# Benthos, Meiofauna & Stream Index

**Background:**

Benthic macroinvertebrates are organisms without backbones that inhabit the bottom substrates of their habitats for at least part of their life cycle. Macroinvertebrates are visible to the naked eye and are retained by mesh sizes greater than or equal to 200 to 500 micrometers. Benthic macroinvertebrates include insect larvae, annelids (leeches), oligochaetes (worms), crustaceans (crayfish and shrimp), mollusks (clams and mussels), and gastropods (snails). Insect larvae tend to be the most abundant benthic macroinvertebrates in freshwater aquatic ecosystems. As benthic macroinvertebrates tend to remain in their original habitat, they are affected by local changes in water quality. Some are capable of tolerating higher loads of pollution than others. Thus if the pollution is severe, or is moderate but sustained over time, the whole community structure may simplify in favor of tolerant species. Although the abundance of certain species may increase, the species richness (the number of different species in a given area) decreases. By assessing indicator species, diversity, and functional groups of the benthic macroinvertebrate community, it is possible to determine water quality.

There are four feeding groups of macroinvertebrates: shredders, filter-collectors, grazers, and predators. Shredders such as stoneflies feed on plant material and some animal material, which is generally dead, and break it into smaller particles through their feeding and digestive process. Collectors, such as caddisflies and blackflies, feed on this fine particle material which they filter from the water. Grazers, such as snails and beetles, feed on algae and other plant material living on rocks and on plant surfaces. Predators such as dobsonflies or dragonflies feed on other macroinvertebrates. Individual species may be generalists, and fit into more than one of these groups (as opposed to specialists).

CLEAN water generally has diverse and rich macroinvertebrate fauna, although certain pristine environments have low diversity of macroinvertebrate fauna because of the cold temperature and/or relatively low nutrient levels. Headwaters and headwater streams may have only two dominant species. Although all classes of invertebrates may be found in headwater streams, crustaceans, caddisflies, leeches, mollusks, flatworms and blackflies tend to be found in such environments. The majority of macroinvertebrates are found in the riffles of streams. Riffles range from uneven bedrock to cobbles to boulders, though the optimum riffle area is caused by gravel to cobbles. The flow of water over these areas provides plentiful oxygen and food particles. Riffle-dwelling communities are made up of macroinvertebrates that generally require high dissolved oxygen levels and clean water, and most are intolerant of pollution.

a. Stonefly larvae (Plecoptera) require high dissolved oxygen concentrations and tend to be found in cold, flowing water with a gravel or stone bottom. Some species may be found along lake shores with wave action. Stonefly nymph groups may be shredders or predators. They may be specialists or generalists.
b. Dobsonfly larvae (Megaloptera) are generally found in the mud of lakes and wetlands but they can be found in any water type. With the exception of the wetland species, dobsonflies are generally found in well-oxygenated lakes and streams. Dobsonflies are predators, feeding on other aquatic insects, annelid worms, crustaceans, and mollusks.
c. Caddisfly larvae (Trichoptera) are generally found in clear flowing water and are sensitive to pollution and oxygen depletion. Caddisflies are found across a range of habitats from cool streams to warm streams, lakes, marshes, and ponds. Caddisflies found in standing water can tolerate some pollution.

MODERATELY POLLUTED water has a slightly different population of benthos. Slow flow areas are made up of decomposer communities that tolerate lower dissolved oxygen levels, higher organic matter and sedimentation. Riffle-dwelling communities are more sensitive to increasing pollution than communities in pools or slow flowing areas in the same stream.

a. Dragonfly nymphs and damselfly nymphs (Odonata) Odonata nymphs prefer slow-moving or standing (lentic) water. They are able to withstand low oxygen levels and are thus more tolerant of organic matter enrichment. Odonata are predators.
b. Crayfish (Decapoda-Astacidea) are relatively pollution tolerant and can be found in standing and flowing waters. They may be found in a variety of environments, from streams and lakes to wetlands, including wet meadows which have no open water. Crayfish may have ecological requirements particular to their habitat. Stream species tend to be less tolerant of changes in temperature, pH, and dissolved oxygen than lake and pond species.
c. Mussels and Clams (Bivalvia) Most bivalves cannot tolerate high turbidity. As filter-feeders, sediments and organic matter prevent them from feeding. Although clams are generally tolerant of siltation, sand clams are extremely sensitive to severe siltation.

