# EVERGLADES NITROGEN:
## *Patterns, Processes, and Implications for Restoration*

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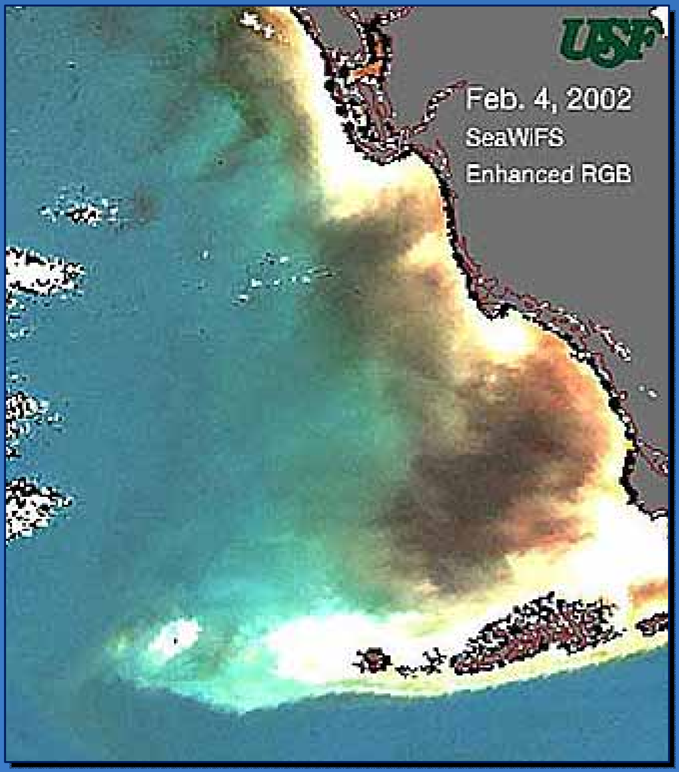
# N Importance

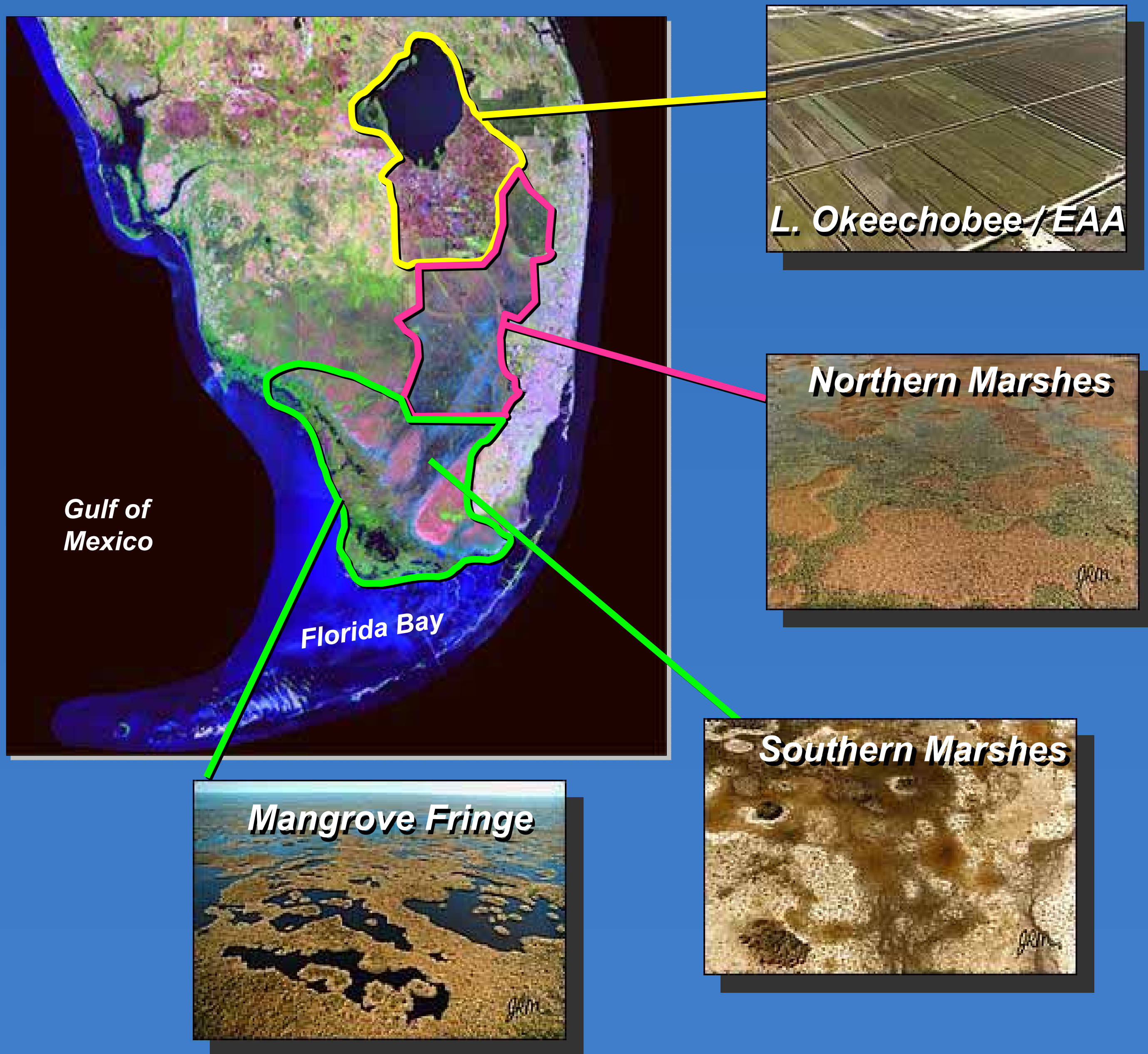
- Limiting nutrient in Florida Bay, Coastal Systems
  - algal blooms/loss of seagrasses



