Water Quality Sampling Basics

Biological Monitoring

Benthic (i.e., bottom-dwelling) macroinvertebrates, such as insects, worms, and crabs, are the most diverse and numerous animals in streams and rivers and have been used extensively to determine water and habitat quality. They are included in most biological programs that assess water quality in streams and rivers because:

- They are a critical part of the food web, representing the primary link between the base of the food web (algae, leaves, microorganisms) and fish
- They are affected by the physical, chemical, and biological conditions of the stream
- They are relatively immobile and thus show the effects of both short and long-term pollution events
- Some are highly susceptible to pollution
- They are relatively easy and inexpensive to sample and identify

While North America and Europe have a long history of biomonitoring, including well-defined sampling protocols and analysis methods, protocols for Central and South America are in earlier stages of development.

Sampling methods:

Several methods for collecting macroinvertebrates are available, and determining the most appropriate method depends on the goals of the monitoring project and the physical nature of the stream's habitat. Because macroinvertebrates are not evenly distributed within a stream, multiple samples should be taken with any method to ensure adequate spatial representation that stream stream.

Surber Sampler:

The dominant habitat for macroinvertebrates in rocky-bottomed streams is fast flowing, rocky areas called riffles, which can be sampled with quantitative methods such as Surber nets. This technique is used less in general biological monitoring programs with limited budgets.

Samples are taken by working the Surber's metal frame into the stream bottom. The area within the frame is disturbed so that animals in the substrate are swept into the net. Rocks within the frame are placed into a bucket of water and scrubbed to dislodge invertebrates clinging to the rock. This process is typically repeated at least 4 times per riffle.

Surber Sample Advantages:

- Samples are quantitative, and replicates can be collect at each site
- Analyses can involve both community structure and abundance
- Samples are often archived
- Taxonomy typically to a minimum of family level

Surber net

Surber Sample Disadvantages:

- Can only be used in a riffle habitat
- Generally requires longer processing time and more resources than other methods

D-Nets (d-frame or dip nets):
Roots, wood and leaves provide the dominant habitat in muddy-bottomed, low gradient streams. D-nets provide good access to these diverse habitats and may be a good choice for monitoring programs having diverse stream types.

Samples are collected by sweeping or jabbing the net into appropriate habitats. Protocols vary from taking a small number of jabs from the major habitats to prescribing a set number of jabs (e.g. 20 from each major habitat type at the site, with the habitats sampled in approximate proportion to their representation of surface area). The jabs are typically combined together for the site and can be sorted on site or preserved for future laboratory examination. Large pieces of submerged wood provide habitat for a number of aquatic fauna. If the monitoring protocols call for sampling all habitats than these large pieces of woody debris should be inspected by hand.

D-Net Advantages:

- Ability to sample multiple habitats
- Potential for quick and relatively inexpensive determination of general water quality condition

D-Net Disadvantage:

- Qualitative and less standardized

Artificial Substrate

Leaves are a dominant habitat in many tropical streams, and artificial leaf packs - created by placing 5-20 grams of leaves into a mesh bag - provide a consistent monitoring tool across a diversity of streams types. Leaf packs should be submerged in the stream for 3-4 weeks and than removed for processing.

Leaf Pack

Rock bags are another way to create an artificial substrate for tropical streams. In this method, rocks are put into a mesh bag and anchored into a stream for a set period of time.

Artificial Substrate Advantages:

- Can sample difficult or unsafe areas
- Able to give each site equal effort
- Inexpensive, easy design
- Usable in rocky- and muddy-bottomed streams

Artificial Substrate Disadvantages:

- Two visits are needed – first to place and later to retrieve samplers
- Collects a subset of the streams fauna that uses that particular substrate

Rock Bag

Sampling Frequency and taxonomic resolution:

Sampling once per year is sufficient for most water-quality monitoring programs. While identification of the macroinvertebrates to order level is generally sufficient to show significant differences between streams (e.g. good vs. poor), resolution to family level, or below, may be necessary to detect finer levels of impairment.

