UNIT 8: Macroinvertebrates

INTRODUCTION

Most likely this is the first time you've heard the term "macroinvertebrates" and we wouldn't be surprised if you don't think they sound like much fun. If so, think again! **This unit is BioSITE's most popular and memorable. You will discover that hidden under the water, among the rocks and plants in any healthy stream, is a tiny universe of critters, including macroinvertebrates.**

For every dragonfly you see above a pond or creek, there are dragonfly nymphs, fearsome hunters living underneath the water. Just as a frog hatches from an egg and begins its life as a tadpole under water, many of the insects you see flying near a waterway spend an early stage of their life cycle in the stream. Some may even spend years living in the water, only to live as a mature flying insect for a few weeks or months.

The number of macroinvertebrates you can find living in the gravel beds of a stream is truly astonishing. Because of the competition for food and shelter from predators, macroinvertebrates are highly adapted to live in specific niches of the underwater environment. They specialize in eating different things and living in different locations. You will see tiny claws for clinging to rocks in fast moving water, special jaws for shredding plants, tiny houses built of pebbles and insect "glue," and more.

You will find that, just as with birds and fish, observing macroinvertebrates teaches us many things. You will learn how to conduct a form of water quality testing using macroinvertebrates instead of test kits. Examples of camouflage and adaptations will be brought to life right in front of your eyes. And, perhaps most importantly, you will find that a crowded "city," full of residents, homes and roads, can fit right under your foot. So watch your step!

UNIT OVERVIEW	
Engage	**Introduction to New Material** Reading: Introduction to Macroinvertebrates
Explore	**Activities to Explore Material** *Activity 1: Who Am I?* *Activity 2: Critter Catch*
Explain and Elaborate	**Advanced Study** Reading and Research: Pollution Tolerance Index *Activity 3: Pollution Tolerance Index* Facilitator Field Day Planning
Experience Evaluate	**Field Study and Teaching:** Macroinvertebrates **Debrief and Reflect**

LEARNING OBJECTIVES

At the end of this unit students should be able to:

- Explain the ecological concepts of camouflage, adaptation and species;
- Identify and classify various creek organisms;
- Observe and record adaptations;
- Review the microenvironments within the stream (riffle, pool) and understand their relationship to macroinvertebrate habitat;
- Learn how to identify the macroinvertebrates of the study site using a dichotomous key; and
- Compare the information they gather to the pollution tolerance index.

Reading: Introduction to Macroinvertebrates

On land in the riparian ecosystem it's easy to see interesting things among the larger animals. Hawks catch field mice, fish jump out of the water to catch an insect in midair, and Snowy Egrets and herons stand patiently waiting to spear their prey when it swims beneath. Life in the water can be just as remarkable. The smallest living organisms can be seen only by microscope. The largest, like fish and amphibians, are easily seen with the human eye.

Macroinvertebrates are animals that can be seen without a microscope, but they differ from fish and amphibians because they have no backbone; they are **invertebrates** protected by an exoskeleton. Among these creatures we find small organisms that live underwater but breathe air through a snorkel-like tube that pokes through the water surface. We also find beetles that carry around air bubbles to help keep them afloat and serve as their personal source of oxygen when they dive below the water surface. Some bugs have a beak with which they pierce their prey and suck out the juices. Others have wax on their feet so they can skate on the surface of the water.

Each of the many different types of macroinvertebrates has interesting physical adaptations and a unique level of tolerance to water pollution. Many have a life cycle that is specific to a **metamorphosis**, or change, from the **larval** to adult stage. Others, like leeches or planaria, do not metamorphose.

Like birds and fish, macroinvertebrates are indicators of water quality. In fact, they can even be used to "test" or measure the quality of water by using a Pollution Tolerance Index, which calculates the number and species of macroinvertebrates found in the water. Macroinvertebrates are first grouped by their ability to tolerate pollution and then counted. The types of organisms found reflect the level of pollution in the water.

One reason macroinvertebrates are considered a good indicator of water quality is because they are relatively limited in their mobility. They tend to stay in one general area, so if a species disappears this can serve as a warning signal that the water quality has declined. For example, if many species that cannot tolerate pollution were found, you could deduce that the water quality is good. If a sample taken revealed only pollution-tolerant species, this would suggest the water was polluted. The test doesn't explain the cause of pollution—it only identifies the symptom. The macroinvertebrate organisms are classified and taxonomically grouped according to their pollution tolerance: most intolerant, moderately intolerant, fairly tolerant, and most tolerant of pollution.

