Restoring Ecosystem Function in the P-Enriched Everglades: Improving Habitat for Wildlife

Mark I. Cook
Lead Scientist
Sue Newman
Section Leader
Everglades System Assessment, SFWMD

Scot Hagerthey*
Ecologist
National Center for Environmental Assessment

R. Mac Kobza *
Wildlife Biologist
Bolder County Parks & Open Space

* Former SFWMD Employee

International Wetlands Conference (INTECOL)
June 3-8, 2012
1. Current environmental conditions: dense emergent vegetation & P storage

2. Create openings → increased habitat complexity and quality → simulate ridge & slough?

3. Jump start restoration towards native Everglades sawgrass ridge and slough landscape?
Ecosystem-Scale Experiment: Cattail Habitat Improvement Project

General Approach

1. Create & maintain large open plots (6.25 ha)

2. Measure: Nutrient storage & cycling
   Ecosystem metabolism
   Food web/community responses
   C:N:P stoichiometry
Primary Objectives

1. To test whether creating openings within densely vegetated areas will sufficiently alter trophic dynamics such that wildlife diversity and abundance is increased.

2. Assess to what extent the structure and function of these created open areas compare to the natural Everglades.
Objective 1: Vegetation Removal

2 Treatments (Control & Open)
2 Regions (Enriched & Transitional)
3 Years (2007 – 2009)
3 Replicates

Objective 2: Nutrient Enrichment

3 Regions (Enriched, Transitional, Reference)
3 Years (2007 – 2009)
3 Replicates
open plot

vegetated control plot
Hypotheses

Objective 1: Relative to emergent controls, open plots will:

- Experience greater production (biomass) of aquatic fauna
- Support a greater proportion of herbivores and omnivores
- Promote increased nutritional quality (C:P) of aquatic fauna
- Support increased avian foraging

Objective 2: Relative to oligotrophic reference, open plots will:

- Experience greater production (biomass) of aquatic fauna
- Support a greater proportion of herbivores and omnivores
- Promote increased nutritional quality (C:P) of aquatic fauna
- Support increased avian foraging
## Habitat Characteristics of Plots
*(mean ± S.D., 2007-2009)*

<table>
<thead>
<tr>
<th></th>
<th>Enriched</th>
<th></th>
<th>Transitional</th>
<th></th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
<td>Open</td>
<td>Control</td>
<td>Open</td>
<td></td>
</tr>
<tr>
<td>Live Biomass</td>
<td>712±265</td>
<td>103±229</td>
<td>561±273</td>
<td>109±128</td>
<td>37±13</td>
</tr>
<tr>
<td>(g m⁻²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent Emergent</td>
<td>98</td>
<td>13</td>
<td>99</td>
<td>10</td>
<td>35</td>
</tr>
<tr>
<td>Periphyton</td>
<td>3±8</td>
<td>30±41</td>
<td>9±13</td>
<td>26±31</td>
<td>997±536</td>
</tr>
<tr>
<td>(g m⁻²)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved O₂</td>
<td>1.4±1.0</td>
<td>3.9±3.6</td>
<td>1.9±1.3</td>
<td>4.2±3.1</td>
<td>6.8±2.5</td>
</tr>
<tr>
<td>(mg L⁻¹)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vegetation treatment resulted in an ecosystem dominated by SAV/openwater
Vegetation Removal Influenced the Production of Aquatic Fauna but Effects Differed by Year & Region

- **Time series of combined biomass (mean±S.D.) of small fish & decapods**

- **Enriched**
  - Biomass similar in EO and EC (LS Means $P = 0.29$)

- **Transitional**
  - Biomass 1.6x greater in TO than TC (LS Means $P = 0.02$)

---

**3-way ANOVA (blocked)**

<table>
<thead>
<tr>
<th>Source</th>
<th>Log Biomass</th>
<th>d.f.</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region x Treatment</td>
<td>1,60</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Treatment x Year</td>
<td>2,60</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Region x Year</td>
<td>2,60</td>
<td>0.01</td>
<td></td>
</tr>
</tbody>
</table>
Vegetation Removal Promoted Greater Faunal Production Relative to Oligotrophic Reference

Time series of combined biomass (mean±S.D.) of small fish & decapods

2-way ANOVA

<table>
<thead>
<tr>
<th>Source</th>
<th>Log Biomass</th>
<th>d.f.</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region x</td>
<td>4.45</td>
<td></td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Water Year</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Biomass similar in EO & TO (LS Means $P = 0.48$)