# N Importance

- Limit to productivity in P-loaded areas
- Limit to P retention in treatment areas
- Greenhouse gas emissions

# Systems

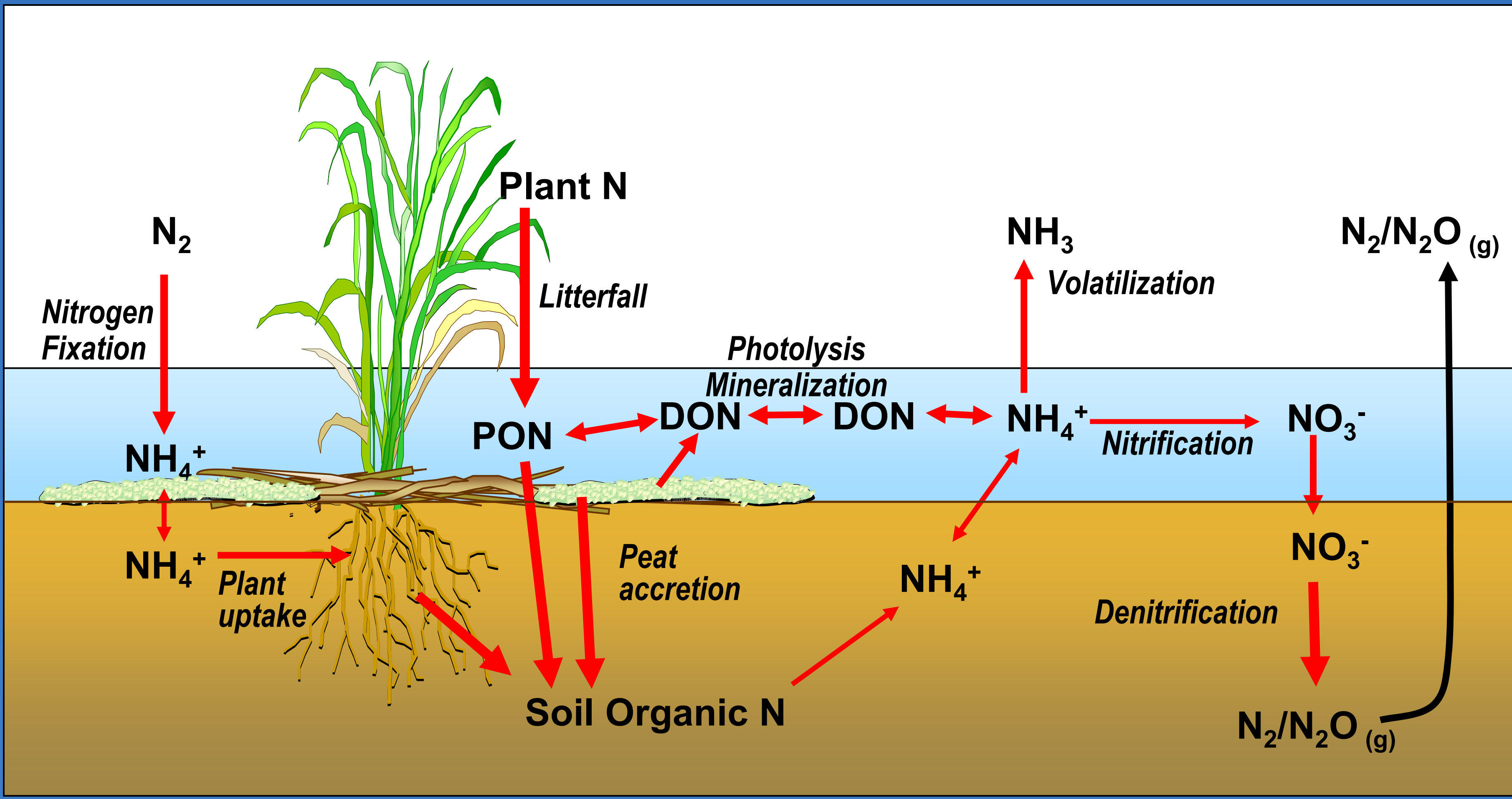


L. Okeechobee / EAA
Northern Marshes
Gulf of
Mexico
Florida Bay
Southern Marshes
Mangrove Fringe

# Processes

- Deposition/Inputs
- $N_2$ Fixation
- $NH_3$ Volatilization
- Nitrification/Denitrification
- Mineralization
- Photolysis

# Cycles




## Major Components

- Water
- Soils
- Biota
  - Macro-, Microphytes
  - Consumers (Food Chain)