It is important to note that finding "fairly tolerant" or "tolerant" critters does not automatically indicate a polluted stream. Even clean streams have tolerant macroinvertebrates, but they are located alongside intolerant species.

Pollution Tolerance Classification

You will notice that macroinvertebrates are basically grouped in a range according to their tolerance for varying levels of oxygen and nutrient pollution in the water. The following describes their tolerance and physical adaptations that allow them to survive in those conditions.

Group I: Pollution Intolerant

These organisms are considered "pollution sensitive." They are intolerant of nutrient pollution (from sources such as sewage and fertilizer) and of decreased oxygen levels. If pollution increases, macroinvertebrates in Group 1 will die. In their ideal habitat – cold, clear streams with high oxygen levels – you would find a diverse and abundant group of stoneflies, alderflies, dobsonflies, and snipeflies. They feed on naturally available food sources such as decaying leaves.

Group II: Moderately Intolerant

Organisms in this group have a higher tolerance for nutrient pollution, but are still mainly intolerant of decreased levels of oxygen. This group contains a diverse number of species, such as mayfly nymphs, caddisflies, riffle beetles and water penny beetles. They can be found in different areas within the stream. Cranefly larva and crayfish live in riffles; dragonfly and damselfly nymphs live in pooling water. Mussels and clams don't move – they are found on the bottom, clinging to rocks.

Group III: Fairly Tolerant

This group can tolerate low levels of oxygen and high levels of nutrient pollution. They tend to be bottom dwellers – scavengers and omnivores like aquatic sowbugs and scuds that feed on decomposing organic matter. Midge larva and gill-breathing or right-hand snails feed on a variety of plant and animal food sources. Blackfly larvae thrive in the nutrient-filled water of sewage treatment plants.

Group IV: Pollution Tolerant

As the name of the group suggests, these macroinvertebrates can tolerate severe nutrient pollution and low levels of oxygen. They often have adaptations to get their oxygen from the surface of the water. Aquatic worms and leeches tolerate stressed, low oxygen environments. Left-hand snails have special air-breathing adaptations and bloodworms (midge larva) have special blood that helps move oxygen through the body.

Types of Macroinvertebrates

Macroinvertebrates can also be categorized by what they eat. In riparian habitats, organic matter such as leaves and needles, twigs, flowers and fruit from nearby trees and vegetation, falls into the stream and eventually sinks to the bottom to decompose. As it falls and sinks, bacterial and fungi **decomposers** begin to consume it. This coarse organic matter is then stripped and shredded into smaller, finer particles by macroinvertebrate **shredders**. The shredders feed on the leaves but get most of their nutrition from the decomposers that attached to the leaf. In small, vegetated streams shredders are the dominant class. **Detritivores** then feed on the decomposed leaf, which now includes the bacteria and fungi along with shredder feces. Further down, the stream opens up and becomes wider. With less vegetation shading the water and more sunlight getting through, more algae grows. In these waters, **scrapers** are dominant. These macroinvertebrates scrape the algae off rocks for consumption.

Looking for Macroinvertebrates and Adaptations

The different physical characteristics of streams determine where macroinvertebrates are found. The organisms are adapted to the levels of oxygen and nutrients found in riffles, runs and pools (for example, riffles have more dissolved oxygen than pools). When you take samples, reflect on what you know about natural cycles, about water quality and about stream composition. You will be more successful finding macroinvertebrates if you consider the following:

- Look during the appropriate season and weather conditions. Heavy rains or flooding may wash critters away. Droughts may kill aquatic critters.
- The water you look in should have at least a moderate rate of flow. If it is stagnant, limited oxygen may reduce their chances for survival.
- Since aquatic critters need oxygen, look for them in places in the stream where you know this is most likely – in riffles. You'll want to look in other parts of the stream, too – near vegetated banks and under rocks.
- You may have more luck finding critters if the streambed is rocky as opposed to silted or sandy. Rocky stream bottoms allow for air pockets and safe places for macroinvertebrates to live.
- Critters need to eat. Look for them in areas that have vegetation along streambanks, as leaves drop in the water providing food when they decompose.

Adaptations and Metamorphosis

In their immature form, macroinvertebrates are either **larva** or **nymphs**. Both go through a process of physical change called **metamorphosis** to become an adult. In the larval stage the organism is generally a soft, wormlike body. Nymphs are further developed than larva and have limited adult features like legs and wing pads. During metamorphosis the larva or nymph hardens, changes shape and transforms: wings and legs develop and the insect becomes sexually active. When larva transform they undergo **complete metamorphosis**. Nymphs undergo **incomplete metamorphosis**. Species that have a larval form include flies, mosquitoes, beetles, crane flies, caddisflies and midges. Species that have a nymph form include stoneflies, mayflies, and true bugs.

