FCE ASM 2008
HYDROLOGY WORKING GROUP

René Price – FIU
Vic Engel - ENP

Students
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Researchers
WHERE OUR WORKING GROUP FITS INTO FCE CONCEPTUAL MODEL
CENTRAL QUESTIONS

1. How will changing hydrologic conditions *(upstream water flow or sea level rise)* affect the position of the brackish mixing zone and alter geochemical conditions in the ecotone?

2. How will changing *freshwater inflows or sea level rise* affect water residence times in the oligohaline ecotones of Taylor and Shark River Sloughs?
1. How will changing hydrologic conditions (upstream water flow or sea level rise) affect the position of the brackish mixing zone and alter geochemical conditions in the ecotone?

Continuous surface water level monitoring stations: ENP, USGS, SFWMD, LTER

Everglades Depth Estimation Network (EDEN) interpolates water depths between stations

Surface Water Discharge: SFWMD canals USGS Tidal stations
Position of seawater mixing zone will be monitored with groundwater wells
Research Question 2:
How will changing freshwater inflows (or sealevel rise) affect water residence times in the oligohaline ecotones of Taylor and Shark River Sloughs?

Methods

Estimating water residence times through a number of techniques

• Mass-Balance of water
Rainfall, ET, surface water flows, groundwater and seawater influences
Rainfall sites

Rainfall monitored at LTER Freshwater sites

And over 40 sites by ENP
ET Stations

Eddy-flux towers - Steve Oberbauer - FIU
Move from SRS-2 to SRS1?

Eddy-flux tower - University of VA

Campbell Scientific, Inc. ET106
Evapotranspiration Station at TS/PH-7b
Instead of originally Proposed TS/PH-6b
Surface water flow monitoring sites

Additional flow meters for FCE II at SRS-3; SRS-4 and TS/Ph-3
Chemical approaches to estimate surface water flow and residence times

- Chemical Mass balance of chloride, oxygen and hydrogen isotopes – (Rene Price – FIU)
- Radium Isotopes ($^{223,224,226,228}$Ra) in surface water (Pete Swarzenski – USGS)
- SF-6 tracer of surface water flow (Vic Engel – ENP)
- Heat Flow (Mark Rains-USF)

- Planned for this November 2008
Ultimate Goal

Combine estimates of water and chemical mass balances with hydrological modeling and nutrient concentrations to calculate fluxes of water and nutrients into and out of the Mangrove ecotone and at individual ecotone sites.
CRITICAL DATA

*Group data:* Water level surveyed to a datum, not just water depth—this is needed to estimate water slopes, for velocity, discharge and residence times estimates

*FCE data:* Modeling group can provide some estimates of water inflows with the TIME/ELM model.

*We will work with Linda and others to make the hydro-data more available.*
11 Sites Sampled In Sept. 2007

Groundwater Wells < 7m deep
June 20, 2003; Cond. = 7.2 mS/cm

Sept. 7, 2007; Cond. = 4 mS/cm

Smith and Anderson, USGS, provisional data
Western Coastline of ENP
Sept. 2007

\[ y = -0.74x + 103.57 \]
\[ R^2 = 0.02 \]

Surface Water
Groundwater
Linear (Groundwater)

Gulf of Mexico

(Boyer et al. 1999)
Western Coastline of ENP
Sept. 2007

\[ y = 0.20x + 0.04 \]
\[ R^2 = 0.72 \]

Total P (μM)
salinity (psu)

Surface Water  Groundwater

(Boyer et al. 1999)
Gulf of Mexico
How much P is incorporated in Biscayne Aquifer limestone?

What are the adsorption/desorption characteristics of P in fresh versus salty groundwater?

Water-Rock Interactions

Ion Exchange  

CaCO₃ Dissolution
Sequential Extraction
1. MgCl – loosely adsorbed fraction
2. HCl digestion followed by filtration for total P determinations
3. Total P determination on filter residue for organic fraction
Surface Soils and Sediments from S. Florida  TP: 56 – 678 µg/g soil

(Koch et al., 2000; Chambers and Pederson, 2006; Chen and Ma, 2001; Levy and Schlesinger, 1999)
1) Increasing TP in limestone with depth due to proximity to underlying Tamiami Sands that contain phosphorite deposits

2) No clear difference in TP between cores in fresh vs. brackish groundwater
Adsorption/Desorption cube experiments

- Cube 0.2m on a side of Key Largo Limestone.
- freshwater (DIW) and seawater matrix
- with $PO_4^{3-}$ varying from 0 to 20μM
Adsorption

DIW vs. Seawater with 8 μM of PO$_4^{3-}$

- DIW + 8 μM of PO$_4$: 80% of P Adsorbed
- SW + 8 μM of PO$_4$: 15% of P Adsorbed
Desorption

