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EPA Response to Peer Review Comments on:

Draft “Ambient Water Quality Criteria Recommendations: Information Supporting the Development of State and Tribal Nutrient Criteria - Lakes and Reservoirs in Ecoregions III, IV, V, and XIV”

Reviewers:

- **Paul J. Garrison, Wisconsin Department of Natural Resources**
- **John E. Reuter, Tahoe Research Group, University of California - Davis**
- **Eugene B. Welch, Independent Water Quality Consultant**

GENERAL COMMENTS

- Minimum values are reported as 0. It is highly unlikely that the minimum values are in fact zero, rather it is more likely that these values were below a detection limit.

EPA Response: If values are reported as less than detection, in many cases we set a number $\frac{1}{2}$ way between zero and lower detection limit. If zero was reported, we assumed it was an accurate reading. Additional statistical methods were presented to deal with the issue, however, the percentage of records below detection and zero was less than 5% of the total records. EPA did not believe it was necessary to treat these values differently given this small number.

- Varying levels of significant figures were noted

EPA Response: Recommendations were provided for correcting the variations - which were accepted and incorporated into the document. Significant figures are adjusted based on the parameter.

- A commenter suggested using only the spectrophotometric method for measuring chlorophyll, rather than the combination of three methods as currently presented.

EPA Response: The chlorophyll-*a* data used were not gathered using a consistent method. There is not sufficient national data based on just one method, so data was pulled “as is.” EPA specified which method was used in the documents. We never combined the values from the 3 methods to determine a 25th percentile. Rather, we developed 25th percentiles for each method, suggesting the values derived from the newer methods were more reliable (fluorometric and spectrophotometric).

- Small sample size was noted as a problem in some cases of reporting minimum, maximum and 25th percentile values.

EPA Response: EPA agrees, and noted in the documents when small sample sizes could make the reported figures and resulting statistics questionable.

- A commenter stated that Section 5 indicates that the document promises to look at the two methods for establishing reference conditions, and that this is not done.

EPA Response: A review of this section shows that the two methods are discussed - one being a statistical determination of reference conditions using the 25th percentile of the entire database, and the other being an *a priori* determination of reference sites using the 75th percentile of an *a priori* population of reference sites. However, the national nutrient database contains mixed data, i.e. reference and degraded systems, so the P75 could not be calculated from just a reference population in any of the ecoregions. EPA notes however, that this section could be more clearly written, and will consider revising for future iterations of the document.

- EPA's claim that there is a high degree of similarity between the two methods is not demonstrated in ecoregion V. The values for TKN, nitrate, TP and chlorophyll-*a* were all problematically higher using the 75th percentile than the 25th percentile, and the aggregate concentrations reported for the P75 approach appear very high and would not serve as good targets to protect water quality.

EPA Response: EPA realizes that the P25 is a theoretical approximation of an actual reference condition. When actual data deviates from this approximation, EPA supports the use of an alternative, scientifically valid approach. In addition to the sources cited in the documents, EPA now has additional data from six states, two academics, and two federal agencies comparing the lower quartile of mixed data samples to the upper quartile of *a priori* reference sites. While the data are not decisive, they continue to support a reasonable approximation of both approaches given the inherent variability of environmental data, and STORET data in particular. Additionally, EPA prefers that States and Tribes develop reference conditions based on the 75th percentile of a reference population. The 25th percentile of all data is a surrogate for actual reference data.

- Commenters generally agreed that the P25 approach is a reasonable first start. They noted, however, that it is too broad if criteria for individual waterbodies are desired. The waterbodies that comprised the P25 population should be evaluated with respect to beneficial use attainment - are they really representative of reference waterbodies?

EPA response: EPA supports those States and Tribes that wish to develop site-specific criteria. EPA believes that protecting a waterbody at reference conditions, will protect all designated uses. If States and Tribes want to set criteria according to specific designated uses, they can.

- The data analysis section was brief, and not convincing. No attempt was made on the part of the authors to address any of the issues the reviewers were asked to comment on. Additionally, it would be very helpful to the users if the data were evaluated to determine how often, during the course of a year, the actual concentration measured in an identified reference waterbody (i.e. a P25 waterbody) would have violated the aggregate median.

EPA response: With regard to compliance with nutrient criteria, our technical guidance manuals describe the details of our statistical treatments of data. For this reason the statistical process is referenced in our criteria documents. EPA will endeavor to address the questions of monitoring frequencies and appropriate compliance measures in future implementation guidance.

Regarding the concern about aggregate median violations, the P25 is a fraction of a mixed population. It is the reference value, not a criterion, and unless adopted into water quality standards, and into an enforceable permit limit, cannot trigger a violation. It assumes a reasonable measure of minimal degradation.