Midge fly larva and adult

Unit 8: Activity 1: Who Am I?

Students learn…
- Life cycle stages of common aquatic macroinvertebrate families;
- Specific adaptations of common macroinvertebrates; and
- How surveying macroinvertebrates can serve as an indicator of pollutants

By doing…
- An introductory game to find matching life-cycle stages of creek animals;
- Detailed drawings of creek macroinvertebrates; and
- Exploration of dichotomous keys and field guides

Then reflecting on…
- The importance of macroinvertebrates in the energy flow of a creek environment;
- The form and function of macroinvertebrate adaptations; and
- The needs of aquatic macroinvertebrates, their relationship to the overall health of the stream and the creatures that live in and near it.

Materials

For groups of 5:
- Pre-made deck of "Who Am I?" cards. These are 4" x 6" index cards folded in half with microinvertebrate information as detailed below. The deck can include as many sets as needed. Each set includes 2 folded cards
- Macroinvertebrate field guides

Getting Started

1. Pass out macroinvertebrate cards and tell everyone that each card is to remain sealed until you instruct everyone that they can break the seal (the sets are scotch taped closed to play the game).
2. When you say go, have everyone move around the room, asking questions and comparing pictures to see if they can decide who may have their match. NO PEEKING!

Introduce the steps

1. Pass out macroinvertebrate cards. The outside of the card just has a picture of one stage of one macroinvertebrate. The inside of the card shows the other stage that makes the match, and gives information on the species including the common name.
2. Students are given a short amount of time to find who they think their partner should be. They can only use the picture on the front of the card - No Peeking inside!!
3. When all students have found a partner, have students share with the class why they think they might match.
4. Time for reality check! Have partners look inside the cards to see if their educated guess is correct.
5. Allow time for students to find their correct match if their guess was not right.
6. As students gather with their matches have pairs brainstorm the advantages of different life stages. Students should discuss: What other creek critters need the presence of this macroinvertebrate in some way? When and how does it manage habitat differences due to seasonal changes?

Mayfly Set:

Card 1
- Inside top half with photocopied picture of **mayfly nymph**
- Inside bottom half with species name and life cycle facts
- Outside front with photocopied picture of **mayfly adult**
- Outside back with hints for ID (since outside front is adult - hints tell facts about the nymph)

Card 2
- Inside top half with photocopied picture of **mayfly adult**
- Inside bottom half with species name and life cycle facts
- Outside front with photocopied picture of **mayfly nymph**
- Outside back with hints for ID (since outside front is nymph – hints tell facts about the adult)

Inside bottom half is the same for each card. Players with adults on the outside try to find the larvae or nymph to match. Players with a larvae on the outside try to find an adult. Follow same pattern for each set: Stonefly, Riffle Beetle, Blackfly, Damselfly, Dragonfly, etc.

Model the steps

7. Have pairs make a list of critter needs.
8. Have pairs use field guides to list related macroinvertebrates.
9. Have pairs list adaptations of their critter family: the type of feeding, place they are found in the creek, special anatomy, etc.
10. Have students give a brief presentation on their macroinvertebrate to the entire class.

Share observations

- Have full group discuss findings. Have students draw posters of their critter to share with class.
- Present special adaptations of macroinvertebrates. Create a chart to share that includes "Did you know?" facts.
- Discuss different families of common macroinvertebrates.

Scientific explanations

- Show students a diagram of the system of classification of living things.
- Show students different macroinvertebrate charts and drawings.
- Show students life cycle stages of macroinvertebrates.
- Explore dichotomous keys and field guides to be used later for identifying macroinvertebrates in the field.

Journal reflection

Now that students have gathered information on different types of macroinvertebrates, have students practice keying out creek critters. Also have them explore these bullets for journaling:

- Have students draw their macroinvertebrate from the matching activity.
- Have students invent a critter – writing specific adaptations and describing specific habitat
- In their journals have the students draw out a food chain that would exist at their creek site. Have students use actual critters that are found at your creek site and see if the can build a food web from one or two food chains they can draw.

Tips for facilitators…

Help students make scientific drawings that include details, labels and several views of same object. Draw with students, taking time to look closely and get help from the key.

Bring your own drawings, charts and posters to use while teaching.

Unit 8: Activity 2: Critter Catch

There are many guides for surveying macroinvertebrates that are available for reference. This activity can be done as a training at the creek or with critters brought in from a creek. If you bring critters in, be careful to keep them in cold stream water by placing the container of critters in stream water inside a larger container that contains ice water.

