

**From:** [Mike Armstrong](#)  
**To:** [Barnett, Mary](#)  
**Subject:** Statistical Error in Binomial Method and Biological Integrity Scoring Comments  
**Date:** Thursday, March 09, 2017 9:51:44 AM

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Ms. Barnett- please accept the comments below as part of the record for the Assessment Methodology Stakeholder Group. I very much appreciate and applaud the ADEQ for the time and effort the Department has put into this inclusive, open and transparent process.

### **A. Binomial Statistical Type I and Type II Errors**

Sampling the natural environment is characterized by variability. My earlier recommendation that the Dept have the Assessment Methodology reviewed by a professional statistician trained in statistical methods applicable to water quality monitoring remains. I believe the intent of the Department to use statistics to identify the amount of uncertainty in their sampling results and structuring their analysis to calculate the level of Type I and Type II errors is appropriate. The binomial method proffered by the Dept will allow the staff to have confidence in impairment listing decisions. However, there is an underlying policy assumption in the binomial testing method recommended by the Dept. The method seeks a high level of certainty against making Type I (false positive) statistical errors- or in this case declaring a stream impaired when it is actually not. By doing so, the Dept increases the possibility of making a Type II (false negative) error- or concluding a stream is not impaired when it actually is.

Structuring the statistical analysis to guard against false impairment decisions assumes the societal and economic costs of impairment decisions are significantly higher than the societal, economic and environmental costs of not recognizing the waterbody as impaired when it is actually impaired. For the many of situations, that assumption may be true, particularly in Category 2 stream. But it should not be assumed in all cases- waters with existing drinking water uses, Extraordinary Resource Waters and Ecologically Sensitive waters contain societal and economic values that arguably more costly if subject to a Type II error. It should also be noted that the Clean Water Act itself is premised on the principle that fishable, swimable and drinkable have inherently more societal and economic value than waters that do not support those uses.

Just as importantly, the department's emphasis on avoiding false impairment declarations at the expense of increasing the probability of false supporting decisions is a public policy decision and should be treated as such. The Department should be able to defend this policy decision on the same basis it does any regulatory decision- on it's economic and environmental merits. The statistical analysis method that includes a discussion of both Type I and Type II errors should be included not only in the Assessment Methodology publication, but also the 305b Integrated Water Quality Assessment Report and 303d Impaired Waters List. These reports should include a description of the statistical method used and the rationale for avoiding Type I errors. It is misleading to the public to state an exceedance value (e.g. 10%) for a water quality standard when in the analytical practice the actual exceedance value may be as high as 30% due to sample size and the high degree of certainty being placed on impairment findings.

In summary:

1. The use of statistics to increase certainty in Dept's analysis and decisions is

appropriate and encouraged. A thorough review of the statistics used in the Assessment Methodology should be performed by a professional statistician trained in the application of statistical analysis to sampling of the natural environment.

2. The emphasis on avoiding Type I errors (false positives) suggests the Dept assumes the societal and economic cost of a false impairment listing is significantly higher than the societal, economic and environmental costs of not remediating impaired waters overlooked due to a Type II error. That assumption should not be made for waters with existing public drinking water uses, Extraordinary Resource Waters and Ecologically Sensitive Waters. A high confidence in avoiding Type II errors should be afforded these waters.

3. The emphasis on avoiding false positives is a policy decision that should be described in the Assessment Methodology, the 305b Integrated Water Quality Monitoring Assessment Report and the 303d Impaired Waters List.

### **Biological Integrity**

I understand that the Department will be re-sending a corrected version of the Biological Integrity data tables presented last meeting. I appreciate the concern expressed by the Arkansas Environmental Federation regarding the basis for the Department's current method of categorizing the biological integrity scores.

Assessing biological integrity through the use of surrogate indices are simplifications of complex ecological form and function processes. Changes to the existing Dept methodology should be approached conservatively and with prudence. Additional discussion and comments may be warranted once the Dept sends the revised data tables.

Again, thank-you for the opportunity to participate and provide comments on revising the Assessment Methodology.

Mike Armstrong