SAB Ecological Processes and Effects Committee 12/3/09 Draft
Review of Empirical Approaches for Nutrient Criteria Derivation

KEY FINDINGS

General Observation on Current Use of Guidance

- The Committee finds that improvements in the Guidance are needed prior to implementation to enable development of technically defensible criteria and to make the document more useful to state and tribal water quality scientists and resource managers. (at 2)
- Large uncertainties in the stressor-response relationship and the fact that causation is neither directly addressed nor documented indicate that the stressor-response approach using empirical data cannot be used in isolation to develop technically defensible water quality criteria that will "protect against environmental degradation by nutrients." (at 37; see also 22)
- A clear framework for statistical model selection is needed. This framework should include: 1) an assessment of whether analysis indicate that the stressor-response approach is appropriate; 2) selection criteria to establish models of cause/effect and direct/indirect relationships between stressors and responses; 3) consideration of model relevance to known mechanisms and existing conditions; 4) establish of biological relevance; and 5) ability to predict probability of meeting designated use categories. (at 30; exec sum at xiv)

A. Cause and Effect Demonstration Necessary

- [T]he final document should clearly state that statistical associations may not be biologically relevant and do not prove cause and effect. (at 2) Without a mechanistic understanding and a clear causative link between nutrient levels and impairment, there is no assurance that managing for particular nutrient levels will lead to the desired outcome. (at 4); The Guidance needs to clearly indicate that the empirical stressor-response approach does not result in cause-effect relationships; it only indicates correlations that need to be explored further. (at 39)

B. Biological Significance/Use Impairment Threshold Relationship

- The use of non-parametric change point analysis and discontinuous regression analysis must be associated with biological significance and the designated uses to be protected by numeric nutrient criteria. … However, although these methods may be able to identify and characterize breakpoints, such breakpoints may not necessarily have any biological significance, nor will they necessarily be related to designated uses that are to be protected by numeric nutrient criteria. Use of these methods must be associated with designated uses. (at 22)
- The Committee emphasizes the importance of choosing the biological endpoints (i.e., response variables) that respond specifically to nutrients. We note that responses of benthic indices can be related to many types of stress. We question why periphyton would not be a better receptor to measure. (at 15)

C. Consideration of Factors Influencing Nutrient Dynamics/Impairment Metric

- The examples provided in the Guidance generally do not demonstrate a strong nutrient stressor linkage to beneficial use impairment. The stream examples show very weak correlations that have high levels of uncertainty, and lump data from distinctly different ecosystems where multiple factors in addition to nutrients will contribute to biotic responses. (at 14,15)
- In order to be scientifically defensible, empirical methods must take into consideration the influence of other variables. …The statistical methods in the Guidance require careful consideration of confounding

variables before being used as predictive tools. … Without such information, nutrient criteria developed using bivariate methods may be highly inaccurate. (at 22)

- For criteria that meet EPA's stated goal of "protecting against environmental degradation by nutrients," the underlying causal models must be correct. Habitat condition is a crucial consideration in this regard (e.g., light [for example, canopy cover], hydrology, grazer abundance, velocity, sediment type) that is not adequately addressed in the Guidance. Thus, a major uncertainty inherent in the Guidance is accounting for factors that influence biological responses to nutrient inputs. Addressing this uncertainty requires adequately accounting for these factors in different types of water bodies. (at 36,37) Numeric nutrient criteria developed and implemented without consideration of site specific conditions can lead to management actions that may have negative social and economic and unintended environmental consequences without additional environmental protection. (at 37)

D. Stream Considerations

- Single variable stressor-response relationships (e.g., those derived using the simple linear regression approach discussed in the Guidance) that explain a substantial amount of variation are likely to be uncommon for most aquatic ecosystems (in particular, streams). (at 10); As previously discussed, relationships for streams may be more complex than for lakes and must account for multiple stressors/conditions and/or stream 'types' or conditions, and then be applied appropriately. (at 23)

F. Loading Versus Concentration Approach

- A basic conceptual problem concerning selection of nutrient concentrations as stressor variables (as illustrated in the Guidance) is that nutrient concentrations directly control only point-in-time, point-in-space kinetics, not peak or standing stock plant biomass. Plant biomass is driven by nutrient supply rates (i.e., nutrient mass loads). Ambient nutrient concentrations are not necessarily good surrogates for nutrient mass loads. Relationships between nutrient mass loads and ambient nutrient concentrations are highly system-specific and depend on many factors including inflows, hydrology, bathymetry, sediment-water exchanges and chemical-biological processes. Consequently, there may be many systems for which nutrient concentrations will not be appropriate stressor variables. For such systems it may be more appropriate, and scientifically defensible, to use site-specific mechanistic models incorporating loading to determine the nutrient controls required to attain designated uses. (at 11)

G. Data Requirements

- The document should better address data requirements, including data acquisition and data quality. Without providing guidelines on data requirements, the potential for applying techniques to inappropriate or inadequate datasets is great. (at 8)

H. Weight of Evidence Approach

- The Guidance should contain a quantitatively based "weight-of-evidence" (WoE) framework using multiple methods and then combining them into figures and tables for visualization. Multiple statistical methods on one dataset do not equate to a reasonable WoE that significantly reduces uncertainty. Rather, the WoE should involve different assessment methods (e.g., different datasets, different biological endpoints, measures of habitat, etc.). This premise has been embraced by other EPA programs and the scientific community. (at 16,17); The Guidance can be used to develop nutrient criteria in a tiered weight of evidence assessment using appropriately modified EPA approved procedures together with other approaches that address causation. (at 37)