

SUMMARY OF EVERGLADES PROTECTION AREA
DISSOLVED OXYGEN SITE SPECIFIC ALTERNATIVE CRITERIA

I. Issue:

Dissolved oxygen (DO) concentrations in the Florida Everglades routinely fall below the 5.0 mg O₂/L state Class III water quality criterion (Section 62-302.530, F.A.C.) due to natural background conditions. Establishment of site specific alternative criteria (SSAC) is appropriate in situations such as this.

II. Background:

The Everglades Forever Act (Section 373.4592(4)(e), F.S.) directs the Department and the South Florida Water Management District (SFWMD) to evaluate existing water quality standards applicable to the Everglades Protection Area (EPA) and Everglades Agricultural Area (EAA) canals. Furthermore, the Act specifies that “the Department’s evaluation of any other water quality standards must include the Department’s antidegradation standards”.

As documented in the Everglades Consolidated and Interim Reports (1999-2003) DO concentrations in the macrophyte and periphyton dominated marshes of the Florida Everglades routinely fall below the 5.0 mg O₂/L state Class III water quality criterion (Section 62-302.530, F.A.C.) on a daily basis and exhibit wide daily (diel) fluctuations due to natural processes of photosynthesis and respiration. Due to oxygen’s importance to life, it is essential to understand the processes that influence dissolved oxygen (DO) concentrations in the Everglades. In any aquatic system, water column DO concentrations are regulated by a variety of sources and sinks. In healthy systems, these controlling factors are balanced. In the Everglades open-water slough communities, where light penetration is high, photosynthetic activity by periphyton and submerged aquatic vegetation (P/SAV) result in increasing oxygen concentrations during daylight hours. At night, respiration and sediment oxygen demand (SOD) draw oxygen concentrations down. Under natural conditions, oxygen production exceeds respiration during the photoperiod, allowing the accumulation of an oxygen reserve, which prevents concentrations from decreasing to extremely low levels at night (< 1.0 to 2.0 mg/L). Conversely, cultural eutrophication results in increased productivity in the system and an increased accumulation of organic matter in the sediments. The breakdown of this organic matter increases sediment oxygen demand (SOD), which results in oxygen declines throughout the diel cycle. Additionally, nutrient enrichment in the Everglades dramatically reduces the native P/SAV community and increases emergent aquatic vegetation coverage. Emergent aquatic vegetation contributes little oxygen to the water column, while also shading periphyton and submerged aquatic vegetation, resulting in further reductions in DO production.

Chapter 62-160 of the Florida Administration Code provides for the consideration of natural background when evaluating attainment of water quality standards. Specifically, Paragraph 62-302.500(1)(f), states that

Notwithstanding the specific numerical criteria applicable to individual classes of water, dissolved oxygen levels that are attributable to natural background conditions or man-induced conditions which cannot be controlled or abated may be established as alternative dissolved oxygen criteria for a water body or portion of a water body. Alternative dissolved oxygen criteria may be established by the Secretary or a Director of District Management in conjunction with the issuance of a permit or other Department action only after public notice and opportunity for public hearing. The determination of alternative criteria shall be based on

consideration of the factors described in Rule 62-302.800(2)(a)-(d), F.A.C. Alternative criteria shall not result in a lowering of dissolved oxygen levels in the water body, water body segment or any adjacent waters, and shall not violate the minimum criteria specified in Rule 62-302.500(1), F.A.C. Daily and seasonal fluctuations in dissolved oxygen levels shall be maintained.

III. Recommendation:

To formally recognize the natural background conditions we recommend the adoption of a Site Specific Alternative Criterion (SSAC) for Everglades marsh DO. If adopted the SSAC would allow differentiation between impacted and background conditions, and provide more realistic information on ecosystem status than the existing Class III criterion.

Because a single value criterion does not adequately account for the wide natural daily (diel) fluctuations observed in the marsh, the SSAC should provide a mechanism to account for the major factors (e.g., time of day and season) influencing natural background DO variation in the Everglades. Department staff have developed an algorithm based on sample collection time and water temperature to model the observed natural sinusoidal diel cycle and seasonal variability. This model provides a lower DO limit and is described by the equation:

$$DO_{LL} = [-3.70 - [1.50 \cdot \sin(2\pi/1440 \cdot t_i) - (0.30 \cdot \sin(4\pi/1440 \cdot t_i))] + \frac{1}{(0.0683 + 0.00198 \cdot C_i + 5.24 \cdot 10^{-6} \cdot C_i^2)}] - 1.4 \quad (1)$$

where

DO_{LL} is the lower limit of the i^{th} annual DO measurement in mg/L

t_i is the sample collection time of the i^{th} annual DO measurement

C_i is the water temperature associated with the i^{th} annual DO measurement in °C

To fully account for seasonal and annual variability in marsh DO, compliance with the SSAC should be determined based on a comparison between the annual average measured DO concentrations and the average of model prediction for the given year. In other words, annual average observed DO at a monitoring station is to be compared to the average of all annual DO_{LL_i} predictions.

Adoption of this recommendation would allow differentiation between natural background DO conditions and areas with impaired DO function. Because the current criterion is clearly inappropriate for the Everglades marsh, it cannot provide such delineation and thus is not protective of the system. An appropriate SSAC will provide a much needed management tool and an enforceable standard.

When applied to Everglades monitoring data the recommended SSAC very acceptably balances type I (false positive) and II (false negative) statistical error rates. Specifically, it correctly identifies and passes sites exhibiting natural background conditions while also correctly identifying sites exhibiting low DO levels resulting from nutrient enrichment, groundwater infiltration, or other anthropogenic impacts.

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