# Systems



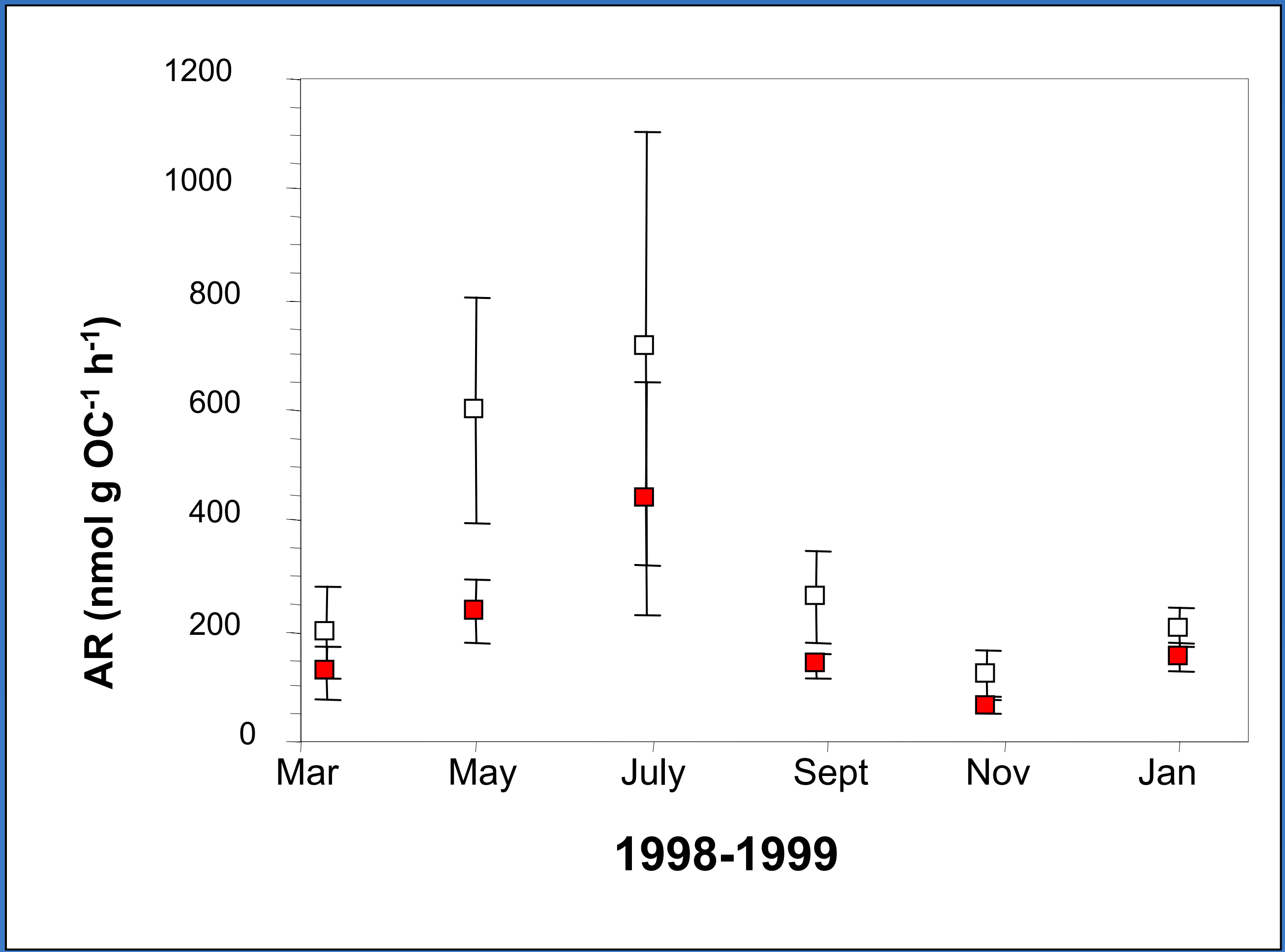
- Major source of N
  - fertilizer
  - peat oxidation
  - Okeechobee
- 1-5 Metric Tons $yr^{-1}$

# Systems


# Periphyton

- Assemblages of prokaryotic and eukaryotic algae.
- Occur at interfaces of water-solid substrates and the water surface.

