Macroinvertebrates

Grade	6th
Time	45 minutes
Overview	Students observe, identify, and investigate macroinvertebrates to consider their importance in determining the health of aquatic systems as well as their roles in aquatic food webs.
Objectives	Understanding: Students understand the importance of macroinvertebrates as indicators of health of aquatic ecosystems. Skills & Processes: Students develop observation skills and conduct a scientific tally of organisms. They measure, record, and analyze a variety of water quality indicators and describe what they mean to the health of an ecosystem. Values: Students develop an appreciation for a diversity of organisms because this diversity is part of/helps to create a healthy functioning ecosystem.
Essential Question	How are diversity and pollution sensitivity of organisms used as indicators of water quality?
Primary VA SOL	Science (2018): 6.1, 6.7, 6.9

Materials

- 5-gallon buckets
- Small clear or white bins (1 per table)
- Small Nets
- Forceps (optional)
- Pipettes
- Petri dishes
- Datasheet for students
- Dicot key & Identification guides
- Dissecting Microscopes
- Sorting trays (we have been using ice-cube trays)

Special Safety

These organisms need to be returned alive to the water. DO NOT harm the organisms!

Set Up

1. Gather macroinvertebrates from a stream or river. Depending on the body of water, you can use a seine net or a D-net to collect. Always take two people to collect for safety reasons. We transport our macros back to our facility in at least one lidded 5-gallon bucket, and then use a bubbler to keep the water oxygenated and the organisms alive.

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2. At your teaching location, scoop water and macros into smaller bins, one per table. Wait to place until after giving sampling instructions.
3. On each table, place petri dishes, identification guides, pipettes, forceps (optional), sorting trays, and dissecting microscopes.

Instructional Strategy	
Recommended Grouping/Instructional style	Small groups Hands-on Sampling and Identification
Steps	**Introduction**: 1. Instruct students to find the corresponding data sheets in their student journals. 2. Next, inform students that one of the things they are investigating today is determining the overall health of Lake Georgette's water. Inquire: a. What are some ways in which we can determine if a body of water is healthy. (At some point discuss what "healthy" means. We are not looking for drinking water for humans, but water that is an integral part of the overall ecosystem.) b. What are things that we can see with the human eye (trash, erosion)? What may be things that we may not see with our human eye (invertebrates, pH, nitrates, phosphates)? c. What tools do scientists use to see organisms that are too small to see? d. What is a macroinvertebrate? It is a small aquatic organism without vertebrae that can be seen without use of a magnifying instrument (although using one may be helpful). e. What is a macroinvertebrate (i.e. zooplankton or phytoplankton)? These are smaller, microscopic animals such as copepods, daphnia, and rotifers or plants, such as single-celled alga. 3. Inform students they are to determine the health of the water by assessing the type and number of macroinvertebrates; macroinvertebrates are indicators of water health. Ask: What is an indicator? What does tolerance mean? Broadly, tolerance means "able to withstand a certain amount of change." Ask for an example of a tolerant organism. Or give examples if students have not yet discussed this concept in class. Refer to the datasheet as a tool for understanding. 4. What is diversity? What is biological diversity? i. Biological Diversity is the variety and number of each species present in an area. If students have trouble understanding diversity, feel free to use food as an example. Give two examples that are starkly different (ex. In waterbody X I found 100 organisms:

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	99 mosquitos and one dragonfly. In waterbody Y, I found 100 organisms: 10 each of 10 different creatures.) and ask them which is more diverse. **Sampling**: 5. How do we measure diversity? (Methodical collection and counting of species and individuals.) Why do we measure diversity? (Critters spend time, sometimes years, in the water – if sensitive creatures are present, it suggests the average water quality has been able to support them.) Why do we care about the health of the system? (All water flows downstream. The water here supports this system, but it also contributes to all downstream waterways in this watershed.) 6. Review microscope rules (Use two hands to adjust both focus knobs, alert to the light switch and two ways to adjust light, swivel of eyepieces, dual levels of magnification.) and how to handle the macroinvertebrates properly with the students (assess if forceps are a good idea). Be sure to include: These organisms are sensitive and are going back to the body of water when we are done. Take care to not harm them. 7. Explain the sampling method used to collect the organisms. (Ex. Used a D-Net and sampled 6 times for 10 seconds at each location). Would we be able to use and accurately assess the health of our water if scientists used a different sampling method each time? What if a scientist only selected organisms that they wanted to look at? Would that be a representative sample? Does that show bias? This is also an excellent time to share volunteer opportunities such as https://vasos.org/ or to discuss career options. 8. Inform students where the organisms were obtained. Again, why is important that we sample the same way each time? (Science process skills: to be able to have accurate information to compare and to be able to replicate the experiment.) 9. Students then look for macros – they should be able to see the organism, capture them with a pipette, small net, or hands, and place them in a petri dish for identification. 10. ***Where do these organisms live? IN THE WATER! Please have the organism in a small drop of water while you are viewing them, so they are able to keep living! *** 11. Students use the dichotomous keys and identification guides to identify organisms and record the data on the Macroinvertebrate Data Sheet in their journal. Explain how scientists use dichotomous keys to help classify organisms. This includes plants, animals, insects, etc.

