Macroinvertebrate Water Quality Survey

OVERVIEW & PURPOSE

This lesson introduces students to the strategy of surveying aquatic macroinvertebrates as a tool to indicate water quality. Students will collect live macroinvertebrates from a river or stream, then observe, classify and count the invertebrates. They will use this collected information to determine the biotic index of the water body in which the study took place. The biotic index is a method of calculating the quality of a habitat by the diversity of the organisms found within it. Surveying aquatic macroinvertebrates is an easy and effective manner to determine water quality because:

1. They are abundant and found in water bodies throughout the world.
2. You do not need a microscope to observe them, hence the title "***macro***invertebrates."
3. They are not very mobile, so they are continuously exposed to the conditions of the aquatic habitat in which they live.
4. They carry out part or all of their life cycle within the stream or river.

EDUCATION STANDARDS

NGSS Cross-Cutting Concepts:

- Patterns: Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
- Cause and Effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts. Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. Cause and effect relationships may be used to predict phenomena in natural or designed systems.

NGSS Disciplinary Core Ideas:

- LS2: Ecosystems: interactions, energy & dynamics
- LS4: Biological evolution: unity & diversity

NGSS Science & Engineering Practices:

- Planning & carrying out investigations
- Analyzing and interpreting data

OBJECTIVES

1. Students will engage in collecting, observing and identifying live aquatic macroinvertebrates.
2. Students will perform calculations on their own collected data to assess the water quality in a local stream, river, or creek.
3. Students will identify connections and patterns between abiotic and biotic features in the aquatic landscape.
4. Students will craft an explanation to predict the patterns they might see in macroinvertebrate diversity in other aquatic habitats with varying water quality.

TIME

60 min. -- 120 min. It is possible to do the entire activity outside in one day. Alternatively, you can have students collect, identify, and record the macroinvertebrates on one day and have them calculate the biotic index and stream quality another day (not necessarily outdoors).

LOCATION

Outdoors, at a creek, stream, or river. Moving water with riffles is ideal. When choosing a stream site, consider the following: Avoid steep, slippery banks. Holes, vertical banks, and other hazards can be especially difficult to see when the banks are very heavily vegetated. Scout the area for dangerous trash such as broken glass, rusted wire, poison

ivy, poison oak, and stinging nettle. Consider weather when implementing this lesson--although macroinvertebrates can be found year round, cold temperatures and ice can increase hazards. If possible, have 1 adult supervisor per six students, and access to a first aid kit. If you choose to spread out along the bank, be sure you can still communicate easily between adult supervisors in case of emergency.

MATERIALS NEEDED

1. Dip net
2. Plastic bin/tubs
3. Ice cube trays
4. Tweezers
5. eyedroppers
6. Hand lenses
7. Macroinvertebrate ID cards
8. Waders or rubber boots for at least a few students

SAFETY BRIEFING

As this activity takes place near a waterway, a safety briefing should be included at the start of the experience. Stress that water can be dangerous, and students should be very careful to not slip and fall while in the water. They should also avoid going in deeper than the top of their boots or waders.

ACTIVITY

Engage:

Begin by asking: Has anyone ever heard of “Macroinvertebrates” before?

- Explain that macroinvertebrates are aquatic insects (they don’t have a backbone) that are big enough to see without a microscope. Some are the larval stage of flying insects such as mayflies, dragonflies, black flies, etc. and others stay in the water their whole life. These macroinvertebrates are living creatures, and therefore are ***biotic*** components of the landscape.

        - What other biotic components are present in this aquatic /riparian ecosystem? (examples: algae, fish, willows, cottonwoods, grasses, aquatic plants, microorganisms, beavers, ducks)
        - Is a rock living? What about the water flowing? The air bubbles in the water?
            - These are ***abiotic*** components of the landscape. Can you think of any others? (examples: sediment, sunlight, pH of water/soil, temperature, nutrients)
- Then ask: Why would we want to go around digging in a stream to find bugs? Could it tell us anything about the stream? Students should think-pair-share.
- Have students make hypotheses about this river's quality. They can record these on the student worksheet. Have the students share with a partner, and then share out as a full group and discuss. Probe students to provide evidence as to why they think it is healthy or not. Ask them to cite evidence.

Explore:

Let's test out our hypotheses!

- Review the safety briefing.

Only one or two students per adult supervisor needs to be in the water collecting samples with the dip net at a time; everyone else can stay on the shore, with trays full of water ready. Students can take turns collecting in the water.

