FATE OF EVERGLADES DISSOLVED ORGANIC MATTER IN FLORIDA BAY

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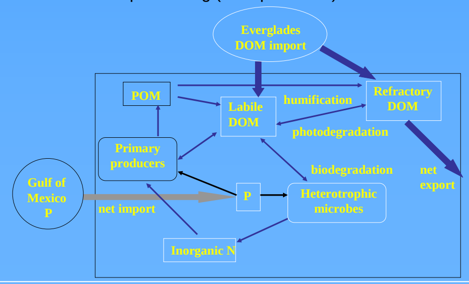
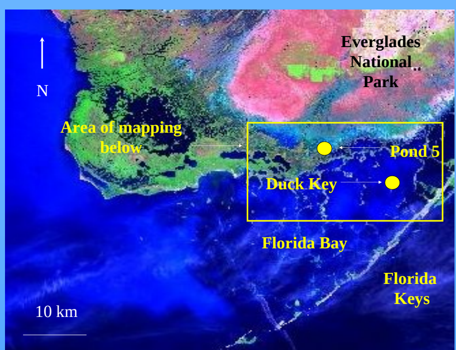
Introduction

Hydrologic restoration of the Everglades system will result in increased fresh water flow toward Florida Bay. Nutrients, especially dissolved organic nitrogen associated with this increased flow, may impact the Florida Bay ecosystem. Little is known of the fate and effects of Everglades dissolved organic matter (DOM) in Florida Bay. This is a key uncertainty regarding the effect of Comprehensive Everglades Restoration Plan (CERP) implementation on the Florida Bay ecosystem.

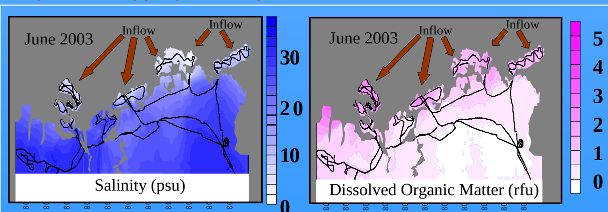
Conceptual Model of DOM processing (N steps in blue):



Study Area



Shipboard Mapping of Everglades' Outflows



Map above shows coverage area with boat tracts

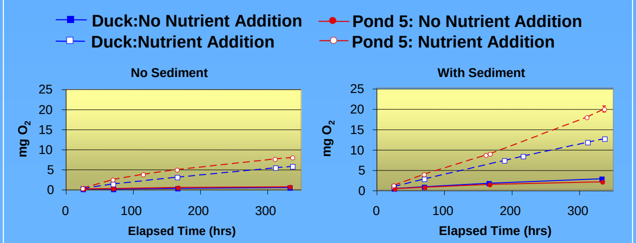
- Areas with high fresh water flow have low salinity and high concentrations of colored DOM (CDOM, measured by fluorescence)
- Fate and effect of this CDOM in the Bay is unknown
- DOM may be degraded via microbial and photochemical processes

Decomposition of Everglades' DOM in Florida Bay

14 Day Decomposition Experiment

An experiment was run for 14 days in duplicate 300 ml BOD bottles in the dark. Duplicate bottles were sacrificed at each time point. Source waters were Duck Key (8 mg/l DOC) and Pond 5 (10 mg/l DOC). Water was filtered (0.2 µm) to exclude ambient microbes. Salinity in Pond 5 water was increased to that of Duck water, using NaCl. An inoculum of Duck Key bacterioplankton (5 mls/l of GF/F filtrate) or benthic microbes (2 g/l of Duck Key sediment slurry) was added to each bottle. Experiments were run with or without nutrient amendments (5 uM phosphate plus 500 uM glucose final concentration) that were intended to ensure N limitation. Results are presented as the cumulative DO uptake per bottle in mg O_2/l.

Cumulative Oxygen Uptake per Liter, August 2003

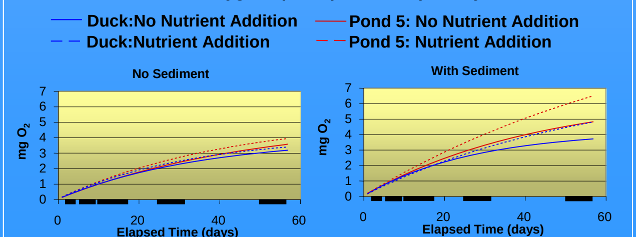


Results show strong nutrient effects - DO consumption was stimulated by nutrient additions. This effect was relatively greater in water column experiments than sediment experiments (12 fold increase in DO consumption vs. 4 -10 fold increase). DO consumption was higher with microbial decomposition of Pond 5 DOM than Duck Key DOM when nutrients were added. This difference was most pronounced in bottles with sediments, with DO demand with Pond 5 water nearly 2 fold that with Duck Key water.

