Benthic Macroinvertebrates (BMI): Identification

In this activity students will identify benthic macroinvertebrates collected from a stream. Benthic macroinvertebrates are stream-dwelling invertebrates capable of being seen with the unaided naked eye. It is these traits that yield the name benthic macroinvertebrate: *benthic = bottom, macro = large, invertebrate = animal without a backbone* Healthy streams will have a wide variety of species in relative abundance so sampling is an effective way to gauge the health of a stream.

For this activity, these resources can be of great value. *A Guide to Common Freshwater Invertebrates of North America* by J. Reese Voshell, Jr. provides fine pictures and an excellent introduction to these critters, their ecology, and their sensitivities to pollution. *Field Guide to Freshwater Invertebrates of North America,* by Thorp and Rogers, has good pictures and covers a wider range of critters in less detail than does Voshell. *Pond Life,* an inexpensive Golden Guide book, is also very helpful and has good illustrations. The HRWC's bug ID sheet *Macroinvertebrates of the Huron River Basin* is another fine resource. It can be downloaded from the HRWC web site or obtained from their office.

It is highly desirable that volunteers in charge of this station be experienced participants in the HRWC's benthic macroinvertebrate surveys, aka the Spring and Fall Roundups. Completing the HRWC leader/collector training will also make running this activity easier and more rewarding.

Although the pre and post discussions are necessary to provide important information about each topic, it is the activity that is most vital to this unit. Be sure to allow plenty of time to complete the activity.

Pre-Activity Discussion (Answers can be found in the Background Information section below)
1) What are benthic macroinvertebrates and why are they important?
2) What are some of the structural features we should look for to help with identification? How do these underwater creatures breathe?
3) What is the difference between a larva and a nymph? Between these critters and an adult?

The Activity

Collecting Specimens

Collecting should be done prior to this station, either by adults before the activity or at a prior station. (See the BMI Collection Activity for details.) Depending on stream quality, off-site collecting may be necessary.

Equipment

To Identify:
-Tub of critters
-Forceps- 1 per student
-A couple eyedroppers
-Plastic netted spoons- 1 per student
-Small picking table or plastic ground sheet- Use a picnic table if available.
-White plastic ice cube trays; a few small tubs for bigger critters
-Magnifying glass- 1 per pair
-HRWC bug ID sheet- 2 copies, preferably laminated in plastic
-Voshell's A Guide to Common Freshwater Invertebrates of North America, 1 copy
-Data forms, clipboards, pencils
-Display boards
-Calculator (Optional- needed if you plan to calculate a water quality index from the data)

-Collecting bottles, labels, isopropyl alcohol 90-99% (Optional- needed only if planning to preserve the collection, rather than catch-and-release, which is the normal practice)

Identification

Students can use the spoons, forceps and eyedroppers to collect the critters from the containers in which they are being held. To sort the critters, fill the compartments of the ice cube trays 2/3rds full of stream water and put different kinds of critters into different compartments. For big critters such as hellgrammites, crayfish, and large cranefly larvae, you may need to use the tubs. The critters will appreciate it if you keep the containers in the shade as much as possible.

For identification, use the HRWC's bug ID sheet, the poster, and Voshell's guide to BMIs. Try to identify the critters to family if possible. If not, identify them to order or suborder. An experienced volunteer can be very helpful with this. Be sure to point our some of the important ways to separate one species from another. (Size, shape, presence of gills and where, number of tail parts)

Fill out the BMI data sheet and use it to determine: 1) the number of taxa (types) of critters that were collected, and 2) How many of these taxa are in the EPT category (Ephemeroptera, Plecoptera, Trichoptera). These taxa include mayflies, stoneflies and caddisflies. They are all sensitive to pollution and low dissolved oxygen levels. Use the data sheets to calculate the water quality index for that stream site and record it.

Post-Activity Discussion

1) How many different types of critters did we find? How many sensitive species (EPT) were present?
2) How would you rate the quality of the stream based on our collection?
3) What are some of the interesting structural features you observed in the critters that were collected.
4) What factors in the stream and the surrounding area do you think affect the quality of life in the water positively or negatively?

Background Information

Contrary to what most kids think, it is good to have lots of bugs in a stream, especially if there is also lots of diversity. If these critters- the benthic macroinvertebrates- are not present, the questions that must be asked are "Why? What is killing them off?"

BMIs live mostly on stream bottoms, on woody debris or leaf packs, on and under rocks, and in root wads, gravel, and aquatic vegetation. BMIs include flatworms, oligochaete worms, leeches, water mites, mollusks (snails, clams, mussels), crustaceans (crayfish, scuds, aquatic sowbugs, freshwater shrimp), and a very broad spectrum of aquatic insects in the adult stage and in the juvenile stages as larvae and nymphs. Many- if not most- of the critters collected will actually be in a juvenile stage and look far different than they will as adults.

