SAB Ecological Processes and Effects Committee
April 27, 2010 Final - 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 its release to make the document more useful to state and tribal water quality scientists and resource managers. (at 2; last sentence of first full paragraph)
- 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 38 (last sentence))
- 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 evaluate the capability of models to consider 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 31 (first bullet under 3.6, slightly different from executive summary; exec sum at xix, first bullet response on Charge Question 6)

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, italicized text in last paragraph) 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 6, first paragraph); 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 41, bullet #1)

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 23, last bullet)
- 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 16, second bullet from bottom)

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 the examples lump data from distinctly different ecosystems where multiple factors in addition to nutrients will contribute to biotic responses. (at 16, fourth bullet)

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- In order to be scientifically defensible, empirical methods must take into consideration the influence of other variables. (at 24, 2nd bullet from bottom)…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 24, first complete bullet)
- 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 38, first bullet) Numeric nutrient criteria developed and implemented without consideration of system specific conditions (e.g., from a classification based on site types) can lead to management actions that may have negative social and economic and unintended environmental consequences without additional environmental protection. (at 38, third bullet)

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 12, second bullet); 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 25, first bullet)

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 13, first bullet)

G. Data Requirements

- The document should better address data requirements (including data acquisition and data quality requirements). Without providing guidelines on data requirements, the potential for applying techniques to inappropriate or inadequate data sets is great. (at 10, bullet #13)

H. Weight of Evidence Approach

- The Guidance should contain a quantitatively based weight-of-evidence framework using multiple methods and then combining them into figures and tables for visualization. Multiple statistical methods

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on one data set do not equate to a reasonable weight-of-evidence that significantly reduces uncertainty. Rather, the weight-of-evidence should involve different assessment methods (e.g., different data sets, different biological endpoints, measures of habitat, etc.). This premise has been embraced by other EPA programs and the scientific community. (at 18, bullet #7); 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 38, last bullet)