- Demonstrate the proper way to collect macroinvertebrates.
    - Ideally find a place where the stream or river is flowing well, perhaps over some rocky substrate. Place the net downstream, and kick your boots around to work up any macros that might be clinging to rocks or in the mud upstream. Let that debris collect into the net as well. If you haven't collected macros before, here is a helpful tutorial: https://www.youtube.com/watch?v=7SaTCEMwemM
- Remove macroinvertebrates from the nets by inverting them into plastic tubs filled with stream water.
- Then, students can use tweezers and eye-droppers to select individual macros,

look at them under hand lenses to identify them using ID cards, and place them into water filled ice-cube trays to “organize” them by order.

- When students are done recording the macros, have them dump all of the macros and stream water back into the stream.

Explain:

- Explain to students that aquatic macroinvertebrates are often used in studies to determine the quality of waters because of their high numbers, known pollution tolerances, limited mobility, wide range of feeding habits, varied life spans, and dependence on the land environment around the stream. When chemical grab samples are taken, they are really a snapshot of the water at that moment, that can change rapidly, but the macroinvertebrates are living there all the time.

Elaborate:

- Have the students use the attached water quality index worksheet to mark how many invertebrates they collected in each category.
- Then, have students use the attached equation to calculate the biotic index stream health category.
- Explain to students that the tolerance values are calculated by scientists to demonstrate how tolerant each group of macroinvertebrates are to poor water quality. A tolerance value of 100 indicates that these macroinvertebrates are highly sensitive to poor water quality, whereas a tolerance value of 0 would indicate complete tolerance to any pollutants or poor water quality.

Evaluate:

Ask students to make conclusions:

- Is this stream healthy?
  - What might make a stream unhealthy? Do you see any of those factors around this stream?
  - What factors might contribute to the health of a stream? Do you see any of those factors around this stream?
- If a stream is not supporting certain macroinvertebrates, what might the implications be for humans?

- After seeing the relationship between water quality and macroinvertebrate diversity in this stream, do you think you could use this as a tool elsewhere?
    - What pattern has been established between water quality and macroinvertebrate diversity?
    - Can you incorporate the terms ***biotic*** and ***abiotic*** into this pattern?

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Biotic Water Quality Index

Name:_____ Date:_____

	Column A	Column B	Column C
Macroinvertebrate	# of this type	Tolerance Value	TOTAL
Ephemeroptera (mayflies)		X 90	=
Odonata (dragonflies & damselflies)		X 60	=
Plecoptera (stoneflies)		X 100	=
Trichoptera (caddisflies)		X 80	=
Diptera (flies)		X 70	=
Megaloptera (fishflies & dobsonflies)		X 90	=
Coleoptera (beetles)		X 70	=
Amphipoda (shrimp & scuds)		X 40	=
Isopoda (sow bugs)		X 30	=
Decapoda (crayfish)		X 50	=
Gastropoda (snails)		X 40	=
Pelecypoda (mussels & clams)		X 20	=
Oligochaeta (segmented worms)0		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 this chart:

Health of this site= _____

Observations about the area that could affect water quality:

_____

Student Worksheet:

Name:_____ Date:_____

1. Define “abiotic” _____

2. Define “biotic” _____

3. List as many abiotic and biotic factors/components of this ecosystem as you can:

Biotic	Abiotic

4. Make a **prediction**: Do you think this aquatic ecosystem is healthy? Provide ***evidence*** to support your prediction.

_____

_____

_____

5. After you’ve calculated the water quality index from your data, re-read your prediction. Did your data support the prediction? _____

Conclusions:

6. Is this aquatic ecosystem healthy? Provide evidence to support your conclusions:

_____

_____

_____

_____

_____

7. What might make an aquatic ecosystem unhealthy?

_____

_____

Do you see any of those factors around this ecosystem? Are they biotic, abiotic, or both?

_____

_____

8. What factors might contribute to the health of an aquatic ecosystem?

_____

_____

Do you see any of those factors around this area? Are they abiotic, biotic, or both?

_____

_____

9. If an aquatic habitat is not supporting certain macroinvertebrates, what could this mean for humans?

_____

_____

_____

10. After seeing the relationship between water quality and macroinvertebrate diversity in this aquatic ecosystem, how could you use this as a tool elsewhere?

_____

_____

_____

11. What pattern has been established between water quality and macroinvertebrate diversity? Can you incorporate the terms ***biotic*** and ***abiotic*** into this pattern?

_____

_____

_____

_____

12. If an aquatic habitat ***is*** healthy, what can that mean for people?

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