Determining Clean Water (Newsletter)*

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The objective of the 1972 Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of waters in the US. Water quality standards define *clean*; therefore, how standards are set is important for policy and regulatory decisions.

Standards based on maximum concentration limits (MCL) of toxic chemicals apply to potable waters but not to aquatic life, wildlife, livestock, human recreation, irrigation, or industrial uses. MCLs provide no knowledge of the physical or biological integrity of the water body. Each use requires appropriate standards. Biological standards are more suitable for these uses because the pattern of aquatic community function reflects water quality integrated over time and space. Biotic communities reflect the physical, chemical, and biotic integrity of water bodies.

Biological water quality measures have been of interest for 40 years. In the 1970s the EPA proposed a Rapid Bioassessment Protocol while other federal agencies offered different approaches (e.g., the Fish & Wildlife Services' Habitat Suitability Index). Academics proposed diversity and biotic integrity indices and other combinations of benthic macroinvertebrate community structure. These approaches are difficult to interpret and compare temporally and spatially and they do not quantify physical, chemical, and biological integrity.

Natural ecosystems are economies: plants are producers of energy and nutrients; animals are consumers of both. Measurements of energy and nutrients are not useful for informing decisions. Aquatic macroinvertebrate community function (the feeding strategies converting energy and cycling nutrients) provide the basis for technically sound and legally defensible statistical results that produce knowledge of physical, chemical, and biological integrity of the waters. When fish are present their functional composition can also be used, but fish are not found in every stream reach or standing water body while macroinvertebrates are.

To effectively use benthic macroinvertebrates for setting water quality standards, determinations of clean water, and whether a permitted activity adversely affects the water body data collection and analytic protocols need to be consistent and long term. Sampling locations and periods should be set in advance and not changed. Abundant data reduce uncertainty of the results and increase confidence in the decisions made. Measuring physical, chemical, and biological data at each collection event allows cause and effect to be determined; that is, what environmental variables cause the observed relative composition of each feeding strategy in the macroinvertebrate community.

The statistical models of compositional data analysis are applied to the biotic community. This mathematical approach is technically sound and legally defensible. The analytic process is consistent while the results are site- and project-specific. This robust approach can be applied to compliance with the CWA, ESA, NEPA, CERCLA, RCRA, and other environmental regulations.

With current concerns about climate change, sustainability, and the impacts of long-term drought in the western US it is necessary to quantitatively measure the amount of spatial and temporal variability in aquatic ecosystems to determine their physical, chemical, and biological integrity. Chemical water quality standards using maximum concentration limits do not yield this knowledge nor assess whether undesired changes occur because of anthropogenic activities within the drainage basin. Benthic macroinvertebrate community function does provide this insight. There is every reason to change how clean water is determined.

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