Water Quality 102: Aquatic Macroinvertebrates Indicators of Watershed Health

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As a water quality specialist I often think of water quality measured as a standard of physical parameters such as we have previously discussed in these articles. The temperature of the water, the solubility of water (pH), or the measurable amount of dissolved oxygen the water may hold; however if I am able to step back from this mechanistic concentration of view, I can assess water quality on a purely biological level as well: by observing and quantifying aquatic invertebrate communities.

Aquatic macroinvertebrates are organisms that live in water for all or part of their lives, are large enough to be seen without the aid of a microscope (macro = large), and do not have backbones (invertebrates). Benthic macroinvertebrates live in the benthos, or stream bottom, and include insect larvae, adult insects, aquatic worms, crustaceans, and mollusks. Macro invertebrates form an essential link in the aquatic food web, providing food for fish and consuming algae, aquatic vegetation, and organic litter carried downstream. According to the Environmental Protection Agency (EPA) “These organisms are sensitive to disturbances in stream chemistry and physical habitat, both in the stream channel and along the riparian zone, and any alterations to the physical habitat or water chemistry of the stream can have direct and indirect impacts on the invertebrate community structure. It is because of the invertebrate communities’ relatively long lives (approximately 1 year) and its limited migration that make benthic macros particularly susceptible to site specific stressors like pollution.”

As water quality managers, the Tribe’s Biological and Environmental Services staff can measure benthic macroinvertebrates in streams to determine water quality; they can also perform the same “biomonitoring” in wetlands to assess aquatic health. If the water quality is generally poor, or if a pollution event occurred within the past several months, it may be reflected through a decline in the macroinvertebrate population. This simple, yet reliable technique is based on the fact that different groups of stream macroinvertebrates have different tolerances to pollution, and therefore can serve as useful indicators of water quality. They may live from several weeks to many years in the same area of a stream and directly depend on adequate habitat and water quality for survival. As a result, macroinvertebrates can indicate pollution from cumulative or multiple sources.

For monitoring streams, tribal staff can identify three categories of macroinvertebrates based on their sensitivity to pollution: sensitive, less sensitive, and tolerant. By simply collecting samples of macroinvertebrates within the streams, staff can identify the organisms, and rate the water quality. A stream with excellent water quality should support organisms from all three tolerance groups.

As an arm-chair naturalist you can perform such a rapid assessment of your own favorite or local stream as well. Poke around in any portion of a stream to see what’s

swimming around, look particularly on and under rocks in shallow riffles. You may see small black and brown creatures clinging to the rock; the nymphs (larva) may have three graceful tail filaments and gills along its abdomen characteristic of mayflies, or perhaps the creature looks like a curious half inch twig made of tiny stones characteristic of caddisfly larvae. Caddisflies use silk (like butterflies) to build cases from gravel, twigs, needles, or sand; different species build distinct cases. Or perhaps you'll see the small black shells of the juga snails, tiny mollusks grazing on the film of algae that covers the rocks.

Mayflies, caddisflies, and mollusks are considered to be clean water benthos, they are the most intolerant to changes in the water's physical and chemical habitat. According to sea.netcom: "high biodiversity (or taxa richness) within a stream indicates a site with low human influence. The total number of different types of organisms (taxa richness) declines as degradation increases. About half to two-thirds the number of taxa found at an excellent site are found in a moderately influenced site. At a poor stream site the total number of taxa will be low, there may be large numbers of individuals present, but that does not necessarily indicate a good site, especially if they are the same species."

Physical testing can be a very important component of understanding the quality or health of a stream, but this technique often supplies limited information, such as solubility or dissolved oxygen concentrations of the water. Regular macroinvertebrate monitoring, can indicate problems that may not easily be detected by physical testing and can reveal pollution problems that may no longer be evident in current water samples (for example a chemical spill that washes downstream). By combining the physical, chemical, and biological testing of a stream, managers recognize the intricate relations that all three components share to tie in the functionality and health of a stream. If physical and chemical measurements are the bare bones of an optimal water quality monitoring program, than the aquatic biomonitoring of the benthic macroinvertebrates would be the flesh and meat of an all inclusive program.