Stream Macroinvertebrates and their Habitats

Setting the Stage

Aquatic insects (macroinvertebrates) are an important component in the structure of aquatic food webs, because they are a key source of food for fish, birds, otters, frogs, and other vertebrates. In fact, many of these taxa rely solely on aquatic insects for food. In addition to being utilized as a food source, aquatic insects can control algae in streams and lakes. The control of algae in streams and lakes is important because algae can influence water quality.

Eben G. Fine Park - Boulder, CO Photo credit: Dave Dugdale

The primary goals for this activity are to encourage students to collect data to answer questions, and to think of the roles of individual macroinvertebrates in aquatic ecosystems. In addition, this activity will encourage students to think about the health of aquatic ecosystems relative to the macroinvertebrates found. Prior to this lesson, students should know basic information on insects and their role in food webs.

Note: This lesson takes place at a stream where students sample macroinvertebrates. Alternatively, components of this lesson may work with access to stream data collected by someone and shared with students. Consider connecting with a local watershed association or watershed ambassador for assistance with this lesson.

Lesson Overview

- *Activity 1 – Engagement (15 minutes) Introduction to Habitat Patterns*
  Have students conduct initial observations and learn how a dichotomous key is used to identify organisms.
- *Activity 2 – Exploration (40 minutes) Stream Sampling*
  Groups of students sample two different sites along the stream.
- *Activity 3 – Explanation (10 minutes) Review of Organisms Found*
  Students discuss as a class the types of organisms were found at each of their sampling locations.
- *Activity 4 - Evaluation and Wrap-up (25 minutes) Data Analysis and Final Questions*
  Construct a simple summary table for the data and have the students answer some follow up questions about the lesson.

Instructional Overview	
Grade Level	Middle School
Instructional Time	90 minutes *(total time needed)* Note: The data can be analyzed in the classroom if pressed for time. The students generally enjoy working in the creek and looking at organisms and therefore, data collection may take longer than expected.
NGSS Standards Alignment	DCIs: MS-LS2.A: Interdependent Relationships In Ecosystems Performance Expectations: MS-LS2.1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. MS-LS2.2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.
Anchoring Phenomenon	Streams are habitats for many organisms and together they make an ecosystem
Driving Question	What can we learn from the presence or absence of stream macroinvertebrates?
Learning Goals	Students will be able to ● Collect the data to answer questions ● Analyze data for patterns and to answer questions

Materials	❏ D-ring Net for sediment bottom streams (1 per student or per group) or Kick-net for rocky bottom streams (1 per student or per group) ❏ White trays (fast food containers and ice cube trays work well) to view insects (1 per student or group) ❏ Plastic spoons to move macroinvertebrates from one container to another for identification and quantifying ❏ Magnifying glasses for viewing (1 per student) ❏ Waders (if the water is too cold for wading in wading shoes) Each group also needs: ❏ A science journal ❏ Two pencils (just in case one gets lost) ❏ Rain coat (if the weather looks questionable) ❏ Macroinvertebrate Sampling Sheet (recreate Figure 3, and print ❏ Clip board ❏ Macroinvertebrate Key such as the ones provided at these links: Stroud Center: https://stroudcenter.org/macros/key/ West Virginia DEP: https://dep.wv.gov/WWE/getinvolved/sos/Documents/MacroID/DichotomousKey.pdf Utah State Extension: https://extension.usu.edu/waterquality/files-ou/macroinvertebrate-key/macrokeyforUtah.pdf
Preparation	Organize all of the equipment along the river so that students can quickly get in the stream when it is time
Safety	● Identify a stream location conducive for this lesson, including the safe access for students ● Review safety protocols when near and in bodies of water. Ensure parents are aware of the precautions taken in field work. ● Limit the number of students who enter the stream, and also limit the amount of sampling that takes place. Overuse of a delicate stream ecosystem will destroy its viability as a habitat.
Vocabulary	Macroinvertebrate: an insect (invertebrate) that is large enough to be seen without the assistance of a microscope Dichotomous Key: a method for categorizing and identifying different taxa using logical choices Habitat: the type of area where a species lives EPT Index: the quantity of Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). The EPT Index is based on the premise

	that high quality streams usually have greater numbers of these taxa than low quality streams.

