

Florida Coastal Everglades Long Term Ecological Research

## Connectivity Between the Mangrove Ecotone Region and Florida Bay: Current Understanding in Carbon and Nutrient Fluxes

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## The Mangrove Ecotone Region: Location and definition



•An extensive region of the Everglades with diffuse/undefined watersheds

•it is limited by phosphorus availability due to lack of terrigenous sediment input and reduced freshwater flow;

•both, low terrestrial P input and natural water flow spatial patterns, control the spatial distribution of vegetation and limits plant productivity, which is dominated by mangrove forests:



The Mangrove Ecotone Region: LTER Research <u>Ouestion</u>

-How does hydrological connectivity, influenced by long-term changes in freshwater flow (ecosystem management), affects mangrove ecotone productivity/nutrient cycling and Florida Bay water quality?

## Mangrove tree height - Large Spatial Differences





Simard et al (2006); Ewe et al (2006)

## Everglades Mangrove Estuaries Conceptual

#### Ecological Model



Davis et al (2005)



Precipitation influences water levelLonger Hydroperiod

•The high wet season water levels influence long duration of

Krauss et al 2006; USGS; Michot, unpublished resultinundation events per year; some mangroves are permanently

## Hydroperiod and salinity gradientes are also strongly affected by extreme metereological and climatic









10 days prior to passa

4 days after

Kelble et al (2007)

Because of this hydrological connectivity the Mangrove Ecotone has been identified as a source of Total Organic Carbon and Nitrogen to Florida Shelf water



Boyer et 2006; Maie et al 2006;

### Mangrove Organic Matter footprint in Florida Bay: Taraxerol



Taraxerol concentration in Florida Bay surface sediments

•Mangrove leaves contain exceptionally high abundance of Taraxerol up to 1.4 mg/g

•More than 60% of Organic Matter is derived from terrestrial mangrove contributions in the North East Section of Florida Bay

•Approximately 12% in the Central and Southwest sections

•Organic matter from the mangrove ecotone has less influence on Florida Bay than the Western Region



Xu et al 2006

# Large spatial scale transects studies show that Soils are calcareous along the Sloughs



### Soil Phosphorous concentration - Spatial Patterns in <u>LTER sites</u>



to Fe and Mg minerals, Ca-bound

inorganic P

Chambers et al 2006

#### Water column TP and TN concentration - Spatial Patterns



•Maximum values of TP are low (1.7 uM) in comparison to

## Estimated N budgets (mg N m<sup>-2</sup> $y^{-1}$ )

•There is currently more detailed information in Taylor than in the Shark River Slough

•The estimated net annual import of N in Taylor Slough is  $649 \text{ mg m}^{-2} \text{ y}^{-1}$ 

•There is limited information on groundwater N and P fluxes from coastal regions inland



## Denitrification rates (mg N m<sup>-2</sup> y<sup>-1</sup>)

•But there is uncertain in budget estimates du to a lack of in situ denitrification and N fixation studies (i.e. Taylor)

•Current work in Taylo River (*Rivera-Monroy e al unpublished results* is updating box model (*Sutula et al 2003*) estimates using field data

•Denitrification rates are similar in Shark a Taylor Rivers indicati N immobilization in soils



•N fixation is greater Rivera-Monroy et al in preparation than denitrification in Denitrification in Taylor River (mg N m<sup>-2</sup> y<sup>-1</sup>) is limited by in situ NO<sub>3</sub> (<2 $\mu$ M) and PO<sub>4</sub> (<1  $\mu$ M) concentrations

•Denitrification rates Taylor River are [ N limited as result of in situ concentration

•Enrichment studies sh that Nitrification is limited by [PO<sub>4</sub>] availability in soil waters

•There is a large potential Denitricati NO<sub>3</sub> > 30 uM



### Findings about N transformations in the Mangrove Ecotone



Florida Bay

Rudnick et al 1999; Sutula et al (2001, 2003); Davis et al (2001, 2003)Rivera-Monroy et al in preparation

## Hurricanes have major impacts on Forest Structure and Community Dynamics

Vegetation Succesion Patterns, Species dominance, Carbon allocation and Nut

Legend

Hurricane Track

nd Speed (m/s)

5-18

10-15

15-20

25-30

30-35

35-40

40-45

45-50

50-55

55-60

Andrew 1992

Wilma 2005

B-BEE







Keqi et al in 2007; Castaneda et al in preparation

#### Hurricanes, as pulsing landscape-level events, add P as result resuspension and redistribution of

Wilma Wind Speed (m/s))





•Total P concentrations in carbonate sediments deposited by Wilma (2005) in southwestern Everglades and Florida Bay were higher than in situ [TP] before the even  $(range: 90-550 ug cm^{-3})$ 

•This P input might be controlling mangrove productivity and structure in the Shark River region in the long term (Chen and Twilley 1999) Simard et al 2006; Castaneda et al in preparation



## Developing Mangrove Dynamic Models: Evaluating Resilience and Responses to Sea Level Rise



## Everglades Mangrove Estuaries Conceptual

#### Ecological Model



Example of Coastal Transgression: interaction between the mangrove ecotone and the "White Zone", particularly



in the Southeast Region



•Closely associated to the mangrove ecotone is the "White Zone", a region of low productivity characterized by low vegetation cover and canopy height

•Over the past 50 years , the interior boundary of the white zone has encroached inland 1.5 km; maximum shifts occurred in areas cut off by canals from upstream fresh water (1.8 k,-Turkey Point)

•In contrast to other coastal regions in the Neotropics there is a Ross et al 2000, 2001 net gain in mangrove area at this boundary •Ecotone productivity is high and shows significant spatial differences

-The scrub mangrove forests reflect suppressed levels of aboveground productivity and seedling development, as influenced by minimal P supply from either the oligotrophic marshes of the southern Everglades or Florida Bay

-Production and organic soil accretion in the mangrove forests of the coastal Everglades are controlled by phosphorus availability

•Productivity is strongly regulated by the interaction of marine phosphorus sources and water residence time

•Freshwater management has had and will have major effects on productivity patterns, particularly in the Taylor Region; changes in salinity in the Shark River area as result of freshwater diversion will potentially modify vegetation boundaries

•Low nutrient conditions are expected to enhance belowground productivity by mangroves, which will maintain peat production and soil elevation increases—ultimately enhancing the ability of these low salinity forests to maintain themselves against sea-level rise.

•Need to understand the relative importance of P groundwater sources in