Students learn…
- How to find critters in a creek;
- How to observe carefully and return critters to the creek; and
- How to identify macroinvertebrate families

By doing…
- Creek exploration and observations of macroinvertebrate habitat;
- Live macroinvertebrate collecting; and
- Field study and identification of macroinvertebrates

Then reflecting on…
- The importance of a healthy stream environment for macroinvertebrates and the critters that feed on them;
- Adaptations of macroinvertebrates; and
- Macroinvertebrate survey numbers that indicate the state of the health of the creek

Materials
- Creek water samples including macroinvertebrates, rocks and vegetation
- Magnifiers (aquatic viewers are best)
- Field guides
- Wading boots (for the creek)
- Collecting nets (mesh aquarium nets are ok)
- Small collecting tubs (i.e. yogurt containers)
- Large holding tubs (i.e. plastic dishpans
- Ice cube trays for sorting

Getting Started

Begin by explaining to students that this activity is very hard on the environment. It is important to survey the critters in the creek, but to do so impacts their habitat. The impact can be minimal if activity guidelines are followed and the study is done carefully.

It is important to remind students throughout the training to work slowly and carefully. This will be a challenge when students are mentoring their elementary students at the creek as well.

Plan a thorough in-class training to introduce the procedure for collecting critters before students actually do the survey at the creek. Ask elementary teacher to prepare students as much as possible.

Introduce the steps

1. Pass out field guides that show the families of macroinvertebrates students are most likely to find.
2. Review the life cycle of macroinvertebrate species and explain where they may be found. (riffle, pools, on rocks)
3. Have all the field equipment in class to show as you explain the critter catch procedure. *See steps for collecting on page 144.*
4. Have a sample of creek water, aquatic vegetation, and macroinvertebrates available for in class training.

As students are exploring and reviewing the information they have already been given, ask students if they have ever searched for aquatic animals in a creek before. Allow students to share stories.

Ask students to think about how having a large number of people even walking carefully through a creek may have an effect on the creek environment. Explain to students that one goal of this activity is to gather information with a minimum negative effect on the stream.

Ask students to suggest how this may be accomplished. Make a chart of goals for the entire class. Remind the students that if they follow the guidelines while keeping their goals in mind they will have a fun and exciting exploration of creek critters! While introducing the steps for this creek survey in the classroom, students will become familiar with ways to carefully observe macroinvertebrates, and then be ready to follow the survey procedures at the creek.

Model the steps in the class

5. Have pairs of students explore a small amount of water collected from the creek. Each pair of students should have access to a field guide, magnifiers and viewers, and smaller containers to help sort the living things they find.
6. Have students draw what they find as well as use guides to identify macroinvertebrates.
7. Encourage students to look for very small things that they may only see by looking in the water for different kinds of movements.
8. Have students keep track of the critters they have identified.

Share observations

- Have the class share information on the kinds of critters they found, how they discovered them, and what challenges they encountered.
- Have volunteers share their drawings.
- Help the class make one detailed scientific drawing that provides information on the characteristics of a specific macroinvertebrate and make special notes on its ecological importance.

Model the steps at the creek

9. Have groups of students explore a small amount of creek. Each group of students should have access to a field guide, magnifiers and viewers, smaller containers to help sort the living things they find, and one larger container to hold collections of creek water,rocks, vegetation and resting critters.
10. Have groups divide into pairs for specific jobs during the exploration. They will rotate through each job before the training is completed.
11. One pair of students will have the job of putting on boots, going in the creek and exploring under rocks, in vegetation, and in sediment using nets, and carefully taking samples off of the underside of rocks. See step by step collecting methods on page 144. They will then give their discoveries to team partners on the side. Students in the creek are working carefully to not disturb the creek environment any more than necessary to collect critters.
12. Another pair of students is receiving samples from the creek and taking them to a large holding tub with fresh cold water. These students are using magnifiers and viewers to observe critters that have been collected. These students are drawing what they observe and carefully labeling their observations.
13. A final pair of students is identifying critters they have found using field guides and dichotomous keys. These students are keeping a tally of the critters and drawing in their journals from guide drawings. These students are also returning critters to the creek by bringing them back to the students in the creek.

Sampling method

Students engaged in macroinvertebrate sampling

Tip for Teachers...

Plan this unit with weather and presence of macroinvertebrates in mind. We prefer late Spring.

Scientific explanations

- Share diagrams and posters of macroinvertebrates.
- Show students creek habitat drawings and areas to be explored when searching for macroinvertebrates.
- Help the class through steps of identifying macroinvertebrates by using a dichotomous key and field guides.
- Show students a chart of macroinvertebrate characteristics, adaptations, and family classifications.

