Missing Macroinvertebrates

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.

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.

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 of the Utah Stream Team manual.

Materials:

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

Duration:
Classroom
20 minutes
Outdoors
50 minutes

Setting:
Classroom
Outdoors

Link to the Utah Core Curriculum:
Earth Systems – 9th grade
Standard II-3b
Standard II-3c
Standard IV-1d

ILO's:
1 a, c-g
2 b
3 a, c, d
4 a-e
(if students report findings)
6 b, c

Missing Macroinvertebrates

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.

1. 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.)

2. Explain to the students they will collect a macroinvertebrate sample in a stream, identify the different types of organisms in their samples, 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.

3. 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).*

4. 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.

5. Review sampling instructions with your students before they go into the field.

Field Activity:

1. 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.

Missing Macroinvertebrates

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!)

Safety First!
Always consider safety factors when working near water.

2. 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.

3. 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.

4. If time allows, give students an opportunity to observe the various types of macroinvertebrates in their sample.

5. 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.

6. 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.

Missing Macroinvertebrates

7. 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?

ACTIVITY 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.

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.

Worksheet

Macroinvertebrate Sorting

Name: _____ Group #: _____
Date: _____ Site ID: _____

MACROINVERTEBRATES	TALLY OF TYPES OF INDIVIDUALS
Ephemeroptera (mayflies)	
Odonata (dragonflies and damselflies)	
Plecoptera (stoneflies)	
Trichoptera (caddisflies)	
Diptera (flies)	
Megaloptera (fishflies and dobsonflies)	
Coleoptera (beetles)	
Amphipoda (shrimp and scuds)	
Isopoda (sow bugs)	
Decapoda (crayfish)	
Gastropoda (snails)	
Pelecypoda (mussels and clams)	
Oligochaeta (All segmented worms except leeches)	
Hirudinea (leeches)	
Other	

Observations about the stream site:

Weather today: _____
Weather yesterday: _____
Air temperature: _____
Water appearance (e.g., clear, brown, foamy, milky):_____
What type of land uses are in the immediate area? _____
What type of land uses are in the surrounding area? _____
Is the area shaded by trees? _____
List any factors that may lead to a disappearance of a species of macroinvertebrates:_____
_____

Water Quality Index

Name: _____ Group #: _____
Date: _____

Follow the Water Quality Index Instruction Sheet to complete this chart:

	(Column A)	(Column B)	(Column C)
MACROINVERTEBRATE	**# of Types**	**Tolerance Value**	**TOTAL**
Ephemeroptera (mayflies)		X 90	=
Odonata (dragonflies and damselflies)		X 60	=
Plecoptera (stoneflies)		X 100	=
Trichoptera (caddisflies)		X 80	=
Diptera (flies)		X 70	=
Megaloptera (fishflies and dobsonflies)		X 90	=
Coleoptera (beetles)		X 70	=
Amphipoda (shrimp and scuds)		X 40	=
Isopoda (sow bugs)		X 30	=
Decapoda (crayfish)		X 50	=
Gastropoda (snails)		X 40	=
Pelecyposa (mussels and clams)		X 20	=
Oligochaeta (All segmented worms except leeches)		X 20	=
Hirudinea (leeches)		X 10	=
SUM OF COLUMNS	(A)	---	(C)

Water Quality Index Number (sum of column A / sum of column C) =_____

Compare your water quality index number to the scale in the box to the right.

Health of the site = _____

Water Quality Index
>79 = Excellent
60-79 = Good
40-59 = Fair
<40 = Poor

Observations about the area that may affect the water quality: _____
_____
_____
_____

Macroinvertebrate Sampling

Time – 40 minutes
Persons – 2
Materials -
- 1 kick net
- plastic pan
- transfer pipettes
- plastic petri dishes
- magnifying glasses
- macroinvertebrate key
- ruler

OPTIONAL
- 5 gal plastic bucket (for decanting)
- waders

Step 1 - Choose your sample site

Select sampling reaches that are safe and easily accessed by everyone in your group. A riffle will offer the best variety of organisms.

Step 2 – Collect your sample

If you are sampling in flowing water:
1. Wade into the stream and place your net so the mouth of the net is perpendicular to and facing the flow of water.
2. Stand upstream of the net and disturb the stream bottom with your feet and hands.
3. Carefully pick up and rub stones directly in front of the net to remove attached animals. The stream bottom material and organisms will be carried by the current into the net. If the rocks are lodged in the stream bottom, rub them vigorously, concentrating your effort on any cracks or indentations.
4. After removing all large stones, disturb the sand and gravel to a depth of about 3 inches by raking and stirring with your hands.
5. Continue this process until you can see no additional animals or organic matter being washed into the net.

If you are sampling in pools or highly-vegetated areas:
1. Scoop material from the stream bottom with the net. Try not to scoop up too much sediment as it will make it difficult to sort the macroinvertebrates.
2. Push and pull the net through aquatic vegetation.
3. Hand pick organisms from sticks and other structures.

Step 3 – Empty your sample

1. Hold your sampling net over a plastic pan and use a bucket of stream water to wash the material into the pan.
2. If your sample contains a lot of rocks or debris, stir the sample in the pan to suspend the animals, then pour the suspended material back into your net. Rinse the debris from the pan, then wash the animals in the net back into the pan.

Macroinvertebrate Sampling

Step 4 – Sort out 100 macroinvertebrates

1. Pour most of the water from the pan, so that the materials and animals are no longer floating. Distribute the material evenly in the bottom of the pan.
2. Take a ruler and divide the material in half. Remove one half of the material from the pan.
3. Redistribute the material again over the bottom of the pan and divide this material again with a ruler.
4. Continue this process until you have a sample with about 100 organisms total.
5. Add some stream water back into the pan for easier sorting.
6. Sort and identify the macroinvertebrates using the petri dishes and pipettes.
7. Keep track of the number of types of organisms on the macroinvertebrate sorting worksheet. For example, if you have two macroinvertebrates that you identify as mayflies, but they have distinct differences, record that you have two types of mayflies.

Water Quality Index Instructions

Step 1

1. Refer to the 100 macroinvertebrates you sorted earlier in the activity, and the macroinvertebrate sampling worksheet.
2. Transfer the number of individuals tallied on the macroinvertebrate sorting worksheet to column "A" of the water quality index worksheet.

Step 2

1. Multiply the number of types of organisms (column A) found in each row with their individual tolerance values. Record this new value in the column labeled "Total" (column C).

Step 3

1. Add the numbers in the column labeled # OF TYPES (column A). Record this number at the bottom of column A.
2. Add the numbers in the column labeled TOTAL (column C). Record this number at the bottom of column C.

Step 4

1. Divide the number at the bottom of the TOTAL column (column C) by the number at the bottom of the # OF TYPES column (column A). This number will be your water quality index number.

Step 5

1. Compare this number to the chart at the end of the student data page.

Example: You have just collected 100 organisms from your sample site. After sorting 100 organisms you find that you have 2 types in the order Ephemeroptera (mayflies) and 3 types in the order Odonata (dragonflies and damselflies).

	(Column A)	(Column B)	(Column C)
MACROINVERTEBRATE	# OF TYPES	TOLERANCE VALUE	TOTAL
Ephemeroptera (mayflies)	2	X 90	= 180
Odonata (dragonflies and damselflies)	3	X 60	= 180
Sum of Columns	5	---	360

Water Quality Index

>79 = Excellent
60-79 = Good
40-59 = Fair
<40 = Poor

Divide column C by column A: 360 / 5 = 72

Compare your water quality index (72) with the scale. Your results indicate the water is in "good" condition.

Key to River Macroinvertebrates