Water Quality and Macroinvertebrates

By Teresa Matteson and Heath Keirstead
Benton Soil & Water Conservation District

Learning Objectives:
- Identify aquatic macroinvertebrate pictures
- Relate insect species/group to water quality
- Gathering and interpretation of data

Activity Time:
- One class period

Space Required:
- Indoors

Materials:
- Laminated pictures of stream invertebrates
- Laminated Group 1, 2 and 3 Stream Invertebrates Charts
- Large plastic tub for stream simulation
- Washed river rock to cover bottom of plastic tub
- Water for stream simulation
- Stickers (data point)
- Graph for data display

Preparation:
- Basic Ecology- how organisms interact with their environment

Vocabulary Words:
- Ecology
- Invertebrate
- Water quality
- Pollution
- Sensitive
- Tolerant
- Data
- Graph

Oregon Educational Benchmarks:
http://www.ode.state.or.us/teachlearn/real/standards/Default.aspx

Life Science:
- Understand the characteristics, structure, and functions of organisms.
- Understand the relationships among living things and between living things and their environments.

Science Inquiry:

- Conduct procedures to collect, organize, and display scientific data. Analyze scientific information to develop and present conclusions.
- Formulate and express scientific question or hypotheses to be investigated.
- Design safe and ethical scientific investigations to address questions or hypotheses.

Overview: Students collect invertebrate pictures from simulated stream, match pictures to group charts and place data stickers on graph. Students will use the data to discuss water quality, how invertebrates are impacted by their environment, and consider other factors, such as season, that may influence data.

Activity Directions:

1. Introduce the watershed concept. Explain how we all live in a watershed and how our activities can impact other humans and organisms living downstream.
2. Use the logging and agriculture/gardening/livestock management graphic to discuss how buffers provide riparian protection from pollution by sediments, fertilizer and manure.
3. Introduce Ecology - The study of the relationships between organisms and their environment. In this exercise we are ecologists who look at the presence of macroinvertebrates to assess water quality.
4. Discuss three groups of macroinvertebrates using the identification charts and what they indicate about water quality:
   Group 1 - Pollution sensitive
   Group 2 - Somewhat pollution tolerant
   Group 3 - Pollution tolerant
5. Follow this Scientific Inquiry process:
   a. **Ask a question** – What is the water quality of our simulated creek?
   b. **Design an investigation** – We will collect and categorize the macroinvertebrates in the creek to assess water quality.
   c. **Collect data -** Each student will:
      - Collect an organism from the stream simulator.
      - Compare the organism to the identification charts.
      - Determine the group and name of the organism.
      - Place a data point (mark or sticker) on the graph according to the macro group number.
      - Students can continue to collect data if time allows.
   d. Analyze results
      - Have each student share the names of organisms they collected and describe what that indicates about water quality.
      - Look at the graph to see which macro group was collected most often. Which macro group was collected the least often?
      - Discuss what the data on the class' graph indicates about water quality:
        - Group 1 is greater than groups 2 and 3 – water quality is good.

- Group 2 is greatest – this could represent increased or decreased pollution
- Group 3 is greatest – water quality is poor.
- If all three groups are equal the water quality may be good because Group 1 is present or could be shifting.

e. Share information

- Discuss why it is important for ecologists to understand the organisms they are collecting; other factors may be influencing data, such as:
- Food web – something may be feeding on certain macros and skewing the data
- Life cycles – some macros may be more prevalent than others at certain times of the year.
- Discuss the importance of collecting more than one sample.

Background Information:***

Water Quality in Streams

Stream Pollution

"Nearly everything that can be found on land eventually makes its way to a stream. This is because every bit of ground on Earth is a part of some river's watershed. Water flows downhill. Whether the water comes from rain, a hose, or a pipe, whatever doesn't sink into the ground will flow into the nearest stream. That is a simplification, of course. In reality, much of the water that soaks down into aquifers also eventually finds its way to a stream.

"The things that belong in a stream are the things that have been flowing into the stream for thousands or even millions of years. They are things that the plants and creatures in the stream have evolved to use to their advantage. They include very low concentrations of chemicals like calcium, iron, phosphorus, and nitrogen. They also include things you can see, like bugs, sediment, leaves, twigs, dead animals, even tree branches and whole trees.

"The things that don't belong in a stream--things that didn't show up there until human technology began to upset stream ecosystems--are called **pollutants**. According to theories of evolution, even a stream filled with a toxic soup of industrial chemicals may one day be able to support life. The problem is that it will take millions of years to get there." (Taken from http://chamisa.freeshell.org/pollution.htm)

Some sources of stream pollution: mining, urban runoff, point source pollution, sewage, power plants, sediment. See http://chamisa.freeshell.org/pollution.htm for details.

Bugs are Good Indicators for the Health of a Stream

Why do we look towards stream bugs for indications of stream health?

“There are several good reasons bugs are such a cool way to tell how healthy a stream is. For one thing, they are relatively easy and inexpensive to collect. But there's more...

“Nutrient Cycle. Bugs play a crucial role in the stream nutrient cycle. If bug populations are suffering it will affect the whole ecosystem.