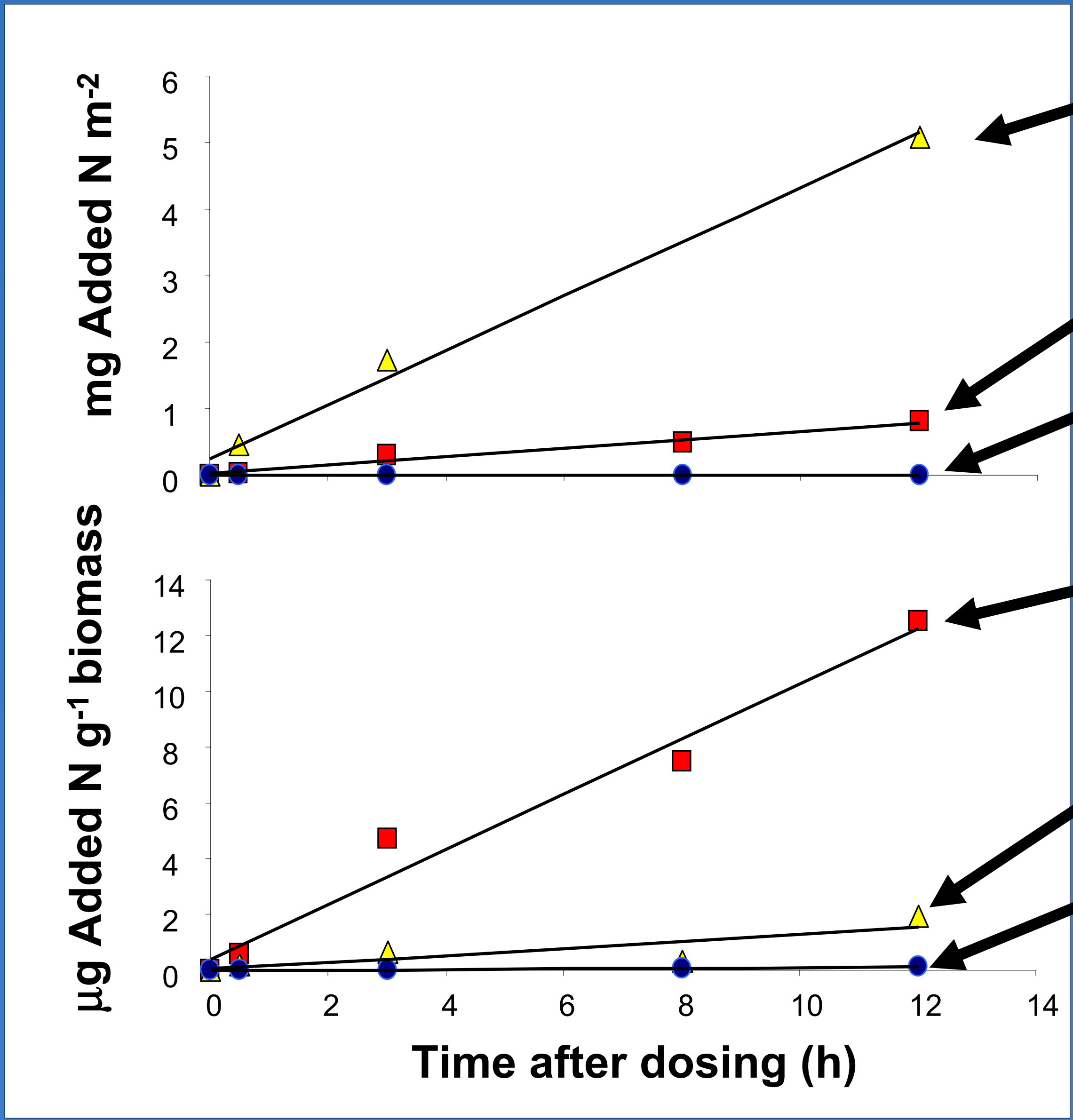
# Periphyton Mat $N_2$ Fixation




**~10g N m$^{-2}$ yr$^{-1}$** contribution to an interior WCA-2A slough

Inglett et al., 2004

# Uptake of Water column N




**Benthic Floc**
0.41 mg N $m^{-2}$ $h^{-1}$

**Metaphyton**
0.06 mg N $m^{-2}$ $h^{-1}$

**Plants**
0.001 mg N $m^{-2}$ $h^{-1}$

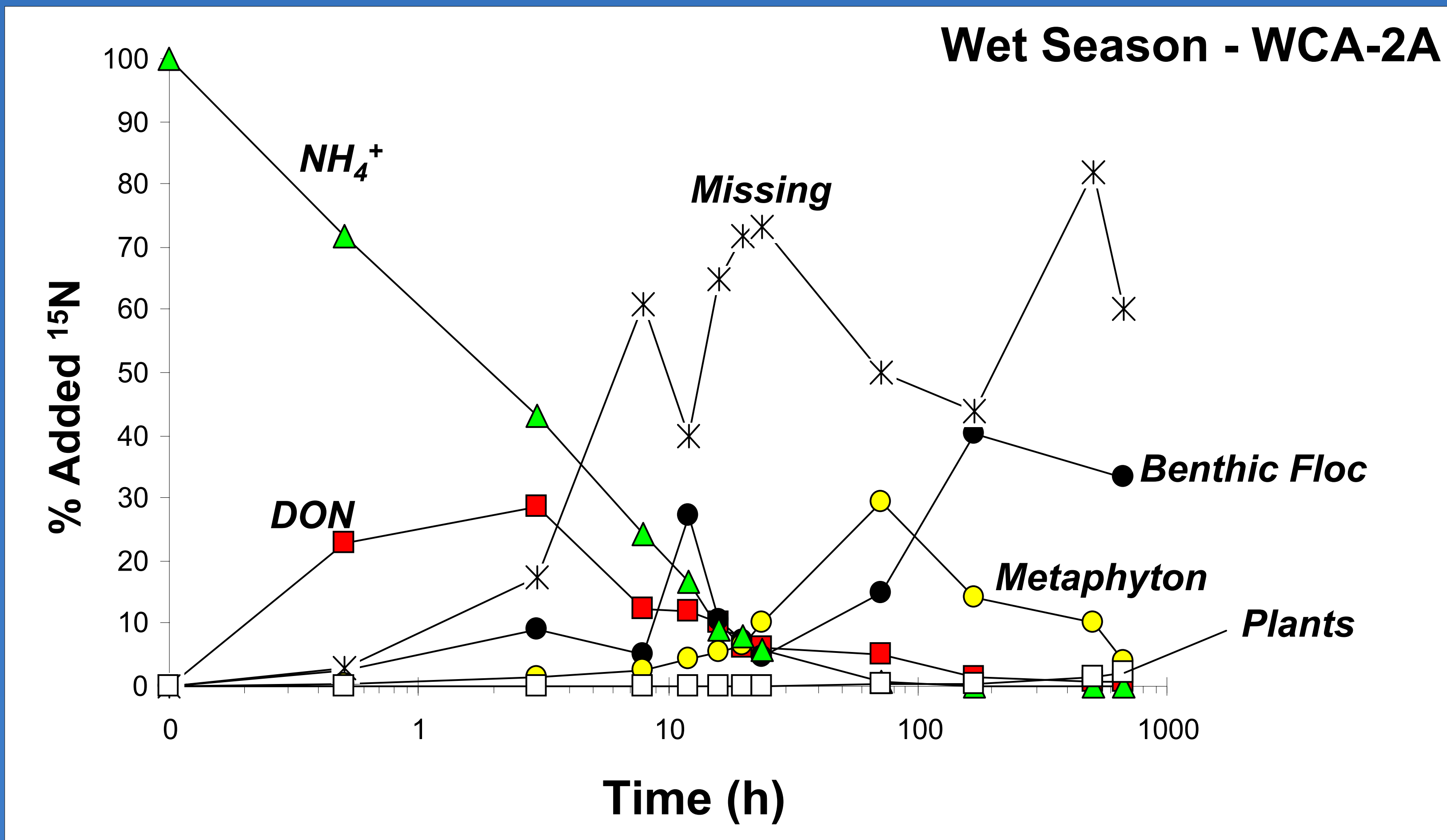
**Metaphyton**
0.99 µg N $g^{-1}$ $h^{-1}$

