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Bioassessment of Water Quality Lab

Objectives:

- Understand the link between water quality and the biotic components in an aquatic ecosystem
- Simulate field bioassessment done in the field by volunteers and scientists
- Collect, sort, identify, and analyze a sample
- Determine the pollution index of a stream using a sample
- Compare the water quality of different samples.

Materials (per group)

"Stream"	Data Sheet I
Collection container	Data Sheet II
Net	Data Sheet III
Sorting Trays	Macroinvertebrete ID Chart

Background Information

"The most direct and effective measure of the integrity of a water body is the status of its living systems" (Karr, 1998). One important way to determine the status of water's living systems is through **biological assessment** (bioassessment), which is the use of biological surveys and other direct measurements of living systems within a watershed. Aquatic **macroinvertebrates** (animals without backbones that live in aquatic environments and are large enough to be seen without the aid of a microscope or other magnification) are commonly monitored and are the basis of this activity.

Macroinvertebrates are valuable indicators of health of aquatic environments in part because they are **benthic**, meaning they are typically found on the bottom of a lake or stream and do not move over large distances. Therefore, they cannot easily or quickly migrate away from pollution or environmental stress. Because different species of macroinvertebrates react differently to environmental stressors like pollution, sediment loading, and habitat changes, quantifying the diversity and density of different macroinvertebrates at a given site can create a picture of the environmental conditions of that body of water.

If exposed to an environmental stressor (e.g., pollution, warming due to low flows, low dissolved oxygen due to algal blooms, etc), those macroinvertebrates that are intolerant to that stress may perish. Tolerant macroinvertebrates often inhabit the spaces left by the intolerant organisms, creating an entirely different population of organisms. For example, an unimpacted body of water will typically contain a majority of macroinvertebrates that are intolerant of environmental stressors, such as mayflies, stoneflies, and Caddisfilies. A body of water that has undergone environmental stress may contain a majority of macroinvertebrates that are tolerant to these conditions such as leeches, Tubifex worms, and Pouch Snails.

Bioassessments are particularly helpful to biologists and others trying to determine the health of a river or stream. Bioassessment is a procedure that uses inexpensive equipment, is scientifically valid if done correctly, and can be conducted by students. Bioasessments can provide benchmarks to which other waters may be compared and can also be used to define rehabilitation goals and to monitor trends. Trend monitoring is a common application for bioassessment by student groups and others involved in water quality monitoring.

Collecting , identifying, and quantifying macroinvertebrates are the initial steps in a bioassessment. The next step involves using formulas to calculate the relative water quality based on the diversity and quantity of the samples organisms. These formulas, called **metrics**, relate the numerical diversity and density of organisms to the water quality rating. The most common metrics are the **EPT/Midge Ratio** and the **Pollution Tolerance Index.**

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The **EPT/Midge Ratio** metric compares the total number of intolerant organisms, specifically *Ephemeroptans* (mayflies), *Plecopterans* (stoneflies), *Tricholpterans* (caddisflies), with the total number of tolerant organisms, specifically *Chironomids* (midges). Typically the higher the number of intolerant organisms, the better the water quality.

The **Pollution Tolerance Index** assigns a numerical value to each macroinvertebrate order, with the higher numbers assigned to pollution intolerant organisms, and decreasing numbers assigned to increasingly pollution tolerant organisms. The scores are totaled and compared with a water quality assessment scale to yield a relative water quality rating for the sample.

Pre-Lab Questions

1. Define the following vocabulary terms:

   Bioassessment

   Macroinvertebrates

   Benthic

   Environmental stressors

   EPT

   EPT/ Midge Ratio

   Pollution Tolerance Index

2. Why are macroinvertebrates used for monitoring the health of a river or stream?

3. Describe how a sample would be collected in an actual stream:

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Procedure:

1. Assign roles in your group. While each person is responsible for a specific task, each task will require the assistance and cooperation of all group members.
   - Collection specialist: _____
     - Duty: Collecting specimens from the stream sing the appropriate methods
   - Taxonomists: _____
     - Duty: Sorting, identifying, and counting the collected specimens (Macro ID Chart)
   - Recorder: _____
     - Duty: Compiling the raw data from the Taxonomist (Data sheet I)
   - Data analyst: _____
     - Duty: Analysis and calculations for Data Sheets II and III
2. Acquire and inventory materials. Set up your stream site as instructed.
3. When instructed, your collection specialist will have twenty seconds to collect samples using the dip net. They will dip the net into the stream, and empty the net into the collection bucket.
4. The taxonomist specialist will oversee the sorting of specimens
5. Record the results on Data Sheet I
6. Use the results on Data Sheet I to complete Data Sheet II, calculating the EPT/Midge Ratio.
7. Use the results on Data Sheet I to complete Data Sheet III, calculating the Pollution Tolerance Index.
8. Share and compare your group's results with the class.

Data:

Stream #:

EPT/ Midge Ratio:

Pollution Tolerance index:

Analysis and Conclusions:

1. Use your results and your knowledge of streams to write a description of your stream.

2. Would your sampling method provide you with accurate results if it was used in an actual stream? How could the methods be improved/ modified?

3. What might be some positive and negative impacts of this type of sampling?

Macroinvertebrate Data Sheet I

Stream #:

Recorded by:

Date of Sampling:

Percent Composition of Major Groups:

After the macroinvertebrates are sorted, tabulate the number of organisms for each of the major groups listed below and calculate their percent composition. This measure yields the relative abundance of macroinvertebrates within your sample.

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

Macroinvertebrates	**Number of Organisms in Each Group**	**Percent Composition**
Mayflies (Order *Ephemeroptera*)		
Stoneflies (Order *Plecoptera*)		
Caddisflies (Order *Trichoptera*)		
Dobsonflies (Order *Megaloptera*)		
Midges (Order *Chironomidae*)		
Craneflies (Order *Diptera*)		
Dragonflies (Order *Odonata*)		
Scuds (Order *Amphipoda*)		
Pouch Snails (Class *Gastropoda*)		
Tubifex Worms (Class *Oligochaeta*)		
Leeches (Class *Hirudinea*)		
Total Number of Organisms		

apted from Mitchell, 1997)

Macroinvertebrate Data Sheet II

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. Complete the chart for all of the macroinvertebrate groups.
3. Calculate the group scores using the multipliers provided.
4. Total all of the group scores for your Total Score.
5. Compare your Total Score with the Water Quality Assessment Chart scores and record the relative water quality rating for your stream sample.

Stream #:_____
Recorded by:_____
Date of Sampling:_____

Group 1 Macroinvertebrates: Very Intolerant	Group 2 Macroinvertebrates: Intolerant	Group 3 Macroinvertebrates: Tolerant	Group 4 Macroinvertebrates: Very Tolerant
_____Stoneflies _____Mayflies _____Caddisflies _____Dobsonflies	_____Dragonflies _____Scuds _____Craneflies	_____Midges _____Leeches	_____Pouch Snails ____Tubifex worms
# of checks = ____ x 4 Group Score=____	# of checks =____ x 3 Group Score=____	# of checks =____ x 2 Group Score=____	# of checks =____ x 1 Group Score=____
Total Score = _____ Your Water Quality Assessment:		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	

(Adapted from Mitchell, 1997)

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Data Sheet III

Stream #: _____

Recorded by: _____

Date of Sampling: _____

Calculating the EPT/Midge Ratio

EPT stands for the orders of mayflies, stoneflies, and caddisflies. The EPT/midge ratio compares the total number of intolerant organisms- the EPT, to the number of tolerant organisms, the midges (Chironomids).

1. Using the total number of individuals from Data Sheet I, add the total number of EPT individuals.

Macroinvertebrete	Number
Mayflies (Ephemeroptera)	
Stoneflies (Plecoptera)	
Caddisflies (Trichotera)	
EPT Total	

2. Divide the EPT total by the number of midges (from Data Sheet I)
   EPT total / Midges =

3. Interpret your results. Generally, the larger the number of individuals in the EPT categories, the better the water quality. Therefore, the higher the final value of the ratio, the better the water quality.