“Pollution Tolerance. Some insects are tolerant of pollution, whereas others are not. The presence or absence of tolerant and intolerant types can indicate the condition of the stream. For example, the order Plecoptera, or Stoneflies, are very sensitive to pollution, so their absence in a stream can signal a problem.

“Population Fluctuations. Because many bug life cycles are short (sometimes one season in length), we can detect population fluctuations in a short period of time. Population fluctuations might indicate that a change (positive or negative) may have occurred in the stream.

(Taken from http://dnr.metrokc.gov/wlr/waterres/Bugs/indicator.htm)

Macroinvertebrate Taxa

Group 1 Pollution sensitive organisms found in good quality water
http://www.pskf.ca/ecology/bugs/class_1.html

Group 2 Somewhat pollution tolerant organisms can be in good or fair quality water
http://www.pskf.ca/ecology/bugs/class_2.html

Group 3 Pollution tolerant organisms can be in any quality water
http://www.pskf.ca/ecology/bugs/class_3.html

***Note: Everything you want to k now about Stream Biology and Ecology can be found at the following FANTASTIC website: http://chamisa.freeshell.org/index.htm#life

Extensions:

1. Extend the activity by taking samples from a local stream. Adopt a reach of a stream near your school for the year. Monitor the aquatic invertebrates found there using a chart, graph or table.
2. Discuss form and function using aquatic macroinvertebrates as examples. Have students guess what kinds of bugs will be found in different sections of a stream (an eddy, under a log, in the gravel, free flowing, in a riffle, etc) or, have them hypothesize what different bugs eat, based on their body forms.
3. Create a stream food web using the aquatic macroinvertebrates found in this lesson. Have the students role play the different bugs and create a web using yarn to represent the connections between them. Who eats whom?
4. Discuss how scientific data is repeatedly collected to reduce the impacts of seasonality, life cycles and other factors on results.

Useful Information for Extensions:

“Ecology is the study of how organisms exist in their environment.

“Invertebrates are animals that don't have backbones. ***Macroinvertebrates*** are invertebrates large enough to be seen with the naked eye.

“Those that live in streams differ from those found in lakes and ponds. This is because the environmental conditions are very different. Most types of ponds offer low velocities (or even stagnant water), great fertility from rotting natural materials that collect on the bottom, microscopic floating diatoms and crustaceans, large amounts of algae and other plants, often warm temperatures, and occasionally low light (because of depth, algae, and plants). The bottom of the pond is usually very dark, and doesn't have much oxygen.

“In contrast, streams are fast, cold, and often clear. Although plant material decays and diatoms cling to rocks to provide food, this food is only available to animals that can eat from the bottom (the ***benthos***). For a macroinvertebrate to be a benthos feeder, it must be able to stay on the bottom when it wants to. Animals do that by clinging, gluing themselves down, or burying themselves in the sediments. Although certain crustaceans, snails, and worms can perform this feat, by far the most numerous of stream invertebrates are insects. Because of their easy availability, they figure strongly in stream research.

“Stream macroinvertebrates develop marvelous strategies for utilizing ***niches***. Each species has a body specially modified to take advantage of the many different foods and habitats available even in the smallest stream. If you take a walk along a stream, you will see that there are places where the water flows slow, fast, and in between. You'll see stream bottom that is covered with mud, sand, pebbles, rocks, or even boulders. You'll notice that parts of the stream are shaded, while others are always in the sun, and that some areas are deep while some are shallow. You'll see areas where debris has piled up, creating dark, shaded, deep areas as well as tiny waterfalls. There are macroinvertebrates that have adapted to each of these varied conditions--and more. Once you know how they have ***specialized***, you'll be able to find them easily.” (Taken from http://chamisa.freeshell.org/inverts.htm#return1)

Trophic Groups

“Of the trophic groups that R. W. Merritt and K. W. Cummins (1978) have identified for aquatic insects, only 5 are likely to be found in a stream using typical collection and sorting methods:

“1. **Shredders** - These have strong, sharp mouthparts that allow them to shred and chew live plants or decomposing fragments. These are common among true flies, caddis flies, and stoneflies.

"2. **Collectors** - These gather the very finest suspended matter in the water. To do this, they often sieve the water through rows of tiny hairs. These sieves of hairs may be displayed in fans on their heads (black fly larvae) or on their forelegs (some mayflies). Some caddis flies and midges spin nets, and catch their food in them as the water flows through.

"3. **Scrapers** - These scrape the algae and diatoms off of surfaces of rocks and debris, using their mouthparts. Many mayflies, caddis flies, and true flies eat this way.

"4. **Piercers** - These herbivores pierce plant tissues or cells and suck the fluids out. Some caddis flies do this.

"5. **Predators** - Predators eat other living creatures. Some of these are *engulfers*; that is, they eat their prey whole or in parts. This is very common in stoneflies and dragonflies, as well as caddis flies. Others are *piercers*, which are like the herbivorous piercers except that they are eating live animal tissues." (Taken from http://chamisa.freeshell.org/inverts.htm#trophic)