**Benthic Floc**
0.12 µg N $g^{-1}$ $h^{-1}$

**Plants**
0.01 µg N $g^{-1}$ $h^{-1}$

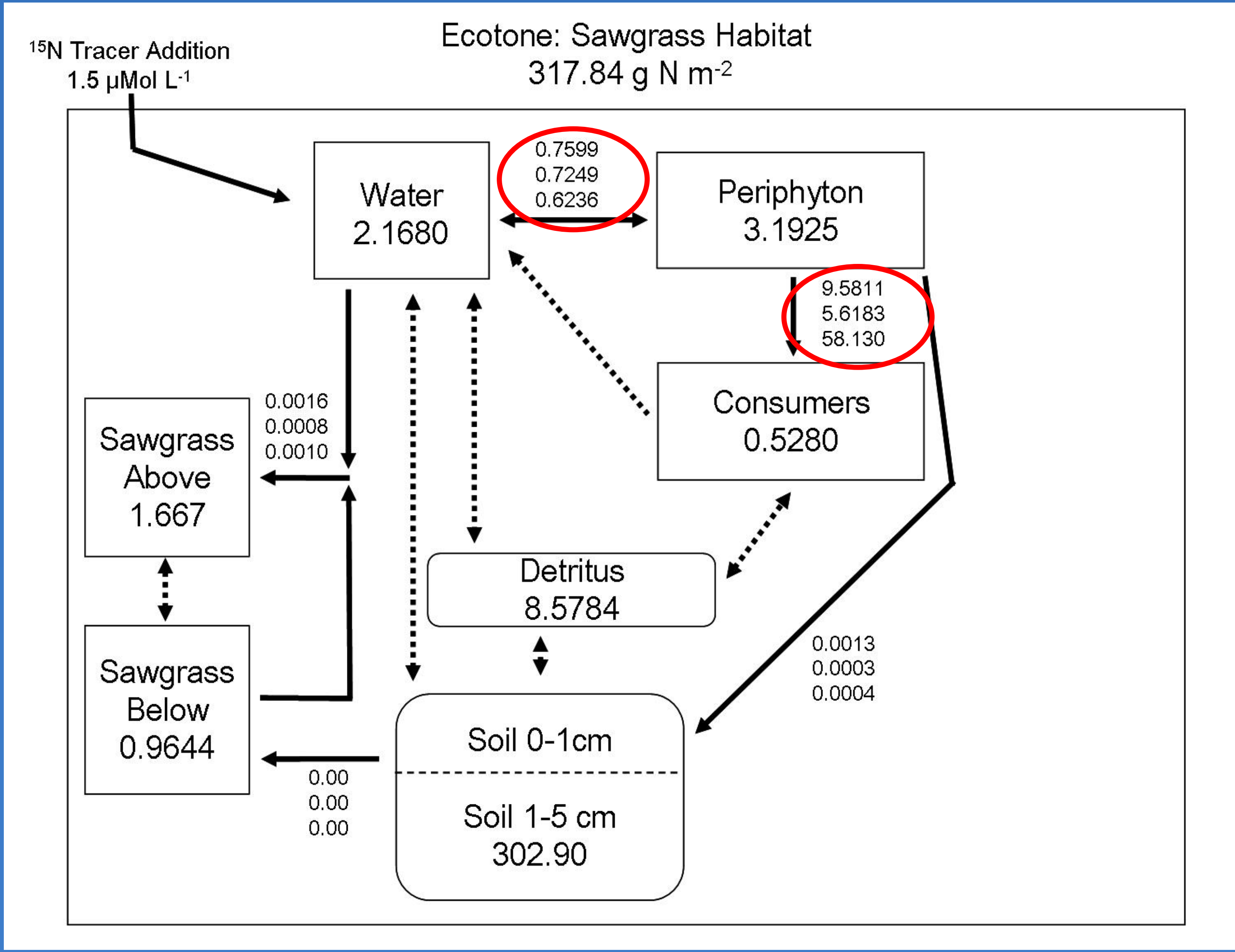
Inglett et al., *in prep*

# Slough N Tracing/Fate



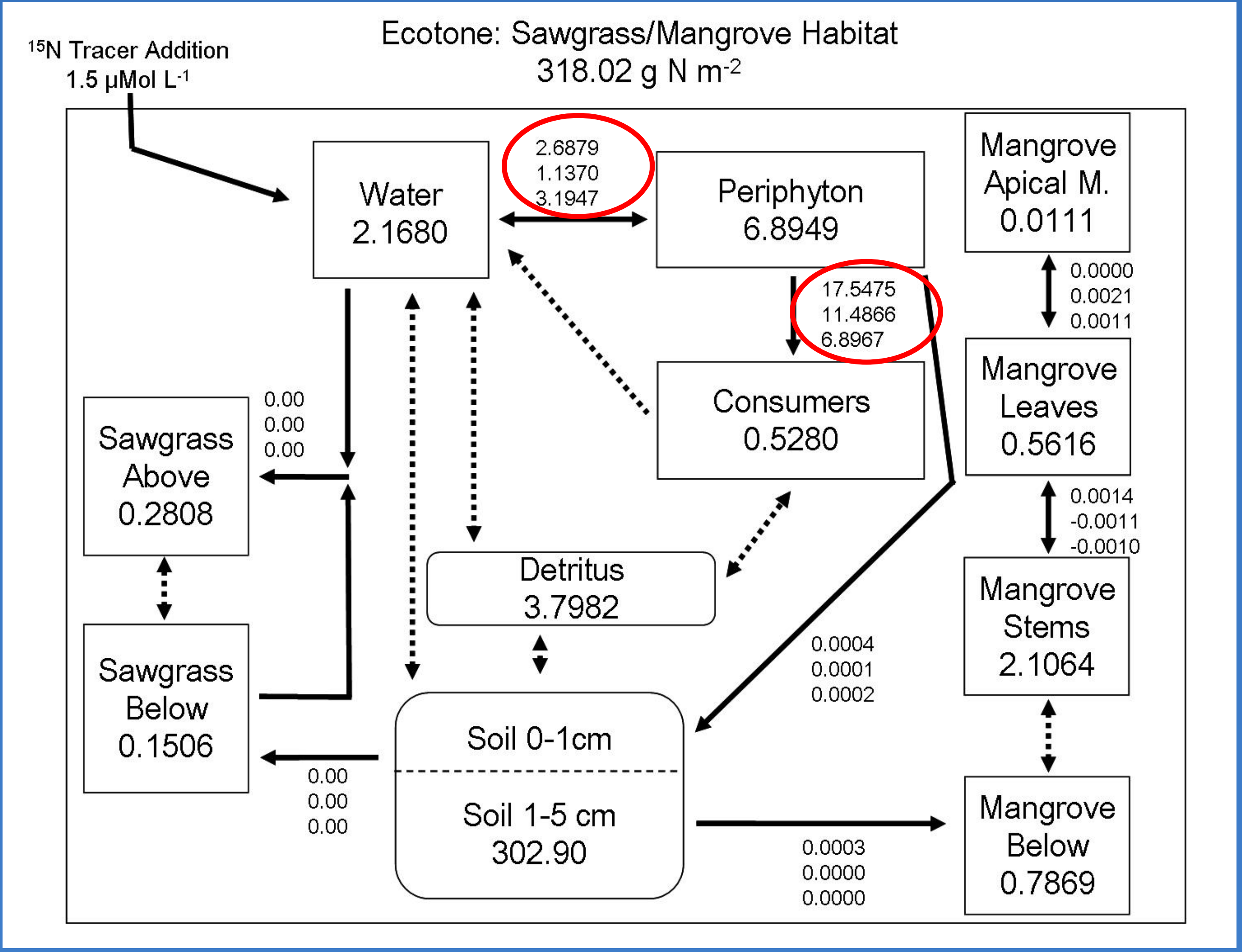

