STATISTICAL ANALYSIS FOR IMPROVED WATER QUALITY TARGETS WITH SPARSE DATA: DISSOLVED OXYGEN IN SOUTHWEST FLORIDA IMPAIRED WATERBODIES

Jeffrey Talbott and L. Donald Duke, Ph.D., P.E.
Department of Marine and Ecological Sciences, Florida Gulf Coast University

Abstract

Very low DO concentrations (below 4.0 mg/L) for periods that may be brief and frequent (daily) or of longer duration (months) are both causes for impairment; thus it is not clear how to distinguish impaired from well-functioning waters, or determine conditions to which impaired waters should be restored. Causes are complex, but one generally assumed cause is anthropogenic eutrophy, resulting in nutrient loads. Some waterbodies in developed coastal Collier and Lee Counties, impaired for low DO, have TMDLs recommending reduced nutrient loadings, with nutrient targets selected using the “reference waterbody” approach because target waters have little or no pre-impairment monitoring data. Selected targets, based on central tendencies of multiple reference waterbodies, assess historical nutrient conditions rather than DO; use reference waters unlike target waterbodies, and aggregate historical data without distinguishing among unlike conditions. Even in reference waterbodies, available data are of limited frequency and density; accessible sampling stations are in impacted waters, while minimally-impacted waters are inside untraveled Everglades wetlands. The present research characterizes existing sparse DO data using mechanism-driven grouping and statistical distributions, with a research objective to better characterize impaired conditions and specify numeric targets that will represent actual healthy conditions in the waterbody. Preliminary results demonstrate computed targets are highly sensitive to the selected period of record. TFEF’s central-tendency approach, absent purposeful grouping, yields TN targets of 0.74 mg/L for one-period of record, 0.2 mg/L for another. Findings also demonstrate that the four-month dry season has DO characteristics that are markedly different from the eight-month wet season, such that averaging the two does not provide an acceptable numeric target. Instead, two different numbers should be computed from the two seasons. This suggests that impairment should be characterized by frequent monitoring of various natural seasons, and not by measurements of central tendency.

Objectives

• Develop quantitative methods to characterize the water quality of healthy waters, in particular the flowing waters of south Florida.
• Assess the effectiveness of the reference waterbody approach; its specific advantages and limitations as applied to the four Everglades West Coast (EWC) waterbodies for which nutrient TMDLs were developed.
• ID meaningful statistics to characterize DO and TN that help to discriminate “unimpaired” waterbodies within the EWC basin.
• Apply developed methods to compute possible site-specific standards for impaired waters that better capture desired conditions within the TMDLs in the EWC: Gordon River, Imperial River, Hendry Creek.

Methods

• Use existing data to apply reference waterbody approach to EWC waterbodies.
• Investigate statistics for central tendency, seasonality, proportions, etc.
• Use available data:
  • Verified period (2000 – 2007)
  • All recorded data (1979 – 2010)
• Four reference waterbodies, 14 sampling stations

Task 1 – The reference waterbody approach for Everglades West Coast impaired waters
Task 2 – Use of central tendency to set targets for unimpaired conditions: problems, limitations
Task 3 – Influence of selected of historical period on target
Task 4 – Influence of seasonality on target

Results

• Variation among WBIDs in close geographic proximity suggests target WBIDs may also differ.
• Unimpaired conditions may not be captured by central tendency of reference waterbodies.
• Divergence in number of data points for each station suggests statistical approach should NOT treat all stations with equal weight.

Conclusions

Task 1 – Selecting target using median of multiple reference waterbodies is not meaningful because of variation. Suggests uncertainty, limitations, and questionable representativeness of place and time.
Task 2 – If reference WBIDs are representative of the eoregion, then a TMDL target of 0.74 is well-supported. However, this number can change and inadecacies in current data collection can be ID’d.
Task 3 – Temporal limitations imposed on a waterbodies can limit our understanding of nutrient variation. Data collections should robust information, non-duplicative samples, and reflect “current conditions” of the waterbody.
Task 4 – Trends in seasonality have a large impact on DO levels, as wet and dry seasons show markedly different impairment levels. Natural seasonal variation of DO should help drive policy decisions in regards to TMDL impairment levels.

References Cited

STORET: http://storet.dep.state.fl.us/ERMTpas/
“TMDL Report: Dissolved Oxygen TMDL for Hendry Creek, WBIDs 32788 and 32788L.”
“TMDL Report: Dissolved Oxygen TMDL for the Gordon River Extension, WBID 32789 (formerly 32706).”