Benthic Macroinvertebrate Monitoring

"In the end, we will conserve only what we love, we will love only what we understand, we will understand only what we are taught." - Bada Dioum, Senegalese conservationist

Benthic macroinvertebrates

Benthic Monitoring is the collection of critters (insects and other invertebrates) from the bottom of a river or stream. Benthic means bottom dwelling and refers to the organisms that live in, crawl upon, or attach themselves to the bottom (or substrate) of the river. Macro means large (in this case, visible to the human eye) and invertebrate refers to animals without backbones. Most benthic macroinvertebrates are aquatic insects or the aquatic stages of insects. They also include such things as clams and worms.

Why study macroinvertebrates?

Benthic macroinvertebrates are an important part of river ecosystems. Stream dwelling invertebrates respond to changes in the physical and chemical environment. Benthic macroinvertebrates generally inhabit a localized area of a stream throughout their life cycle. Therefore, the individual organisms are continually exposed to any changes that occur in the chemical and physical environment. Collecting macroinvertebrates can provide an understanding of a river's condition. Because many macroinvertebrates live in the stream year-round and sometimes over multiple years, their presence or absence provides valuable information about a river's health over time.

Methodology and equipment

(Adapted from green.org)

The method described here generally follows a qualitative or semi-quantitative approach. It has been used successfully by non-biologists to monitor water quality and identify trouble spots.

1. Choose a 3-foot by 3-foot area in a riffle typical of the stream. A riffle good for sampling will have cobble-sized rocks, fast moving water, and a depth of 3 to 12 inches.
2. Use the kick seine method to collect the sample. Enter the water downstream of your sampling location. Have one person hold the poles on the net upright in the sampling area and push the poles firmly into the substrate. No water should wash under or over the net. Place small rocks on the bottom edge, if needed, to hold it down.
3. As the net is held, a second person brushes all organisms off the cobbles and rocks. Completely brush rocks and set them outside the sampling area. Next, stir the substrate to a depth of several inches to dislodge any burrowing macroinvertebrates. You can use a metal tool, such as a long screw driver, or use your feet in a shuffling motion to kick the substrate toward the net. Stir for at least one minute.
4. Lift the kick seine out of the water with a forward scooping action to avoid losing macroinvertebrates off the end of the screen.
5. After carrying the seine to the stream bank, wash the contents into a large bucket filled with stream water. Washing from behind the screen helps to dislodge the animals. Use only stream water for rinsing organisms off the net into the bucket. If you plan to sort back at your lab or school, you can transport the sample in the large bucket, preferable with a lid, with plenty of stream water.
6. You can begin sorting directly from the bucket into ice cube trays or other sorting containers filled with stream water. However, it is often easier to scoop parts of the sample into shallow pans from which to sort. Keep scooping and sorting until you've identified the entire sample (or reached whatever maximum number of organisms your program prescribes). Sort the different taxa (types of specimens) into separate containers or sections of the ice trays.
7. Once you have sorted the organisms, they can be identified in the field or lab using identification keys and guides.
8. Record the results of your assessment using the Benthic Field Data Sheet. (Appendix A)

Additional information useful for stream site characterizations include: canopy cover, stream bed substrate, flow, turbidity, water temperature, acidity (pH), and dissolved oxygen. Detecting degradation through evaluation of invertebrate communities requires establishment of a description for reference condition. This is the focal point for developing analytical tools commonly used to evaluate stream condition and "biological integrity".

The following equipment is recommended by green.org for collecting benthic macroinvertebrates:

- Kick seine or kick net (or other sampler) - for collecting sample.
- Metal screw driver (or similar device) - for stirring the sample substrate.
- Large white sheet or plastic - to lay out all equipment, keeping it clean and in one place.
- Large buckets - for washing sample out of net and/or for transporting for later identification.
- Plastic scooping devices (large measuring cups or modified plastic milk jugs) - to rinse insects off net (using river water) into collecting bucket or pans.
- White enamel or shallow plastic pans - for dividing the sample for multiple groups; for picking and sorting from.
- Ice cube trays, white preferable - for sorting the organisms by major group.
- Small jars or vials - can be used for sorting and are especially helpful if you want plan to save and transport your sorted sample.
- Seventy-percent alcohol solution - if you plan to save your sample.
- Forceps/tweezers, spoons, small paint brushes - for picking organisms and sorting organisms into major groups.
- Hand-held magnifiers - to aid in identification.
- Vegetable brushes - to gently remove attached organisms from rocks.
- Rubber boots or hip waders and rubber gloves - to keep you dry and warm during collection.
- Meter stick - for making depth measurements.
- Thermometer - for recording water and air temperatures at time of collection.

