Review of

Empirical Approaches for Nutrient Criteria Derivation

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Science Advisory Board
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The Guidelines

GUIDELINES FOR DERIVING NUMERICAL NATIONAL WATER QUALITY CRITERIA

FOR THE PROTECTION OF AQUATIC ORGANISMS AND THEIR USES

by

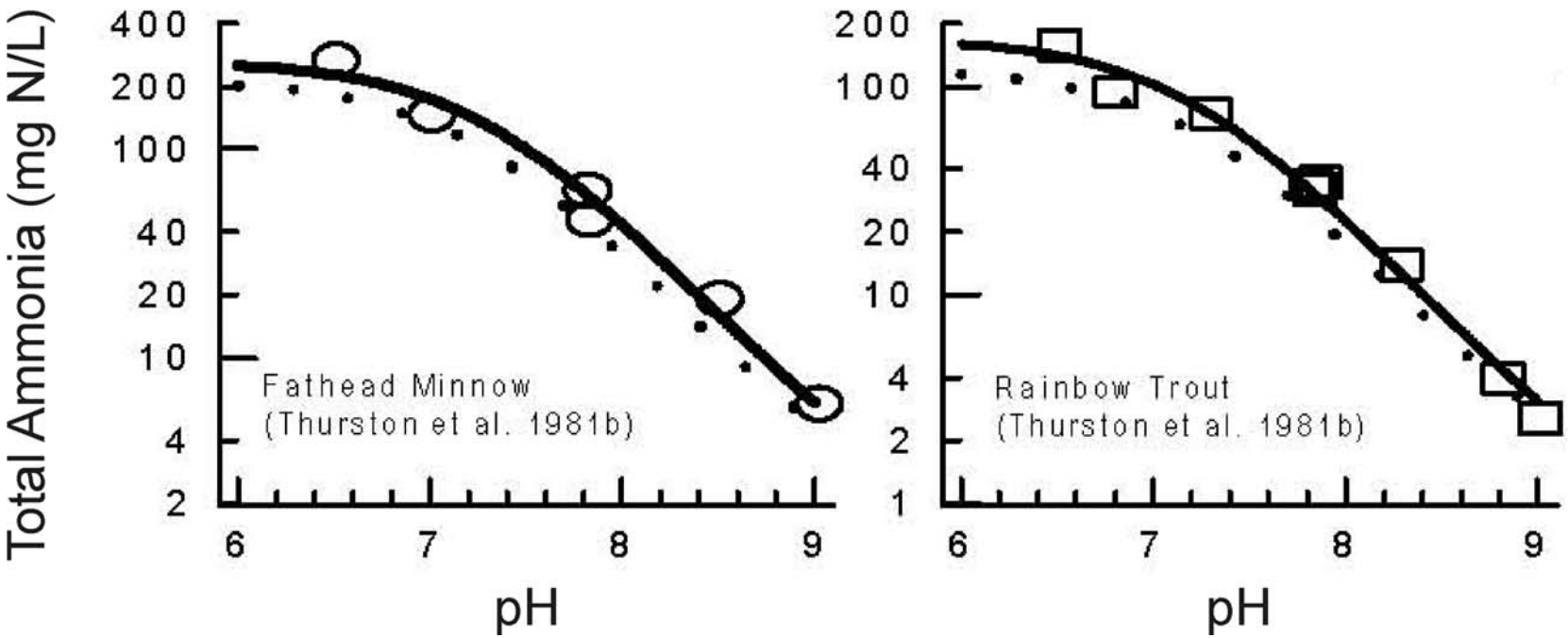
Charles E. Stephan, Donald I. Mount, David J. Hansen, John H. Gentile,

Gary A. Chapman, and William A. Brungs

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RESEARCH AND DEVELOPMENT
ENVIRONMENTAL RESEARCH LABORATORIES
DULUTH, MINNESOTA
NARRAGANSETT, RHODE ISLAND
CORVALLIS, OREGON