Inglett et al., *in prep*

# N-Cycling in Southern Marshes




Wozniak et al., *in prep*

# N-Cycling in Southern Marshes

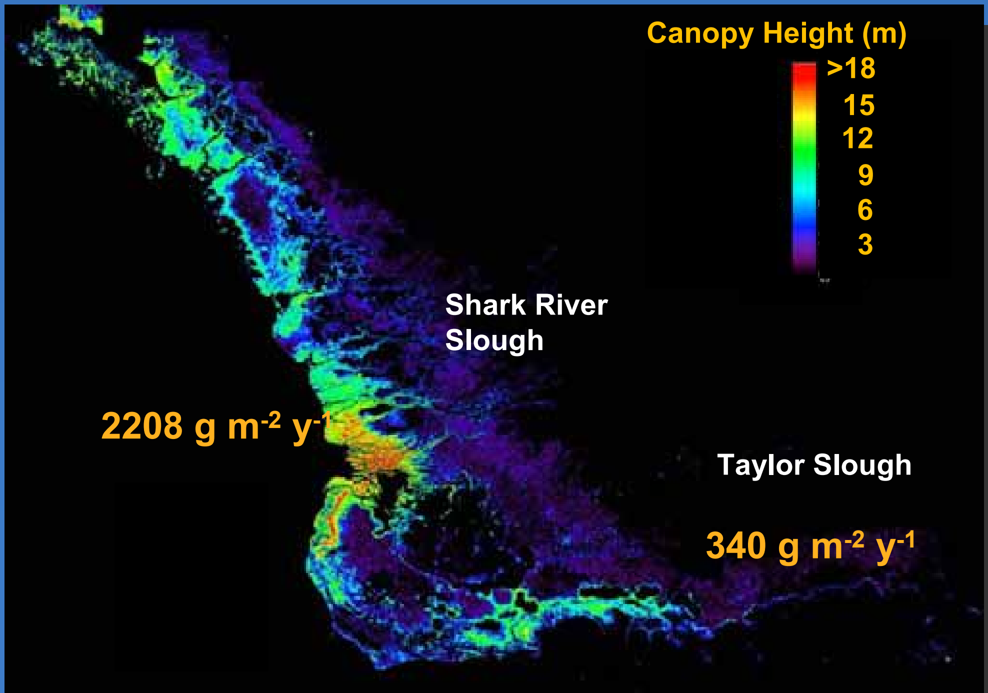



Wozniak et al. In prep