Determining Sampling Station Locations

Although the specific purpose of the monitoring project will determine the exact sampling locations, a few general guidelines include:

1. Locate all known and significant point-source discharges (sewage treatment plants, towns, industrial outfalls) and land-use impacts (agriculture, residential development, etc.) on map of drainage basin.

2. Locate a station upstream and downstream of each potential major impact (you may need to prioritize among these if the number of stations becomes overwhelming).

3. Focus on third- to fifth-order tributaries initially (there are usually just too many first- and second-order tributaries).

4. Prioritize sites based on the most efficient use of your limited resources (budget, personnel, time). It is better to start small and grow than to overreach and have to drop sites.

5. Choose sites with comparable habitat and flow.

6. Locate a monitoring station on at least one tributary draining the least disturbed section of the watershed as a reference site. (Reference sites are locations in similar water bodies and habitat types at which data can be selected for comparison with test sites.)

When choosing a reference site look for the following characteristics:

- Pristine or at least minimally impaired
- Extensive, natural vegetation
- Diversity of substrate materials and channel structure
- No upstream impoundments
- Minimal non-point-source issues (agriculture, urban, logging, mining)

Chemical Monitoring

The geology, soils, and vegetation of a region influence water chemistry. Water chemistry data on the nutrients and major ions in a watershed thus provide a baseline for characterizing current conditions and assessing future changes. Major ions include cations (i.e., sodium, magnesium, calcium, and potassium), and anions (i.e., sulfate, chloride). Nutrients include various forms of nitrogen and phosphorus. In addition, pH, alkalinity, and conductivity are important measurements.

Monitoring a full range of chemical parameters can be costly but monitoring a few basic parameters can provide useful and more affordable information. Parameters for initial focus include:

- pH
- Temperature
- Dissolved Oxygen
- Conductivity
- Nitrogen

Data quality objectives, cost, and the reliability and ease of use are considerations when selecting equipment for chemical monitoring. Electronic

meters, for example, generate high quality results but can be expensive and temperamental to use. There are variety of inexpensive kits and meters on the market, which are easy to use but may not produce the same level of data assurance.

Parameter	**Data Quality**	**Approximate Cost** (U.S.A. dollars)
pH		
Meter (YSI)	High	$730
Pocket testers	Medium	$70
Liquid reagent	Medium	$25 (50 tests)
tablet	Med/low	$18 (100 tests)
Dissolved Oxygen		
Meter (YSI)	High	$700
Liquid reagent (winkler titration)	High/Med	$44 (50)
Tablet	Low	$26 (100 tests)
Conductivity		
Meter (YSI)	High	$700
Pocket testers	Medium	$67

Equipment:
Aquatic Macroinvertebrate Insect Flashcards - Code 5882-SA1
Aquatic Macroinvertebrate Life Cycle & Habitat Flashcards - Code 5946
LaMotte Company

Nets
D-frame (code 0168, LaMotte)
(code 53755, Forestry Suppliers)
Surber (code 77926, Forestry Suppliers)
(code 6JF-223562, Ben Meadows

GREEN Low Cost Water Monitoring Kit -(Code 3-5886, LaMotte)

PockeTesters & Electronic Meters
LaMotte, Forestry Suppliers, Ben Meadows

Suppliers

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Forestry Suppliers International 60

Ben Meadows International 608-743-8001 www.benmeadows.com

Macroinvertebrate Resources:

Carrera, C. & Fierro, K. 2001. Manual de monitoreo. Los Macroinvertebrados Acuáticos como Indicadores de la Calidad del Agua. EcoCiencia. Quito.

Perez, G. 1988. Guia para el estudio de los macroinvertebrados aquaticos del Departamento de Antioquia.. Universidad de Antioquia, Colombia.

Fernandez, H.R., Dominguez, E. 2001. Guia para la determinacion de los artropodos bentonicos sudamericanos. Univerdidad Nacional de Tucuman, Argentina.