1985

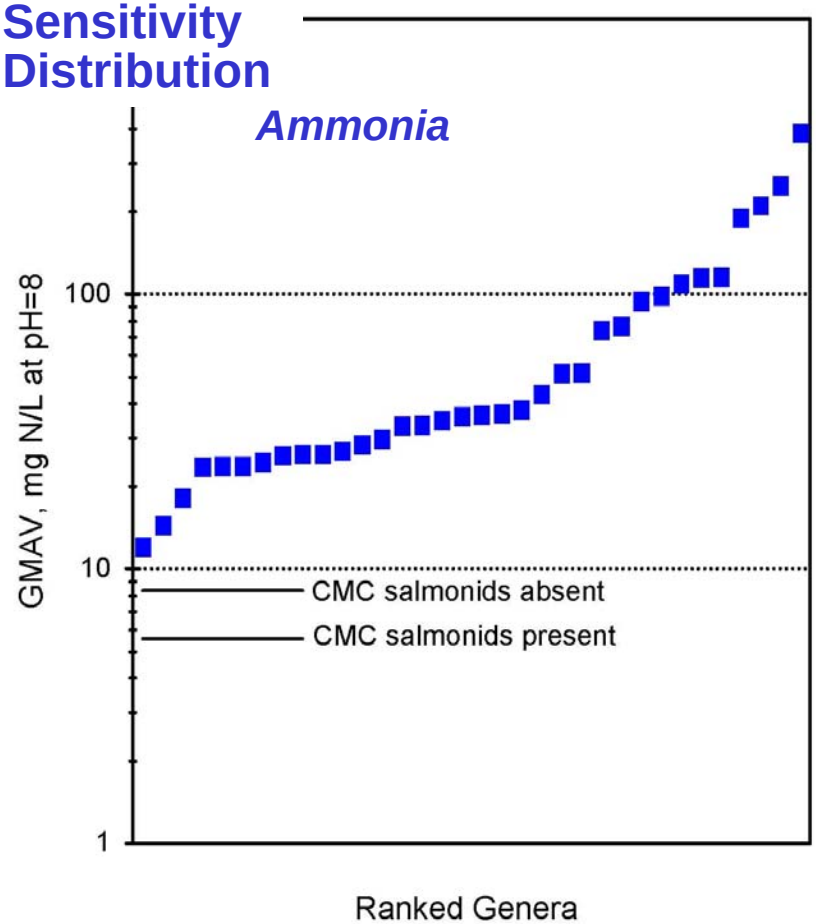
Dose-Response



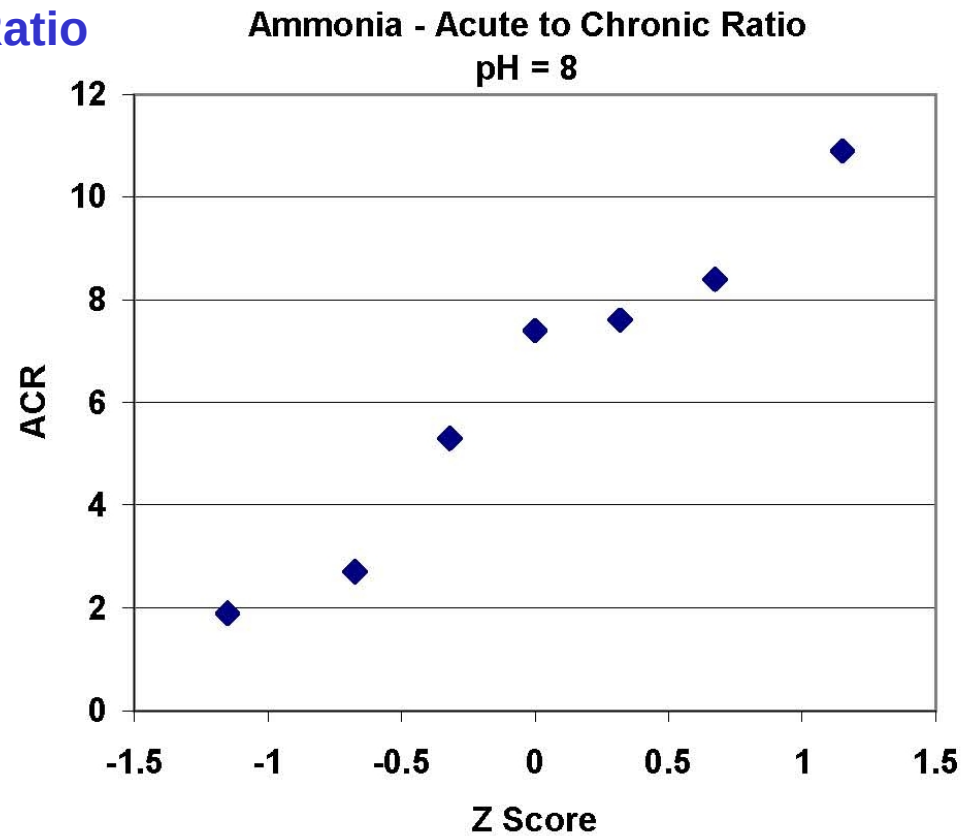
EPA 1998 Update of Ambient Water Quality Criteria for Ammonia
EPA 822-R-98-008 August 1998

Derivation of Criteria

(1) Species Sensitivity Distribution



(2) Acute Chronic Ratio

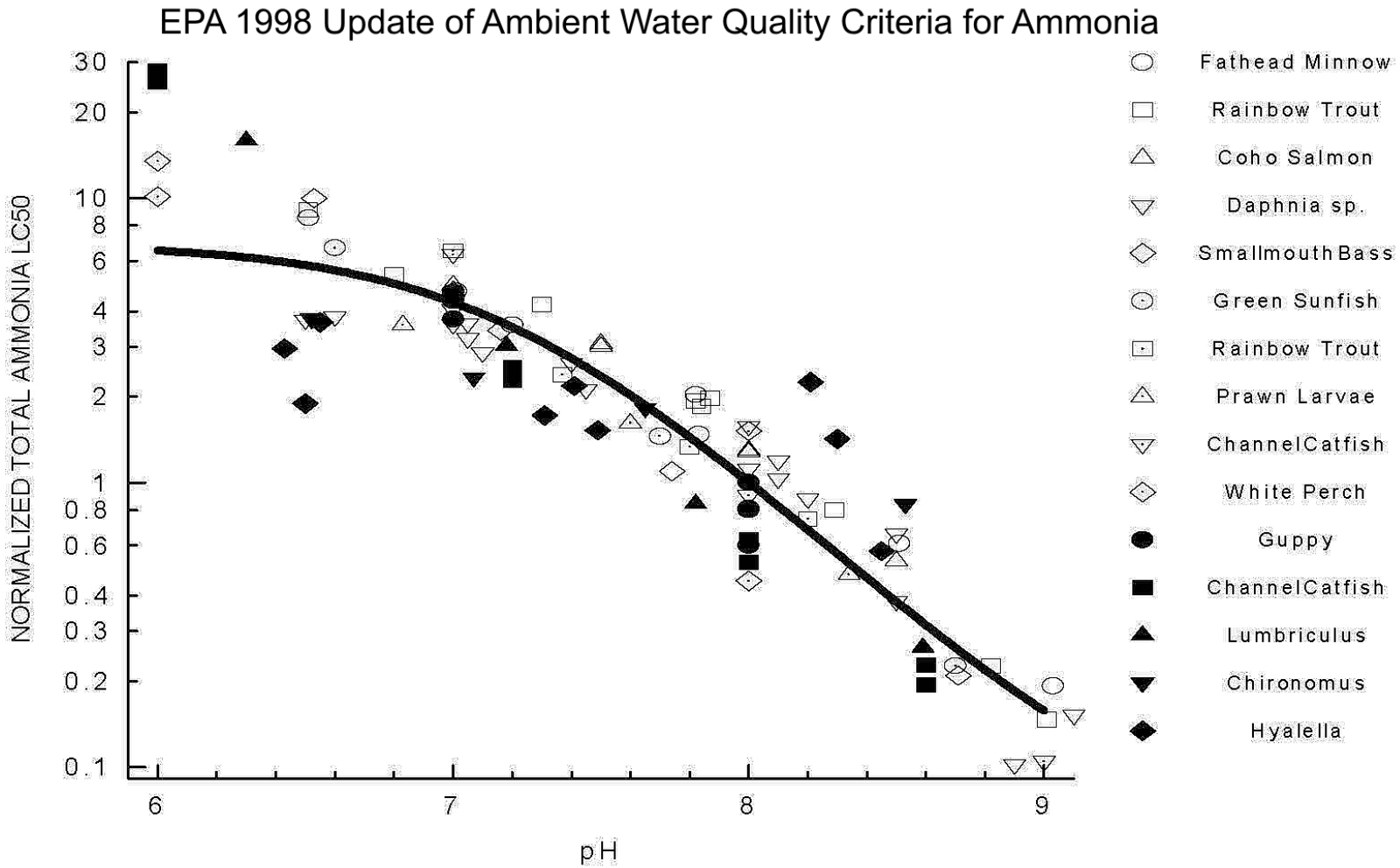


Stephan, C. E., Mount, D. I., Hansen, D. J., Gentile, J. H., Chapman, G. A., & Brungs, W. A. (1985).
Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses.

