Missing Macroinvertebrates - Stream Side Science

Summary

In this exercise, students will collect macroinvertebrates from a stream site, sort and identify them, and use their findings to identify current and past impacts to the quality of the water. They will also make predictions of how the impacts to the water quality contributed to the localized extinction of some types of macroinvertebrates.

Time Frame

1 class periods of 70 minutes each

Materials

- Plastic petri dishes*
- Magnifying glasses*
- Macroinvertebrate keys (pdf)
- Copies of student worksheets (pdf)
- Copies of macroinvertebrate sampling instructions (pdf)
- Copies of water quality index instructions (pdf)
- Kick nets*
- Plastic pans*
- Transfer pipettes*
- Bucket
- Waders
- Clipboards
- Pencils

* For information on equipment for loan or for purchase, contact USU Water Quality Extension at (435) 797-2580 or www.extension.usu.edu/waterquality

Background for Teachers

Purpose

To make inferences about the quality and/or quantity of freshwater using macroinvertebrate data collected from local water systems. To explain the factors that contribute to the extinction of a species.

Background

Aquatic macroinvertebrates (insects and other organisms that live in streams and ponds) display a wide range of adaptations to different aquatic conditions. Some types of macroinvertebrates are extremely tolerant of changes in temperature, flow, food or even the presence of pollutants, while other types are so sensitive to these changes that they may die or move to other areas. In this activity, students identify the macroinvertebrates in a stream. By noting which types are most abundant and which of the sensitive species are missing, we can learn a lot about present and past conditions of the stream.

For more background on macroinvertebrates in streams, see the Macroinvertebrate section (pdf) of the Utah Stream Team manual.

Intended Learning Outcomes

- Use Science Process and Thinking Skills
  - Observe objects, events and patterns and record both qualitative and quantitative information.

Evaluate, sort, and sequence data according to given criteria.
Select and use appropriate technological instruments to collect and analyze data.
Plan and conduct experiments in which students may:
Identify a problem.
Formulate research questions and hypotheses.
Predict results of investigations based upon prior data.
Identify variables and describe the relationships between them.
Plan procedures to control independent variables.
Collect data on the dependent variable(s).
Select the appropriate format (e.g., graph, chart, diagram) and use it to summarize the data obtained.
Analyze data, check it for accuracy and construct reasonable conclusions.
Prepare written and oral reports of investigations.
Distinguish between factual statements and inferences.
Develop and use classification systems.

Manifest Scientific Attitudes and Interests
Raise questions about objects, events and processes that can be answered through scientific investigation.

Demonstrate Understanding of Science Concepts, Principles and Systems
Know and explain science information specified for the subject being studied.
Apply principles and concepts of science to explain various phenomena.
Solve problems by applying science principles and procedures.

Communicate Effectively Using Science Language and Reasoning
Provide relevant data to support their inferences and conclusions.
Use precise scientific language in oral and written communication.
Use proper English in oral and written reports.
Use reference sources to obtain information and cite the sources.
Use mathematical language and reasoning to communicate information.

Demonstrate Understanding of the Nature of Science
Understand that science investigations use a variety of methods and do not always use the same set of procedures; understand that there is not just one "scientific method."
Science findings are based upon evidence.

Instructional Procedures

Classroom Activity:

NOTE: If you have already done the activity Who Lives in the Water? review the classroom activity with the students, then skip to step 6 of the field activity.

Ask the students to identify the types of plants and animals that live in streams (or other aquatic systems such as wetlands or ponds). Tell them this activity will focus on the diversity of macroinvertebrates found in streams. (Make sure they know the definition of a macroinvertebrate.)

Explain to the students they will collect a macroinvertebrate sample in a stream, identify the different types of organisms in their sample, and calculate a "water quality index", which is a numeric way of rating the health of a stream. An index like this allows them to compare different sites in an objective way.

Ask the students to think about what might affect the diversity of plants and animals they would find in this aquatic ecosystem (*e.g., pollutants entering the water, changes in habitat, natural or human caused changes in temperature, flow, substrate, food abundance or quality, predators in the system*).

Review common macroinvertebrates found in your area with the students. Have the students hypothesize what kinds of macroinvertebrates they expect to find. Be sure they are familiar with the macroinvertebrate keys they will be using in the field. If you would like a larger, laminated version of the key provided, please contact USU Water Quality Extension at (435) 797-2580.
Review sampling instructions with your students before they go into the field.