Identification and interpretation

Back in the house, you'll need data sheets, pencils, and clipboard - for recording sampling results. Also a field guide - to aid in identification of organisms (can be plastic coated for wet weather). Example: Save Our Streams Macroinvertebrate Identification Key (http://wsrv.clas.virginia.edu/%7Esos-iwla/Stream-Study/StreamStudy-HomePage/StreamStudy.HTML). You'll then write a report that can be published and compared to future studies.

Appendix A

Benthic Field Data Sheet

General Information	
Date:	
Name of Stream or River (or other water body):	
Site Name or Number:	
Site Location (be specific):	
Latitude and Longitude:	
Stream Order of Site:	
Watershed:	
Nearest Town:	
Country:	
State, Region or Province:	
Monitors: Organization: School: Names:	
Time:	
Weather: Today: Previous 2 days: Date of Last Precipitation:	
Air Temperature (^{0}C):	
Water Temperature (^{0}C):	
Estimated Elevation:	

Recording Macroinvertebrate Data

The calculations for Total Taxa Richness, EPT Taxa Richness, and either a 3-part or 4-part Pollution Tolerance Index will be automatically generated when you enter your data into the GREEN database. Directions will be provided on-line. Additional information is available in the resource "Biological Analysis Instructions".

Directions: Use hash marks to tally the number of individuals in major groups. Use a different Taxon column any time you encounter a different type of organism *within* a major group. For example: if you find one each of three different types of mayflies, then you will record a hash mark under three taxon columns. If you find another organism just like the one you "named" *Taxon 1*, then put another hash mark in the *Taxon 1* column.

Note: If you do not want richness numbers calculated for you and plan only to analyze using a 3- or 4- part Pollution Tolerance Index, you may opt for recording totals for each major group in just the Taxon 1 column. The computer will take it from there to calculate your PTI.

Major Groups	**Taxon 1**	**Taxon 2**	**Taxon 3**	**Taxon 4**	**Taxon 5**	**Taxon 6**	**Total Number of Taxa**	**Total Number of Individuals**
mayfly nymphs *(Ephemeroptera)*								
stonefly nymphs *(Plecoptera)*								
caddisfly larvae *(Trichoptera)*								
gilled/right-handed snails								
riffle beetle adult								
hellgrammite/dobsonflies								
water penny larvae								
beetle larvae								
Clams								
cranefly larvae								
Crayfish								
damselfly nymphs								
dragonfly nymphs								
Scuds								
Sowbugs								
fishfly larvae								
alderfly larvae								
watersnipe fly larvae								
aquatic worms								
blackfly larvae								
Leeches								
midge larvae								
pouch/left-handed & other snails								
filtering caddisfly								
Mosquitoes								
Bivalves								

Benthic Analysis Instructions

The calculations for Total Taxa Richness, EPT Taxa Richness, and either a 3-part or 4-part Pollution Tolerance Index will be automatically generated when you enter your data into the GREEN database. Directions will be provided on-line.

Using the GREEN database, you will have the ability to:

1. Select a 3- or 4-part Pollution Tolerance Index for automatic calculation. You will be asked to select a preference when you create a project. If you do not select, the default setting is the 4-part PTI. (Total Taxa Richness and EPT Taxa Richness will be calculated regardless of PTI choice.)

2. Customize the organisms listed in the 3-part PTI. Only the 3-part PTI can be modified to suit the geographic region where you live. When you create a project, you will be asked if you wish to customize the list and then given a menu of organisms to choose from for placement in the table.

3. Record benthic collection procedures (such information is important for interpreting and comparing monitoring results). This option is accessed when you create or edit your project information and click on enter data link.