Journal reflection

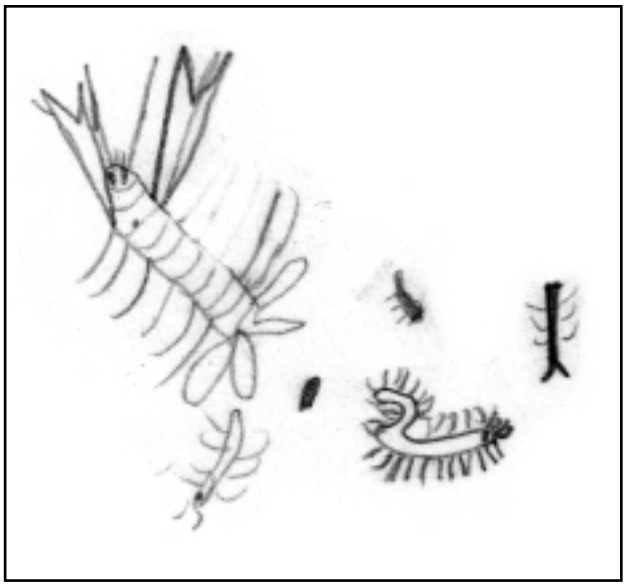
Now that students have explored creek critters, allow time for students to work on their scientific drawings. Use these bullets as a guide for journaling:

- Have students pick out their favorite macroinvertebrates and make larger scientific drawings to share with the class.
- Have students research online to find out more about macroinvertebrates, creek studies, and macroinvertebrate survey statistics.
- Have teams of students make presentations of macroinvertebrate families and their characteristics (a skit idea?).
- Have students write tips to help with correct identification of macroinvertebrates.
- Chart adaptations and their functions.
- In their journals, have students make a chart that shows different macroinvertebrates found in their stream. The chart should show name of macroinvertebrate, drawing of immature stage, drawing of adult, classification order, type of feeder, and tolerance level.

Tip for facilitators…

This activity is always a favorite!! Planning ahead, keeping organized, and having clear goals will protect the creek and provide a great field exploration for your students.

When using dichotomous keys, avoid the temptation to identify macroinvertebrates by comparing with the pictures in the guide. Some critters look very similar and only through following step by step identification methods in the key can you be sure of correct identification.



Elementary Student Journal

Steps to collecting macroinvertebrates:

Demonstrate the following steps before allowing any student to enter the water.

1. Set up a “holding tank” of river water in a white dish tub or bucket (in the shade if possible).
2. You will need a fine mesh net and wading boots before you enter the water.
3. Hold hands with someone on the bank when you first step into the water (in case it is slippery)
4. Always look before you step.
5. Move slowly to be safe and to protect as many
6. Look for critters in the following areas if possible:
   - Among rocks in the fastest water in the riffles
   - Hanging on plants submerged in water at stream’s edge
   - Crawling along the bottom in slower moving water
7. Position your net immediately downstream of the area you want to search.
8. Slowly bend over and “dust” off the rock or plants that are upstream of the net.
9. Replace the rock and bring the net out of the water.
10. As quickly as possible turn the net inside out into the “holding tank” or any container of water.
11. You should be able to see anything you caught swimming around in the “holding tank.”
12. To get a closer look, use a small container to catch the critters and look at them under a magnifier.

When finished for the day, carefully lower the holding tank into the water and rinse it and all nets and smaller containers in the stream until no more critters can be found. Have another person look in the containers to see if you missed any before packing up.

If you don’t have enough nets and boots, you can also try picking up rocks near the stream edge. Look closely for anything tiny moving on the rock or for debris attached to rocks—these could be eggs or shelters built by critters. Rocks with critters on them can be brought to the “holding tank” for better viewing.

Reading and Research: Pollution Tolerance Index

The study of macroinvertebrates and the activities in this unit tie in with many aspects of science and water quality monitoring. In the critter catch activity we practice observing, recording data, and using a field journal. When we look for critters in the creek, we use our knowledge of physical stream char-acteristics, such as pools and riffles, and of water quality—where the stream has the most oxygen, to find where aquatic organisms thrive. Then, we pool our data and observations and together compile it to analyze the creek's water quality with the Pollution Tolerance Index (PTI).

