Nashua River Watershed Investigations for Grades K - 8

Lesson # 8-1

Title: 8-1 Macro-Speak: How Benthic Macroinvertebrates Help Humans Determine Water Quality

Grade Level & Standard: Grade 8
8MS-LS1-5 Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. Examples of environmental factors could include drought decreasing plant growth, fertilizer increasing plant growth, and fish growing larger in large ponds than they do in small ponds. Examples of both genetic and environmental factors could include different varieties of plants growing at different rates in different conditions.

Objective: Students will determine the water quality of a fresh waterbody (river, stream, pond) through the collection, identification, and recording of benthic macroinvertebrates. These indicator species range in sensitivity to pollution, depending upon their need for various levels of dissolved oxygen availability in the water. For example, some species breathe with lungs and are “pollution tolerant” thus can be found in polluted waters whereas other species are “pollution sensitive” and cannot survive or thrive in polluted water due to low levels of dissolved oxygen. Students will use their findings to determine a *biotic index value* as a measure of water quality for the sampled water body.

Vocabulary:

- **Benthic macroinvertebrates** (also known as "**benthos**") are small animals living among stones, logs, sediments and aquatic plants on the bottom of streams, rivers and lakes. They are large enough to see with the naked eye (macro) and have no backbone (invertebrate).
- **Metamorphosis** - the process of transformation from an immature form to an adult form in two or more distinct stages.

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- **Larval stage -** an independent, immature stage in the life cycle of an animal, in which it is markedly unlike the parent and must undergo changes in form and size to reach the adult stage.
- **Indicator species** - an organism whose presence, absence or abundance reflects a specific environmental condition. Indicator species can signal a change in the biological condition of a particular ecosystem, and thus may be used as a proxy to diagnose the health of an ecosystem.
- **Biotic Index** is a scale for showing the quality of an environment by indicating the types of organisms present in it. It is often used to assess the quality of water in rivers. It is measured from 1 to 10 and corresponds to the four basic water quality (Excellent, Good, Fair or Poor). To assign a biotic index value to a specific water site, the tester first collects macro invertebrates from portions of the sample area of the stream, river or lake and separates them into groups of similar-looking organisms. More extensive testing can be done by looking for certain microscopic organisms.Then an identification key is used to help determine which category or group the organism belongs in and allows a numerical value to be assigned to that organism. A worksheet is then used to calculate the final value or score of all the organisms found. Depending upon the worksheet's equations, the score determines the condition of the water quality.

Materials:

- 5 white plastic rectangular basins
- 10 white plastic bowls
- 5 white ice cube trays
- 25 - 30 white plastic spoons
- 5-10 hand lenses or magnifying boxes
- 5 clipboards
- 5 NRWA Macro-Invertebrate Keys (identification chart)
- 5 Aquatic Insect Investigations data sheets
- 5 How to Calculate the Biotic Index Rating sheets
- 5 Golden Guide Pond Life books (3” x 5” size)
- 5 zip lock baggies
- 5 pencils
- 5 long handled aquatic nets
- one large tarp

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8-1 Macroinvertebrate sampling materials
Photo taken by Carolyn Perkins

Procedure:

I) Outdoor activity at water body: Set up five investigation stations with equipment listed on the large tarp. Introduce students to the definition of “macro-invertebrate” and their role in the aquatic food web. Demonstrate collecting techniques with net and proper handling of living organisms.

1. **Collecting** aquatic insects: Divide class into five groups and assign a sampling site along the water’s edge. Allow for 10 - 20 minutes of collecting time.
2. **Sorting:** Each group works as a team to sort their collection. Encourage gentle handling using spoons and minimal contact with organisms.
3. **Identifying:** Each group uses observation skills, magnifiers, and research materials to identify their organisms and determine what quality of water each species is able to tolerate (good, fair, any).
4. **Counting:** Each group records the species collected and the number of each species. Each group completes a biotic index data sheet to determine water quality using their specimen sample. Collectively the class can then total the

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numbers of each species and determine the biotic index factor using the whole class specimen totals.

5. **Presenting:** Each group chooses one organism to research more thoroughly, identifying three observations or facts obtained from their research. Groups present their organism to the class and teach their classmates about their research subject.
6. **Releasing:** Groups gently return all organisms to their sampling site, making sure to thoroughly rinse each container to assure that animals are not clinging to the edges.