FAIRLY POLLUTED waters are often characterized by higher turbidities. Turbidity reduces light penetration and submersed aquatic plant productivity. Thus turbidity will affect those macroinvertebrates depending on plant matter for food and predator macroinvertebrates that rely heavily on visual location of prey. Filter feeders' filtering mechanisms may be blocked by sediment. As sedimentation increases, rock dwelling or attaching macroinvertebrates such as mayflies, stoneflies, and caddisflies, will be replaced by silt-tolerant oligochaetes, chironomids, and lunged snails.

a. Midge larvae (Diptera-Chironomidae) are found in all water types, including salt water. They live in the silt bottom, on solid substrates, or on aquatic plants.

b. Snails (Gastropoda) Snails with gills are sensitive to oxygen depletion. However, those with lungs (pulmonate snails) can tolerate water with little or no oxygen.
c. Leeches (Hirudimea) Leeches are generally pollution tolerant, however, some species of leeches are much less pollution tolerant than others. Leeches are found in warm water of shallow standing water. They generally cannot tolerate very acidic waters. They are also limited by low calcium content. Siltation does prevent leeches from attaching to stones or other objects. Leeches feed on dead organic matter, snails, insects, oligochaetes, and other small invertebrates.

EXTREMELY POLLUTED waters, receiving high inputs of organic matter or nutrient enrichment from nonpoint and point sources, tend to have a low diversity of macroinvertebrates. Only those species capable of surviving and thriving under low dissolved oxygen or highly turbid conditions inhabit polluted waters.

a. Aquatic Worms (Oligochaeta) and Tubifex Worms (tubificids) are found in soft sediments rich in organic matter. Some aquatic worm species actively seek habitats with organic pollution and low dissolved oxygen levels. Aquatic worms feed on detritus, algae, and diatoms in the substrate.
b. Leeches (Hirudimea) [see above].
c. Snails (Gastropoda) [see above]. *(source: NCSU)*

**Prelab Questions:**

1. What are benthic macroinvertebrates?
2. Why are benthic macroinvertebrates particularly susceptible to changes in water quality?
3. Identify the four types of feeding strategies among benthic macroinvertebrates.
4. Why are riffle areas important for many species of benthic macroinvertebrates?
5. Identify a common trait among the benthos found in clean water environments.
6. How do benthos found in moderately polluted waters differ from those in clean water environments?
7. What is turbidity? How does turbidity change in aquatic environments?
8. What effect does turbidity have on benthic macroinvertebrates?
9. What are the characteristics of an extremely polluted water environment?
10. These examples of benthos are all from freshwater systems. How would the characteristics of freshwater benthos differ from those of estuarine (brackish) benthos? How would they differ from marine benthos?
11. Give two examples of benthos in an estuarine environment.
12. Give two examples of motile (able to move) marine benthos that make an appearance in *Finding Nemo*.
13. Give two examples of sessile (fixed in place) marine benthos that make an appearance in *Finding Nemo*.

**Activity:**

Identify the organisms in each sample set using the dichotomous key provided. Then calculate the stream index for each. (Remember to only count a species once when calculating stream index – duplicates should not be included). A stream index of 0-10 has a quality rating of "poor". A stream index of 11-16 has a quality rating of "fair". A stream index of 17-22 has a quality rating of "good". A stream index above 23 has a quality rating of "excellent".