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	12. Once organisms are identified, they need to be placed into the sorting trays on the tables (WITH WATER). Throughout, but by the end of the activity, students will tally and record the organisms on their data sheet (and potentially in a spreadsheet on the computer). 13. If datasheets are printed in color, students may ask what the colors on their datasheet mean. These colors indicate whether the species is very tolerant, tolerant, or not tolerant to pollution. The green organisms mean that they are not tolerant to pollution. They are green because we connect green with healthy. When these species, which cannot tolerate a lot of pollution, are present in our water, then the stream has little pollution and can be considered healthy. The red colored organisms are very tolerant of pollution meaning they are able to live in conditions that are not as favorable. If there are a lot of tolerant organisms in the sample, then the water may be not healthy. 14. Remember to stress the importance of diversity of organisms in our water. Yes, we want green, but we strive for more diversity. A rainbow is favorable! Reds, orange, greens, and blues! **Conclusion**: 15. Ask if students think the water is diverse and healthy or not? Explain your reasoning using evidence!

Extensions

1. Data Sheet II will be completed at school. To add additional mathematical analysis, students can create circle graphs on datasheet III back at school as well.
2. Compare and contrast macroinvertebrate data over time OR from different locations. You can make a copy of this spreadsheet to collect, compile, and compare. Please create your own copy and do not modify the template.

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Macroinvertebrate Data Sheet I

In your Water Sample:
Find, Identify, Count, and
Record the number of each type of macroinvertebrate.
You will use this data to help determine the overall quality of the water and the diversity of organisms.

- **Invertebrate** – organism without a backbone
- **Macro** – visible to the naked eye
- **Aquatic** – lives in the water for part of its life cycle
- **Indicator**- tells us about the health of an ecosystem

Remember! Scientists strive to collect accurate data, so count every organism in your water sample!

Biodiversity Calculation:
After sorting the macroinvertebrates, add up the total number of organisms listed on the macro data sheet and use the formula below to find what percent of the total each group represents. (You can add a column for "Biodiversity Percent" and record your findings in this column.)

Percent Composition = Number of Organisms in Each Group X 100

	Macroinvertebrate	Totals
Pollution Sensitive	Stonefly	
	Dobsonfly	
	Water penny	
	Caddisfly	
	Mayfly	
Somewhat Sensitive	Damselfly	
	Dragonfly	
	Cranefly	
	Riffle Beetle	
	Scud	
Somewhat Tolerant	Right-handed snail	
	Midge Larva	
	Blackfly	
	Sowbug	
	Orb Snail	
Pollution Tolerant	Aquatic worm	
	Leeches	
	Bloodworm midge larva	
	Left-handed snail	
Other Aquatic Organisms	Crawling Water Beetle	
	Fishing Spider	
	Water Scavenger Beetle	
	Whirligig Beetle	
	Water Strider	
	Mosquito	
	Giant Water Bug	
	Back Swimmer	
	Water Boatman	
	Predacious Diving Beetle	
	Ostracod	
	Copepod	
	Daphnia/ Water flea	
	Total Number of Organisms	

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Macroinvertebrate Data Sheet II
(to be completed at school)

Pollution Tolerance Index

1. Place a check next to each macroinvertebrate group present in your sample. For example, whether you found one mayfly or fifty mayflies, place one check next to the mayfly line in Group 1.
2. Calculate the group scores using the multipliers provided.
3. Find the sum of the group scores for your Total Score.
4. Compare your Total Score with the Water Quality Assessment Chart scores and record the relative water quality rating for your stream sample.