II) Indoor activity in the classroom: Teacher collects aquatic insects before lesson. (see note below) Set up five investigation stations with equipment listed around the classroom. Introduce students to the definition of "macro-invertebrate" and their role in the aquatic food web. Demonstrate proper handling of living organisms. Divide class into five groups and assign a station to each group.

1. **Sorting:** Each group works as a team to sort their collection. Encourage gentle handling using spoons and minimal contact with organisms.
2. **Identifying:** Each group uses observation skills, magnifiers, and research materials to identify their organisms and determine what quality of water each species is able to tolerate (good, fair, any).
3. **Counting:** Each group records the species collected and the number of each species. Each group completes a biotic index data sheet to determine water quality using their specimen sample. Collectively the class can then total the numbers of each species and determine the biotic index factor using the whole class specimen totals.
4. **Presenting:** Each group chooses one organism to research more thoroughly, identifying three observations or facts obtained from their research. Groups present their organism to the class and teach their classmates about their research subject.
5. **Clean up:** Groups gently return all organisms to their white basin, making sure to thoroughly rinse each container to assure that animals are not clinging to the edges.

NOTE: Aquatic insects can be carried to and from the river or pond in a large five gallon bucket with a lid. Provide plenty of water, some leaf litter from river bottom, and oxygenate with a fish tank bubbler if possible.

Data Sheets: (attached)

- NRWA Macro-Invertebrate Key (identification chart)
- Aquatic Insect Investigations data sheet
- How to Calculate the Biotic Index Rating

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Extension:
For a third option, this simpler version without live specimens, use the Biotic Index activity with a **simulated "aquatic insect collection"** using the macroinvertebrate cards cut out from the Nashua River Watershed Aquatic Insects identification chart.

1. Make 25 copies of the Nashua River Watershed Aquatic Insects identification chart.

2. Cut out the aquatic insects into individual cards representing the collected organisms.

3. Using the cards, create five "sampling collections" of various species making sure that some collections represent poor quality, fair quality, or good quality samples.

4. Assign these simulated "aquatic insect collections" to five groups of students working together.

5. Students will identify, count and record results using the Biotic Index Rating data sheet and compare their findings with the other groups.

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How to Calculate the Biotic Index Rating.

Site_____

About Pollution Tolerance Values...

Because aquatic organisms vary in their sensitivity to water pollution, scientists use numbers or "values" to represent an organism's pollution tolerance. Some organisms such as stoneflies, are very sensitive to water pollution so their tolerance value is low. Other organisms like leeches are able to withstand high levels of pollution so their tolerance value is high. Scientists refer to the tolerance values system of rating an organism's pollution tolerance levels as a *biotic index*.

Group (order)	**Tolerance Value**		**Number of Organisms**		**Biotic Index Value**
stonefly nymph (Plecoptera)	**1**	**X**		**=**	
caddisfly larva (Trichoptera)	**3**	**X**		**=**	
mayfly nymph (Ephemeroptera)	**3**	**X**		**=**	
dobsonfly larvae (Megaloptere)	**4**	**X**		**=**	
dragonfly nymph (Odonata)	**5**	**X**		**=**	
scuds (Amphipoda)	**5**	**X**		**=**	
damselfly nymph (Odonata)	**6**	**X**		**=**	
beetles (Coleoptera)	**6**	**X**		**=**	
true flies (Diptera)	**6**	**X**		**=**	
true bugs (Hemiptera)	**8**	**X**		**=**	
sowbugs (Isopoda)	**8**	**X**		**=**	
midge larva (Diptera)	**8**	**X**		**=**	
leeches (Hirudinea)	**8**	**X**		**=**	
aquatic segmented worms (Oligochaeta)	**8**	**X**		**=**	
Totals			(A)		(B)

Biotic index Rating

To calculate the Biotic Index Rating for your site: Multiply the Major Group (Order) Tolerance Values by the number of organisms found in that major group (order), this is the Biotic Index Value. Then add up all the Biotic Index Values (B) and divide by the total number of organisms (A). **(B) divided by (A) = Biotic Index Rating**

0-4 not impaired (great water quality)
4-6 Slightly impaired (good water quality)
6-8 Moderately impaired (not so great water quality)
8-10 Impaired (poor water quality)

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