

## **Field Lab: Biological Indicators** Summary

Students identify and count aquatic macroinvertebrate specimens and use the result to calculate a value for the quality of the water body.

### **Grade 7 Curriculum**

#### Life Systems

B2. demonstrate an understanding of interactions between and among biotic and abiotic components in the environment

B2.7 explain how biotic and abiotic factors limit the number of organisms an ecosystem can sustain

### **Learning Goal**

- Understand that chemical parameters of an ecosystem are limiting factors for different organisms at different levels

### **Success Criteria**

- Assess the water quality of an ecosystem by observing the presence or absence of aquatic macroinvertebrates using the pollution tolerance of each species

### **Grade Curriculum**

#### Earth and Space Systems

E2.6 describe various indicators of water quality, and explain the impact of human activity on those indicators

#### STEM Investigation and Communication Skills

A1: use a scientific research process, a scientific experimentation process, and an engineering design process to conduct investigations, following appropriate health and safety procedures

### **Learning Goal**

- Understand what and how human and natural actions affect the environment

### **Success Criteria**

- Make inferences about what could cause unhealthy changes to water chemistry and how they can be remediated



## Field Lab: Biological Indicators Materials and Resources

### Materials

- Dip nets
- Holding tubs (dishwashing tub work well)
- Sorting dishes (ice cube trays, petri dishes, yogurt tubs)
- Turkey basters
- Spoons
- Recording and calculating sheets
- Clipboards, pencils
- Calculators
- Identification guides or keys

### Identification Guides

- Key to Macroinvertebrate Life in the River
  - [https://www.tu.org/wp-content/uploads/2019/04/Macroinvertebrate\\_Key.pdf](https://www.tu.org/wp-content/uploads/2019/04/Macroinvertebrate_Key.pdf)
  - Should be printed on 11"x17" paper
- Identification Guide to Freshwater Macroinvertebrates
  - <https://3jgs2o4a02n22u73bi2gnd3l-wpeng.ine.netdna-ssl.com/wp-content/uploads/StreamWebsiteMacroKeyFNL.pdf>
  - Slide based

### Online Index Calculators

Leaf Pack Pollution Tolerance Index:

- <https://leafpacknetwork.org/biotic-index/>

Stream Quality Index Calculator

- <https://inside.nku.edu/row/macroinvertebrates/sqi-calculator.html>
- From Northern Kentucky University

Pollution Tolerance Indicator

- <https://inside.nku.edu/row/macroinvertebrates/pti-calculator.html>
- From Northern Kentucky University



## Field Lab: Biological Indicators Outline

min	Topic	Details	Supplies
	Travel to site		
10	Safety Talk	<ul style="list-style-type: none"> <li>- establish boundaries</li> <li>- establish a signal if a student is in distress</li> <li>- establish a signal that time is up</li> <li>- how to treat the bugs with care</li> </ul>	
10	Catching Bugs	<ul style="list-style-type: none"> <li>- teacher or students collect clear water in the holding containers (dishwashing tubs recommended)</li> <li>- teacher or students collect bugs from the stream and distributes to the holding containers</li> </ul>	<ul style="list-style-type: none"> <li>- nets</li> <li>- holding containers one per group</li> <li>- basters and spoons</li> </ul>
20	Identifying Bugs	<ul style="list-style-type: none"> <li>- students may use basters and spoons to sort the bugs into species groups using smaller containers (ice cube trays are ideal)</li> <li>- using identification guides, students record which bugs they found and how many of each</li> </ul>	<ul style="list-style-type: none"> <li>- id guides</li> <li>- recording sheets</li> <li>- clipboards, pencils</li> </ul>
5	Clean up and Go	<ul style="list-style-type: none"> <li>- gently return the bugs to where they were caught</li> <li>- collect all materials, double check nothing is left</li> <li>- head count and return home</li> </ul>	
10	Calculate the FBI	<ul style="list-style-type: none"> <li>- transfer data and calculate               <ul style="list-style-type: none"> <li>- manually using worksheet</li> <li>- with an online calculator</li> </ul> </li> <li>- complete calculations and determine the water quality rating</li> <li>- create a water quality statement</li> </ul>	<ul style="list-style-type: none"> <li>- worksheet and calculator</li> <li>Or</li> <li>- online calculator</li> </ul>



## Field Lab: Biological Indicators Index Options

There are a variety of indexes that evaluate water quality using aquatic (benthic) macroinvertebrates. This lesson plan includes worksheets for two protocols. Please review the information below and the included worksheets to decide which protocol is best for your class.