(3) Averaging Period

(4) Compliance Frequency

Ammonia Criteria
Effect of pH



EPA 1998 Update of Ambient Water Quality Criteria for Ammonia
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Regressions provide no sound basis

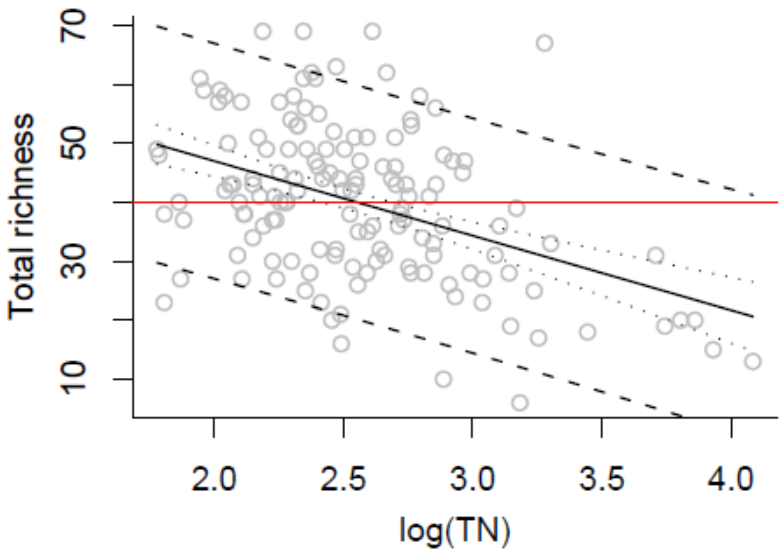


Figure 13. Log(TN) versus total species richness in EMAP-West Xer regression relationship, dashed lines: 90% prediction intervals. Re richness = 40. Units are µg/L for log(TN). Regression equation: Tot R^2=0.19, p<0.001.

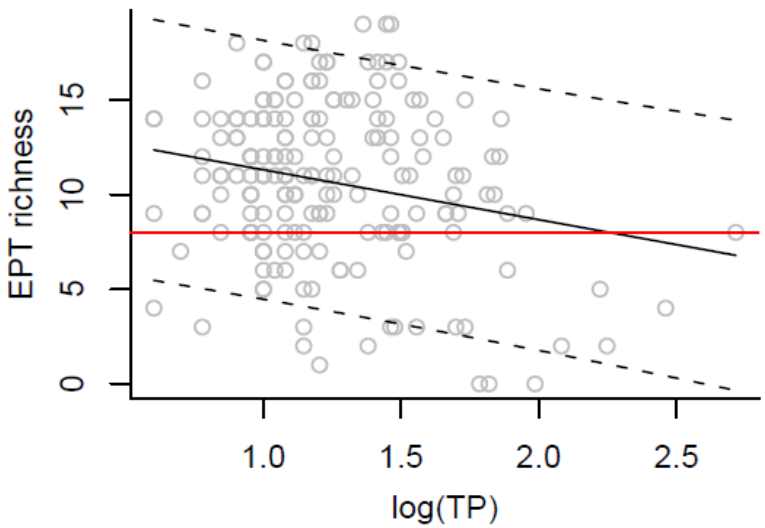
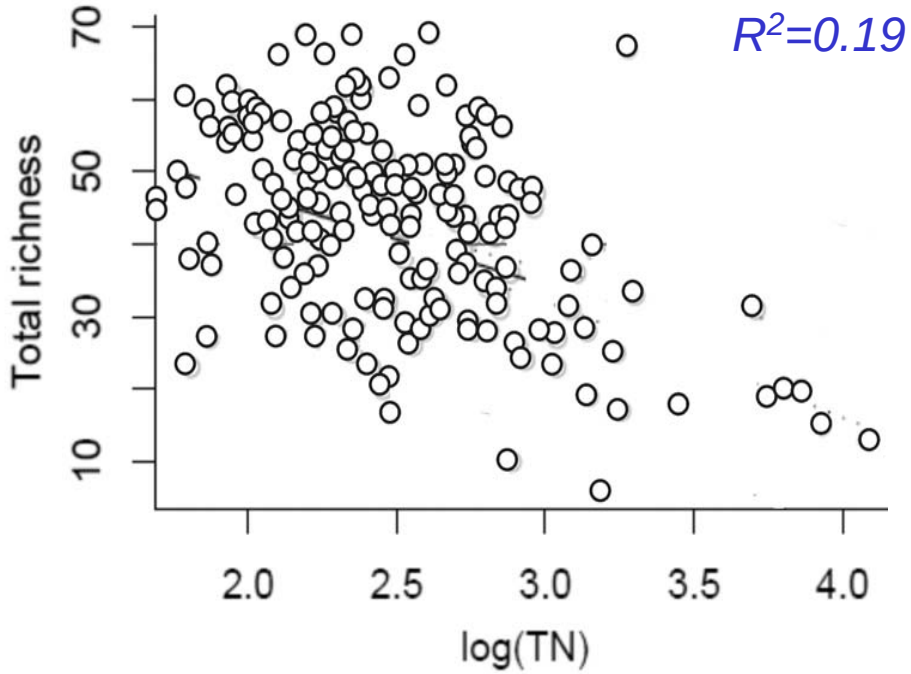
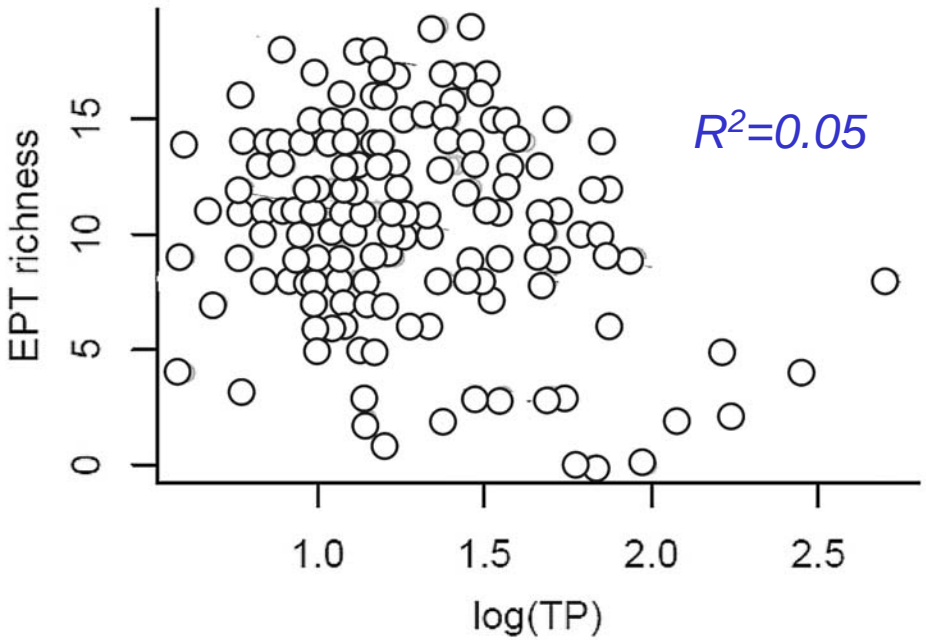


Figure 14. Log(TP) versus EPT species richness using the least urban dataset. Solid line: mean regression relationship, dashed lines: 90% line indicates EPT richness = 8. Units are µg/L for log(TP). Regressio 2.63[Log(TP)]; R^2=0.05, p<0.005.

