Chapter 1

MACROINVERTEBRATE MONITORING

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Macroinvertebrate monitoring involves identifying and counting macroinvertebrates. The purpose of macroinvertebrate monitoring is to quickly assess both **water quality and habitat**. The abundance and diversity of macroinvertebrates found is an indication of overall stream quality. Macroinvertebrates are organisms that lack a backbone and can be seen with the naked eye, including aquatic insects, crustaceans, worms, and mollusks. The organisms that are being sampled for are benthic macroinvertebrates meaning that they live in the substrate, or bottom of a waterbody. Macros live in various stream habitats and derive their oxygen from water. They are used as indicators of stream quality. These organisms are impacted by all the stresses that occur in a stream environment, both man-made and naturally occurring.

Aquatic macroinvertebrates are good indicators of stream quality because:

- They are affected by the physical, chemical and biological conditions of the stream.
- They are not very mobile. They can't escape pollution and, therefore, will show effects of short- and long-term pollution events.
- They are relatively long lived – the life cycles of some sensitive macroinvertebrates range from one to several years.
- They are an important part of the food web, representing a broad range of trophic levels.
- They are abundant in most streams. Some 1st and 2nd order streams may lack fish, but they generally have macroinvertebrates.
- They are a food source for many recreationally and commercially important fish.
- They are relatively easy to collect, view, and identify with inexpensive materials.

Macroinvertebrates are present during all kinds of stream conditions from drought to floods. Macroinvertebrates are adaptable to extremes of water flow. Some may burrow when it is raining and flow increases. However, heavy rain in areas with a high percentage of impervious surface (most urban areas) can cause flash floods and carry macroinvertebrates downstream.

Populations of macroinvertebrates may differ in north and south Georgia. For example, since the Adopt-A-Stream macroinvertebrate index is based on dissolved oxygen, the "sensitive" organisms that require a lot of oxygen, such as the stonefly, may not be found in warm, slow-moving streams in south Georgia. That does not mean that the stream has bad water quality or habitat, just that streams in north and south Georgia support different populations of macros. If you are monitoring in south or coastal Georgia, it is important for you to conduct monitoring each season for several years. Doing this will help you recognize biological trends in your stream so that you can determine which changes are natural and which may be induced by human impact.

Populations of macroinvertebrates may vary from headwater streams to the river mouth. For more information, please review "The River Continuum Concept" in the *Visual Stream Survey* manual.

Seasonal cycles can also affect the number and kinds of macroinvertebrates collected. Organisms such as immature stoneflies and mayflies will gain weight and size primarily during the fall and winter. During the spring and summer they may reach maturity and begin to metamorphose into their adult (non-aquatic) stage. Therefore, the presence of aquatic macroinvertebrates will tend to be more evident during winter and spring just before metamorphosis. After adults emerge, females lay eggs near or in the water. Soon after, the larvae and nymphs hatch and begin to grow, feeding on leaf litter, detritus and other organic matter that might be present. For more information on macroinvertebrates and their life cycles, please turn to "Background on Aquatic Insects" in the Appendix.

If conditions are unsafe for any reason, including high water or slippery rocks, **DO NOT SAMPLE**.

Why Monitor for Macroinvertebrates?

The basic principle behind the study of macroinvertebrates is that some species are more sensitive to pollution than others. Therefore, if a stream site is inhabited by organisms that can tolerate pollution, and the pollution-sensitive organisms are missing, a pollution problem is likely.

For example, stonefly nymphs, which are very sensitive to most pollutants, cannot survive if a stream's dissolved oxygen falls below a certain level. If a biosurvey shows that no stoneflies are present in a stream that used to support them, a hypothesis might be that dissolved oxygen has fallen to a point that keeps stoneflies from reproducing or has killed them outright.

This brings up both the advantage and disadvantage of the biosurvey. The advantage of the biosurvey is it tells us very clearly when the stream ecosystem is impaired, or "sick," due to pollution or habitat loss. It is not difficult to realize that a stream full of many kinds of crawling and swimming "critters" is healthier than one without much life. Different macros occupy different ecological niches within the aquatic environment, so diversity of species generally means a healthy, balanced ecosystem. The disadvantage of the biosurvey, on the other hand, is it cannot definitively tell us why certain types of creatures are present or absent.

In this case, the absence of stoneflies might indeed be due to low dissolved oxygen. But is the stream under-oxygenated because it flows too sluggishly, or because pollutants in the stream are damaging water quality by using up the oxygen? The absence of stoneflies might also be due to other pollutants discharged by factories or run off from farmland, water temperatures that are too high, habitat degradation such as excess sand or silt on the stream bottom has ruined stonefly sheltering areas, or other conditions. Thus a biosurvey should be accompanied by an assessment of *habitat and water quality* conditions in order to help explain biosurvey results.

Determining Stream Type and Sampling Location

Find a sampling location in your stream. This location should be within your stream reach, which you should have determined during your visual survey. Sample the same stretch of stream each time, to ensure consistency. Sample every three months, approximately once each season (spring, summer, fall and winter).

