Contrasting productivity between a long- and short-hydroperiod marsh in the Florida Everglades

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Wetlands as Carbon Sources or Sinks

• Peatlands – generally sinks for carbon unless exposed to the atmosphere

• Lakes – generally sources

• Everglades water column generally exhibits heterotrophy

• Above-ground production in the Everglades is generally a sink

Engle et al. 2008
Lazzarino et al. 2009
Hagerthey et al. 2009
Barr et al. 2009
Shurpali et al. 1995
Oechel et al. 1993
Ewe et al. 2006
Study Sites

Whole-ecosystem measures of CO₂ flux were taken at existing Florida Coastal Everglades LTER sites in Shark River Slough and Taylor Slough.
SRS 2

- Long-hydroperiod
- Peat soil
- Sawgrass ridges and *Eleocharis* / *Panicum* sloughs
- Located between oligohaline ecotone and Tamiami Canal

Photo courtesy: Jessica L. Schedlbauer
TS 1b

- Short-hydroperiod
- Limestone and marl
- Dominated by sawgrass and *Muhlenbergia*
- Located near canal
Everglades Primary Production

- Aboveground Net Primary Production (Ewe et al. 2006)
- SRS
  - Sawgrass: 255 - 606 g biomass m$^{-2}$ yr$^{-1}$
  - Periphyton: 17 - 68 g C m$^{-2}$ yr$^{-1}$
  - Mangroves: 2208 g biomass m$^{-2}$ yr$^{-1}$
- TS
  - Sawgrass: 255 – 441 g biomass m$^{-2}$ yr$^{-1}$
  - Periphyton: 342 – 10,371 g C m$^{-2}$ yr$^{-1}$
  - Mangroves: 340 g biomass m$^{-2}$ yr$^{-1}$
- Periphyton has extremely high values compared to other wetlands even though the Everglades has very low concentrations of water nutrients
Questions and Methods of Testing

1. How do sites with contrasting hydroperiod differ in ecosystem productivity?
   
   Method: Measure NEP and ER at contrasting sites

2. Does hydrology drive seasonal changes in productivity?
   
   Method: Measure ecosystem productivity for 1 year
Methods

NEP Measurement

ER Measurement
Methods

• TS1b
  – 5 bases installed at 10cm depth
Methods

• SRS2
  – 5 plots
  – Macrophytes dried and weighed
    • Macrophytes removed from plots by shearing just below surface of water
Data Analysis

\[
\text{CO}_2 \text{ Flux (\mu mol m}^{-2}\text{s}^{-1}) = \left( \frac{\Delta \text{CO}_2}{\Delta t} \right) \times \left( \frac{PV}{RTA} \right)
\]

- \( t \) = time (seconds)
- \( P \) = atmospheric pressure (Pascals [kg m s\(^{-2}\)])
- \( R \) = gas constant (8.3143 Joule [kg m\(^2\) s\(^{-2}\)] mole\(^{-1}\) Kelvin\(^{-1}\))
- \( T \) = Temperature (Kelvin)
- \( V \) = Volume of chamber (m\(^3\))
- \( A \) = Area of chamber open to ecosystem (m\(^2\))

• Statistical Analysis
  - t-tests were used to analyze between-site seasonal differences
  - Multiple regression analysis was performed to determine which environmental factors best predict productivity
Hypotheses

1. How do sites with contrasting hydroperiod differ in ecosystem productivity?

*Hypothesis*: I expected ecosystem productivity would be greater at long-hydroperiod SRS2 than short-hydroperiod TS1b.

2. Does hydrology drive seasonal changes in productivity?

*Hypothesis*: I expected greater ecosystem productivity during the wet season than during the dry season at TS1b.
NEP at TS1b
• Multiple regression analysis of water level, air temperature, pressure,
  – Temperature good predictor of ER
    \( p=0.006, R^2_{adj}=0.343 \)
  – Water level good predictor of GEP
    \( p=0.039, R^2_{adj}=0.197 \)
NEP at SRS2

Net Ecosystem Productivity (g C m⁻² mo⁻¹)

Water level in relation to soil surface (m)

Date
Jul/08 Sep/08 Nov/08 Jan/09 Mar/09 May/09 Jul/09 Sep/09
Multiple Regression Analysis
- Temperature was a good predictor of NEP and above-water macrophyte biomass was a good predictor of GEP

\[(p < 0.05, R_{adj}^2 = 0.8372 \& 0.8503, \text{respectively})\]
NEP significantly correlated with above-water macrophyte biomass at SRS2
Carbon Source or Sink?

TS 1b could be a source
-84 g C m⁻² yr⁻¹

SRS 2 could be a sink
342 g C m⁻² yr⁻¹
Questions (revisited)

1. How do sites with contrasting hydroperiod differ in ecosystem productivity?
   - Long-hydroperiod marshes have highest NEP values while inundated
   - Short-hydroperiod marshes have highest NEP values while dry

2. Does hydrology drive seasonal changes in productivity?
   - Yes. Significant decreases of NEP at TS1b while wet.
Questions?