In fact there is NO relationship



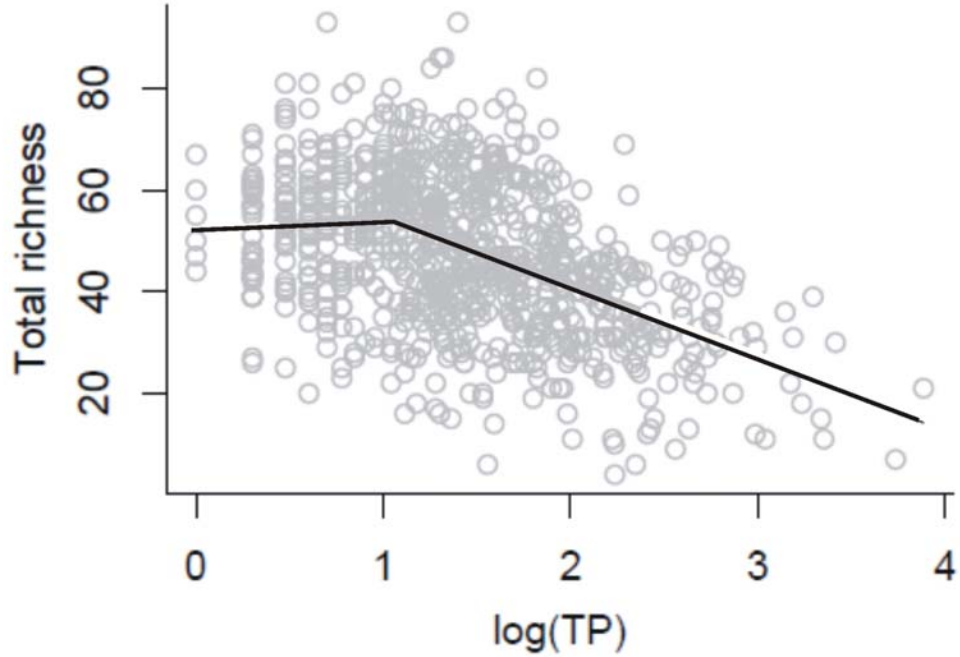


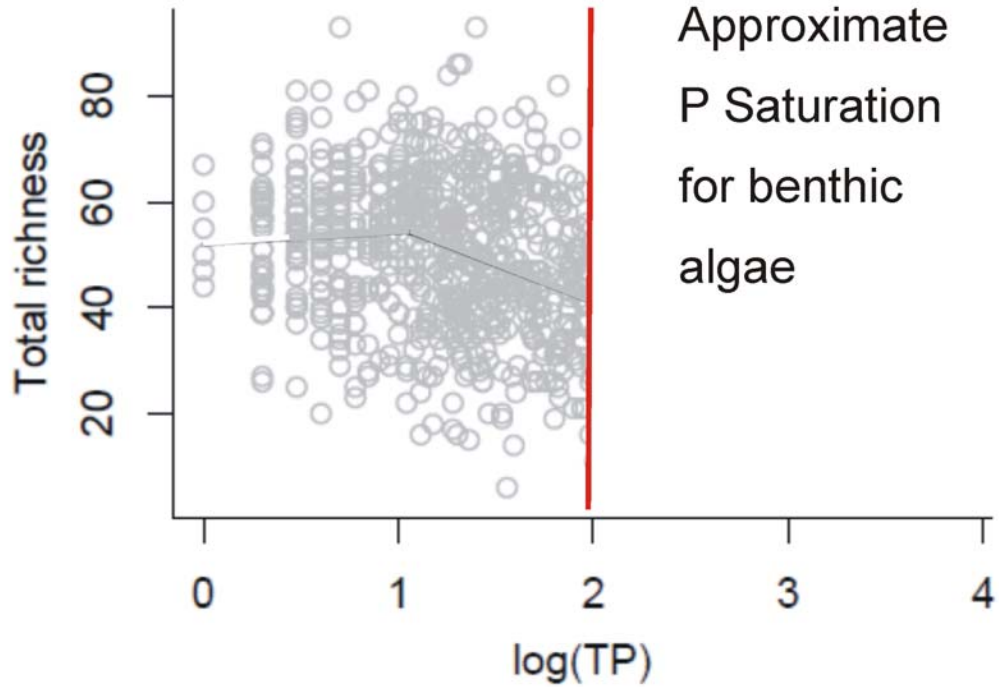
More precisely

There is no

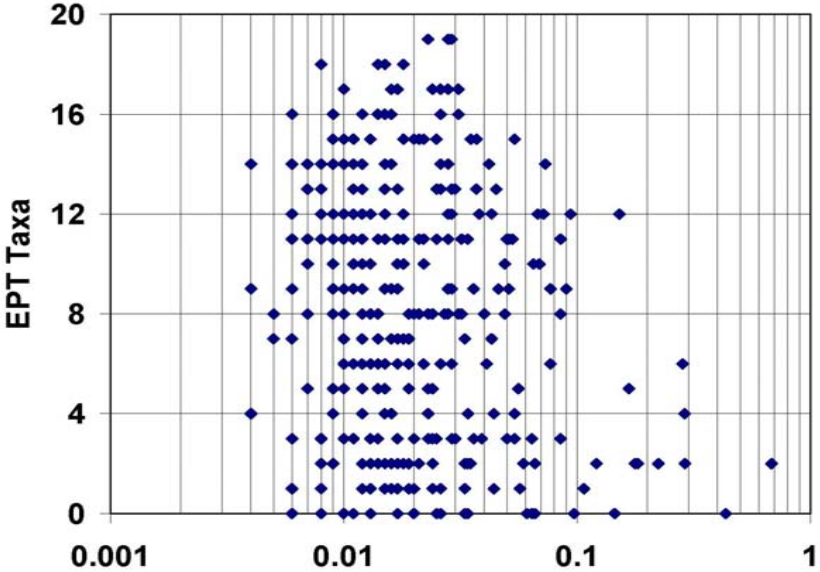
