimes, however, a polluted stream looks and smells clean. They should understand that there are different ways to test water quality which include macroinvertebrate stream studies.

Classroom Activity

Students are introduced to the practice of sampling macroinvertebrate populations to monitor stream quality. They are shown pictures or samples of macroinvertebrates used to monitor stream quality.

Divide the class into seven groups and assign each group one macroinvertebrate (from Macroinvertebrate Groups). Ask group members to 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.

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

Macroinvertebrate Groups

identification labels. The picture of each group's macroinvertebrate should face outward when labels are attached.

Students are informed that some macroinvertebrates have hindrances to crossing the field (see the following Intolerant Macroinvertebrates and Hindrances):

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.		

These obstacles symbolize sensitive organisms' intolerance to pollutants. Students then practice their motions.

Macroinvertebrate groups are assembled at one end of the playing field and the environmental stressor(s) at midfield. When a round starts, macroinvertebrates 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.

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

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

Play the Animal Game to identify these Macroinvertebrates!

Extensions

Visit a nearby stream to determine what types of macroinvertebrates live there. Have the students identify and describe the diversity of organisms. Ask the students if their findings provide insight into the quality of the stream and what other observations they may need to make to determine stream quality. They may want to report their findings to local watershed managers or water quality inspectors.

Have students analyze the stream based on a visual assessment. Have them describe macroinvertebrate organisms and identify what stream conditions they need to survive. Explain how some organisms indicate stream quality. Interpret stream quality based upon 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.

in a tolerant species group do not flip their labels.

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

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

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.

back to top

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."

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.

back to top

Macroinvertebrate Tolerance to Pollution

Artwork: Gould League of WA and Waterwatch SA

Sensitive Macroinvertebrates

STONEFLY LARVAE
Stonefly larvae have two long tails, tubes of thread-like gills on their undersides, wing pads, antennae, and two claws on each foot. They are found among stones or plants in clear, cool, well oxygenated streams.

Background Information

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 (maggot is the term used for the larva of some flies), scuds, snails, and leeches. These organisms may spend all or part of their lives in water; usually their immature

MAYFLY LARVAE
Mayfly larvae have three long filaments at the end of their abdomen, with wing pads and lateral gills along the abdomen. They have short antennae, and a single claw on each foot. They are found under stones in fast flowing water or among plants in slow flowing water.

CADDISFLY LARVAE
These are worm-like insect larvae with three pairs of legs on the first three body segments. They are usually found in cases made from rolled leaves or hollow twigs, with only their head and legs protruding when they move.

DRAGONFLY LARVAE
Dragonfly larvae are short, chunky predators with wing pads and internal gills. They are found on plants, among stones and leaf litter, or on the bottom.

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. 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 alternation 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-

DAMSELFLY LARVAE
Damselfly larvae are more slender than dragonflies, have a distinct head section, and three gills on the tail tip. They are also found on plants, among stones and leaf litter, or on the bottom.

Tolerant Macroinvertebrates

BEETLE LARVAE
Beetle larvae may be confused with other animals. They are segmented, have three distinct pairs of legs, are never found in cases, but have a wide variety of forms. They are very active, aggressive predators with large mouth parts, and are found in all habitats.

BEETLES (COLEOPTERA)
Beetles have hard front wings folded side by side along the center of the back. From above, they have a more oval shape than bugs. Beetles have biting mouth parts They are found on plants, or swimming in or on the water at all levels.

BUGS (HEMIPTERA)
Bugs tend to be shield shaped when viewed from above. Their soft front wings are folded and overlap to leave a small triangle on the back, and they have sucking mouth parts They are found among the aquatic

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

plants on the water's surface, or swimming freely at all levels of slowly flowing water. Water boatmen and backstriders are bugs.

Very Tolerant Macroinvertebrates

FLY LARVAE
There are many types of fly larvae. They are worm-like creatures with no legs, or stumpy unjointed legs, and may have a sucker on the abdomen and a brush on the head. They occur in all sorts of aquatic habitats; swimming, on rocks, or on the bottom.

MIDGE LARVAE
Midge larvae are slender worm-like creatures, sometimes red, with no legs, or stumpy unjointed legs, and bristles. They are found in all sorts of aquatic habitats; swimming, on rocks, or on the bottom.

Pictures

Materials

Samples of macroinvertebrates. Field guides and other information resources. 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