IMPACT OF WILLOW INVASION ON WATER AND CARBON EXCHANGE IN THE VEGETATION OF A SUBTROPICAL WETLAND

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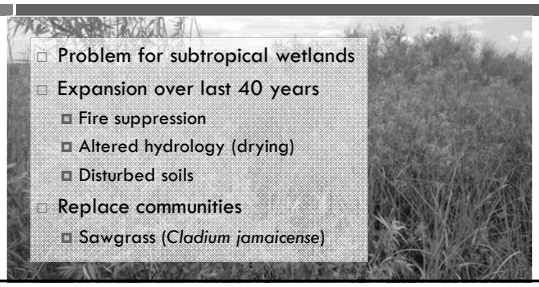
Shrub encroachment in subtropical Florida



- 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

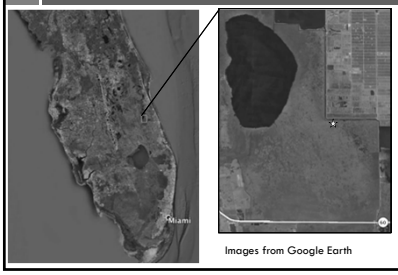
Table 1: Comparison of physiological characteristics of sawgrass and willow

Species	Growth morphology	Stomatal Conductance (mmol H_2O m^{-2} s^{-1})	Transpiration (mm day^{-1})
Sawgrass	Perennial graminoid	152 ±12[a]	3.16 – 5.93[b]
Willow spp.	Deciduous broadleaf	~170[c]	1.54 – 16.34[d]

Objectives

- Quantify leaf gas exchange of sawgrass and willow
  (Leaf gas exchange: movement of CO_2 and water vapor)
- Estimate effects of land cover change

Field Site - Blue Cypress Management Conservation Area

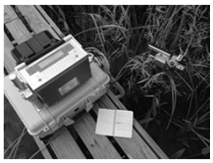


- Subtropical floodplain marsh
- Long hydroperiod
- 1-4 m peat depth
- Sawgrass and open water
- Shrubs in elevated areas

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

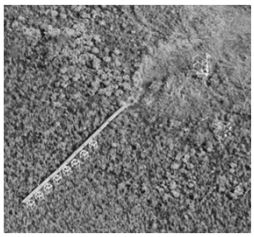
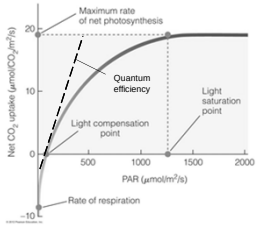


Photo courtesy of SJRWMD

- 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



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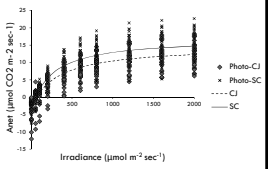
- Net photosynthetic rate (A_{net})
  - Gross photosynthesis – (photorespiration + dark respiration)
- Maximum photosynthetic rate (A_{max})
- Quantum efficiency (Φ)
- Dark respiration rate (R_d)
  - A_{net} when PAR = 0
- Light compensation point (I_c)
  - PAR when A_{net} = 0
- Light saturation point (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):
  - CO_2 stored for water lost during photosynthesis (A_{net}/g_s)
- Parameters compared between species

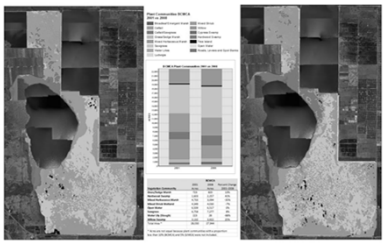
Results – light response curves

- Willow has greater $\bar{A}_{net}$, A_{max}, g_s, Φ
- No difference for R_d, I_c, I_s
- Lower water use efficiency by willow



Species	$\bar{A}_{net}$	A_{max}	Φ	R_d	I_c	I_s	g_s	WUE
Sawgrass	***6.436***	***17.47***	***0.052***	-2.347	54.77	3008	***0.153***	***55.94***
Willow	***8.052***	***20.57***	***0.078***	-2.994	55.43	2562	***0.261***	***46.67***

BCMCA vegetation surveys

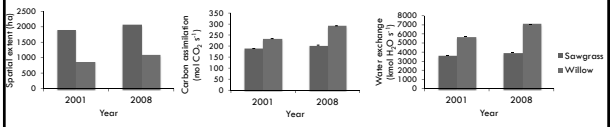


2001 2008

- 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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