mechanistic

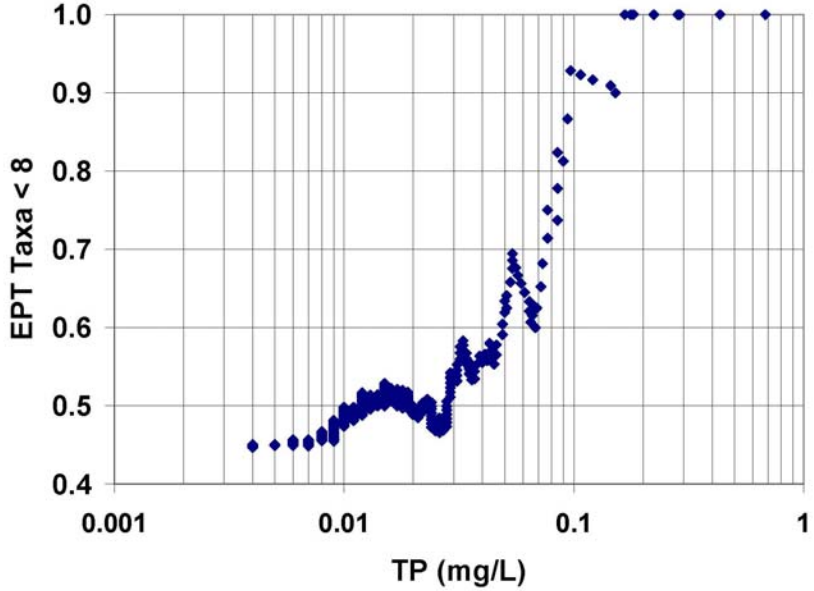
relationship

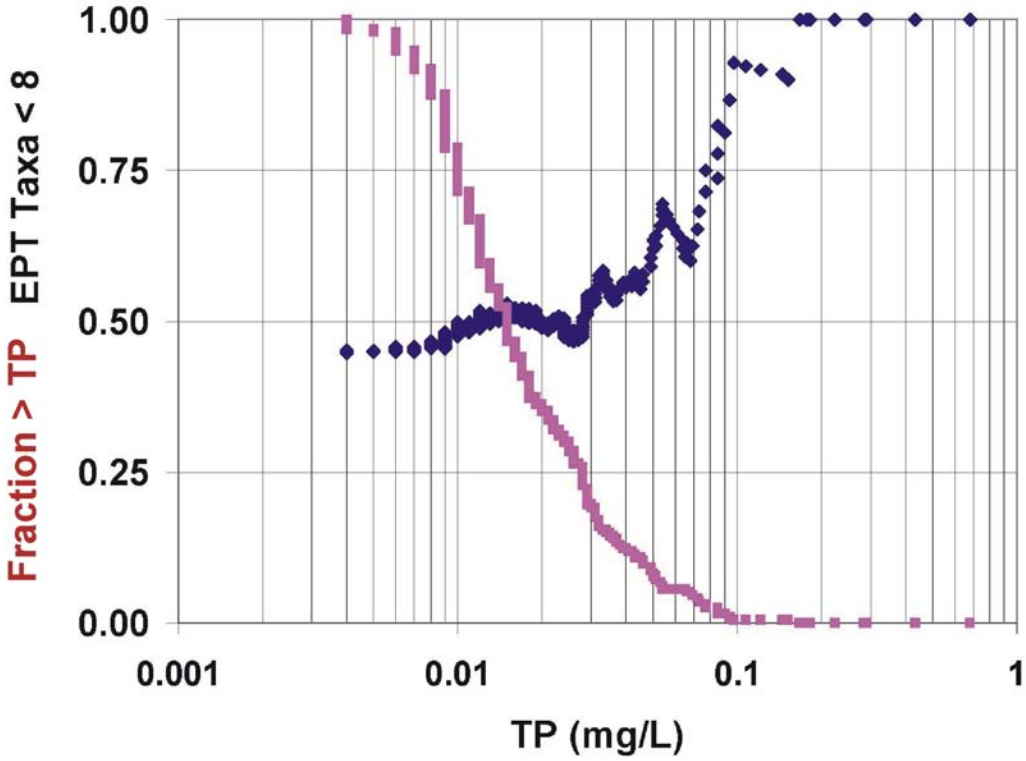




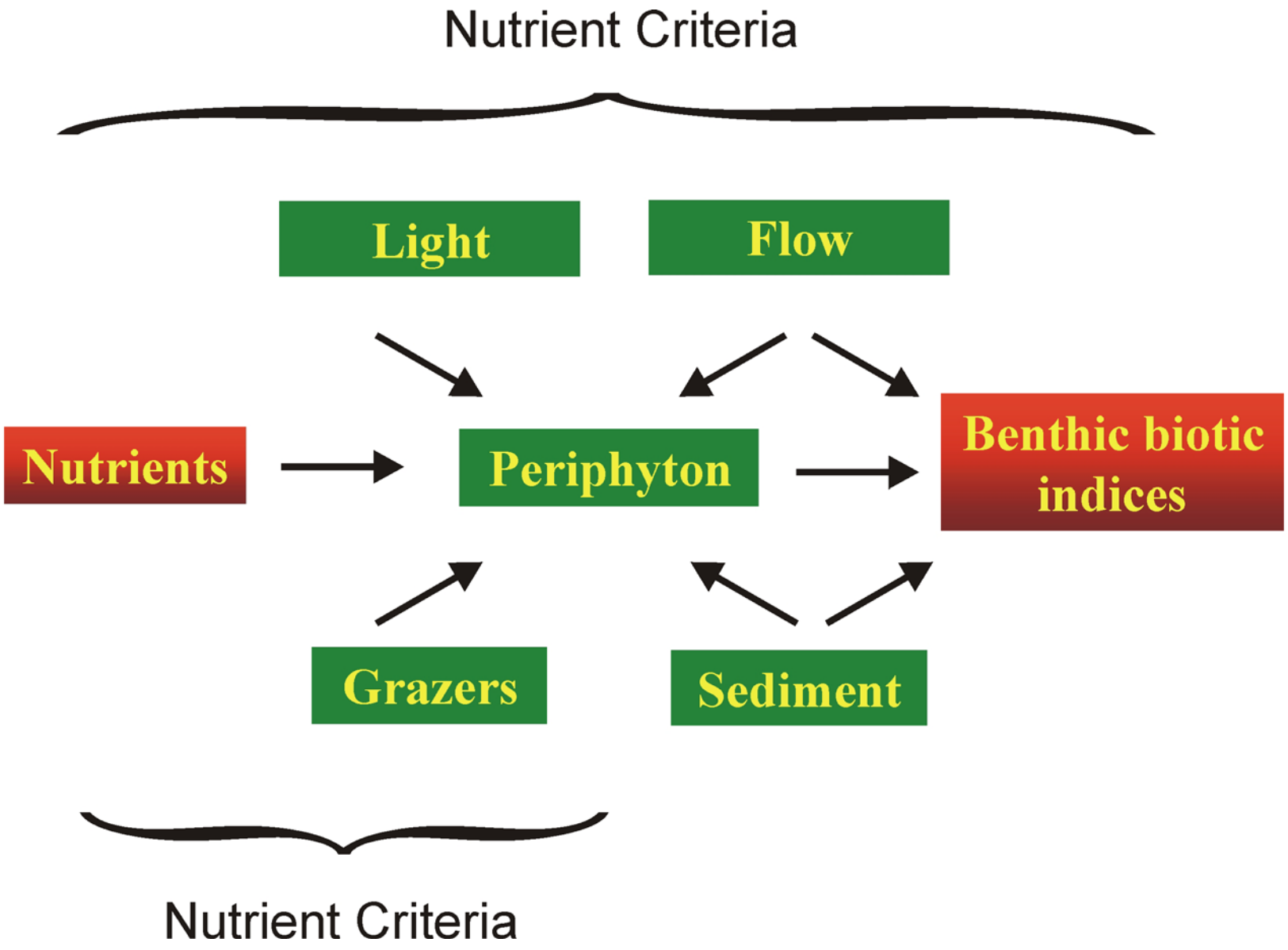
