

DEVELOPMENT OF NUTRIENT CRITERIA FOR INDIANA'S SURFACE WATERS
Shivi Selvaratnam, IDEM

The national goals of the Clean Water Act are to achieve, wherever attainable, water quality that provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water. As part of state and tribal water quality standards, the Clean Water Act requires states and authorized tribes to specify designated uses for their waters in consideration of these goals, and to adopt water quality criteria that protect those designated uses. Most waters in Indiana are designated for uses such as warm-water aquatic life, full body contact recreation, and drinking water supply.

According to the 1998 National Water Quality Inventory, about 40% of U.S. streams, lakes, and estuaries that were assessed were not clean enough to support uses such as fishing and swimming (1). Nutrients were the third most common cause of impairments in streams and rivers, and the most common cause of lakes'/reservoirs' impairments. The introduction of excess nutrients from human activity contributes to a degradation of water quality and has resulted in many waters not meeting designated uses. Excess nutrients can have negative ecological effects and can pose risks to human health. For example, algae usually are the first to respond to increased levels of N and P in water bodies, and their populations increase quickly, sometimes causing algal "blooms." When algal blooms eventually die off, there is consumption of dissolved oxygen (DO) from the water column. Low DO concentrations adversely impact other aquatic organisms and can result in decreased biological diversity and populations, including smaller populations of game and commercial fish.

To address the issues of nutrient enrichment problems, in 2000, EPA developed several nutrient technical guidance documents. Ecoregional nutrient criteria, based on the geographical framework called the ecoregion approach, were developed to account for the natural variation existing within various parts of the country. For each Nutrient Ecoregion, EPA developed a set of recommendations for two causal variables (total nitrogen and total phosphorus) and two early indicator response variables (chlorophyll *a* and some measure of turbidity). Though other indicators such as dissolved oxygen and changes in the biological community were also deemed useful, the first four were considered to be the best suited for protecting designated uses.

For developing nutrient criteria, States and authorized Tribes have several options available to them. EPA recommends the following approaches:

- (1) Develop nutrient criteria that reflect localized conditions and protect specific designated uses using the process described in EPA's Technical Guidance Manuals for nutrient criteria development. Such criteria may be expressed either as numeric criteria or as procedures to translate a State or Tribal narrative criterion into a quantified endpoint in State or Tribal water quality standards.
- (2) Adopt EPA's section 304(a) water quality criteria for nutrients, either as numeric criteria or as procedures to translate a State or Tribal narrative nutrient criterion into a quantified endpoint.
- (3) Develop nutrient criteria protective of designated uses using other scientifically

defensible methods and appropriate water quality data.

One approach that is useful in developing criteria is the frequency distribution approach, in which a percentile is selected (EPA generally recommends the 75th percentile) from the distribution of primary variables of known reference systems (that is, the highest quality or least impacted streams for that stream class within a region). Another form of the frequency distribution approach involves selecting a percentile of (1) all streams in the class (reference and non-reference), or (2) a random sample distribution of all streams within a particular class. Due to the random selection process, EPA suggests the selection of an upper percentile because the sample distribution is expected to contain some degraded systems. This option is most useful in regions where the number of legitimate “natural” reference water bodies is usually very small, such as highly developed land use areas (e.g., the agricultural lands of the Midwest and the urbanized east or west coasts). The EPA recommendation in this case is usually the 5th to 25th percentile depending on the number of “natural” reference streams available. If almost all reference streams are impaired to some extent, then the 5th percentile is recommended (2).

A second approach, commonly used for developing criteria for toxics, is the dose-response approach, which identifies specific cause and effect relationships between nutrient concentrations and adverse impacts.

IDEM is utilizing EPA’s technical guidance to refine and develop criteria for Indiana. The actual approaches used will most likely depend on the result of the analysis of available data and future data collections. In order of preference, these approaches are:

- Cause-Effect-Based — nutrient concentrations will be correlated with measurable water quality or biological effects or impairments utilizing available data and data to be collected, findings in published literature, and historical information.
- Reference-Based — a percentile of the frequency distribution of all sites for different water body types based on Indiana-specific data and ecoregions will be utilized to derive numerical criteria.

IDEM and the U.S. Geological Survey (USGS) are working collaboratively to develop nutrient criteria for rivers and streams. Preliminary analysis, using the cause-effect-based approach, suggested no significant correlation between nutrients and chlorophyll *a* concentrations. Therefore, utilizing biological data and different statistical tools, IDEM and USGS are in the process of determining if nutrient enrichment is correlated to adverse impacts on the biological community

For lakes and reservoirs, candidate endpoints for nutrient criteria have been developed by Limno-Tech, Inc., and Tetra-Tech, Inc., utilizing multiple lines of analyses including stressor-response and frequency distribution approaches. The statistical approaches undertaken and the recommended criteria are currently under review by Indiana’s Nutrient Technical Advisory Group.

References

- (1) Water Quality Conditions in the United States A Profile from the 1998 National Water Quality Inventory Report to Congress (EPA841-F-00-006 Environmental Protection Washington, DC 20460, June 2000)
- (2) Ambient Water Quality Criteria Recommendations (EPA 822-B-00-017, December 2000)