### Family Biotic Index

This is the protocol used by Conservation Authorities and is based on the Ontario Stream Assessment Protocol. The system used in this lesson is a simplified version based on the EcoSpark [Changing Currents](#) program. By using standardized methods and calculations, data from different water bodies and changes over time can be accurately compared.

This protocol involves counting numbers of aquatic macroinvertebrates and weighting each species count with a Tolerance Value using an equation to calculate the Family Biotic Index.

#### Pros:

- What the professionals use, it's (almost) the real deal
- Very accurate and detailed

#### Cons:

- Students will need to identify a wider range of species
- Calculations may be challenging

### Leaf Pack Biotic Index

The [Leaf Pack Network](#) is an initiative of [Stroud™ Water Research Center](#). They have developed a set of standardized sampling protocols and assessment calculations that teachers and students can follow. However, you can use their Biotic Index calculation procedure even if you are not participating in their program.

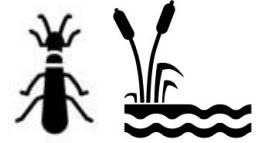
This protocol involves identifying invertebrates to their family taxonomic level and recording presence or absence.

#### Pros:

- Identification is easier
- Calculations are more simple
- There is an online tool that will do the calculations for you

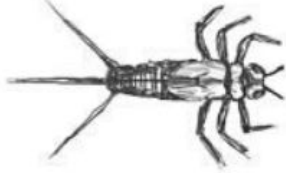
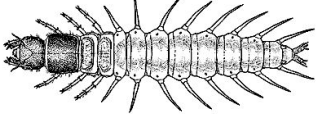
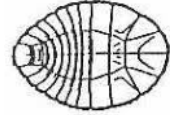
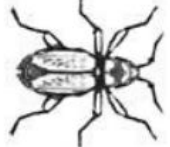

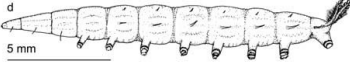
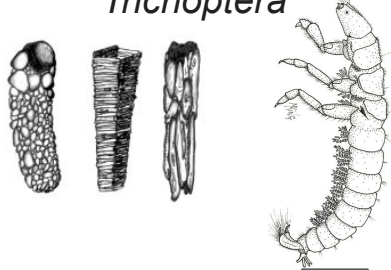
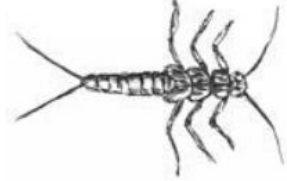
#### Cons:

- This is a simplified index and provides a more general assessment

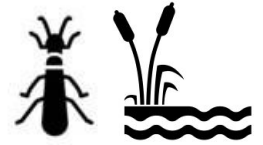


## Field Lab: Biological Indicators Tracking Sheet for Leaf Pack Biotic Index

Each box is a taxon (group of related species). Circle as present if even one specimen is found. Make a tally mark for each specimen you find from the taxa below.





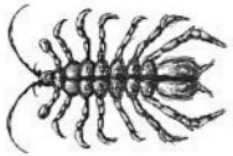
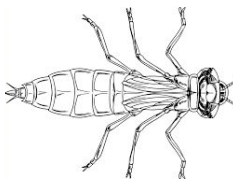
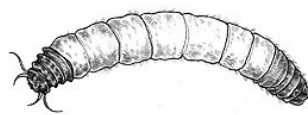

GROUP 1: <b>Sensitive</b>		GROUP 1 NUMBER OF TAXA PRESENT:	
<p>Mayflies <i>Ephemeroptera</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Dobsonflies, Alderflies, Fishflies <i>Megaloptera</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Waterpenny (larva) <i>Psephenidae</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Riffle Beetle (adult) <i>Psephenidae</i></p>  <p>PRESENT <input type="checkbox"/></p>
<p>Right-Handed Snail</p>  <p>PRESENT <input type="checkbox"/></p>	<p>Aquatic Snipe Flies <i>Athericidae</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Caddisfly (with tube) <i>Trichoptera</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Stonefly Larva <i>Plecoptera</i></p>  <p>PRESENT <input type="checkbox"/></p>





## Field Lab: Biological Indicators Tracking Sheet for Leaf Pack Biotic Index

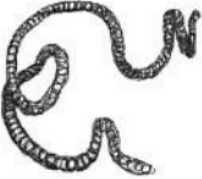


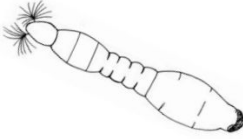



Each box is a taxon (group of related species). Circle as present if even one specimen is found. Make a tally mark for each specimen you find from the taxa below.