Activity 1 (Engage)
Introduction to Habitat Patterns (15 minutes)

Note: *This lesson takes place at a stream, and assumes students have been briefed on safety around water, handling of insects, and on the protocols they will be using while at the stream. Read this entire lesson to ensure all proper preparations have been attended to. These preparations are extremely important to the success of this lesson.*

At the Stream:

Upon approaching the stream, ask the students to identify some of the plants and animals they observe living around the stream.

> If someone mentions an animal that could live around a stream but isn't observed, remind them that they are correct in thinking that the creature could be around a stream, but scientists try to make hypotheses based only on what they observe.

Ask them how streams and stream ecosystems differ from lakes and ponds and their ecosystems. Tell them that this activity will focus on aquatic insects, also known as aquatic macroinvertebrates.

Tell the students that just like zebras need to live in open grasslands and whales live in the oceans, different organisms in a stream live in different habitats. Ask the students why they think it might be important to collect and analyze aquatic macroinvertebrates.

> Explain to them that collecting macroinvertebrates is important for understanding 1) habitat quality and therefore, water quality, 2) how much food there is for fish and birds since birds feed on the terrestrial stages of many aquatic insects.

Tell students that the purpose of their stream investigation is to answer two questions:

1. First, is there a pattern in the type of habitat where macroinvertebrates live?

2. Second, what can we learn about the health of the stream habitat based on the macroinvertebrates found in it?

Encourage them to look at the habitat variables they will analyze for ideas. They should walk round the area, and list the components they think contribute to the habitat of macroinvertebrates. Warn them not to go into the water. Review their observations, and ask them which of the components are most important for habitat quality.

Mention that in the next step they will collect and identify the macroinvertebrates using a "dichotomous key." See Figure 2 for an example of a dichotomous key. Mention here that a key can be developed to classify and therefore identify anything.

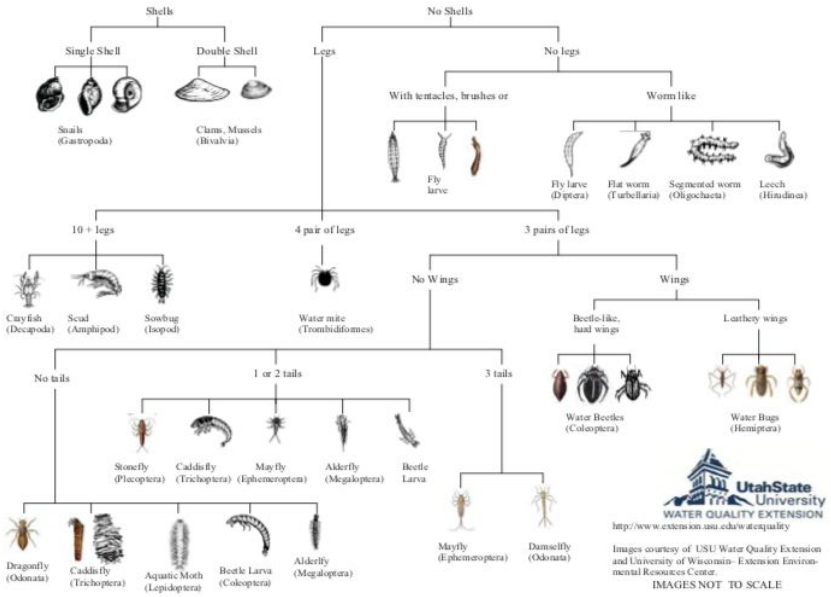

Figure 1: Example of a macroinvertebrate key.

Note: For students with little practice in using a dichotomous key, before heading to the stream consider using this shoe sort for practice. Here is a possible procedure for this exercise:

Developing a Dichotomous Key Based on Shoe Types

Ask students to list possible characteristics to separate shoes should everyone in class put one shoe in a pile. You may want to limit the pile to 10 shoes for the sake of time. Here is a list of sample characteristics:

- Right foot, left foot
- Log, no logo, logo style
- Laces, no laces
- Boot, not a boot
- Shoe color
- Straps
- Open-toe, closed toe
- Rounded toe, box toe
- Heal, no heal

Challenge students to use these characteristics to identify each shoe through a dichotomous key process such as the one in the figure below.

