

EPA Response to Peer Review Comments on:

Draft “Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria for Rivers and Streams in Nutrient Ecoregions I, IV, V, VIII and X.

Reviewers:

- **Dr. Nina Caraco - Institute of Ecosystem Studies**
- **Amy Parker - Georgia Environmental Protection Division**
- **Dr. R. Jan Stevenson - University of Michigan**

GENERAL COMMENTS:

- Regarding use of the 25th percentile (P25) of all river and stream data for the region or sub-region to identify reference conditions, it is unlikely that the lower percentile actually represents reference conditions. For some regions, only the upper 50% of systems may be substantially impacted by human activity. For others it is likely that as few as 5% of all systems are not greatly impacted by human activity. For example it seems likely that the higher NO₃, TN, TP and turbidity of the P25 for ecoregion V as compared to IV is due to the fact that a higher proportion of streams and rivers in ecoregion V are impacted by agriculture.

EPA Response: EPA prefers that States or Tribes identify actual reference sites to establish a reference condition. The P25 is an attempt to determine a reference site by choosing water quality data from the lowest quartile of an entire data set. Logic would dictate that the highest quality waters reside in the lowest quartile. In addition, land use practices in some ecoregions will make finding a true reference condition very difficult. EPA also does not suggest that “reference values” be set on a population of systems that are known to already be significantly degraded. In these cases, EPA recommends an extensive search for historical data on the systems to be considered by the RTAG when establishing nutrient criteria.

- Water column chlorophyll- *a* and turbidity may not be appropriate response variables in small streams. Sediment chlorophyll should have been included as a response variable for small streams. Turbidity should be considered causative, rather than a response variable. Turbidity is closely related to TP values because input of sediments directly causes increased turbidity and these sediments account for a large fraction of the P in streams.

EPA Response: EPA recognized that periphytic algal growth is the more relevant response variable for shallow streams and planktonic algae are more characteristic of deeper slow moving streams. The national nutrient database contains little data on periphytic algae and data were unavailable to classify streams as to shallow vs. deep or fast-flowing vs. slow moving (see Nutrient Criteria Technical Guidance Manual–Rivers and Streams, EPA-822-B-00-002, July 2000; www.epa.gov/ost/standards/nutrient.html). The chlorophyll- *a* values reported in the nutrient criteria recommendations for rivers and streams have primary relevance to slow moving

streams and rivers.

The issue of turbidity is complicated as pointed out in the peer review. Increased turbidity can also be associated with increased planktonic growth. Turbidity has both an inorganic and a biological component. EPA agrees that sediment particles may be a source of phosphorus to periphyton. However, increased sediment loads are often associated with increased loads of nutrients and therefore sediments are often an indicator of increasing algal biomass. It is true that high concentrations of sediments can limit light availability to algae growing in a stream water column and to periphyton. Thus, the relationship of turbidity to algal growth has a stimulatory component when suspended sediments are not limiting light and a growth-limiting component when contributing to light limitation, e.g. a source of phosphorus.

- Given the potential problems of using P25 values to evaluate reference conditions it is too bad that other methods for assessing reference conditions have not been compared to the P25 values presented. Possible alternatives are reference or benchmark data, historic data, and paleodata. Although there are columns in the data tables presented for comparisons of the P25 values for all systems to the P75 values for reference systems no data are, in fact, given. As USGS has already put together data for nutrients in undeveloped stream basins throughout the US (Clark et al. 2001), this data should have been presented so that a direct comparison of the P25 values reference streams could be made.

EPA Response: EPA's preferred process for state/tribal development of nutrient criteria, as stated in the "Ambient Water Quality Criteria Recommendations" documents, and in the technical guidance manuals, is to incorporate historic and other relevant data that will assist in the development of nutrient criteria. While these methods are not "compared" to the P25 method of evaluating reference conditions, they are suggested as methods to refine the statistically derived reference conditions. Further, EPA has evaluated the study by Clark et al. 2001, but is unable to compare those national data of the Hydrologic Benchmark Network (HBN) or the National Water-Quality Assessment (NAWQA), to the ecoregional data that has been used to develop the 25th percentiles for each ecoregion.

- Because many of the problems of nutrients in rivers and streams are due not only to the impact of the nutrients on the streams or rivers but due to their impact of nutrient in put from streams on reservoirs, lakes, and estuaries. Because this impact may be related ore to nutrient load than from nutrient concentration in streams, it might be useful to consider criteria based on areal export of nutrients (Clark et al. 2001).

EPA Response: EPA has reviewed the study by Clark et al. 2000. EPA concurs that atmospheric deposition, especially nitrogen is a significant source in some parts of the country. EPA does not, however, have sufficient data with which to develop criteria recommendations based on areal export of nutrients.