Conditional Probability Analysis



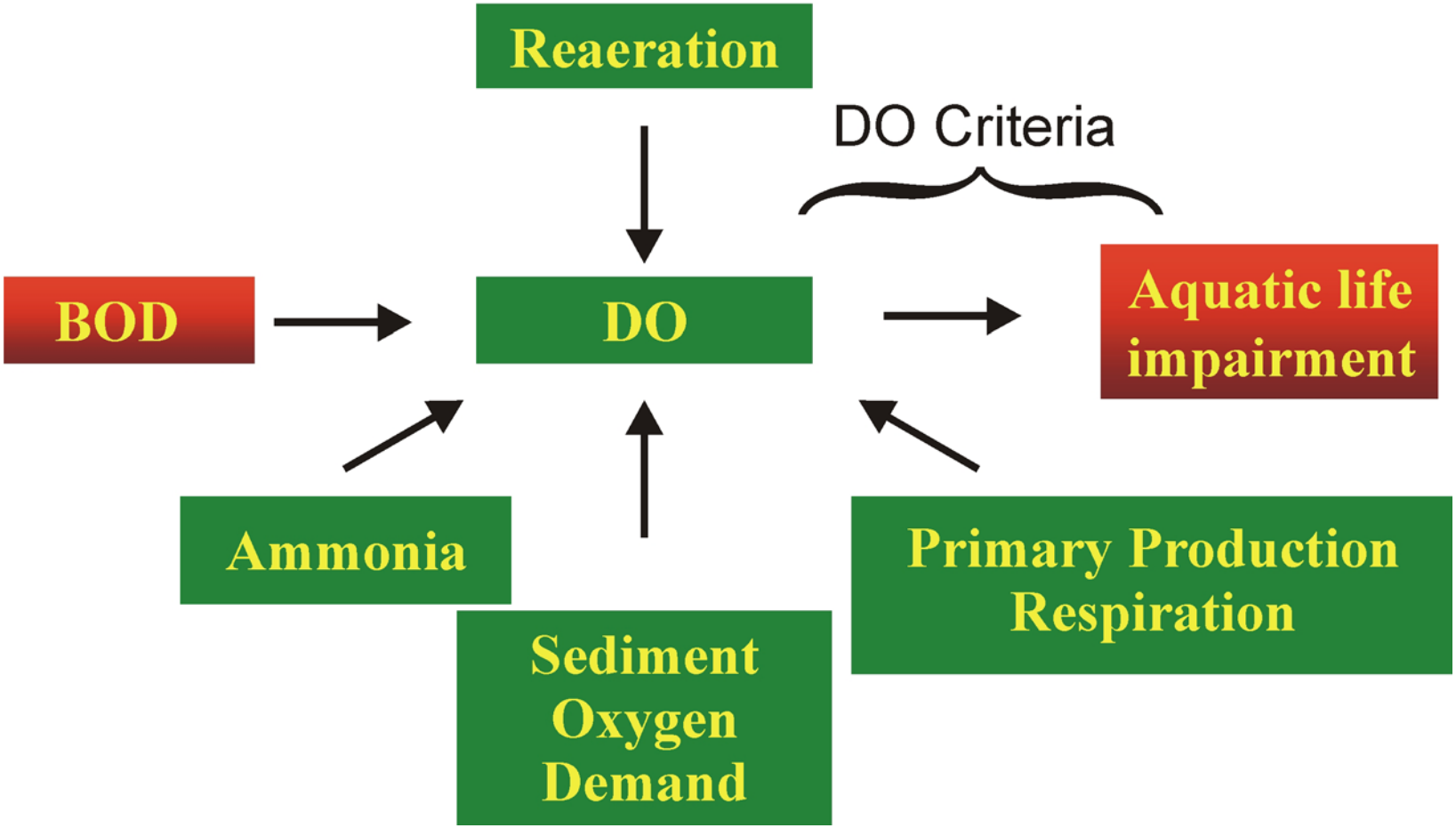




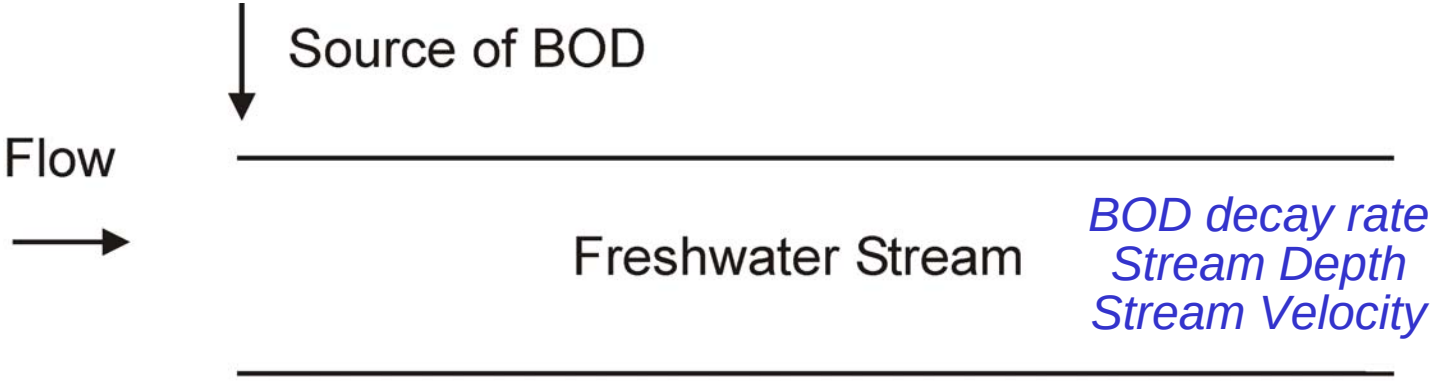
Empirical Approaches for Nutrient Criteria Derivation