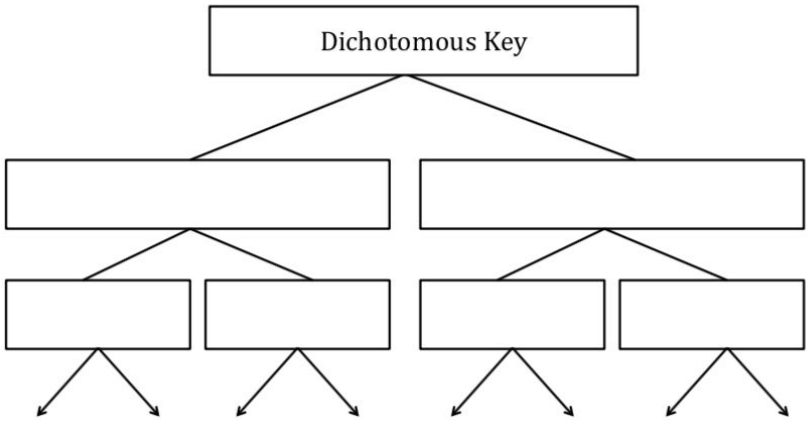

Figure 2: Possible dichotomous key template.

Activity 2 (Explore)
Stream Sampling (40 minutes)

Demonstrate how to collect samples by modeling the use of a D-ring net (muddy bottom), or a kick-net (rocky bottom). If a kick-net is used, then at least two students will need to enter the water. Also, demonstrate how to use the key to identify the macroinvertebrates, and how to use the data sheet (Figure 3) to record data.

Divide the students into groups of four. Students will rotate between the following positions: official sampler, official recorder, and two sample evaluators.

- *Official sampler* - collects macroinvertebrates for their group at each site
- *Official habitat assessor* - collects data about the habitat
- *Sample identifier* - identifies and quantifies the macroinvertebrates found at each site.
- *Official recorder* - records all the data for that particular site

Tell the students they will sample two locations along the stream within the identified upper boundary and lower boundary (determine the boundaries based on line of sight and the condition of the stream). The areas for sampling should be easily accessible and have a range of substrate varieties and sizes (small pebbles, sand, large rocks, or woody debris).

Have the students come up with a hypothesis for the driving factors that influence the quality of habitat for macroinvertebrates at each site. Tell the students that they will share and analyze the data when they return to the classroom, so they need to collect really good data. Remind the students that recording absences (zeros) can be just as important as recording the number of organisms that are there.

Macroinvertebrate Sampling Sheet

Student 1:_____ Student 2:_____
Student 3:_____ Student 4:_____
Date:_____ Weather_____
Air temperature_____ Water temperature_____
Habitat factor that they think is most important for determining macroinvertebrate communities (e.g. rock size, substrate variety, speed of the water)_____
_____

Site Number 1
What does the surrounding area look like (e.g., forested, grassy, houses)_____
_____
Is the sampling site shaded?_____
What is the speed of the water (fast, medium, slow, not moving)_____
What is the substrate (bottom material) size being sampled_____
What is the material being sampled (rock, gravel, wood)_____
Other notes on this site_____

Macroinvertebrate Type	Average Size (mm)	Tally of individuals
Ephemeroptera (mayflies)		
Plecoptera (stoneflies)		
Trichoptera (caddisflies)		
Diptera (fly larvae)		
Odonata (dragonflies)		
Coleoptera (beetles)		
Worm like (worms)		
Other		

Site Number 2
What does the surrounding area look like (e.g., forested, grassy, houses)_____
_____
Is the sampling site shaded?_____
What is the speed of the water (fast, medium, slow, not moving)_____
What is the substrate (bottom material) size being sampled_____
What is the material being sampled (rock, gravel, wood)_____
Other notes on this site_____

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Worm like (worms)		
Other		

Figure 3: Sample Macroinvertebrate Data Sheet for two sites

Activity 3 (Explain)

Review of Organisms Found (10 minutes)

Scientists can learn a lot about a stream from the types of insects that are present. After students have collected their data, have them share and discuss as a class the types of organisms they found and where they found them.