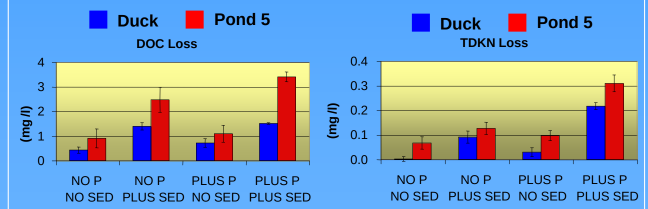
2 Month Decomposition Experiment

A two month experiment (April-May, 2004) was run with modifications to the original design. Incubations were done in quadruplicate 2.5 liter polycarbonate bottles, with sub-samples removed to triplicate 60 ml BOD bottles for DO uptake rate measurements. Duck Key (5.5 mg/l DOC) and Pond 5 (15 mg/l DOC) water, along with a sediment control in artificial seawater (ASW), were incubated with and without phosphorus (P) amendments. Rates from ASW controls were subtracted from the sediment addition treatments. Linear regressions of LN transformed oxygen uptake rates were modeled to yield the cumulative oxygen uptake in mg/l. Dark rectangles along X-axis represent time and duration of BOD incubations.

Cumulative Oxygen Uptake per Liter, April-May 2004



Once again, DO uptake (and therefore DOM consumption) was higher with Pond 5 water than Duck Key water, and more pronounced in the sediment plus P treatments. There was little P effect on water column DO consumption, and only a slight effect on the sediment treatments (1.3 fold higher). The loss of DOC and TDKN confirm these trends.



We calculated the minimum bioavailable carbon pool and the decay constants for this pool using linear regressions of LN transformed oxygen uptake rates. The bioavailable pool is a minimum because the day 1 data rates were dropped due to experimental errors. The magnitude of this negative bias in our estimate is unknown. The decay rates refer to the bioavailable carbon pool, not the total carbon pool. Data are reported as mean ± standard deviation.

	Duck Key Decay Constant k (d^{-1})		Duck Key Minimum Bioavailable (mg C /l)		Pond 5 Decay Constant k (d^{-1})		Pond 5 Minimum Bioavailable (mg C /l)	
No P, No Sed	0.028	±0.006	1.54	± 0.13	0.021	±0.007	2.04	± 0.30
No P, Plus Sed	0.037	±0.007	1.64	± 0.19	0.023	±0.009	2.68	± 0.57
Plus P, No Sed	0.031	±0.004	1.58	± 0.23	0.024	±0.005	2.06	± 0.33
Plus P, Plus Sed	0.018	±0.004	2.95	± 0.40	0.013	±0.002	4.83	± 0.66

Multifactor ANOVA's were run to examine how decay rates (k d^{-1}) were affected by the main factors (site, P, sediment) and interactions among these factors. These analyses suggests there was a significant difference between sites (Duck k > Pond 5 k) and a sediment by P interaction effect ($p < 0.01$, df=24). No other significant differences were noted. In addition, the sediment plus P treatments at both sites had lower decay constants, but a larger bioavailable carbon pool, suggesting that P may enhance microbial decay of less labile DOM.

Conclusions

- DOM is transported from the Everglades to Florida Bay with fresh water.
- CDOM in Florida Bay decreases rapidly with distance from the shore line.
- During two week experiments, microbial respiration increased with Everglades DOM additions when P and C were readily available.
- During two month experiments, microbial respiration once again increased with Everglades DOM additions and enhanced further with sediment additions.
- Increased P levels may allow the microbial decomposition of less labile DOM.
- At least 14% of the DOM from Pond 5 and 28% of the DOM from Duck Key appears to be bioavailable. Bioavailable DOM concentrations are similar in this pond and eastern Florida Bay and have similar decay rates that are surprisingly fast (~2% / day).
- These results indicate that Everglades DOM decomposition may be more rapid at the sediment-water interface and during resuspension events than in clear Florida Bay waters, especially in central and western parts of the Bay where P levels are relatively high.
- The effects of changing fresh water flow on the Florida Bay ecosystem depend upon changes in DOM inputs, bioavailability, decay rates and water residence times in different regions of Florida Bay