**Data:**

**Benthic Macroinvertebrate Sample One**

| Intolerant = 3 pts | Moderate = 2 pts | Tolerant = 1 pt |
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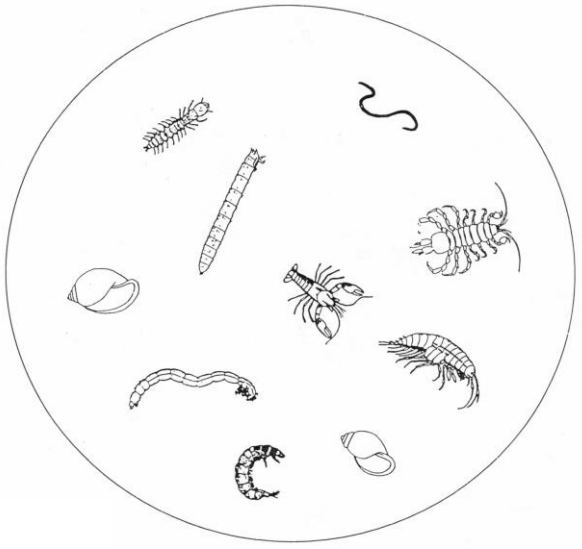

Stream Index = _____

Quality Rating = _____

**Benthic Macroinvertebrates Sample Two**

| Intolerant = 3 pts | Moderate = 2 pts | Tolerant = 1 pt |
|---|---|---|
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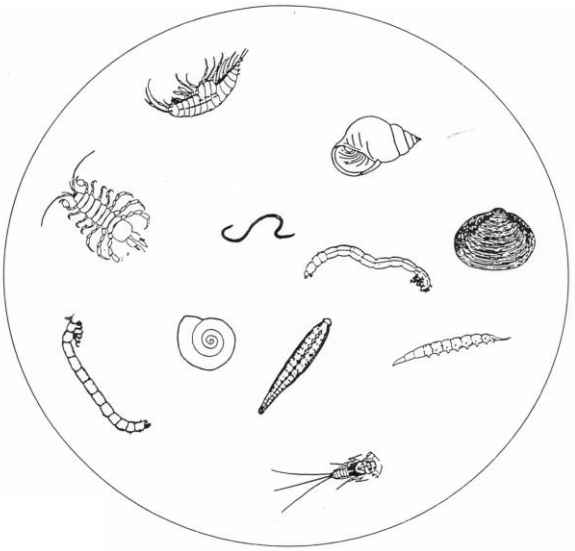

Stream Index = _____

Quality Rating = _____

**Benthic Macroinvertebrates Sample Three**

| Intolerant = 3 pts | Moderate = 2 pts | Tolerant = 1 pt |
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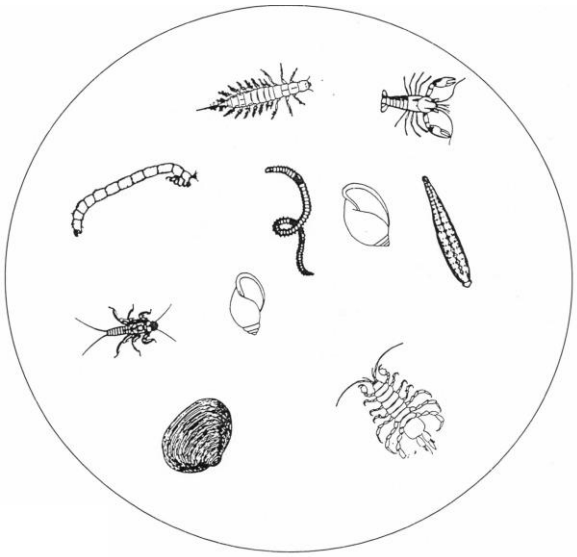

Stream Index = _____

Quality Rating = _____

**Benthic Macroinvertebrates Sample Four**

| Intolerant = 3 pts | Moderate = 2 pts | Tolerant = 1 pt |
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Stream Index = _____

Quality Rating = _____

**Analysis:**

14. Which sample of benthos had the highest stream index? The lowest?
15. What assumptions can you make about those two environments based on stream index?
16. Why do you think stream index is used exclusively for freshwater environments?
17. How does the health of freshwater rivers and streams affect ocean environments?