Spatial and Water Source Effects on Ecosystem-Level Processes in Everglades Marsh

Periphyton Assemblages

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Abstract

Everglades restoration efforts have included the removal of a major canal levee thereby increasing freshwater through the adjacent oligotrophic Southern Everglades marsh and mangrove wetland to Florida Bay. We are currently monitoring sites along marsh transects across the canal, and have sampled biweekly during the wet season since August 1998. Periphyton dynamics are estimated with whole system metabolism experiments by measuring dissolved oxygen changes in light and dark bottles. The focus of our work is to investigate patterns and magnitudes of metabolic responses to novel local system restoration to spatial and water source effects. Additionally, we are using a spatially extensive network of study sites across the urban Everglades, with the study sites and their spatial arrangement. Periphyton biomass was incubated with ambient water and water from other sites along the transects. Chlorophyll a, chlorophyll b, and total phytoplankton biomass were measured using a fluorometer. The data indicate significant landscape variation and water source effects. Future work includes comparing these metabolic responses with nutrient concentrations to reveal nutrient effects.

Figure 1: Location of the study sites in Everglades LTER

Introduction

Periphyton mat - an assembly of algal and bacterial communities, characteristic of the oligotrophic Everglades

Significance
- nutrient cycling (functionally the microbial loop)
- susceptible to small changes in nutrient concentrations

Site description (see figure 1)
- 2 transects (approx. 10 km apart)
- generally North to South from the canal into the mangrove ecotone
- 5 study sites located along the transects (approx. 2 km apart)
- East transect includes 2 sites:
  - canal-marsh interface
  - mangrove/mangrove marsh
- West transect includes 3 sites:
  - canal-marsh interface
  - mangrove-dominated marsh
  - mangrove/mangrove marsh

Methods

Metabolic rates
- dissolved oxygen change in light and dark BOD bottles (see figure 2)
- Gross system productivity (GPP)
- Net system productivity (NP)
- Respiration (Resp)

Background study
- to reveal and compare seasonal patterns and magnitudes of metabolic rates
  - biweekly during the wet season (Aug-Dec) since Aug 1998
  - periphyton is incubated in ambient water for all sites
  - in triplicate
  - ANOVA then Fisher's PLSD to evaluate significant differences

Transplant study
- to determine if significant differences of metabolic rates (from the background study) are caused by water source or periphyton source
  - Day 1998 and 1999 conjunction with background study
  - periphyton from all sites is incubated with water from all sites
  - in triplicate
  - ANOVA then Fisher's PLSD to evaluate significant differences

Results and Discussion

P/R Ratios (see table 1)
- mangrove/mangrove sites had lower P/R ratios
  - both canal interface and mangrove dominated sites had considerably higher P/R ratios

GPP (see figure 3)
- Background study
  - East transect: mangrove/mangrove sites was significantly higher than canal interface site (p=0.0002)
  - West transect: mangrove/mangrove sites was significantly higher than both canal interface and savanna sites (p=0.0001) and (p=0.0001), respectively
- Transplant study: significant water source effect (p=0.0001)

NPP (see figure 4)
- Background study
  - West transect: canal interface site was significantly higher than both savanna and mangrove/mangrove sites (p=0.0002) and (p=0.0025), respectively
  - Tranplant study: significant periphyton source effect (p=0.0146)

Resp (see figure 5)
- Background study
  - East transect: mangrove/mangrove sites was significantly higher than canal interface site (p=0.0282)
  - West transect: mangrove/mangrove sites was significantly higher than both canal interface and savanna sites (p=0.0024) and (p=0.0116), respectively
  - Tranplant study: significant water source effect (p=0.0021)

To summarize, the low P/R ratios and high GPP rates of the mangrove/mangrove sites were a result of high respiration rates. The transplant study showed that increased respiration rates were due to water treatment, and not periphyton treatment. Since the distance from the canal to both the West transect and mangrove/mangrove-dominant sites and the East transect mangrove/mangrove sites are similar, it is unlikely that these water source effects were caused by canal inflows. We hypothesize that these water source effects were a result of the sites' proximity to mangrove vegetation. Specifically, we believe that the dissolved organic matter flushed from mangrove leaf litter may contribute to the regulation of periphyton metabolic rates. Data taken from a recent mangrove leaf-teaching experiment (Figure 6) show substantial losses of organic carbon and phosphorus from individual mangrove leaves to the water column. These losses were qualitatively indicated by the change in water color during the first 10 days of the experiment (Figure 7). It is our contention that phosphorus and organic carbon leached from decaying mangrove leaf litter fueled the high respiration rates unique to the mangrove/mangrove sites. Future work will address the specific effect of mangrove leachate on periphyton metabolism.

From the transplant study we saw that NPP rates were not affected by water treatment, but instead displayed a significant periphyton treatment effect. We considered the possibility of this periphyton treatment effect as being related to the nutrient content of the periphyton mat. However, there was no change in the C/N/P ratio of the periphyton mat (see Figure 8). Instead, we view that higher NPP rates at the West transect canal-marsh interface site may have been a result of a shift in species composition along the canal-erosion gradient. (Insert future work comments)

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Table 1: P/R ratios (mean±SE) for all five study sites, data collected from 1998

<table>
<thead>
<tr>
<th>Site</th>
<th>Mean P/R</th>
<th>SE</th>
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<tbody>
<tr>
<td>East Transect</td>
<td>0.75</td>
<td>0.06</td>
</tr>
<tr>
<td>Canal Interface</td>
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<td>0.40</td>
</tr>
<tr>
<td>West Transect</td>
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<td>0.40</td>
</tr>
<tr>
<td>Mangrove-Savann</td>
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<td>0.08</td>
</tr>
<tr>
<td>Mangrove-Mangro</td>
<td>1.14</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Figure 2: Diagram and equation for determining metabolic rates

Figure 3: Mean GPP and standard error, data from background study during 1998

Figure 4: Mean NPP and standard error, data from background study during 1998

Figure 5: Mean Resp and standard error, data from background study during 1998

Figure 6: Change in water color due to mangrove leaf litter

Figure 7: Change in water color due to mangrove leaf litter