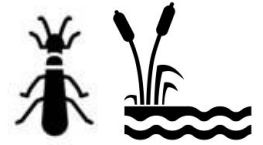
GROUP 2: <b>Somewhat Sensitive</b>		GROUP 2 NUMBER OF TAXA PRESENT:	
<p>Mayfly Larva <i>Ephemeroptera</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Crayfish <i>Decapoda</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Clams or Molluscs <i>Bivalvia</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Scud <i>Amphipoda</i></p>  <p>PRESENT <input type="checkbox"/></p>
<p>Aquatic Sow Bug <i>Asellus aquaticus</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Dragonfly Larva <i>Anisoptera</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Cranefly Larva <i>Tipulidae</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Net Spinning Caddisfly (no tube) <i>Trichoptera</i></p>  <p>PRESENT <input type="checkbox"/></p>



## Field Lab: Biological Indicators Tracking Sheet for Leaf Pack Biotic Index

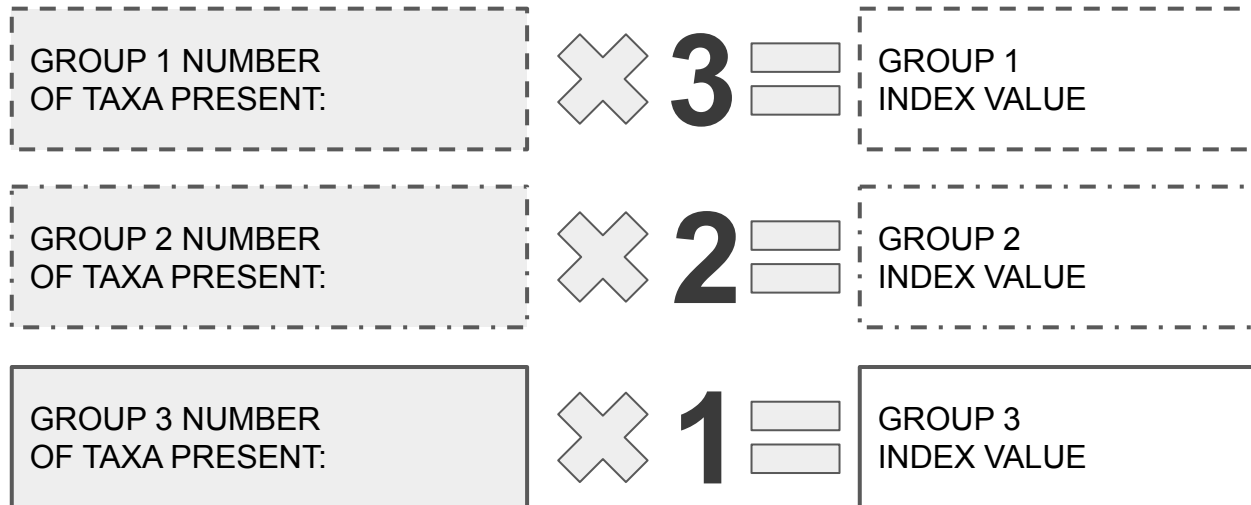
Each box is a taxon (group of related species). Circle as present if even one specimen is found. Make a tally mark for each specimen you find from the taxa below.

GROUP 3: Tolerant		GROUP 3 NUMBER OF TAXA PRESENT:	
<p>Aquatic Worm <i>Oligochaeta</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Midge Larva <i>Chironomidae</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Leeches <i>Hirudinea</i></p>  <p>PRESENT <input type="checkbox"/></p>	<p>Black Fly Larva <i>Simuliidae</i></p>  <p>PRESENT <input type="checkbox"/></p>
<p>Left-Handed Snail</p>  <p>PRESENT <input type="checkbox"/></p>	<p>Flatworms Planarians</p>  <p>PRESENT <input type="checkbox"/></p>	<p>Rat-Tail Maggot <i>Syrphidae</i></p>  <p>PRESENT <input type="checkbox"/></p>	

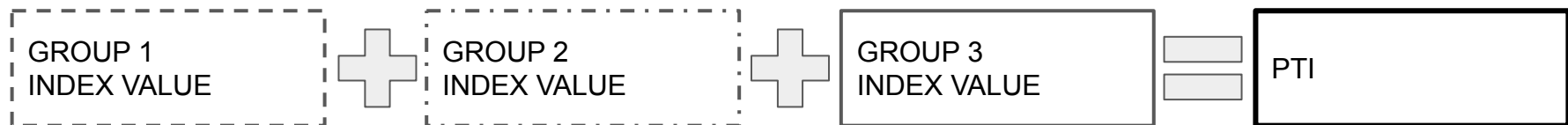


## Field Lab: Biological Indicators Pollution Tolerance Index Calculating Sheet

Follow the steps to calculate the Biotic Index of the water body.