Macroinvertebrates can be found in many kinds of habitats—places like riffles (where shallow water flows quickly over rocks), packs of leaves, roots hanging into the water, old wood or logs, or the streambed. Based on the types of habitats that characterize your stream, determine if you have a **muddy bottom or rocky bottom stream.** Follow the directions that correspond with your stream type.

- **Rocky bottom streams** are generally found in north Georgia and the Piedmont Region. However, there are exceptions—some south Georgia streams possess rocky bottom characteristics. Rocky bottom streams are characterized by fast-moving water flowing over and between large rocks and boulders, interspersed with longer, smooth sections where the water forms pools.
- **Muddy bottom streams** include most south Georgia streams and many streams found in urban environments, which have been degraded by the introduction of sediment. In muddy bottom streams the pool/riffle system is replaced by slow moving water with little or no disturbances. The substrate is generally composed of fine silt, sand or coarse gravel.

Equipment List:

- Aquatic Macroinvertebrate Field Guide for Georgia's Streams (found on the AAS website)
- Macroinvertebrate Data Form (found on the AAS website)
- D-Frame and/ or Kick Seine Nets
- Spoons, forceps, hand lenses, petri dishes, sorting pans, ice trays, bucket(s), small pieces of screening
- Pitcher or jug for rinsing out macros from nets into sorting pans
- Clear container or Whirl-pak® bag for the visual observations
- Pens/pencils
- Clipboard
- Trash bag to pick up litter
- The 'Who to Call List' (found on the AAS website)
- First Aid Kit
- Waders, boots, or old tennis shoes

Optional:

- Rubber gloves for rubbing rocks
- Bucket with screen bottom (for muddy bottom sampling)

The Appendix provides information on how to make a kick seine net.
A list of places to purchase equipment is located on the AAS website.

Begin Sampling for: Rocky Bottom Streams

In the “rocky bottom” method, you will sample two different habitats—**riffles** and **leaf packs**. The rocky bottom method requires a minimum of two volunteers; one to hold the kick seine and one to “work” the sample area.

First, identify three different riffle areas. Collect macroinvertebrates in all three riffles with a kick seine, sampling a 2 x 2 foot area (the kick seines are usually 3 x 3 feet). Look for an area where the water is 3 to 12 inches deep. Place the kick seine downstream and firmly wedge the seine into the streambed, weighting the bottom edge with rocks. Gently rub any loose debris off rocks and sticks so that you catch everything in the seine. When you have "washed off" all the rocks in a 2 x 2 foot area, kick the streambed with your feet. Push rocks around; shuffle your feet so that you really kick up the streambed. Now gently lift the seine, being careful not to lose any of the macroinvertebrates you have caught. Take the seine to an area where you can look it over or wash the contents into a bucket.

Now look for decayed (old, dead) packs of leaves next to rocks, logs or on the streambed. Leaf packs may be found throughout your designated stream reach, in the riffle or pool systems. Add 4 handfuls of decayed leaves to your sample. The total area of stream you will sample is 16 square feet.

In summary, collect:

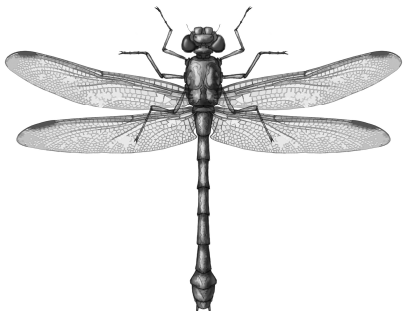
- 3 kick seine samples of substrate from the riffle area (4 square feet each)
- 4 handfuls of organic matter or leaf packs (1 square foot each)

Substrate: Riffles

Riffle areas constitute shallow areas of a stream or river with a fast-moving current bubbling over rocks. The water in riffle areas is highly oxygenated and provides excellent habitat, shelter, and food for a variety of macroinvertebrates.

Organic Matter: Leaf packs

This includes decomposing vegetation (leaves and twigs) that is submerged in the water. Leaf packs serve as a food source for organisms and provide shelter from predators.



Dragon Fly Adult

Begin Sampling for: Muddy Bottom Streams

In this method you will sample three different habitats, using a D-frame (or dip) net. The habitats are **vegetated margins, woody debris with organic matter,** and **sand/rock/gravel streambed** (or substrate). Each scoop involves a quick forward motion of one foot, thus covering a sample area of one square foot. With this method you will sample the stream a total of 14 times or 14 square feet. To maintain consistency, collect the following numbers of scoops from each habitat each time you sample:

- 7 scoops from vegetated margins (1 square foot each)
- 4 scoops of organic matter (woody debris, 1 square foot each)
- 3 scoops of substrate from sand/rock/gravel or coarsest area of the streambed (1 square foot each)

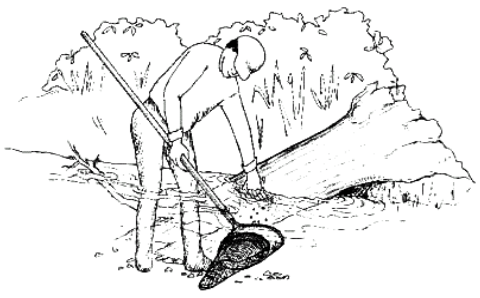
Each time you sample you should sweep the mesh bottom of the D-frame net back and forth through the water (not allowing water to run over the top of the net) to rinse fine silt from the net. This will prevent a large amount of sediment and silt from collecting in the pan and clouding your sample.

