Macroinvertebrate Bioasseys: How Little Creatures Provide Big Answers

A Primer on Bioasseys as a Teaching and Learning Tool

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Environmental scientists sometimes field calls requesting a test to determine whether water is "good." However, no single test can determine water quality. Testing typically consists of screening for specifically suspected problems.

When specific contaminants are suspected, based on past or present watershed uses, water samples can be submitted for laboratory testing for petroleum products, metals, organics, or inorganic constituents. If a short list of potential contaminants is not available, this process can be time-consuming and costly. Water treatment facilities test for regulated contaminants to ensure that waste water is safe to release to water bodies and that drinking water is safe to consume. Environmental studies may include groundwater testing if contamination is suspected. However, for conservation and management, a simple test to roughly characterize a water body can provide valuable information.

Bioasseys provide a broad spectrum snapshot of general water quality rather than testing for specific contaminants. The species able to survive in a particular water body indicate general levels of dissolved oxygen, turbidity, sedimentation, pH, and toxic chemicals.

Bioasseys sample for populations living in and around the water body in question. Scientists class the organisms into several tiers or taxa. For instance, juvenile mayflies (Order *Ephemeroptera*) require abundant dissolved oxygen and are very sensitive to pollution. They are typically found in good quality streams, along with riffle beetles (Family *Elmidae*), caddisflies (Order *Trichoptera*), and some species of snails (Class *Gastropoda*). Mayflies indicate good water quality in southern streams where the temperature is too warm to hold enough oxygen to support juvenile stoneflies (Order *Plecoptera*), which are typically used to indicate high quality waterbodies. Dragonfly and damselfly nymphs (Order *Odonata*, Suborders *Anisoptera* and *Zygoptera*, respectively), sowbugs (Order *Isopoda*), scuds (Order *Amphipoda*), blackfly pupae and larvae (Family *Simuliidae*), hellgrammites (Dobsonfly larvae, Family *Coridalydae*), and crayfish (Order *Decopoda*) are the main components of Taxa 2, which includes organisms able to survive in a wide range of water quality conditions. Taxa 3 consists of pollution-tolerant organisms which dominate in fair and poor waters. This group includes midge larvae and pupae (Order *Diptera*), juvenile crane flies (Family *Tipulidae*), horseflies (Family *Tabanidae*), and mosquitoes (Family *Culicidae*), rat-tail maggots (Family *Syrphidae*), pouch snails (Subclass *Pulmonata*), and aquatic worms (Phylum *Annelidae*). Some of these species obtain supplemental oxygen from the surface in order to survive in water with low dissolved oxygen.

Aquatic macroinvertebrates are typically netted. One or two people hold a kick seine across a stream, just downstream of a riffle, where dissolved oxygen is highest in a stream reach.

After securing the net to the streambed, an additional person moves through the area directly upstream of the net, disturbing the substrate and detaching macroinvertebrates from the undersides of rocks. Then the net is removed from the water and the organisms identified and classified.

Taxa that require high levels of dissolved oxygen and low levels of sediment give way to taxa that require less oxygen or obtain it from the surface and do not require gravel beds for shelter and breeding as land use in the watershed results in habitat degradation. Habitat parameters reflect water quality and thus, macroinvertebrate populations can be used to quickly assess water quality holistically.

A seine, a white pan (the contrast makes organisms easier to see), and a chart classifying macroinvertebrates into water quality indicator taxa are the only pieces of equipment necessary for a bioassay of macroinvertebrates. The results are immediate, as identification to the class level is often all that is required. This can be performed by children and adults with minimal training in most seasons, although care should be taken on extremely hot or cold days, and flood stage streams should be avoided until water returns to safe levels. Bioassays can answer questions about population ecology, habitat enhancement, or restoration success in addition to water quality. This method can indicate the quality of riparian and upland areas since species usually found in these areas often have a juvenile stage that is aquatic.

Alabama Water Watch utilizes macroinvertebrate bioassays supplemented by simple chemical tests for temperature, pH, dissolved oxygen, alkalinity, hardness, and turbidity. School and community groups ranging from kindergarteners to senior citizens volunteer for a one-day training course and report data to a central office at Auburn University. These data serve as a general gauge of water quality throughout the state.

An ideal solution is easy for the target researcher to understand and simple to deploy, and garners reliable, repeatable data. Although seasonal shifts in populations do occur, bioassays can provide long-term data about water quality, and can be used as periodic check-ups for water bodies of concern to communities, conservationists, scientists, and students. While bioasseys don't typically indicate a particular pollutant, they provide an inexpensive, repeatable check-up for a broad spectrum of parameters.

Resources:

M.T. Barbour, J. Gerritsen, B.D. Snyder, and J. B. Stribling, "Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, 2nd ed.," *U.S. Environmental Protection Agency Report* 841-B-99-002 (1999).

A. P. Covich, M.A. Palmer and T.A. Crowl, "The Role of Benthic Invertebrate Species in Freshwater Ecosystems," *Bioscience* 49, i. 2 (1999): 119.

Bill Deutsch, "Alabama Water Watch: 1992-2002. 10th Anniversary Edition," (2002): 79.

Rockie English, “Bioassessment of Streams,” Teaching Kids About the Environment, Environmental Water Quality Extension, Department of Forest Resources, Clemson University, www.teachingkate.org/streams.htm.

Rick Webb, “Sample Collection Procedures,” The Stream Study, Department of Environmental Sciences, University of Virginia, Charlottesville, VA, http://wsrv.clas.virginia.edu/~sos-iwla/Stream-Study/Methods/Procedures.HTML

“Sample Record and Assessment,” The Stream Study, Department of Environmental Sciences, University of Virginia, Charlottesville, VA, http://wsrv.clas.virginia.edu/~sos-iwla/Stream-Study/Methods/Form.HTML.