The effects of vegetation and water depth on wading bird foraging habitat selection and foraging success in the Everglades

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Prey Availability

- Prey availability limits the success of avian populations
- Decreases in prey availability have had detrimental effects on wading bird populations worldwide (Butler 1994, Hafner 1997)
- Little research on specific aspects or mechanisms
Prey Availability

- Prey density is often used as a surrogate for prey availability
- Availability is a combination of prey density and vulnerability to capture

- Vulnerability: Affected by characteristics of the predator, prey, and environment
Objectives

- Quantify the effects of environmental features on prey availability by measuring foraging habitat selection and foraging success

1. 2007: water depth and submerged aquatic vegetation

2. 2008: water depth and emergent vegetation
Study Site
A.R.M. Loxahatchee National Wildlife Refuge
Loxahatchee Impoundment Landscape Assessment project (LILA)

- Experimental facility simulates a landscape response
- Physical features mimic the Everglades
Study Site

- 10 × 10 m enclosures
- Allows for controlled prey and vegetation
- Replication:
  - Two macrocosms
  - Two replicates/experiment
Treatment variables

• Water depth
  • Shallow slough (10 cm)
  • Deep slough (25 cm)

• Vegetation

• 2007: Submerged Aquatic Vegetation
  • Bladderwort (*Utricularia* sp.)
  • 0, 2, 5 L/m²

• 2008: Emergent vegetation
  • Spikerush (*Eleocharis* sp.)
  • None, Sparse, Moderate densities
Fixed variables

Decoys

- Great Egrets
- Snomingos

Fish

- *Gambusia affinis*
- 20 fish/m²
- Used mark-recapture with VIE to estimate fish populations and restock daily
Data collection

• Foraging habitat selection
  • Use vs. availability measured using Manly’s standardized selection index

• Foraging success
  • Foraging birds were videoed and time-activity budgets were conducted using Etholog 2.2 (Ottoni 2000)
  • Capture rates and efficiencies analyzed in SAS using ANOVA
Foraging habitat selection

Tricolored Heron  White Ibis  Great Egret  Little Blue Heron
Snowy Egret  Glossy Ibis  Roseate Spoonbill  Wood Stork
SAV Results: Foraging Habitat Selection

- Birds prefer shallow water
- Trend exaggerated throughout the season

<table>
<thead>
<tr>
<th>Depth</th>
<th>January</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 cm</td>
<td>0.58</td>
<td>1.0</td>
</tr>
<tr>
<td>25 cm</td>
<td>0.42</td>
<td>0.0</td>
</tr>
</tbody>
</table>
SAV Results: Foraging Habitat Selection

- Birds selected enclosures with SAV

<table>
<thead>
<tr>
<th>SAV</th>
<th>January</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 L/m²</td>
<td>0.19</td>
<td>0.32</td>
</tr>
<tr>
<td>2 L/m²</td>
<td>0.36</td>
<td><strong>0.48</strong></td>
</tr>
<tr>
<td>5 L/m²</td>
<td><strong>0.45</strong></td>
<td>0.20</td>
</tr>
</tbody>
</table>
SAV results: Foraging success

- Significant differences based on the season (Jan or April replicate)
- Environmental factors had little affect on foraging success

<table>
<thead>
<tr>
<th>Capture Rate</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Season</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Water depth</td>
<td>0.99</td>
</tr>
<tr>
<td>SAV density</td>
<td>0.28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capture Efficiency</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Season</td>
<td>0.057</td>
</tr>
<tr>
<td>Water depth</td>
<td>0.046</td>
</tr>
<tr>
<td>SAV density</td>
<td>0.20</td>
</tr>
</tbody>
</table>
SAV results: Foraging success

- Great Egrets had higher foraging success in deeper water
- Great Egrets may prefer deeper water (Moreno et al. 2004)
- Great Egrets have a lower GUD than other species (Gawlik 2002)
Emergent vegetation: Foraging habitat selection

- Birds selected enclosures with shallow water and sparse vegetation

<table>
<thead>
<tr>
<th>Water Depth</th>
<th>Emergent Vegetation Density</th>
<th>Standardized Selection Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shallow</td>
<td>None</td>
<td>0.302</td>
</tr>
<tr>
<td>Shallow</td>
<td>Sparse</td>
<td>0.404</td>
</tr>
<tr>
<td>Shallow</td>
<td>Moderate</td>
<td>0.208</td>
</tr>
<tr>
<td>Deep</td>
<td>None</td>
<td>0.037</td>
</tr>
<tr>
<td>Deep</td>
<td>Sparse</td>
<td>0.030</td>
</tr>
<tr>
<td>Deep</td>
<td>Moderate</td>
<td>0.019</td>
</tr>
</tbody>
</table>
Emergent vegetation: Foraging success results

- Because of strong selection for shallow water, vegetation was the only treatment variable.
- Vegetation density had little affect on foraging success.

<table>
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<tr>
<td>Vegetation Density</td>
<td>0.19</td>
</tr>
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<table>
<thead>
<tr>
<th>Capture Efficiency</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation Density</td>
<td>0.29</td>
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</tbody>
</table>
Discussion: SAV and Emergent vegetation

- In both years, birds showed a preference for shallow water and intermediate levels of vegetation density

- Differences between 2007 and 2008
  - 2007: Seasonal differences
  - Increased foraging success in April
    - Change in needs of birds
      - Pre-breeding vs. breeding season birds
      - Higher foraging success during breeding season
Discussion

• Selection for shallow water is consistent with other studies

• Prior studies show mixed results regarding vegetation

• Kersten et al. (2001) found that fish were pushed into open patches during early morning hours because of overnight respiration by macrophytes

• Vegetation may calm the water surface, thus increasing visibility

• Vegetated areas may have higher prey densities
Discussion

- Birds showed strong selection patterns but treatments did not appear to affect foraging success
- Contradicts studies of piscine predators foraging in vegetation
- Why select for shallow water and vegetated habitat?
Why select for shallow water and vegetated habitat?

• Anticipated elevated prey densities
  • Dry season recession in the Everglades may concentrate prey in shallow water
  • Prey densities often higher within vegetation (Dvorac and Best 1982, Diehl 1988, Rozas and Odum 1988)
  • No difference here because of controlled fish densities
• Other possibilities: ecological trap theory (Battin 2004), high prey density may have resulted in a threshold response (Holling 1959), intra- and interspecific differences between birds (age, relative satiation, etc.)
Applications to Everglades Restoration

• One of the first studies to investigate the linkages between wading birds, fish, and habitat features

• Understanding how upper trophic level animals respond to hydrologic manipulations is essential in using these species to set targets or track restoration progress
Applications to Everglades Restoration

• CERP has an emphasis on getting the water right, and changes to hydrology are known to affect vegetative communities

• Changes in hydrology and vegetative communities could affect the attractiveness of habitat to foraging birds

• Remains uncertain how this may affect wading bird population dynamics

• There is a wide gradient of habitat features that provide suitable foraging habitat for wading birds
Acknowledgments

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Dedicated in memory of Gareth Akerman, Phil Heidemann, and Damion Marx