# Systems


# The Mangrove Ecotone Region

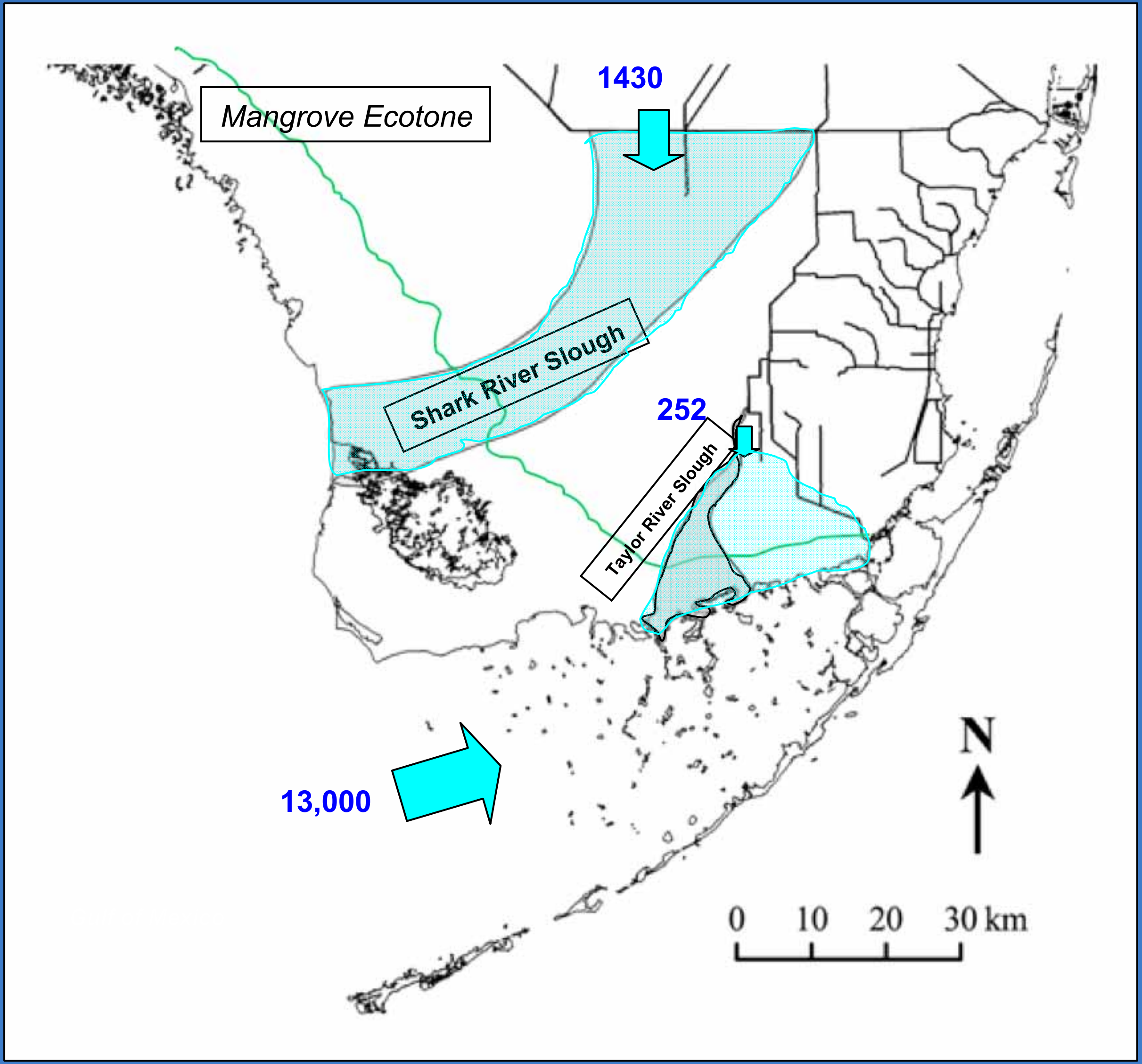
An extensive region of the Everglades limited by phosphorus availability due to lack of terrigenous sediment input and reduced freshwater flow