4. Auto-calculate. To get automatically calculated results, you will enter a number representing your hash marks for each taxon from your Benthic Field Data Sheet into the identical Macroinvertebrate Data Entry Form (sample below). Both Total Number columns will be automatically calculated, as will Total Taxa Richness and EPT Richness. In addition, your selected PTI will be calculated. *To see these calculations, you will need to go back to View Data and select your particular monitoring event*.

5. Omit richness calculations. If you do not want richness numbers calculated for you and plan to analyze only using a 3- or 4-part Pollution Tolerance Index, you may opt for recording totals for each major group in just the Taxon 1 column. The computer will take it from there to calculate your PTI.

Sample Richness and Pollution Tolerance tables

Total Taxa Richness & EPT Taxa Richness
The computer will automatically calculate the two richness values using the lines below. Good water quality is indicated by high richness.

Line	Description	Totals
A	Taxa Richness (total number of taxa)	
B	Number of Mayfly taxa	
C	Number of Stonefly taxa	
D	Number of Caddisfly taxa	
E	EPT Taxa Richness (total number of EPT taxa [B+C+D])	

3-part Pollution Tolerance Index (PTI)

The computer will automatically calculate the Pollution Tolerance Index number for you using the standard directions: Use letter codes (A=1-9, B=10-99, C=100 or more) to record the numbers of organisms found. Then add up the number of letters in each column and multiply by the indicated index value. The columns correspond to the organisms' sensitivity to pollution.

3-part Pollution Tolerance Index (PTI)

Sensitive	Somewhat Sensitive	Tolerant
____ caddisfly larvae ____ dobsonfly larvae (hellgrammite) ____ stonefly nymph ____ mayfly nymph ____ gilled snails ____ rifle beetle adult ____ water penny beetle larvae	____ dragonfly larvae ____ crane fly larvae ____ damselfly nymph ____ beetle larvae ____ sowbug ____ crayfish ____ clams ____ scud	____ aquatic worms ____ pouch (& other) snails ____ leeches ____ midge larvae ____ black fly larvae
____ # of letters x 3 = ____ index value	____ # of letters x 2 = ____ index value	____ # of letters x 1 = ____ index value

Total Index Value = _____ (add together the 3 index values, one from each column)

Compare Total Index Value to Water Quality Rating numbers below to determine an estimate of the water quality of your stream.

Water Quality Rating

_____ Excellent (>22) _____ Good (17-22) _____ Fair (11-16) _____ Poor (<11)

4-part Pollution Tolerance Index (PTI)

The computer will automatically calculate the Pollution Tolerance Index number for you using the standard directions: Use letter codes (A=1-9, B=10-49, C=50-99, D=100 or more) to estimate the numbers of organisms found. To calculate the PTI, add up the number of types of letters in each tolerance level column and multiply by the indicated index value. The columns correspond to the organisms' tolerance to pollution. Reference: See Mitchell & Stapp, *Field Manual for Water Quality Monitoring*, *12th Edition*, for further information on using the 4-part PTI. www.earthforce.org/green/catalog.

4-part Pollution Tolerance Index

Group 1 - most intolerant	**Group 2 - moderately intolerant**	**Group 3 - moderately tolerant**	**Group 4 - most tolerant**
____ gilled snails ____ stonefly nymph ____ mayfly nymph ____ rifle beetle adult ____ caddisfly larvae ____ dobsonfly larvae (hellgrammite) ____ water penny beetle larvae	____ sowbug ____ scud ____ dragonfly larvae ____ damselfly nymph ____ crane fly larvae ____ clams	____ leech ____ midge (excluding blood midges) ____ flat worm ____ black fly larvae ____ water mite	____ pouch (& other) snails ____ maggot ____ tubifex worm ____ blood midge larvae
____ # of letters x 4 = ____ index value	____ # of letters x 3 = ____ index value	____ # of letters x 2 =____ index value	____ # of letters x 1 =____ index value

Total Index Value = _____ (add together the 4 index values, one from each column)

Compare Total Index Value to Water Quality Rating numbers below to determine an estimate of the water quality of your stream.

Water Quality Rating

_____ Excellent (>22) _____ Good (17-22) _____ Fair (11-16) _____ Poor (<11)