Aquatic Life Water Quality Standard (Newsletter)*

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The EPA, and many state regulators, consider aquatic life to be the highest designated beneficial use of water. Closely related to this water quality standard is "fishable and swimable". The latter is easier to define and to assess attainment: if fish are present all water quality variables suit their needs; when there are no human parasites or known toxic chemicals water quality is swimable. The aquatic life water quality standard is not as easy to define and measure.

Chemical standards are appropriate for human potable water sources, but not for determining if the waters attain the goals of aquatic life by fully support aquatic biota (benthic macroinvertebrates and fish). Water chemistry is highly variable on time scales from daily to annually, constituent concentration measurements are isolated in time and space, and values at single points are difficult to interpret as suitable for fish and wildlife.

Biological-based standards of water quality are more robust and appropriate because the presence of aquatic organisms reflect water quality conditions integrated over time and space. Biological measures have been of interest to ecologists and regulators for several decades. Attempts to capture the inherent natural complexity of aquatic ecosystems have been based on diversity indices, indices of biotic integrity, EPT ratios (the proportion of insects of the orders Ephemeroptera [mayflies], Plecoptera [stoneflies], and Trichoptera [caddisflies], a very coarse taxonomic level), and similar measures. While these efforts have won broad adoption because they are simple and well known, they do not capture sufficient ecological, temporal, and spatial variability. These indices are difficult to interpret and to compare among locations, times, and collecting techniques.

The dynamics of natural ecosystems are based on energy processing and nutrient cycling. In aquatic ecosystems, benthic macroinvertebrates reflect the status of energy sources and processing and the cycling of nutrients by their presence, numbers, and feeding behaviors.

Aquatic macroinvertebrates cannot easily be identified to species (or even genus) in all cases. This means that when so-called 'species' indices are calculated they are really a mix of taxonomic levels. The results are ambiguous because the relative numbers of each taxon will vary from one collection to the next. Taxonomic identification to family level is sufficient to assign these macroinvertebrates to their functional feeding groups (FFG) of filtering collector, gathering collector, scraper/grazer, shredder, and predator.

Functional feeding groups reflect energy processing of organic food materials regardless of the taxonomic identity of the individual. In headwater reaches most organic materials enter the stream ecosystem as leaves and stems from riparian or overhanging vegetation and shredder organisms are common. Shredders reduce large organic matter to smaller particles which are either entrained within the water column and captured by filtering gatherers or settle on the substrate to be fed upon by gathering collectors. In lower reaches of the river network the channel is open to sunlight and water velocity is comparatively slow. Algae and mosses grow on the substrate and are these foods are consumed primarily by scrapers/grazers. Throughout the system predators feed upon other animals. Using FFGs to classify aquatic biotic communities facilitates understanding of the dynamics and status of water quality without depending upon taxonomic identification to the levels of genus or species. Animals can be of different taxa at different locations but still process energy and cycle nutrients by having a common feeding strategy.

Statistical models calculate similarity (distance) coefficients among biotic communities and determine which environmental variables produce the observed proportions of individuals and taxa in each community. Statistical analytical results justify setting aquatic life (and other) water quality standards based on designated beneficial uses, identify when they change, and determine whether those changes are natural or anthropogenic.
