Biological Data to Set Water Quality Standards (Newsletter)*

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The previous newsletter (#43) explained the severe limitations of diversity and biotic integrity indices for interpreting biotic macroinvertebrate data and recommended statistical approaches be used instead. This newsletter focuses on the use of aquatic macroinvertebrate data to set water quality standards with particular attention to that most difficult designated beneficial use, aquatic life (sometimes called fishable/swimmable).

Historically, aquatic macroinvertebrate data have been analyzed using diversity and integrity indices and contrived metrics such as the percentage of organisms in the orders Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies) commonly referred to as the EPT ratio. These metrics are based on macroinvertebrate structure–taxonomic identification–which is not the appropriate aspect of the data. An analogy to mining vehicles should illustrate why structure does not provide a basis for answers needed by regulators and the regulated community.

A list of vehicles at a mine might include drill rigs, dump trucks, shovels, front-end loaders, water trucks, graders, and bulldozers. These are functional categories, not structural ones. It does not matter if the vehicles are manufactured by Caterpillar, Volvo, Liebheer, Komatsu, or other companies.

Terrestrial ecology uses functional descriptions of plants and animals based on economics. Organisms are classified as producers or consumers and biotic assemblages are described by food webs and chains. These functional descriptions reflect how energy is processed and minerals cycled by biological organisms. Aquatic ecology also routinely applies functional descriptions to fish communities, yet very rarely to the benthic macroinvertebrate communities. This is particularly the case in the regulatory context of setting water quality standards and measuring attainment of designated beneficial uses.

Benthic macroinvertebrates can be assigned to four broad functional feeding groups: shredders, scrapers, collectors, and predators. Scrapers are also called grazers and collectors are commonly separated into filterers and gatherers. Sometimes omnivores and parasites are listed as separate groups.

Just as mine vehicles, mammals, birds, and fish can be usefully assigned to groups by their function regardless of brand or taxonomic level, so can wa-

ter quality standards and designated beneficial uses be assessed using benthic macroinvertebrate data classified by functional feeding groups.

The groups reflect the types of organic foods available where the animals are collected. Shredders feed on leaves from riparian trees, shrubs, and grasses falling into the water. The shredder's role is to chew on these large particles and produce smaller ones that can be used by other animals. Collectors feed by filtering organic particles of specific size ranges from the water flowing past them or by gathering loose organic particles off the stream bed, rocks, or large woody debris. Scrapers (grazers) feed primarily on algae, fungi, and mosses that grow attached to solid substates in areas where the stream channel is open to abundant sunlight. Predators feed on other animals. All insect orders have families, genera, and species in each of the shredder, collector, and scraper functional feeding groups; beetles (order Coleoptera) and most true flies (order Diptera) are predominately predators.

Relative percentages of each functional feeding group in a stream or specific reach reflect stream channel substrate, water flow, organic food resources, and water chemistry. Variability in percentages over time or relative to anthropogenic activities reflect biotic assemblage stability (aquatic life designated use is fully attained) or indicate the need to look at additional environmental data to understand the dynamics of the biota. Other statistical techniques such as cluster analysis, non-metric multidimensional scaling, and mixed effects models can also be productive in answering questions of businesses and regulators about water quality and human activities.