A larva is a juvenile form of an insect that goes through complete metamorphosis like a butterfly (egg, larva, pupa, adult). A nymph is a juvenile form of an insect that goes through incomplete metamorphosis like a dragonfly (egg, nymph, adult). Some juvenile forms live as long as two or three years before becoming an adult which means that for most of these critters they live longer in their larval or nymph form than they do as adults. Some of these insects do not even eat as adults and some live only a few days, such as members of the order the Ephemeroptera (ie mayflies). In some instances, juvenile insects have the same form as adults but are smaller.

It can be difficult to identify many of the critters you will encounter to the species level but by careful observation it should be possible to determine the family. Instruct the students to attend to things such as

the overall shape and size of the critter; the presence and location of gills; the number of tails; for caddisflies, the presence and type of housing; the shape and size of legs and jaws; methods of locomotion. Astute observation is an important tool for any scientist.

BMIs are a vital part of the living community of a stream. They are a major link in the aquatic food chain. In most streams the energy stored by plants is available to herbivores and omnivores as (1) leaves that fall into the water, (2) algae and bacteria that grow on rocks, woody debris, etc., and (3) other aquatic submerged, floating, and emergent plants. These provide an energy source to the herbivores and omnivores, who in turn provide an energy source to the carnivores—predatory BMIs, fish, frogs, turtles, etc. Without BMIs, most sport fish would quickly starve to death. Closer study of these energy relationships shows that the food chain is quite complex, more of a food web than a food chain.

Among the BMIs are some that are very sensitive to pollution and low dissolved oxygen levels. This includes what is often referred to as the EPT category (Ephemeroptera, Plecoptera, Trichoptera). These taxa include mayflies, stoneflies and caddisflies. When critters are collected to determine the health of a stream, the collectors look for diversity and also to see how many of the sensitive species are present. These are your indicator species. In winter, the HRWC looks for a couple of species of stoneflies that are also sensitive indicators of stream health.

To protect our streams' small inhabitants, we must also protect the watershed so that erosion and pollutants from surrounding areas don't damage the health of our waterways. By protecting the critters, we also create an environment that is friendly to humans and safe for swimming, fishing and other activities. There is much to be gained by keeping our waters clean and free from silt and contaminants.

For this and all other units, advanced level information is available if desired. Contact the HRWC and request an electronic version of the unabridged manual.

Benthic Macroinvertebrates Worksheet (Elementary)

Put the different kinds of animals into different compartments in the ice cube trays.
Use the bug identification chart Macroinvertebrates of the Huron River Basin to figure out their names. Get help from an adult if you're not sure.
Make a mark beside the right name below to keep track of the number of each kind of animal.
When you're done, count the marks and write down the total for each animal.

Group 1. *Very sensitive* to pollution

Critter Name	Total	Critter Name	Total
1. Caddisfly larvae		4. Gilled Snails (right-handed)	
2. Clubtail Dragonfly nymphs		5. Stonefly nymphs	
3. Dobsonfly larvae		6. Watersnipe Fly larvae	

Group 2. Can *tolerate a little* pollution

Critter Name	Total	Critter Name	Total
7. Alderfly larvae		13. Mayfly nymphs	
8. Caddisfly larvae (without cases)		14. Pea (Fingernail) Clam	
9. Cranefly larvae		15. Riffle Beetles	
10. Crayfish		16. Scud	
11. Damselfly nymphs		17. Sowbug	
12. Dragonfly nymphs (most)		18. Water Penny Beetle	

<u>Group 3</u>. Pollution tolerant—can *live in quite polluted* water

Critter Name	Total	Critter Name	Total
18. Aquatic Worms		21. Midge larvae	
19. Blackfly larvae		22. Pouch (left-handed) Snails	
20. Leeches			

***If you have any critters from Group 1, the water quality is excellent.**

***If you have no critters from Group 1, but do have critters from Group 2, the water quality is fair to good.**

***If you have no critters from Group 1 or Group 2 but do have critters from Group 3, the water quality is poor.**

***If you found no critters at all, the water quality is bad.**

1. **In general, what do benthic macro-invertebrates tell us about water quality over time?**

2. **What was the water quality in this spot, as indicated by the animals your group found?**

3. **What can you do to improve this condition?**

KEY Benthic Macroinvertebrates, Elem.

1. In general, what do benthic macro-invertebrates tell us about water quality over time?

   They tell us if the water conditions were right for these creatures to live here.

2. What was the water quality in this spot, as indicated by the animals your group found?

   Answers will vary

3. What can you do to improve this condition?
   A. Decrease dirt in water
   B. Decrease salt in water
   C. Stabilize banks
   D. Increase trees and shrubs near banks
   E. Slow flow of storm water to river
   F.

Benthic Macroinvertebrates Worksheet (Secondary)

Put the different kinds of animals into different compartments in the ice cube trays.
Use the bug identification chart Macroinvertebrates of the Huron River Basin to figure out their names. Get help from an adult if you're not sure.
Make a mark beside the right name below to keep track of the number of each kind of animal.
When you're done, count the marks and write down the total for each animal.