P_{out} (\mu M/L) vs. Liters through the cube

Salinity fraction

- Seawater
- DIW
- Salinity

0 2 0 4 0 6 0 8 1 0 0
Geochemical Analysis

![Graphs showing the relationship between Cl⁻ and Ca²⁺ concentrations, with seawater mixing lines and different flushing conditions depicted.](image-url)
Water Table

Seawater Intrusion

Brackish Zone

Ocean

CaCO₃ Dissolution

Ion Exchange
Florida Bay Sept. 2007

Surface water salinity

Deep Groundwater salinity

5 sites: 10 Wells: shallow < 10 m; deep <20 m deep
Florida Bay Sept. 2007

- **Total N (μM)**
  - Surface Water
  - Groundwater
  - Linear (Groundwater): $y = 0.72x + 5.52$  
    - $R^2 = 0.23$

- **Total P (μM)**
  - Surface Water
  - Groundwater
  - Linear (Groundwater): $y = -0.13x + 6.30$  
    - $R^2 = 0.30$
### Water Flow in NE Shark Slough

#### A. Unfiltered Velocity Data

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<thead>
<tr>
<th>Date</th>
<th>Discharge (ft³sec⁻¹)</th>
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#### B. Filtered Velocity Data

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#### C. Discharge from Gate S333

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#### D. Unfiltered Velocity Data

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#### E. Filtered Velocity Data

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#### F. Discharge from Gates S12B & C

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Guoqing He, Helena Solo-Gabriele, Michael Laas, Lynn Leonard, and Daniel Childers
Flow was negatively correlated with biovolume

surface periphyton and floating biomass exert greater control over flow characteristics than either the type of vegetation (i.e., spike rush or sawgrass) or the density of emergent macrophytes (Leonard et al., 2006)

Guoqing He, Helena Solo-Gabriele, Michael Laas, Lynn Leonard, and Daniel Childers
Two of the flow meters will be moved this year to established LTER sites in Shark Slough.
Determination of Large-scale Flow Patterns in the Everglades Ridge and Slough Habitat with Tracer Release Experiments

Four tracer in WCA-3A releases of inert gas (SF$_6$; sulfur hexafluoride) Between 6 to 11 days in 2006-2007

- David T. Ho and Evan A. Variano, Vic Engel
Well preserved ridge and slough topography with
Some periphyton and no *Utricularia*

average velocity of 0.25 cm s$^{-1}$
Degraded ridge and slough; flow is across the topography towards nearby canals

Surface water flow velocity: 0.4 cm s\(^{-1}\)
PRODUCTS TO DATE

Publications


Reports


WHERE WE WANT TO BE IN 2009 MID-TERM REVIEW

1. Characterization of groundwater brackish zone in Taylor and Shark Sloughs and NE Florida Bay
2. Completion of wet-season tracer studies (Nov. 2008)
3. Estimate Evapotranspiration from 4 towers
4. Residence Times Synthesis
5. Installation and movement of all flow meters in Shark and Taylor Sloughs
6. Preliminary results of 1 M.S. (Xavier Zapata) and 1 Ph.D. (Greg Koch) research on water-balance and residence times in Taylor Slough
WHERE WE WANT TO BE IN 2009 MID-TERM REVIEW

Papers submitted:

1. Brackish groundwater dynamics in FCE LTER - Price
2. Phosphorus concentrations in Biscayne Aquifer Limestone - Price
3. Adsorption/Desorption of phosphorus in Biscayne Aquifer Limestone - Price
4. Flows in NE Shark Slough – Solo-Gabriele
5. Surface Water flow with Biovolume- Leonard
6. SF6 tracer work in WCA-3A – Engel et al. – 3 papers
7. Synthesis paper with FCE and Mexico coastal LTERs – Price, Rivera, Rains, Stalker
OUR VISION FOR DECADAL PLAN

Cross-Site Comparisons with Mexico Coastal LTER sites

Rene Price, Jeremy Stalker, Victor Rivera, Mark Rains

Shared Objective:
Quantify the water sources of the lagoons and mangroves that link the terrestrial and marine environments
Mangrove Sites Network in the Gulf of Mexico
Red Mexicana de Investigación Ecológica a Largo Plazo
Mark Rains - Mexican Project Sites

Initial Effort

This Effort

Future Efforts?
1. Increasing inputs of freshwater will enhance oligotrophy in nutrient-poor coastal systems, as long as the inflowing water has low nutrient content; this dynamic will be most pronounced in the oligohaline ecotone.

2. An increase in freshwater inflow will increase the physical transport of detrital organic matter to the oligohaline ecotone, which will enhance estuarine productivity. The quality of these allochthonous detrital inputs will be controlled by upstream ecological processes.

Quantifying flows across Tamiami Trial as well as water flow velocity measurements along Shark and Taylor Sloughs
3. Water residence time, groundwater inputs, and tidal energy interact with climatic and disturbance regimes to modify ecological pattern and process in oligotrophic estuaries; this dynamic will be most pronounced in the oligohaline ecotone.

Quantifying water residence times and groundwater inputs