1	Group I Macroinvertebrates: Very Intolerant __ Stoneflies __ Mayflies __ Caddisflies __ Dobsonflies	Group 2 Macroinvertebrates : Intolerant __ Damselfly __ Dragonfly __ Craneflies __ Riffle Beetle __ Scud	Group 3 Macroinvertebrates : Tolerant __ Right-Handed Snail __ Midge larva __ Blackfly larva __ sowbug __ Orb snail	Group 4 Macroinvertebrates : Very Tolerant __ Aquatic worm __ Leeches __ Bloodworm Midge Larva __ Left-Handed Snails
2	# of checks= _____ x4 Group Score = ____	# of checks = ___ x3 Group Score = ____	# of checks = ____ x2 Group Score = ____	# of checks =__ X 1 Group Score =___
3	Your Water Quality Assessment: Total Score = _____	4	Water Quality Assessment Chart: ≥ 23 Potentially Excellent Water Quality 17-22 Potentially Good Water Quality 11-16 Potentially Fair Water Quality ≤ 10 Potentially Poor Water Quality	

Biodiversity Calculation:

After sorting the macroinvertebrates, add up the total number of organisms listed on the front page and use the formula below to find what percent of the total each group represents. Label the empty column on the front of this page "Biodiversity Percent" and record your findings in this column. To check your work, remember, percent should always add up to 100.

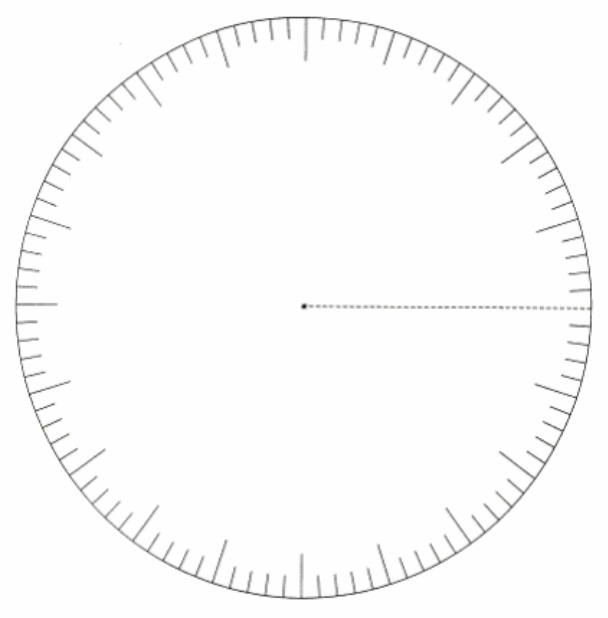
$$\text{Percent Composition} = \frac{\text{Number of Organisms in Each Group}}{\text{Total Number of Organisms}} \times 100$$

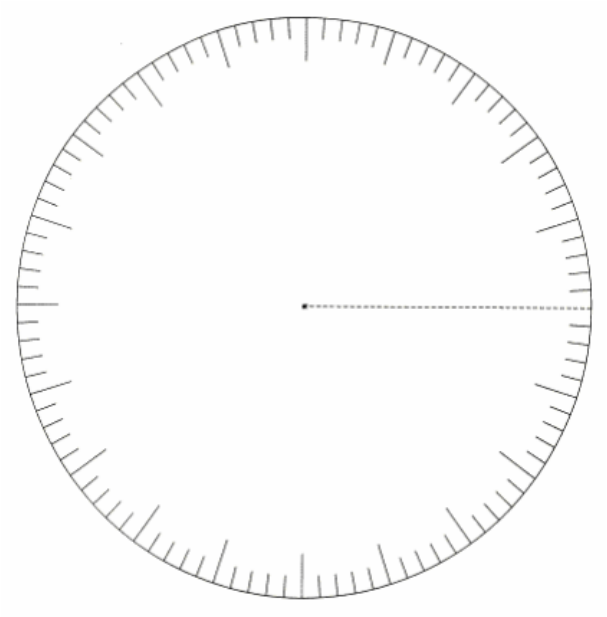
Examine the Data

- Does your data support your prediction? Why or why not?

Macroinvertebrate Data Sheet III

At school, you will create a circle graph that represents the diversity of organisms the classes found.





Record any questions you have about this activity.