Biomass 6.8x greater in EO/TO than reference (LS Means $P < 0.0001$)
Open Plots were Dominated by Herbivores and Omnivores

NMDS Ordination of Faunal Biomass

MRPP (control versus open plots):

\[ A = 0.14, \quad P < 0.001 \]

Biomass (mean±S.D.) of 5 species accounting for 83% of community dissimilarity
Vegetation Removal did not Improve the Quantity or Quality of Individuals

<table>
<thead>
<tr>
<th></th>
<th>Sailfin molly</th>
<th>Crayfish</th>
<th>fish relative to crayfish</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EC</td>
<td>EO</td>
<td>EC</td>
</tr>
<tr>
<td>C %</td>
<td>44.0 ± 1.9</td>
<td>47.0 ± 2.7</td>
<td>35.4 ± 4.2</td>
</tr>
<tr>
<td>N %</td>
<td>10.2 ± 0.7</td>
<td>10.4 ± 1.2</td>
<td>8.1 ± 1.0</td>
</tr>
<tr>
<td>P%</td>
<td>2.6 ± 0.1</td>
<td>2.2 ± 0.5</td>
<td>1.3 ± 0.2</td>
</tr>
<tr>
<td>C:P (quality)</td>
<td>43.5 ± 3.1</td>
<td>53.0 ± 12.6</td>
<td>74.5 ± 21.2</td>
</tr>
<tr>
<td>Calories (kcal ind⁻¹)</td>
<td>0.93 ± 0.4</td>
<td>0.36 ± 0.38</td>
<td>1.31 ± 1.16</td>
</tr>
</tbody>
</table>

Openings improved ecosystem function through improved quality & diversity of the prey community.
Quantity & Quality of Individuals were Greater in Eutrophic Openings than in Oligotrophic Everglades

<table>
<thead>
<tr>
<th></th>
<th>Sailfin molly</th>
<th>Crayfish</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EO</td>
<td>Reference</td>
</tr>
<tr>
<td>C %</td>
<td>47.0 ± 2.7</td>
<td>53.7 ± 2.6</td>
</tr>
<tr>
<td>N %</td>
<td>10.4 ± 1.2</td>
<td>7.9 ± 1.6</td>
</tr>
<tr>
<td>P%</td>
<td>2.2 ± 0.5</td>
<td>1.1 ± 0.1</td>
</tr>
<tr>
<td>C:P</td>
<td>53.0 ± 12.6</td>
<td>126 ± 19.7</td>
</tr>
<tr>
<td>Calories (kcal ind⁻¹)</td>
<td>0.36 ± 0.38</td>
<td>0.26 ± 0.29</td>
</tr>
</tbody>
</table>

![Bar chart showing average total & proportional mass of phosphorus/m²](image.jpg)

- **Gambusia holbrooki**
- **Jordanella floridae**
- **Palaemonetes paludosus**
- **Poecilia latipinna**
- **Procambarus fallax**
Vegetation Removal Considerably Improved Foraging Conditions for Wading Birds

Invertivorous white ibis dominated (>50%) the wading bird community in open plots.
Dense Cattail is an Important Habitat for Listed Species of Rails & Bitterns

Consider employing a mosaic of openings and dense vegetation as a restoration strategy?
Summary

• Eutrophication increases secondary production in the oligotrophic Everglades (greater biomass of crayfish in the cattail region).

• But invasive emergent vegetation creates a physical barrier to many predators.

• Active management (openings)
  – Maintained abundance and biomass
  – Resulted in a compositional shift towards a higher quality, more varied prey resource

• Openings are therefore different in function from the oligotrophic Everglades but provide benefits by providing abundant high quality prey.

• Cattail is an important habitat for rails and bitterns.
With thanks to:

**Staff** - J. Beerens, B. Bellinger, R. Bennett, E. Call, H. Herring, S. Hohner, M. Jacoby, F. Laroche, M. Manna, L. Rodgers, K. Seitz, R. Shuford, S. Smith, J. Zimmerman

**Aerial support** - SFWMD, Aircoastal and Helicopters Applicators Inc

**Fire** - Florida Fish and Wildlife Conservation Commission

**UF** - A. Wright

And all other conscripts too numerous to name!