Field Activity:

Set up stations for sampling macroinvertebrates. These areas should be easily accessible and if possible have a range of substrate, such as small pebble, larger cobble, or woody debris.

Safety First!

Always consider safety factors when working near water.

Each station should include:

- Sampling instruction sheets (it helps to laminate these!)
- Waders
- Kick net
- Plastic pan
- Transfer pipettes
- Magnifying glasses
- Petri dishes
- Macroinvertebrate keys (it helps to laminate these!)

Divide the students into groups. Group size should be six students or less to make sure that everyone gets to participate. Provide each group with clipboards, pencils, and student worksheets. Each group will sample at a different station.
Demonstrate to the group how to sample for macroinvertebrates, then have the students collect samples. Have the students follow the instructions on the macroinvertebrate sampling sheet.
If time allows, give students an opportunity to observe the various types of macroinvertebrates in their sample.
The students must sort and count the types of organisms found in a subsample (~100 organisms). They will record this information on the macroinvertebrate sorting worksheet. Complete instructions on taking a subsample and sorting organisms are provided on the macroinvertebrate sampling page. NOTE: The subsampling, sorting and counting can be done in the field or back in the classroom with preserved samples.
Calculate the water quality index for each sample. Have the students follow the instructions on the water quality index instructions worksheet. NOTE: This step can be done in the classroom.
Have the students hypothesize the driving factors behind their water quality index. If they have a low water quality index (an absence of some species of macroinvertebrates), what is causing the populations to disappear?

Applying the Data:

Have the students compile and graph their data results. For example:

- A graph showing the diversity of macroinvertebrates found at the site.
- A graph showing the water quality index at different sites.

Further Discussion:

1. What kind of information does the water quality index provide that simple observations of diversity might miss?

   Diversity tells you how many types of organisms are found in an area. The Water Quality Index includes some of the attributes of the macroinvertebrates found in a stream, such as their sensitivity or tolerance to pollutants or other adverse conditions. Therefore it provides additional information. The two measurements are closely related, however, because polluted streams

often have less diverse macroinvertebrate populations.

2. Why do some types of organisms seem to be more sensitive to pollutants than others?
   This question doesn't have one simple answer, but it's an interesting opportunity to discuss and speculate on the differences in these organisms.

   More tolerant organisms may be those that evolved under more diverse conditions, and therefore are now able to handle a wider range of conditions. Animals that evolved under very unique or non-varying conditions may have very narrow ranges of tolerance to change.

   Another way to look at this question is to consider the adaptations these organisms have and the type of pollutants or stressors they experience. Mayflies, caddisflies and stoneflies that are typically found in fast moving streams probably have a high metabolic rate and require a lot of oxygen. If your class has already looked at the chemical properties of a stream, you know that as the temperature increases in a stream, the oxygen concentration declines. Therefore, just increasing the average temperature in a stream may deprive these organisms of the oxygen they need. Also, with high metabolic rates, these organisms may be more sensitive to small concentrations of toxic pollutants in a stream.
3. What does the water quality index tell you about the conditions in a stream that a water chemistry sample collected at the same time doesn't tell you?
   A water sample only tells you about conditions in the stream at the very moment you are sampling. Water that was at that site yesterday is already downstream, and water that will be at that site tomorrow is upstream. Therefore, your water sample is like a "snapshot" of the stream. Because the macroinvertebrates live in a stream for periods of up to several years (typically for months at least), they are exposed to many different conditions. Because of this, the types of macroinvertebrates found on a given day reflect the conditions in the stream for the past several months or more. Therefore, macroinvertebrates can tell you about past conditions.

Extensions

Calculate and compare water quality index using macroinvertebrates from other water sources (e.g., see the activity Wetland versus Stream Macroinvertebrates)
Sample the same stations on multiple dates and compare results.
Research factors that would contribute to a decline in the diversity of macroinvertebrates.

Bibliography

Lesson plan authors: Andree Walker and Nancy Mesner (Utah State University Water Quality Extension)
This curriculum was made possible through funding from the Environmental Protection Agency, the United States Department of Agriculture, Cooperative State Research, Education, and Extension Service, the Utah Division of Wildlife Resources, and Utah State University Extension.
Additional resources can be found on the USU Stream Side Science 9th Grade Curriculum web page.

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