



Freshwater Benthic Macroinvertebrates

Useful Indicators of Water Quality

What are freshwater benthic macroinvertebrates?

Freshwater benthic macroinvertebrates, or more simply “benthos”, are animals without backbones that are larger than ½ millimeter (the size of a pencil dot). These animals live on rocks, logs, sediment, debris and aquatic plants during some period in their life. The benthos includes crustaceans such as crayfish, mollusks such as clams and snails, aquatic worms and the immature forms of aquatic insects such as stonefly and mayfly nymphs.



Where and when are freshwater benthic macroinvertebrates found?

These animals are widespread in their distribution and can live on all bottom types, even on manmade objects. They can be found in hot springs, small ponds and large lakes. Some are even found in the soil beneath puddles. Many species of benthos are able to move around and expand their distribution by drifting with currents to a new location during the aquatic phase of their life or by flying to a new stream during their terrestrial phase. Most benthic species can be found throughout the year, but the largest numbers occur in the spring just before the reproductive period. In colder months, many species burrow deep within the mud or remain inactive on rock surfaces. Many aquatic insects undergo a complete metamorphosis - the transition from egg to larva to pupa and finally to adult. They remain in the water for most of their lives (typically one month to four years). After becoming adults, the majority of insects live for only a brief time, usually a few hours to a few days, while they locate mates and reproduce.

What is the ecological importance of benthic macroinvertebrates?

Benthos is an important part of the food chain, especially for fish. Many invertebrates feed on algae and bacteria, which are on the lower end of the food chain. Some shred and eat leaves and other organic matter that enters the water. Because of their abundance and position as “middlemen” in the aquatic food chain, benthos plays a critical role in the natural flow of energy and nutrients. As benthic invertebrates die, they decay, leaving behind nutrients that are reused by aquatic plants and other animals in the food chain.



What are the advantages of using benthic macroinvertebrates to monitor water quality?

Unlike fish, benthos cannot move around much so they are less able to escape the effects of sediment and other pollutants that diminish water quality. Therefore, benthos can give us reliable information on stream and lake water quality. Their long life cycles allow studies conducted by aquatic ecologists to determine any decline in environmental quality.

Benthos represents an extremely diverse group of aquatic animals, and the large number of species possess a wide range of responses to stressors such as organic pollutants, sediments, and toxicants.

Many benthic macroinvertebrates are long-lived, allowing detection of past pollution events such as pesticide spills and illegal dumping.



How are benthic macroinvertebrates sampled and analyzed?

Sampling is based on the type of aquatic habitat under study. In turbulent riffles (shallow areas with fast flows), the most commonly sampled stream habitat, various nets are used to capture benthos. The nets are secured and the water is stirred up causing the benthos to float down stream into the net. In slow moving or still water, a dip net is often used to sample shore areas under bank overhangs or tree roots. In ponds or lakes with soft mud bottoms, grab samplers may be used to collect benthos.

Benthic communities can be used to monitor stream quality conditions over a broad area or they can be used to determine the effects of point source discharges from sources such as sewage treatment plants and factories. Ecologists who evaluate environmental quality using the benthos often consider the following characteristics of a benthic sample to be important indicators of stream, river or lake quality:

taxa richness: a measure of the number of different types of animals; greater taxa richness generally indicates better water quality.

pollution tolerance: many types of benthos are sensitive to pollutants such as metals and organic wastes. Mayflies, stoneflies, and caddisflies are generally intolerant of pollution. If a large number of these insect types are collected in a sample, the water quality in the stream is likely to be good. If only pollution-tolerant organisms such as non-biting midges and worms are found, the water is likely to be polluted.

functional groups: the presence or absences of certain feeding groups (such as scrapers and filterers) may indicate a disturbance in the food supply of the benthic animals in the stream and the possible effects of toxic chemicals.

How is the Maryland Department of Natural Resources (DNR) using benthic macroinvertebrates to monitor the quality of the State's waters?

When water quality, habitat condition, land use and fish are evaluated along with benthos, the result is a comprehensive picture of environmental quality. This information helps resource managers at DNR to determine which rivers and streams in Maryland have good habitat quality and should be protected. The benthos can also help identify those rivers and stream showing signs of stress. Resource managers can then apply management actions that will improve environmental quality, such as storm water control in urban areas and best management practices on farmlands to control nutrient runoff.

Each year, ecologists in DNR's Resource Assessment Service monitor freshwater benthos at more than 250 randomly-selected small to medium-sized streams as part of the nationally-recognized Maryland Biological Stream Survey (MBSS). On larger rivers, 116 sites have been sampled annually or biennially since 1974.

How can you help?

Participate in Maryland's Stream Waders Program. Stream Waders is a Statewide volunteer stream monitoring program run by Maryland Department of Natural Resources. To learn more about Stream Waders, check our web site:

http://www.dnr.maryland.gov/streams/mbss/mbss_volun.html

or contact us at:
streamwaders@dnr.state.md.us
or (410) 260-8623.

Toll free in Maryland: 1-(877)-260-8DNR x8611
TTY users call via the Maryland Relay

How can I learn more?

Here are some good references for more information on freshwater macroinvertebrates:

Family-Level Key to Stream Invertebrates of Maryland and Surrounding Areas. 1999. Maryland Department of Natural Resources CBWP-MANTA-EA-99-2 (revised)

http://www.dnr.state.md.us/streams/pubs/ea99_2rev2003.pdf (1.5 MB)

A Guide to Common Freshwater Invertebrates of North America. 2002. J. Reese Voshell, Jr. McDonald and Woodward Publishing Company, Blacksburg, VA

An Introduction to the Aquatic Insects of North America, 3rd edition. Edited by R.W. Merritt and K.W. Cummins. 1996. Kendall-Hunt Publishing Company, New York.

Information on ways that you can protect Maryland's waters can be found in "Fragile: Handle with Care":

<http://www.dnr.maryland.gov/bay/protect/>

Learn more about the watershed in which you live by checking our SurfYour Watershed site:

<http://www.dnr.maryland.gov/watersheds/surf/>

Join a volunteer water quality monitoring organization in your community. For information and resources on volunteer monitoring as well as internet links to volunteer monitoring organizations around the State, check our volunteer monitoring web page:

http://www.dnr.maryland.gov/streams/volunteer/vol_index.html .



You'll learn more about these incredible creatures, gain a better understanding of aquatic ecology and environmental stewardship, and have fun getting your feet wet!

For more information on what DNR is doing, call the Monitoring and Non-tidal Assessment Division at (410) 260-8611 or write to the Maryland Department of Natural Resources, Monitoring and Non-tidal Assessment Division, 580 Taylor Avenue, C-2, Annapolis, MD 21401. Your actions can make a real difference.



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