Environmental Variance and Dispersal Explain Benthic Diatom Spatial and Temporal Beta Diversity in the Florida Everglades

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Florida Coastal Everglades LTER
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Introduction
Introduction: Everglades restoration

- Restore oligotrophic freshwater flow
- Mitigate effects of saltwater intrusion
- Oligohaline ecotone environmental & species diversity
Introduction: FCE LTER

- Ecotone primary producer composition regulated by phosphorus, salinity, hydrology
Introduction: Periphyton

• Periphyton roles

• Composition
Introduction: Diatoms

- Unicellular, siliceous microalgae

- Sensitive to environmental & spatial heterogeneity

Freshwater

Oligohaline
Introduction: Diatoms

- Indicators of water quality changes
Introduction: Beta diversity ($\beta$)

- Metacommunity framework
- Species turnover
  - Difference in species composition between:
    - 2+ local communities
    - Local and regional communities
- Spatial and temporal
Introduction: Microbial community structure

- Ecosystem structure & function

- Controls on microbial assembly unresolved
  - Particularly in Everglades ecotone
    - Sensitive to changes from SLR
Objectives
Objectives: Q$_{1}$ and H$_{1}$

- Q$_{1}$: How do spatial and temporal diatom β compare among freshwater and oligohaline?

- H$_{1}$: Oligohaline higher than freshwater
Objectives: $Q_2$ and $H_2$

- $Q_2$: What is natural environmental variance in freshwater and oligohaline?

- $H_2$: Oligohaline higher than freshwater
Objectives: $Q_3$ and $H_3$

- $Q_3$: What environmental variables explain freshwater and oligohaline $\beta$ across sites and years?

- $H_3$: Both $\rightarrow$ Phosphorus & conductivity
  Freshwater $\rightarrow$ Hydroperiod & periphyton quantity
  Oligohaline $\rightarrow$ Periphyton quality
Methods
Methods: Site selection

- CERP MAP sites
  - 2006 – 2013
  - 8 freshwater
  - 8 oligohaline

Saha et al. 2011
Methods: Site selection

- CERP MAP sites
  - 2006 – 2013
  - 8 freshwater
  - 8 oligohaline

CERP MAP oligohaline (O) and freshwater (Δ) sites
Methods: Data collection

- Hydrology
  - Hydroperiod
  - Conductivity
- Periphyton quantity
  - Biovolume
  - Ash-free dry mass
- Periphyton quality
  - % Phosphorus
  - % Organic content
- Diatom composition
Methods: Data analysis

• Tests of homogeneity of dispersion
  – Variability of \( \beta \)

• “BEST” analyses
  – Variables explaining \( \beta \)

• Variation partitioning
  – Categorize explanatory factors of \( \beta \)
Results
**H₁ Results: Species dispersion**

- Higher spatial $\beta$ in oligohaline
- Low temporal $\beta$ difference between regions
**H₂ Results: Environmental dispersion**

- Higher spatiotemporal variability in freshwater

![Graph showing environmental spatial and temporal dispersion for freshwater and oligohaline years/sites.](image-url)
### H₃ Results: Explanations of β

<table>
<thead>
<tr>
<th>Region</th>
<th>ρ</th>
<th>Explanatory Variables (no order)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>0.599</td>
<td>COND, BIOV, TP, OC, WD</td>
</tr>
<tr>
<td>Freshwater</td>
<td>0.373</td>
<td>BIOV, COV, AFDM, WD, HYDRO</td>
</tr>
<tr>
<td>Oligohaline</td>
<td>0.379</td>
<td>OC, DM, WD, HYDRO</td>
</tr>
</tbody>
</table>

- **Both** → Conductivity & phosphorus
- **Freshwater** → Hydroperiod & periphyton abundance
- **Oligohaline** → Periphyton quality & hydroperiod
Discussion

- Both regions $\rightarrow$ environmental controls?
  - Low dispersal between regions?

- Freshwater $\beta$ $\rightarrow$ dispersal limitation?
  - Low environmental correlation despite high variability

- Oligohaline $\beta$ $\rightarrow$ species interactions?
  - Low environmental correlation and variability
Ongoing and future work
Discussion: Ongoing and future work

- Contributions of dispersal-based factors
- Species interactions
- Diatom & periphyton community structure change
- Using diatoms to monitor ecotone change
Conclusions
Conclusions

- More species turnover across oligohaline region
- Low temporal change within sites in both regions
- More environmental variance in freshwater
- Regional $\beta$ explained by environmental differences
- Local $\beta$ likely influenced by dispersal & species interactions
Questions?

Even the fish are frightened, as the weird ray strikes the one-celled diatom, making it... grow... grow!

Stephanocyclyclus meneghiniana??