RESPONSE TO CHARGES

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

- No: Significant seasonal differences are likely to occur in lakes and reservoirs, especially those which experience ice cover.
- Use of the median values at a number of steps in this analysis act to reduce “apparent” variability. Small sample sizes (i.e. where $N=2$), different forms (i.e. bound vs. unbound TP) of the causal parameters, can reduce variability. Variability within ecoregions and within seasons differs, however, for each of the variables.
- Noting differences in seasonal variability among different parameters - summer is the period when poor water quality and high recreational use occur, and may therefore be more appropriate for criteria and water quality control. Presentation of summer only 25th percentile values would be a useful addition to the document.
- Annual median values for chlorophyll-*a* and Secchi are not appropriate, because they mask conditions during the summer growth period and time of high recreational use. Also the actual values in the tables for chlorophyll-*a* do not correspond with the expectations given the annual TP values and Secchi values are probably not realistic for summer conditions because of interference due to non-algal substances affecting light transmittance during the non-growth period.

EPA Response: EPA concurs with the comments provided. EPA has provided annual medians for the given parameters, as well as spring, summer, fall, and winter seasonal medians in the appendices of the documents. States, Tribes, and RTAGs are encouraged to consider whether specific seasonal data are more appropriate for a given geographic area and if so to apply these values as necessary. EPA could not discuss which season(s) is most appropriate for a given ecoregion, and encourages States, Tribes and RTAGs to consider these comments in the development of their nutrient criteria plans. If States and Tribes cannot determine which season is most appropriate for causal and response variables, the annual median may be most appropriate.

2. Are the calculated reference condition values representative of conditions within the

nutrient ecoregions/subcoregions?

- There is no indication in the documents if this is true. For example, there is no discussion of the types of lakes, what percentage of lakes in each ecoregion was sampled, that reservoirs usually receive higher nutrient loading than lakes (absent significant point sources) and thus have elevated nutrient levels compared to lakes. In order for these reference condition values to be representative of conditions within the ecoregions, there needs to be a discussion of what percentage the entire population of lakes within each ecoregion were sampled.
- Unless we know the measured constituents in the actual reference lakes, it is difficult to say with any certainty.
- The large difference in the criteria based on the P25 method and the P75 method raises questions as to the validity of the overall statistical approach. This type of comparison should be included before these guidance documents are released.
- The suggested values may or may not be adequate for the aggregate of subcoregions. Representativeness is difficult to judge without knowing the total population of lakes in the respective regions. Including lake population size or stating the importance of that information in the document is recommended. EPA has led in methods to statistically estimate lake-sample representativeness, in the areas of acid precipitation and eutrophication. This effort, however, is expensive and probably can/will not be undertaken by States and Tribes. Volunteer monitoring is a cheap way to enlarge the data base, but there is some evidence that volunteer monitoring is biased, because it is not random.
- Some analysis/characterization should be provided on those waterbodies that comprised the P25 population

EPA Response: EPA concurs that knowing the total population of lakes and the specific lake classes in a geographic region, and what percentage of those lakes are represented by the samples used here would be valuable. Similarly, definitive knowledge of which lakes and reservoirs are of reference quality would be invaluable. EPA notes, however, that in most cases, this information was not available at the time of the writing of these documents, nor is it available now. EPA did attempt to obtain representative samples for each ecoregion. In addition, EPA criteria documents provide maps with sampling locations to illustrate the distribution of sample locations with attendant data. EPA therefore, developed the lower quartile as a surrogate for the reference condition approach to compensate for the lack of available data. EPA prefers the use of *a priori* reference conditions in conjunction with knowledge provided by the members of the RTAGs as the optimal way to derive the criteria, however where actual reference information is lacking, use of the alternative lower quartile of mixed data is believed to be acceptable.

EPA has received several reports of data comparisons by states and other federal agencies supporting the idea that the values derived from P25 and P75 approaches and established

reference sites are variable but are generally comparable (Pers. coms.: J.Davis, 2001; K. Price and B.Glazer 2001; G. Denton, 2000, R. Smith, 2001; S. Heiskary, 2000).