- Did you find any differences in what types of organisms were present in different habitats? Explain why or why not.

  Generally, the three insect groups that are dominant in streams with low nutrient levels (nutrients refer to nitrogen, phosphorus, and potassium typically found in streams near fertilized land such as lawns, golf courses, and farms), high water quality, and a healthy stream are Ephemeroptera, Plecoptera, and Trichoptera (known as the EPT index). Although the presence of the E, P, T taxa typically indicates the health of a system, it does not always.

  The group Diptera is found in most habitat types, but these macroinvertebrates are typically found in higher abundances in streams where there are higher nutrient levels , lower water quality, and a stream of poor health.

- Evaluate your data. How does your data line up with these common assumptions?

Activity 4 (Evaluate and Wrap-up)
Data Analysis and Final Questions (25 minutes)

Back in the classroom, ask students to look at data from both sites. Remind them of the two questions they set out to answer:

1. Is there a pattern in the type of habitat where macroinvertebrates live?

2. What can we learn about the health of the stream habitat based on the macroinvertebrates found in it?

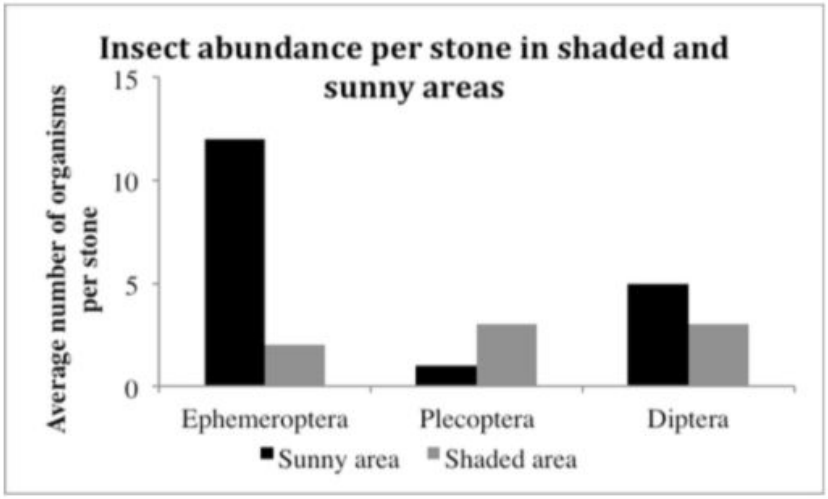
Ask them to choose one question (individually or as a group), and use their data and what they learned from this lesson to answer it. They are to construct a simple summary table and graph for the data of the three taxa as related to their selected variable. (see below for a model).

Example Summary Table:

	Sunny area	Shaded area
Ephemeroptera	12	2
Plecoptera	1	3
Diptera	5	3

If you have the available software to graph the data in the table, have the students make a bar chart of their data so they can easily visualize similarities and differences between habitats.

Example Bar Chart:



Ask students to analyze the data for patterns, and be ready to report it out to the class.

Ask students to share their graphs and analysis. While one student or group is presenting, the rest of the class should be making note of what was shared so that trends in the class data could be discussed. After the last student or group shares their work, ask the students to identify any patterns they saw in the data, and what it may mean about the stream habitat.

Wrap-up:
As a formative assessment, ask the students if they think they were successful in answering the following questions.

- What did the data show about the different habitat types/ecosystems?
- Were these differences in community composition different in different habitats (sites)?
- Ask the students to link their knowledge of organisms and habitat and apply it to their stream. Is it a healthy stream or an unhealthy stream?
- What if you found a stream with lots of Ephemeroptera, Plecoptera, and Trichoptera, would that be a healthy stream?
- What about a stream full of Diptera?
- What questions about the stream habitat should we explore next?