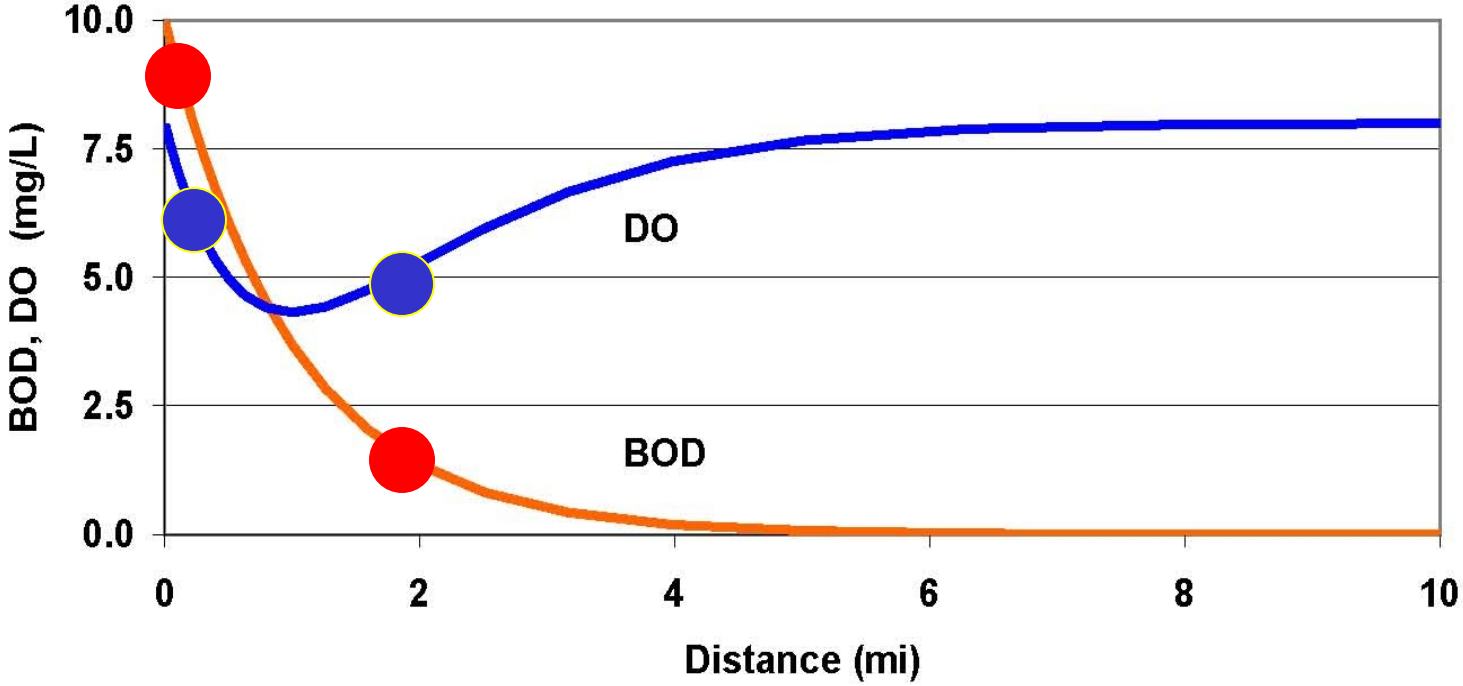

Nutrient Criteria
Light
Flow
Nutrients
Periphyton
Benthic biotic indices
Grazers
Sediment
Nutrient Criteria

BOD Criteria?