Pollution Tolerance Index Rating (PTI)	
23 or more	Excellent
17 - 22	Good
11 - 16	Fair
0 - 10	Poor



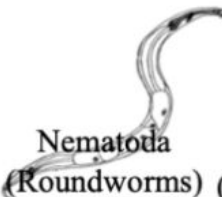
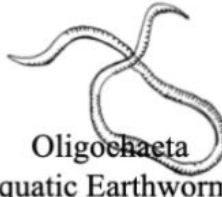


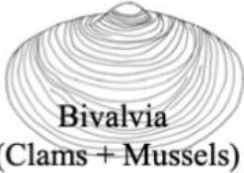
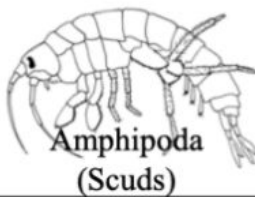


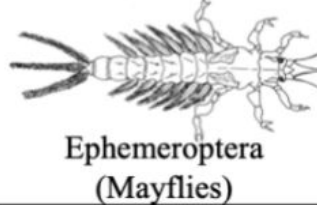


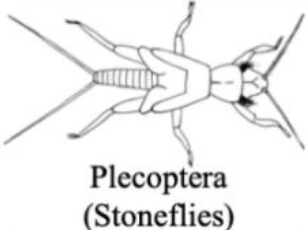

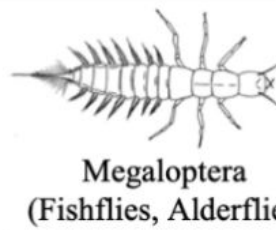


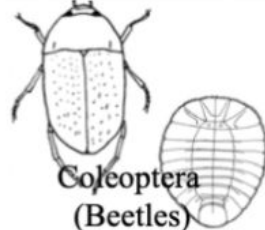
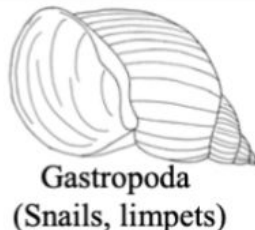
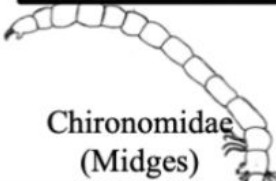
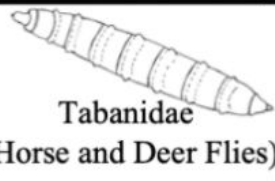

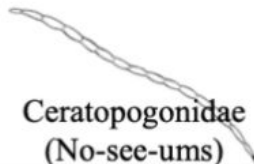
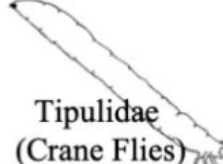




You may choose to use the Leaf Pack Network online Biotic Index Calculator  
<https://leafpacknetwork.org/biotic-index/>



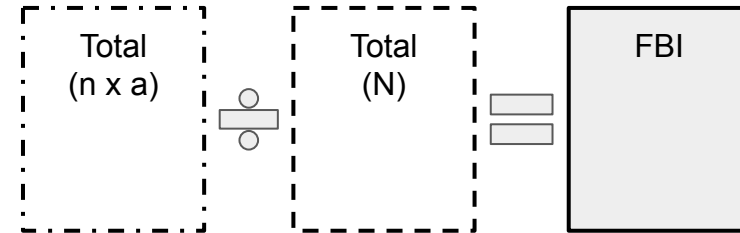
# Field Lab: Biological Indicators Family Biotic Index Tracking Sheet

Make a tally for each specimen found.