As you collect your scoops, place the contents of the net into a bucket. Separate the samples collected from the streambed and vegetated margin or woody debris samples. Keep water in the bucket to keep the organisms alive. Note descriptions below of each muddy bottom habitat and collection tips:

Vegetated margins
This habitat is the area along the bank and the edge of the waterbody consisting of overhanging bank vegetation, plants living along the shoreline, and submerged root mats. Vegetated margins may be home to a diverse assemblage of dragonflies, damselflies, and other organisms. Move the dip-net quickly in a bottom-to-surface motion (scooping towards the stream bank), jabbing at the bank to loosen organisms. Each scoop of the net should cover one foot of submerged (under water) area.

Organic Matter: Woody debris
Woody debris consists of dead or living trees, roots, limbs, sticks, leaf packs, cypress knees, and other submerged organic matter. It is a very important habitat in slow moving streams and rivers. The wood helps trap organic particles that serve as a food source for the organisms and provides shelter from predators such as fish.

To collect woody debris, approach the area from downstream and hold the net under the section of wood you wish to sample, such as a submerged log. Rub the surface of the log for a total surface area of one square foot. It is also good to dislodge some of the bark as organisms may be hiding underneath. You can also collect sticks, leaf litter, and rub roots attached to submerged logs. Be sure to thoroughly examine any small sticks you collect before discarding them. There may be caddisflies, stoneflies, and midges attached to the bark.



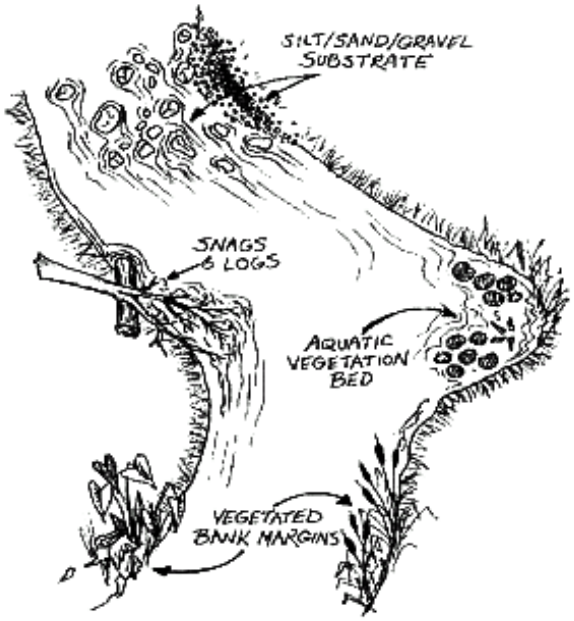
Substrate: Sand/rock/gravel or coarsest area of the streambed

In slow moving streams, the substrate is generally composed of only sand or mud because the velocity of the water is not fast enough to transport large rocks. Sample the coarsest area of the streambed—gravel or sand may be all you can find. Sometimes, you may find a gravel bar located at a bend in the river. The streambed can be sampled by moving the net forward (upstream) with a jabbing motion to dislodge the first few inches of gravel, sand, or rocks. You may want to gently wash the gravel in your screen bottom bucket and then discard gravel in the water.

If you have large rocks (greater than two inches in diameter) you should also kick the substrate upstream of the net to dislodge any burrowing organisms. Remember to disturb only one square foot of upstream sample area.

Elutriation

Some substrate samples are composed almost entirely of fine silt and mud. To separate aquatic organisms, place the sample in a bucket with water and stir. Pour off water into the D-frame net and repeat 3 times. Any macroinvertebrates present will separate from the collected mud and be caught in the net. Before dumping remaining substrate, inspect bucket for snails or mollusks. This process is called elutriation.



Calculate Your Results

Place your macroinvertebrates in a white sorting pan or plastic tray. Separate creatures that look similar into groups. Use the Adopt-A-Stream's *Macroinvertebrate Field Guide For Georgia's Streams* to classify the types and numbers of each kind of insect. As you sort through your collection, remember each stream will have different types and numbers of macroinvertebrates. Calculate the score for your stream using the index on the Macroinvertebrate Data Form. Use the table below to interpret your results.

If you find:	**You may have:**
Variety of macroinvertebrates, lots of each kind	Healthy stream
Little variety, with many of each kind	Water enriched with organic matter
A variety of macroinvertebrates, but a few of each kind, or **NO** macroinvertebrates, but the stream appears clean	Toxic pollution
Few macroinvertebrates and the streambed is covered with sediment	Poor habitat from sedimentation