Patterns of peat elevation in the ridge-slough mosaic

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Alternative States

Ridge
Higher Peat Elevation
Higher Productivity
Decreased Periphyton

Slough
Lower Peat Elevation
Lower Productivity
Increased Periphyton

Increased hydroperiod
Increased water depth

Decreased hydroperiod
Decreased water depth
Question 1

Does the ridge-slough mosaic express alternative stable states?
Predictions

- \(P_{1-1}\): There is a bimodal distribution of water depths.

- \(P_{1-2}\): Veg communities show fidelity to discrete water depth distributions.

- \(P_{1-3}\): Spatial autocorrelation is high at near-point neighbors, decreases with increasing distances.
Question 2

- How do the underlying characteristics of ridge-slough change with hydrologic modification?
Predictions

• $P_{2-1}$: Bimodality is lost with increasing hydrologic impairment.

• $P_{2-2}$: Occurrences of communities alters with hydrologic modification.

• $P_{2-3}$: Water depth variance increases with hydrologic impairment within communities.

• $P_{2-4\&5}$: Anisotropy and spatial structure decline with hydrologic impairment.
Sampling
Analyses - Vegetation

Ridge: C. jamaicense

Wet Prairie: Various graminoids, rushes, sedges

Slough: N. odorata, Utricularia spp
Anisotropy

- Property of being directionally dependent
- Difference in a variable when measured along different axes.
Spatial Structure

- Principle of organization

- Amount of spatial variability not explained by human or natural error

Autocorrelation

• Tool for finding repeating patterns

• Correlations between points over distances

• (-1,1) indicate perfect negative correlation and positive correlation
Results
Bimodality
## Vegetation and water depth

<table>
<thead>
<tr>
<th>Site designation</th>
<th>Community</th>
<th>t-value</th>
<th>p-value</th>
<th>mean (cm)</th>
<th>var (cm²)</th>
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<tbody>
<tr>
<td>Drained/Low Flow</td>
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<td>21.20</td>
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<td>36.94</td>
<td>72.43</td>
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</table>
Spatial Analyses

![Graph showing Q vs. Anisotropy Factor for different land use types: Drained/Low Flow, Drained, Conserved 1, Conserved 2, Transition 1, Transition 2, Impounded. The graph compares Q and Anisotropy Factor across various categories.]
Autocorrelation
Conclusions

1. The ridge-slough mosaic exhibits bimodal patterns.

2. Hydrologic modification is associated with a convergence of ridge-sloughs, increases in variance.

3. Drained areas lose spatial structure; impounded areas lose directional anisotropy.

4. Community abundance shifts with altered hydrology, as does the type of slough vegetation.
Further...

- Evidence highly suggestive of alt. stable states
- Hydrologic modification alters:
  - State stability
  - Pattern dynamics
- Discrete set of hydrologic conditions for R-S patterning
- Multi-level responses for patterning
So….

- Soil elevation key indicator of ridge-slough stability and loss.
Potential Mechanisms

1. Nutrient subsidy
2. Floc/sediment transport  
   (Larsen et al 2007)
3. Locally positive feedbacks (productivity and respiration) and landscape negative feedbacks (hydrology)  
   (Scheffer et al 2008)
Multiple Equilibria
Next Steps

• Test predictions regarding potential mechanisms for patterning.

• Quantify carbon budget for ridge and sloughs along hydrologic gradients.

• Partition carbon budget (respiration, production, photolysis) to understand peat accretion drivers.
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