- The document needs to more clearly emphasize that these recommendations are a first step, perhaps interim criteria. But these interim criteria should be a part of a continuing

process of refining nutrient criteria for protection of different designated uses in different waterbody types. The rationale is that some states/tribes may adopt criteria without further modification, which enhances the potential for adopting criteria that are either over or under protective.

In particular, algal-nutrient relations should be an important factor in determining nutrient criteria, in addition to the nutrient and algal conditions in reference conditions. There may be some stream types in some subcoregions in which least impacted or best available conditions would not support the CWA interim goal of propagation of fish, shellfish, and wildlife. Certainly this is the case for protecting the designated use of biological and ecological integrity (Sensu CWA interpretations by Frey, Cairns, and Karr). Over protection is just as important as under protection of designated use. Different kinds of streams are affected differently by nutrient enrichment. Moderately elevated nutrient concentrations may not affect many valued biological attributes of aquatic ecosystems in some stream types. Thus, setting nutrient criteria based on reference condition without accounting for algal-nutrient relations could over protect ecosystems if algal responses are not problematic with moderate enrichment.

EPA Response:

RESPONSE TO CHARGES

1. Are percentiles using annual median values appropriate given data variability?

- The problem in using P25 values is the variation within the lower 25%. If nutrient data were not variable within regions it would suggest either that they were not impacted by human activity or that there was little variation in human activity within a region. Large variation in P25 values within ecoregions suggest either that these regions have great variability in natural conditions within them or that even the systems with the lowest 25% of values have been substantially impacted by human activity. One possibility is that this variation could be reduced by further dividing data into subregions where natural conditions are more uniform.
- Further investigation of extreme values to reduce variability may be warranted.
- The central tendency of nutrient concentrations (whether expressed as median, mode, or average should relate well to responses by valued ecological attributes. Median nutrient concentrations probably represent the central tendency well enough to provide guidance in developing nutrient criteria. Comparisons of values should be made and a better understanding of algal-nutrient relations should be the goal of further data analysis to refine nutrient criteria. This recommendation seems to be presented in section 6.0 of these documents, which should be explained more clearly

EPA Response: EPA agrees that median nutrient concentrations represent the central tendency well enough to provide guidance in developing nutrient criteria. EPA does not have the capacity to investigate extreme values i.e., what component is natural versus

anthropogenic. These extreme values, however, have been noted and readers are encouraged in the document to consider their relevance for a particular ecoregion. EPA also agrees that variation within the lower 25% could be reduced by further dividing data into subregions or classes or rivers and streams where natural conditions are more uniform. In fact, EPA guidance on the use of these criteria encourages States, Tribes and Regional Technical Assistance Groups (RTAGs) to explore these options where practicable.

2. Are the calculated reference condition values representative of conditions within the nutrient ecoregions/subcoregions?

- Appear to be, given information provided.
- Yes in many cases. Sample size and timing of samples are the key issues for obtaining representative assessments of nutrient conditions at reference sites. Samples should evenly represent streams with different sizes, hydrogeomorphology, and climate. Sample size will affect precision of samples while the other factors affect bias.

The abundance of water column chlorophyll- *a* data indicates that rivers (versus streams) may be over-represented in the database when compared to streams. That could create a significant bias for setting criteria for small streams. In addition, frequency, duration and extent of elevated levels within one ecosystem should be evaluated, and that is not readily apparent from review of this data. The latter data should be a priority of refining criteria. Use of remote sensing may facilitate that effort.

- 3 subquestions:
 - 1) Are the 25% of systems with lowest TN, TP turbidity and chlorophyll-*a* values still highly human impacted?
 - Likely for some sub-regions but comparison to “benchmark” systems should be made to further evaluate this.
 - 2) Are there enough data to insure regional representation of P25, P75 or median values? For some parameters in some ecoregions there are very few data. With low system numbers represented, P25 criteria may not be meaningful.
 - 3) Is seasonal variation so great to make annual values based on the seasonal median meaningless? Coefficients of variation for seasonal variation are generally low for TN, so seasonal variation is generally low compared to variation between regions. For NO₃, there is great seasonal variation in many areas, thus seasonal criteria may need to be considered for NO₃ or there would have to be assurance that full seasonal data were available when evaluating how a given system compares to reference conditions.

EPA Response: EPA agrees that sample size and timing of samples are key issues for

obtaining representative assessments of nutrient conditions at reference sites, or any site. EPA guidance provides the flexibility for States and Tribes to develop their sampling regime that best fits their geographical and seasonal conditions. With respect to the abundance of chlorophyll-*a* data for rivers relative to stream systems, EPA recommends that the measure of primary vegetative production response in streams be made using phreatophytic (obtaining water from the water table or soil layer immediately above it) growth as the chlorophyll-*a* source for streams, and planktonic sources for rivers.