 Coelenterata (Hydras)	 Turbellaria (Flatworms)	 Nematoda (Roundworms)	 Oligochaeta (Aquatic Earthworms)	 Hirudinea (Leeches)	 Isopoda (Sow Bugs)	 Bivalvia (Clams + Mussels)
 Amphipoda (Scuds)	 Decapoda (Crayfish)	 Hydrachnida (Mites)	 Ephemeroptera (Mayflies)	 Anisoptera (Dragonflies)	 Zygoptera (Damselflies)	
 Plecoptera (Stoneflies)	 Hemiptera (True Bugs)	 Megaloptera (Fishflies, Alderflies)	 Trichoptera (Caddisflies)	 Lepidoptera (Aquatic Moths)	 Coleoptera (Beetles)	 Gastropoda (Snails, limpets)
 Chironomidae (Midges)	 Tabanidae (Horse and Deer Flies)	 Culicidae (Mosquitos)	 Ceratopogonidae (No-see-ums)	 Tipulidae (Crane Flies)	 Simuliidae (Black Flies)	 Misc. Diptera (Misc. True Flies)

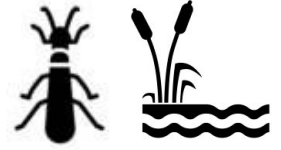


Taxa	Common Name	Frequency (n)	Tolerance (a)	Product nxa
Coelenterate	Hydras		8	
Turbellaria	Flatworms		8	
Nematoda	Roundworms		8	
Oligochaeta	Aquatic Earthworms		8	
Hirudinea	Leeches		8	
Isopoda	Sow Bugs		8	
Gastropoda	Snails, Limpets		8	
Zygoptera	Damselflies		7	
Chironomidae	Midges		7	
Ceratopogonidae	No-See-Ums		6	
Simulidae	Black Flies		6	
Pelecypoda	Clams, Mussels		6	
Amiphipoda	Scuds		6	
Hydracarina	Water Mites		6	
Ephemeroptera	Mayflies		5	
Anisoptera	Dragonflies		5	
Hemiptera	True Bugs		5	
Decapoda	Crayfish		5	
Lepidoptera	Aquatic Moths		5	
Tabanidae	Horse and Deer Flies		5	
Culicidae	Mosquitos		5	
Megaloptera	Fishlies, Alderflies		4	
Trichoptera	Caddisflies		4	
Coleoptera	Beetles		4	
Tipulidae	Crane Flies		3	
Plecoptera	Stoneflies		1	
	Total (n)		Total nxa	



Family Biotic Index	Water Quality
0.00-3.50	Excellent
3.51-4.50	Very Good
4.51-5.50	Good
5.51-6.50	Fair
6.51-7.50	Fairly Poor
7.51-8.50	Poor
8.51-10.0	Very Poor

FBI Table from: The Use of the Biotic Index as an Indication of Water Quality Melvin C. Zimmerman Department of Biology Lycoming College Williamsport, Pennsylvania 17701  
<https://www.ableweb.org/biologylabs/wp-content/uploads/volumes/vol-5/6-zimmerman.pdf>



## Field Lab: Biological Indicators Family Biotic Index Water Quality Statement

Name:

Date:

The **Family Biotic Index** of my sample is

Family Biotic Index	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	Organic pollution unlikely
3.51-4.50	Very Good	Possible slight organic pollution
4.51-5.50	Good	Some organic pollution probable
5.51-6.50	Fair	Fair substantial pollution likely
6.51-7.50	Fairly Poor	Substantial pollution likely
7.51-8.50	Poor	Very substantial pollution likely
8.51-10.0	Very Poor	Severe organic pollution likely

Write a water quality statement by filling in the blanks below:

FBI Table from: The Use of the Biotic Index as an Indication of Water Quality Melvin C. Zimmerman Department of Biology Lycoming College Williamsport, Pennsylvania 17701  
<https://www.ableweb.org/biologylabs/wp-content/uploads/volumes/vol-5/6-zimmerman.pdf>

The water quality from the sample is \_\_\_\_\_.

Organic pollution is \_\_\_\_\_.



## Field Lab: Biological Indicators Submitting Your Data

### Leaf Pack Network

In order to submit data to the Leaf Pack Network database, you will need to follow their protocols. Some special equipment is required. A complete kit is available from LaMotte. However, not all items are essential and it is possible to order only the required equipment by phone.

- Equipment List: <https://leafpacknetwork.org/resources/equipment/>
- Digital Manual: <https://leafpacknetwork.org/resources/manual/>
  - Free, can be downloaded or printed from the web
- Introduction Video: <https://youtu.be/zCeCj5qu4K4>
- Data Submission: <https://leafpacknetwork.org/data/>
  - You will need to create a free account

### iNaturalist

If you are not able to follow all the procedures for the Leaf Pack Network, your observations of macroinvertebrates can still be submitted to iNaturalist. Your photos, location and species identification will be added to their database. Many scientific research groups use the data from iNaturalist for their studies.

- Uses an app for phone or tablet, web based for laptop
- Free
- You will need to create an account
- [www.inaturalist.org](http://www.inaturalist.org)