In Activity 3 you will prepare a Pollution Tolerance Index. At the beginning of this unit we described that scientists group macroinvertebrates into four taxonomic groups of different species, according to their tolerance for pollution:

- Group I: Pollution-Intolerant organisms
- Group II: Moderately Intolerant organisms
- Group III: Fairly Tolerant organisms
- Group IV: Pollution-Tolerant organisms

Once you search for, collect, identify, and release these macroinvertebrate critters, you will tally the number of critters you find in each group according to a special formula. When done properly, the group in which you find the most number of critters will reflect the pollution level of the water. This does not mean that if you find one pollution-tolerant organism the stream is polluted (even clean streams will have these organisms living along with pollution-intolerant organisms), rather it means that you are likely to find organisms that the conditions of the habitat support. So if the water quality is very good, critters that are very sensitive to pollution will be able to survive. But if the water quality is very polluted, they will not survive and you won't likely find them.

Look for macroinvertebrates in these areas:

Caddisfly: in still ponds or flowing areas of the stream where the current is not strong. They are adapted for either low or high dissolved oxygen. They are easily recognized with their case. Out of their case they look worm-like.

Mayfly: in fresh, running water; under or on sub-merged rocks. They often have a flat body shape so water can run smoothly over them. Mayflies are quick, undulating swimmers.

Dragonfly/damselfly: in marshes or ponds, along lakeshores, possibly in slow-moving parts of the stream and in submerged vegetation. Dragonflies are slow walkers and tend to swim sideways.

Beetles: in water; on the surface. Different species are adapted to various parts of the water. Some become terrestrial adults.

Mosquito: in still or stagnant water like ponds, marshes, or swamps. They hang just below the suface when breathing.

Stoneflies: in icy cold streams and under small water falls – places where there are high levels of dissolved oxygen. They cling strongly to rocks in very fast water. They look like mayflies but have no gills on abdomen.

Waterstrider: on the water surface.

Giant Waterbug: on the water surface.

Dobson flies, fish flies, alder flies: on and among rocks in unpolluted sstreams.

Flies (black flies, etc.): in cool headwaters of stream, cool flowing water with high dissolved oxygen. They are attached to rocks in clusters that almost look furry.

Rat-tail maggot and horse fly: ponds, stream edge.

Midge (including bloodworms): lakes, ponds, streams

Crustaceans/crayfish: streams, bottom

Scud: pond, lake, stream, spring.

Aquatic Sowbug: in water, under stones.

Once you've identified the critters, you'll be using the PTI survey form to calculate your pollution tolerance index. The process will be something like this:

Taxonomic Group I (3 points each)	**Taxonomic Group II** (2 points each)	**Taxonomic III** (1 point each)
Intolerant of Pollution	Moderately Tolerant of Pollution	Fairly Tolerant of Pollution
❑ Stonefly ❑ Alderfly ❑ Dobsonfly ❑ Snipefly	❑ Crayfish ❑ Clam/mussel ❑ Damselfly ❑ Caddisfly ❑ Mayfly ❑ Cranefly ❑ Dragonfly ❑ Water penny ❑ Riffle beetle	❑ Midgefly ❑ Black fly ❑ Scud ❑ Sowbug

- **Count the critters you find by checking off the organisms in each taxa.**
- **Don't count the quantity you find, just count that you found it.**
- **Then multiply by the number of points and get the total.**
- **For example, a recent BioSITE class recorded the following:**

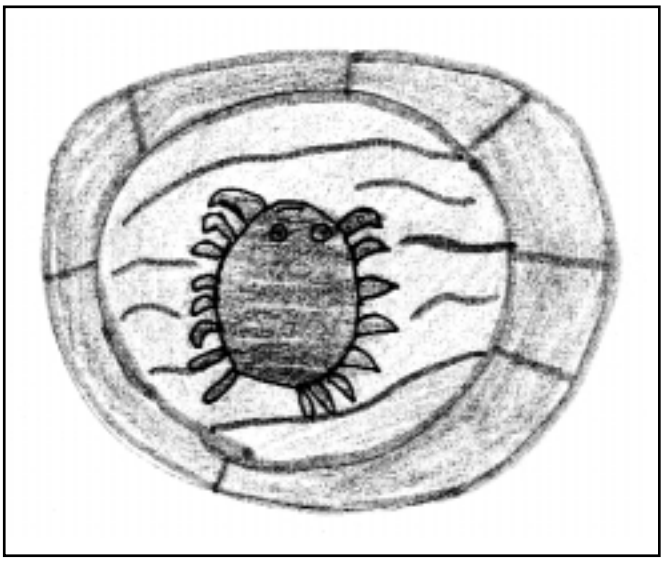
Taxa I: 3 different critters found x 3 points each = 9;

Taxa II: 5 different critters found x 2 points each = 10;

Taxa III: 2 different critters found x 1 point each = 2.