Group 1. *Very sensitive* to pollution

Critter Name	Total	Critter Name	Total
1. Caddisfly larvae		4. Gilled Snails (right-handed)	
2. Clubtail Dragonfly nymphs		5. Stonefly nymphs	
3. Dobsonfly larvae		6. Watersnipe Fly larvae	

Group 2. Can *tolerate a little* pollution

Critter Name	Total	Critter Name	Total
7. Alderfly larvae		13. Mayfly nymphs	
8. Caddisfly larvae (without cases)		14. Pea (Fingernail) Clam	
9. Cranefly larvae		15. Riffle Beetles	
10. Crayfish		16. Scud	
11. Damselfly nymphs		17. Sowbug	
12. Dragonfly nymphs (most)		18. Water Penny Beetle	

Group 3. Pollution tolerant—can *live in quite polluted* water

Critter Name	Total	Critter Name	Total
18. Aquatic Worms		21. Midge larvae	
19. Blackfly larvae		22. Pouch Snails (left-handed)	
20. Leeches			

***If you have any critters from Group 1, the water quality is excellent.**
***If you have no critters from Group 1, but do have critters from Group 2, the water quality is fair to good.**
***If you have no critters from Group 1 or Group 2 but do have critters from Group 3, the water quality is poor.**
***If you found no critters at all, the water quality is bad.**

1. Calculate a taxon-averaged water quality index:

A. Write down the number of taxa (kinds) (e.g. all mayflies together are one taxa, all midge larvae count as "1", etc.) of critters found in each of the three groups above; N_1 = number of kinds in Group 1, N_2 = number of kinds in Group 2, N_3 = number of kinds in Group 3.

N_1 = _____ N_2 = _____ N_3 = _____

B. Calculate the sum $N_1 + N_2 + N_3 = N_{total}$ = _____

C. Calculate the water quality index

$Q_{taxa} = [1xN_1 + 3xN_2 + 5xN_3]/ N_{total}$ = _____

This index lies in the range 1 to 5. The <u>smaller</u> the index you calculate, the higher the water quality is.

4. In general, what do benthic macro-invertebrates tell us about water quality over time?

5. What was the water quality in this spot, as indicated by the animals your group found?

6. What can you do to improve this condition?

KEY: Macro-Invertebrates, Secondary

4. In general, what do benthic macro-invertebrates tell us about water quality over time?

   They tell us if the water conditions were right for these creatures to live here.

5. What was the water quality in this spot, as indicated by the animals your group found?

   Answers will vary

6. What can you do to improve this condition?
   G. Decrease dirt in water
   H. Decrease salt in water
   I. Stabilize banks
   J. Increase trees and shrubs near banks
   K. Slow flow of storm water to river
   L.

BMI Identification Lesson Narrative (Elementary and Middle School)

Intro. 5 – 8 minutes. The mission is to make these points: We collect the benthic macroinvertebrates because they are indicators of water quality. When we know what we have collected, we will be able to tell what kind of water quality has been present here. The BMIs only can live where the conditions are right for them.

1. 1. My name is _____ and I'm a volunteer with the Benthic Macroinvertebrates Identification station. Please tell me your names. (Go around)
2. There are lots of ways to know something about water quality. For example, we can sample the water to test for dissolved oxygen, for chemicals in the water or for the amount of dirt in the water. There are laws that say what chemicals can be in the water, and at what percentage. However, all those tests have one big limitation. Can you think what might be the problem with testing the conditions of the water? (The tests only measure the condition of the water at the moment of testing.)
3. Explain that another type of monitoring is to collect and identify the macroinvertebrates that live in the water. Point out that these critters live here every day and night. They have certain requirements and tolerances. If the conditions are right, they will be here. If things weren't right, they won't be here.
4. Explain that if we know which critters are here, we can know something about the quality of the water over time.

The Activity. 10 – 15 minutes. Explain the activity. Assign the roles. Start sorting and identifying.

5. Show how to use the spoons and forceps to capture the critters from the labeled cups. Show the ice cube trays, and ask them to put similar critters together.
6. Show the posters with the pictures and names of the commonly found BMIs.
7. Students pick through the cups, sorting and identifying.
8. Students use the lab sheet to tally the names of critters they have identified.

The Wrap Up: 5 minutes. Gather the group back at the table/station. Discuss the key questions.

9. Take a look at the lab sheets to see the names and tallies of the BMI's identified.
10. How many different types of critters did we find? How many sensitive species (EPT) were present?
11. How would you rate the quality of the stream based on our collection?
12. Explain some results of good BMI bio-diversity. (Stronger food web, more sport fish.)
13. What factors in the stream and the surrounding area do you think affect the quality of life in the water positively or negatively?
14. Explain that they will learn more about how to help the creatures in the streams at the other stations.
15. Thanks for visiting with me today. It's time for you to go to your next station _____.