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

- No - because in order to make these reference conditions defensible, I would recommend that there be a discussion of what percentage of the total lakes in each ecoregion were sampled. This will not get around the issue that these lakes were not randomly sampled. but it would make the arguments stronger. There should be a minimal number of lakes that have been sampled within an ecoregion. Lakes and reservoirs should be separated because of their likely differences in relative watershed size.
- From the perspective of setting WQS for an individual lake: no-to-maybe. While the P25 values appear generally representative of conditions in the ecoregion/subcoregion, transferring these to an individual waterbody may not be appropriate. Unlike toxicity criterion which protect against mortality, nutrient levels, clarity and chlorophyll must be viewed within the context of ecosystem process.
- The statistical procedures are appropriate, but annual means are not appropriate for the response variables, chl and Secchi. Criteria for those variables should be based on summer or spring-summer, depending on what is determined to be the growth period, which probably varies with longitude. The other important requirement for using these data to develop defensible criteria is to assure that the population of lakes sampled is representative of the total population in the level III ecoregions.
- The document lacked any data analysis that would provide a convincing case for the utility of the data as reference conditions. The data analysis was disappointingly brief. None of the issues that peer reviewers were asked to comment on were addressed in the data analysis. An analysis should be performed to determine how often during the course of a year, the actual concentration measured in an identified reference waterbody (i.e. a P25 waterbody) would have violated the aggregate median.

EPA Response: The total number of lakes within an ecoregion was often not available. EPA agrees that there should be a minimal number of lakes identified per Ecoregion, but made best use of the data that was available. EPA concurs that transferring P25 values from an ecoregion/subcoregion to an individual waterbody may not always be appropriate, however, the document is intended for those who will not have the resources to do waterbody-specific criteria development. Further, it is intended for those who will need to set nutrient criteria for a large number of comparable waterbodies in a relatively homogeneous ecoregion, using a consistent methodology. In those cases where site specific criteria are necessary, EPA recommends an evaluation of the physiology, ecology, and hydrology of the lake/reservoir, and how they change with the seasons.

EPA concurs that annual medians for Chlorophyll-*a* and Secchi may not be applicable to all waterbodies within an ecoregion given seasonal variability among ecoregions. In these cases

seasonal medians can be developed (see discussion above).

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

- No, reference values are necessary for each type of lake (seepage and drainage, and also shallow and deep, stratified), and for reservoirs. If it could be demonstrated that the 25th percentile was similar for all these water body types, then 1 reference condition value would be appropriate.
- Difficult to answer without seeing data for each waterbody.
- If the population of lakes sampled is representative of the total population in the level III ecoregions, then subcoregional reference values derived this way should be suitable for use as criteria without additional physical criteria. Lake typing to set reference nutrient concentrations for lakes would unnecessarily complicate the criteria.

EPA Response: EPA concurs that the reference condition values alone are generally insufficient to translate directly into nutrient criteria. The other factors such as historical data trends, empirical modeling, consideration of downstream effects, and especially RTAG objective and professional interpretation and assessment of this information are essential to the process. However, in the absence of this information, EPA believes these criteria are protective of beneficial uses in water bodies.

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

- It is necessary to limit which seasons are used for the data analysis. I recommend eliminating winter data because in at least the northern portion of the USA it is climatically much different than the southern part of the country. With the presence of ice cover, causal variables other than nutrients become more important for the distribution of chlorophyll-*a* and Secchi values. Another important data item that is needed is the percentage of lakes that were sampled in each ecoregion. I recommend that around 20% of the lakes should be sampled in most ecoregions. Fewer percentages would be necessary in the areas that possess abundant lakes such as ecoregions in the upper Midwest, Florida, and northeastern USA.
- Only upper epilimnetic values should be used to generate the reference condition values. In stratified lakes that experience appreciable internal loading, P and ammonium concentrations will be much higher in the bottom waters than those in the epilimnion. The inclusion of these higher levels will elevate the median value for a given lake and not accurately portray the nutrient levels.
- Secchi and chlorophyll-*a* should be established for the summer growth period, because response to nutrients occurs then and averaging with values from the rest of the years results in a lower, unrealistic response for chlorophyll-*a* and unrelated to Secchi values.

Hence, addition of summer values for chlorophyll-*a* and Secchi would help. The other point is the difficulty in defending representativeness without knowing the total population of lakes from which the sample was drawn. While probably not available for these reports, the States and Tribes should be advised of the need for that data.

EPA Response: The use of only epilimnetic nutrient values is an insightful and appropriate suggestion and we will explore this further. However, in many cases, the depth of the sampling location is unknown. Internal loading may also be seen as part of the characteristic nutrient recycling dynamic of such lakes. The matter will be reviewed by the National Nutrient Team and if the suggestion is endorsed, it will be incorporated in future guidance. If so, we will also make a website notation as an up-date to the criteria documents indicating that users may generate and use such epilimnetic data for reference condition determinations.

While annual values for Secchi depth and chlorophyll-*a* are presented in the criteria documents, the same information is also presented on a seasonal basis and States and Tribes are encouraged to index their criteria by season, especially the spring/summer growing intervals.

EPA concurs that States and Tribes should be encouraged to develop more data about the total population of lakes from which the sample was drawn. EPA has discussed this issue with States and Tribes, and encourages this data gathering.