The total number of points is 21, which according to the following table rates "good" water quality.

>23 = excellent
17-22 = good
11-16 = fair
<10 = poor



Elementary Student drawing in journal

Unit 8: Activity 3: Pollution Tolerance Index

This is an important activity to do a few times a year. The first time, you learn how to do it. The second time you practice what you learned the first time. And the third time allows you to have data to compare and analyze over a period of time.

Students learn…

- How macroinvertebrate surveys are completed to provide a pollution tolerance index;
- How macroinvertebrate studies are important in monitoring water quality; and
- How to study macroinvertebrate populations and use data collected over time

By doing…

- A macroinvertebrate survey following guidelines for determining a pollution tolerance index; and
- Research on macroinvertebrates

Then reflecting on…

- The importance of macroinvertebrate populations in the creek ecosystem;
- The importance of long-range studies in understanding creek restoration and habitat protection; and
- Differences between PTI and chemical water quality testing

Materials

- Critter catch materials
- Pollution Tolerance Index Guide from *BioSITE online* (www.cdm.org/biosite)

Getting Started

Begin by reviewing macroinvertebrate information. Ask students to explain the importance of these creatures in the creek ecosystem. Ask students to share how they think studying macroinvertebrates could help scientists monitor the health of the riparian corridor.

If possible, invite a visiting scientist to come and share their research about macroinvertebrates (see pages 160-161 for guidelines to help scientists prepare for a visit). In addition, have students conduct research on macroinvertebrate studies. Explain to students that one way to understand the importance of macroinvertebrates to overall creek health is to complete a Pollution Tolerance Index (PTI).

Introduce the steps

1. Have students review the kinds of macroinvertebrate families they identified in their critter catch.
2. Introduce students to the PTI method by explaining that the presence of families of macroinvertebrates in a creek can be used to indicate levels of pollution.
3. Have students brainstorm which families they think may be present in polluted areas (they may know of leeches) and which may be found only in very clean creeks (stonefly).

As students are reviewing macroinvertebrates and the critter catch procedure, generate a list of which creatures they believe may be found in polluted and clean waters and why. Could it be related to behavioral characteristics, adaptations, or predator/prey interdependence?

After students have explored their own ideas, supply a PTI survey form. Tell the students that they will be doing this survey very carefully to protect the creek habitat as well as to collect accurate and precise data.

Model the steps at the creek

4. Each group of students should have a PTI guide and materials for critter catch.
5. Have each group work in different sections of the creek
6. Have each group do a survey of general creek conditions to record data on specific day, weather, location and conditions of study area.
7. If possible, have students perform water quality tests before they survey for macroinvertebrates.
8. Have groups tally for each family they are able to collect – students do not need to count specific number of same critters, but may want to use in later discussion
9. Have groups collect data and observations on critters they are unable to identify.
10. Following the steps of the PTI, have each group complete the survey to determine the PTI at their site.

Share observations

- Have class share creek survey information and water quality test data from the survey day.
- Summarize for group and discuss differences.
- Share tally of families and numbers present for macroinvertebrate survey.
- Have groups report their individual PTI numbers and do one collective PTI for the completed class data.
- Discuss differences and ask students to share their explanations and challenges completing the survey.

Scientific explanations

- Share statistics for macroinvertebrate studies within your watershed for comparison of PTI numbers.
- Provide research information for comparison of other waterways including PTI numbers and other methods of study.
- Have students research other riparian studies that focus on monitoring water quality and riparian habitat preservation.

Journal reflection

Now that students have completed a PTI survey, make a plan with students to complete research on pollution levels in their watershed. Have students work in their journals, using these bullets for journaling:

- Make a monitoring plan to continue survey work over a longer period of time. Do they have any prediction of things that may change as the seasons change?
- Have students do research on other issues in their watershed.
- Have facilitators research watershed projects that have used water quality index or PTI as a basis for health measurement. Have facilitators present the data collected at other research sites and compare to their study site data.

Tips for teachers...

Students could do special projects on their own time to collect further data on their field site. Students could complete surveys over time to study bird populations, vegetation and tree studies, soil conditions, and macro-invertebrate populations.

Facilitator Field Day Planning

Facilitators determine how to go about teaching students. To structure the lesson planning process, refer to the *Team Lesson Plan Worksheet* (Template 1) in the *Tools for Implementation* section.

Based on the lesson planning discussion, the high school teacher reviews and summarizes facilitator suggestions and develops an overall agenda to give to the entire group for the field day (see *Field Day Agenda* (Template 2) in *Tools for Implementation*.