3. Can defensible reference conditions be derived from this database via the statistical analyses performed?

- The reference criteria will not be easily defended until they are compared to reference conditions developed from “reference systems” and to any historical data available. The statistical difficulty of the P25 values is that they are often far closer to median values than they are to P5 values. For example, P5 values in ecoregion VIII are 4-fold lower than P25 values for the ecoregion while P25 values are only 2-fold different from median P values. Thus the P25 values do not appear to be a clearly distinct statistical grouping.
- In most cases yes, but be cautious about the defensibility of reference conditions calculated from such highly variable data.
- Yes, in many cases. Just using the 25th percentile of the best conditions, however, does not evaluate the probability of protection of the valued ecological attributes we want to preserve. Characterizing reference condition based on assessment of minimally impacted sites (natural) and knowledge of nutrient-response relationships are ultimately the most sound approach for establishing criteria.

The weaknesses in the scientific process used to develop the EPA recommended criteria should be acknowledged and used to direct further refinement of the criteria. These directions have been identified at different places in the document, but I recommend a better synthesis of guidelines for further refinement of criteria. I recommend writing a separate section that identifies the kinds of weaknesses that could exist in the database and statistical analyses and specific steps (guidelines) that should be taken to refine the criteria. This new section, and clear early statements in the foreword and introduction should emphasize that: “The criteria in these documents represent preliminary recommendations (interim criteria).” Such statements and organization of the documents would limit blind implementation of these criteria, which would limit the scientific merit of the nutrient management strategies. The document should more clearly address the following weaknesses:

- Database
- Better definition and identification of reference sites
- Sample additional reference sites and compare to existing database
- Increase sample size for different stream types with different geomorphologies and climates, regardless of nutrient ecoregion.
- Get more information about fish, invertebrate, benthic algae, nutrient and dissolved

- oxygen conditions in streams.
- Statistical analysis
 - Model attainable reference conditions based on BMP implementation, nutrient response, and algal response to nutrient decreases.

EPA Response: EPA recognizes that the “defensibility” of the reference conditions is dependent on the validity of the available data and the variability within a given ecoregion. That is why EPA encourages States/Tribes/RTAGs to look for additional data, talk to individuals in the area that may have historical data/insights that can increase the dataset, thus improving defensibility.

EPA recognizes that comparing the results of the statistical approach suggested to actual reference systems is the most substantial approach. EPA must consider, however, those circumstances where reference systems are not available. Initial studies from six States, academics, and other federal agencies comparing the lower quartile of mixed data samples to the upper quartile of *a priori* reference sites, while not decisive, suggests a reasonable approximation of both approaches given the inherent variability of environmental data and STORET data in particular.

EPA accepts the recommendation that weaknesses in the database, statistical analysis and other sections listed - be identified, and that the document recommend steps that readers can take to refine the criteria. This will be done in future iterations of the manuals.

4. Are the cited subcoregional reference condition values suitable for nutrient criteria development without the use of additional physical classification factors?

- It may be possible to evaluate some variables as continuously varying functions in models rather than by artificially dividing data into categories. For example hydrologic load, watershed slope, soil depth are all continuous variables that would have to be rather artificially categorized.
- If the EPA has consistent waterbody classification information available for entire Nutrient Ecoregions, then I would strongly encourage its use to reduce data availability.
- Greater use of the database could be made by stratifying according to physical stream classification than by subcoregions, if that information were available. The next refinement of this database should be the collection and addition of data that would help classify streams in the database.

EPA Response: All of the information that EPA has is already incorporated into criteria documents with the inherent presumption of being continuously varying functions. However, where data are available to support subcoregionalization and further physical waterbody-type subclassification, as with lake studies in Minnesota, variability seems to be substantially reduced. Some RTAGs are currently gathering data that would help classify streams and EPA is interested in incorporating this data into the nutrients database to compare the two levels of specificity.

5. Is there additional information (data or literature) that would improve the analysis provided in this document?

- Clark, G. M.; D. K. Mueller; M.A. Mast 2001; Nutrient concentrations and yields in undeveloped stream basins in the United States USGS report from (usgs.gov).
- Smith, R.A. et al. 1993 Stream water quality in the conterminous United States - Status and trends in selected indicators during the 1980-2 in: National Water Summary 1990-91: Hydrologic events and stream water quality. pp. 111-140 United States Geological Survey.
- The Peer reviewed publication produced by USGS personnel that analyzed nutrient data from NASQAN and HBN datasets, in most cases supports the criteria values that EPA is recommending and should be included.
- USGS circular 1225 provides useful information that would provide additional support for the criteria recommendations.

EPA Response: EPA appreciates the suggested additional information, and will consider inclusion of relevant data in future refinements of this document.