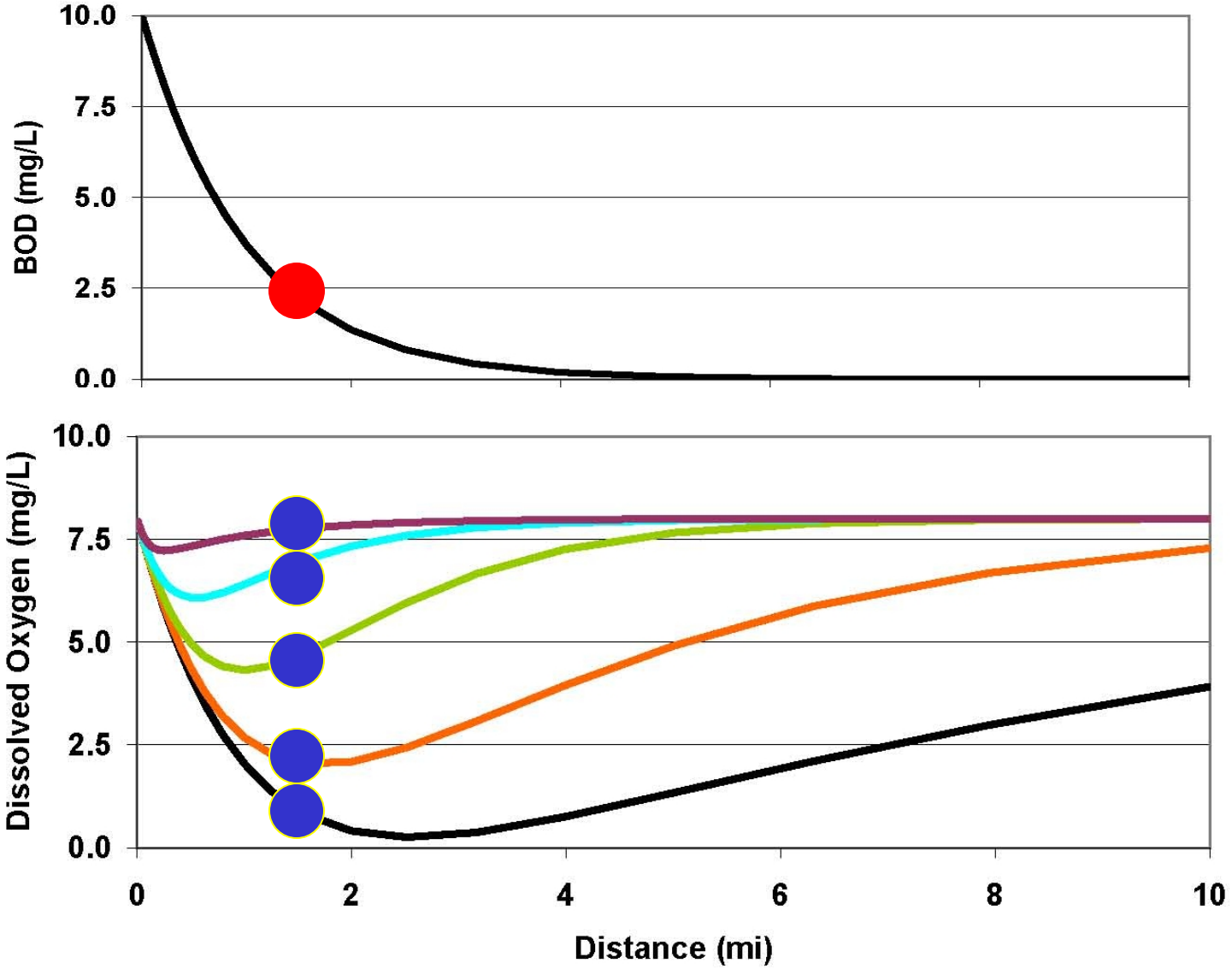


Why no BOD criteria?

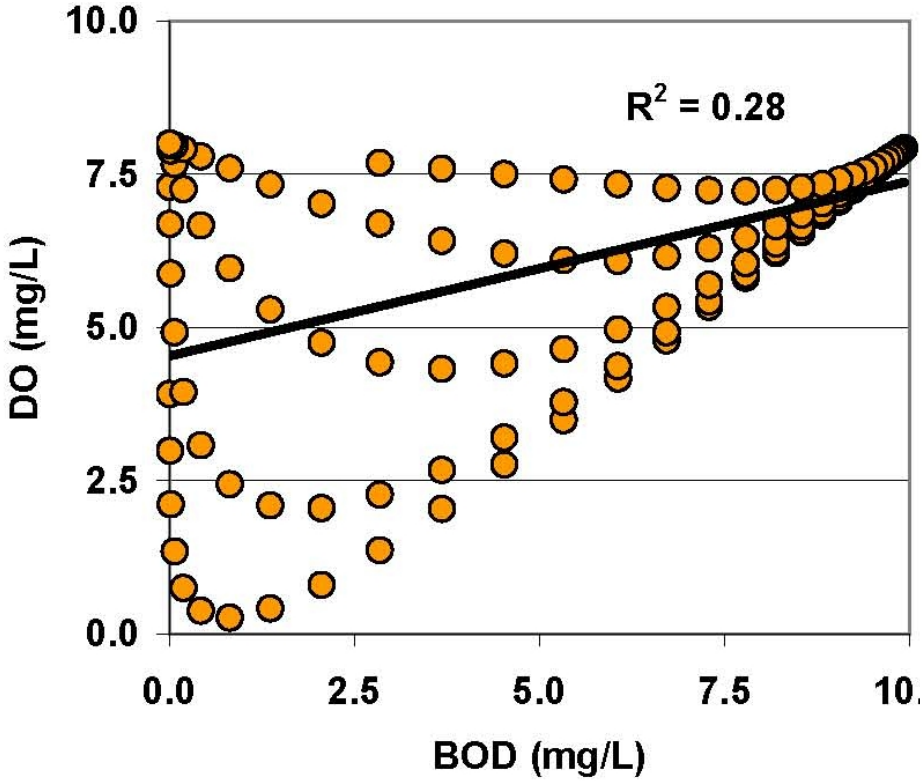


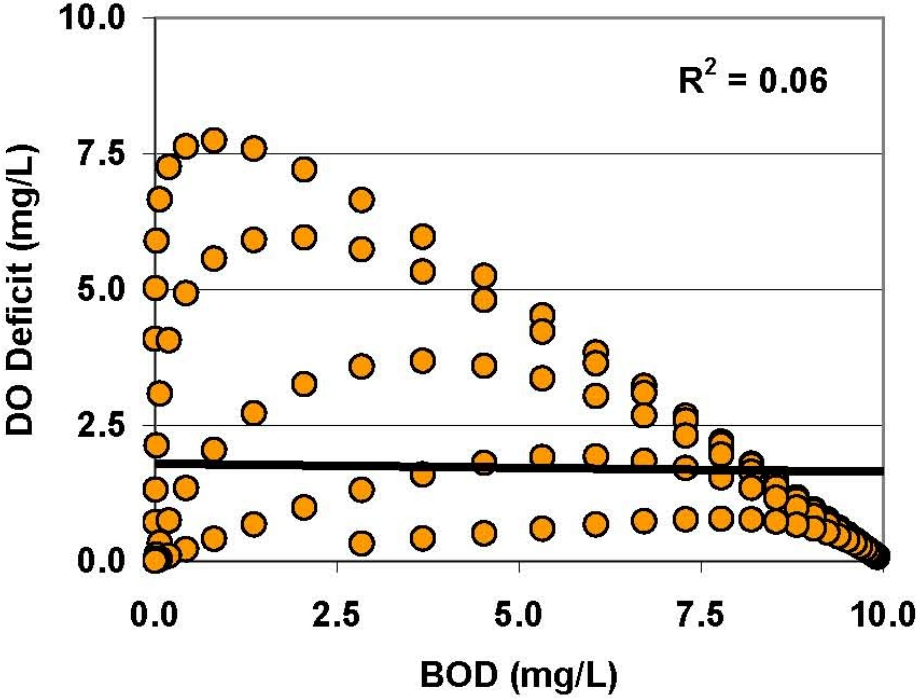


BOD Criteria – Predict DO
All Streams



BOD Criteria – Predict DO





Conclusions

- Nutrient criteria are an inappropriate National Water Quality Criteria
- There is no relationship between metrics of biological impairment and total nutrient concentrations that have general validity
- The analogy with BOD and DO demonstrates that there can be no mechanistic relationship

Recommendations

- Abandon the effort to develop nutrient criteria. The method is fatally flawed, and does not work
- Develop Appropriate Aquatic Life Criteria
  - Identify thresholds for use impairment metrics for lakes, streams, estuaries, bays, e.g.
  - Excessive Algae, Transparency Reduction, Biotic Indices
- Identify principle factors that contribute to impairment threshold
- Develop mechanistic models that account for principle contributing factors
- Evaluate solution (nutrient reduction, habitat improvement, etc) on a site-specific basis