Have students consider the following:

Terms and Concepts
With a partner, review the material learned in this unit by describing the following macroinvertebrate terms in words that fourth grade students would understand. After each partner takes turns describing the term in his or her own words, write down your definition of the word.

Macroinvertebrate
Decomposer
Scraper
Invertebrate
Shredder
Larva
Metamorphosis
Detritivore
Nymph

EVALUATION

Reflect on your field day teaching:

- Do you think the students learned what you intended?
- How can you tell?
- Is there any part of the new material about which you are unclear?

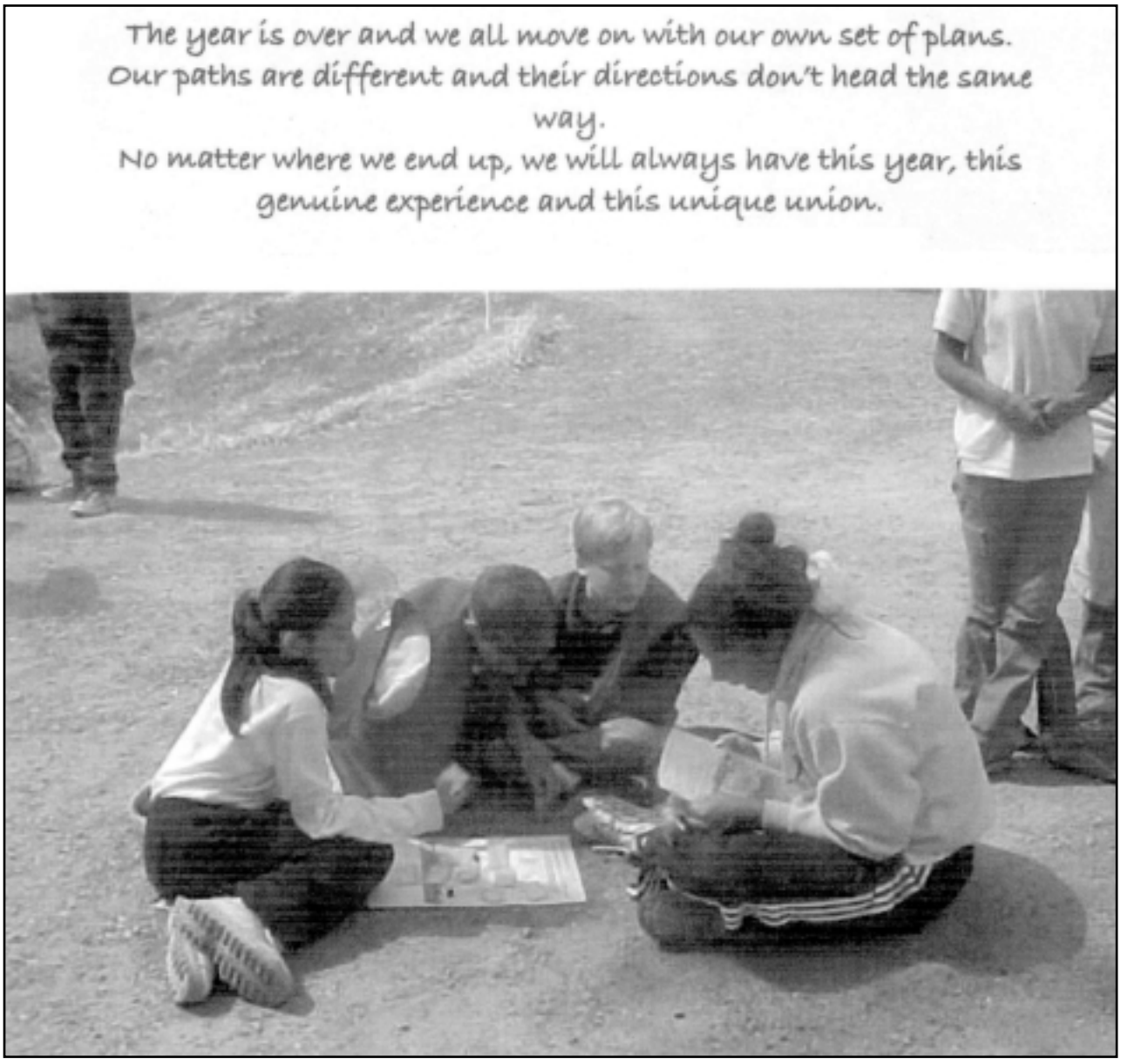
Activities Assessment

Consider the following questions about the activities:

- What went well?
- What can be improved upon for next time?

Journal

In your journal, write down your thoughts about the above questions and issues so that you can keep a record of your teaching experience.



High school students created this reflection piece