Shrub encroachment in subtropical Florida

- Problem for subtropical wetlands
- Expansion over last 40 years
  - Fire suppression
  - Altered hydrology (drying)
  - Disturbed soils
- Replace communities
  - Sawgrass (Cladium jamaicense)

Carolina willow (Salix caroliniana)

- Native to Florida
- Woody, deciduous broadleaf
  - Up to 10 m tall, 35 cm diameter, 50 yrs
  - Shade intolerant
  - Grow after disturbances
Consequences of shrub invasion

- Change plant community composition
- Accelerate ecosystem gas exchange (carbon and water)
- Evapotranspiration rates could increase
  - Reduce water availability

Table 1: Comparison of physiological characteristics of sawgrass and willow

<table>
<thead>
<tr>
<th>Species</th>
<th>Growth morphology</th>
<th>Stomatal Conductance (mmol H₂O m⁻² s⁻¹)</th>
<th>Transpiration (mm day⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawgrass</td>
<td>Perenn. graminoid</td>
<td>152 ±12²</td>
<td>3.16 - 5.9²</td>
</tr>
<tr>
<td>Willow spp.</td>
<td>Decid. broadleaf</td>
<td>~170²</td>
<td>1.34 - 16.34²</td>
</tr>
</tbody>
</table>

Objectives

- Quantify leaf gas exchange of sawgrass and willow
  (Leaf gas exchange: movement of CO₂ and water vapor)
- Estimate effects of land cover change

Field Site - Blue Cypress Management Conservation Area

- Subtropical floodplain marsh
- Long hydroperiod
- 1-4 m peat depth
- Sawgrass and open water
- Shrubs in elevated areas

Images from Google Earth.
Leaf gas exchange measurements

- LI-6400xt portable photosynthesis system
- Non-destructive sampling
- Net photosynthesis ($A_{net}$) and stomatal conductance ($g_s$)

Light response data

- Each sample day: one leaf from five plants
  - 19 sample days (June - November 2014)
  - 41 sawgrass leaves, 46 willow leaves
- Collect measurements of leaf gas exchange
  - 10 PAR points (2000-0 μmol m$^{-2}$ sec$^{-1}$)
  - Constant environmental conditions within leaf chamber
  - Young, undamaged leaves
  - No resampling

Light Response Curve

- Net photosynthetic rate ($A_{net}$)
- Gross photosynthesis = (photorespiration + dark respiration)
- Maximum photosynthetic rate ($A_{max}$)
- Quantum efficiency ($\Phi$)
- Dark respiration rate ($R_d$)
- $A_{max}$ when PAR = 0
- Light compensation point ($I_c$)
- PAR when $A_{max}$ = 0
- Light saturation point ($I_s$)
- PAR at $A_{max}$
Parameter calculation and analysis
- Non-linear least squares regression
- Model used to calculate physiological parameters
- Water use efficiency (WUE): CO₂ stored for water lost during photosynthesis (Aₙₐₜ/gₛ)
- Parameters compared between species

Results – light response curves
- Willow has greater Āₙₐₜ, Aₘₐₓ, gₛ, Φ
- No difference for Rₑ, Iₛ, Iₚ
- Lower water use efficiency by willow

<table>
<thead>
<tr>
<th>Species</th>
<th>Āₙₐₜ</th>
<th>Aₘₐₓ</th>
<th>Φ</th>
<th>Rₑ</th>
<th>Iₛ</th>
<th>Iₚ</th>
<th>gₛ</th>
<th>WUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawgrass</td>
<td>6.436</td>
<td>17.47</td>
<td>0.052</td>
<td>-2.347</td>
<td>54.77</td>
<td>3000</td>
<td>0.153</td>
<td>55.94</td>
</tr>
<tr>
<td>Willow</td>
<td>8.052</td>
<td>20.57</td>
<td>0.078</td>
<td>-2.994</td>
<td>55.43</td>
<td>2562</td>
<td>0.261</td>
<td>46.67</td>
</tr>
</tbody>
</table>

BCMCA vegetation surveys
- Surveys in 2001 and 2008
- Estimate population gas flux
  - Species cover
  - Leaf area index
  - Leaf gas exchange rates
Landscape estimates

- Both sawgrass and willow extent increased from 2001-2008
- Sawgrass cover twice that of willow
- Willow population has greater influence on ecosystem flux than the sawgrass population

Implications

- Take home message:
  - Willow has higher gas exchange rates, lower WUE
  - Higher ecosystem exchange even at smaller area
- Future considerations:
  - Leaf age and canopy position
  - Responses to water level manipulation
  - Improve wetland water and carbon exchange models
  - Changes in groundwater availability, relate to human use

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