ANPP is 6 times higher in the western than in the eastern region

# Mangroves: Major TN Surface Water inputs- (metric tons $yr^{-1}$)

- Most N studies perfomed in Shark River and Taylor River Sloughs
- Larger N loading (surface water) in Shark River Slough than in Taylor
- Seasonal patterns, controlled by hydrology

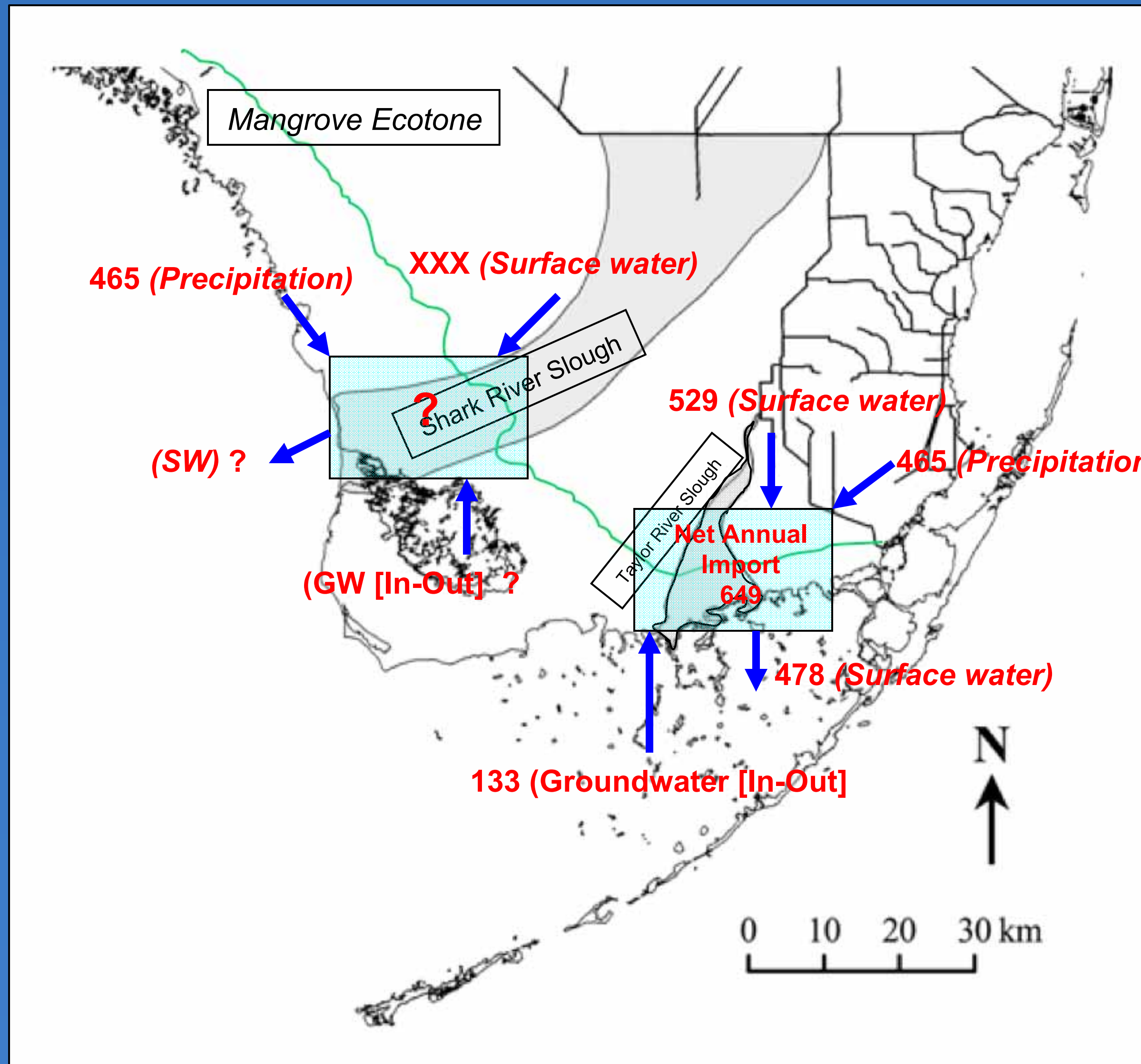



Rudnick et al 1999; Sutula et al 2001, 2003

# Estimated N budgets (mg N $m^{-2}$ $yr^{-1}$)

- Currently more detailed information on N budgets in Taylor River than in Shark River

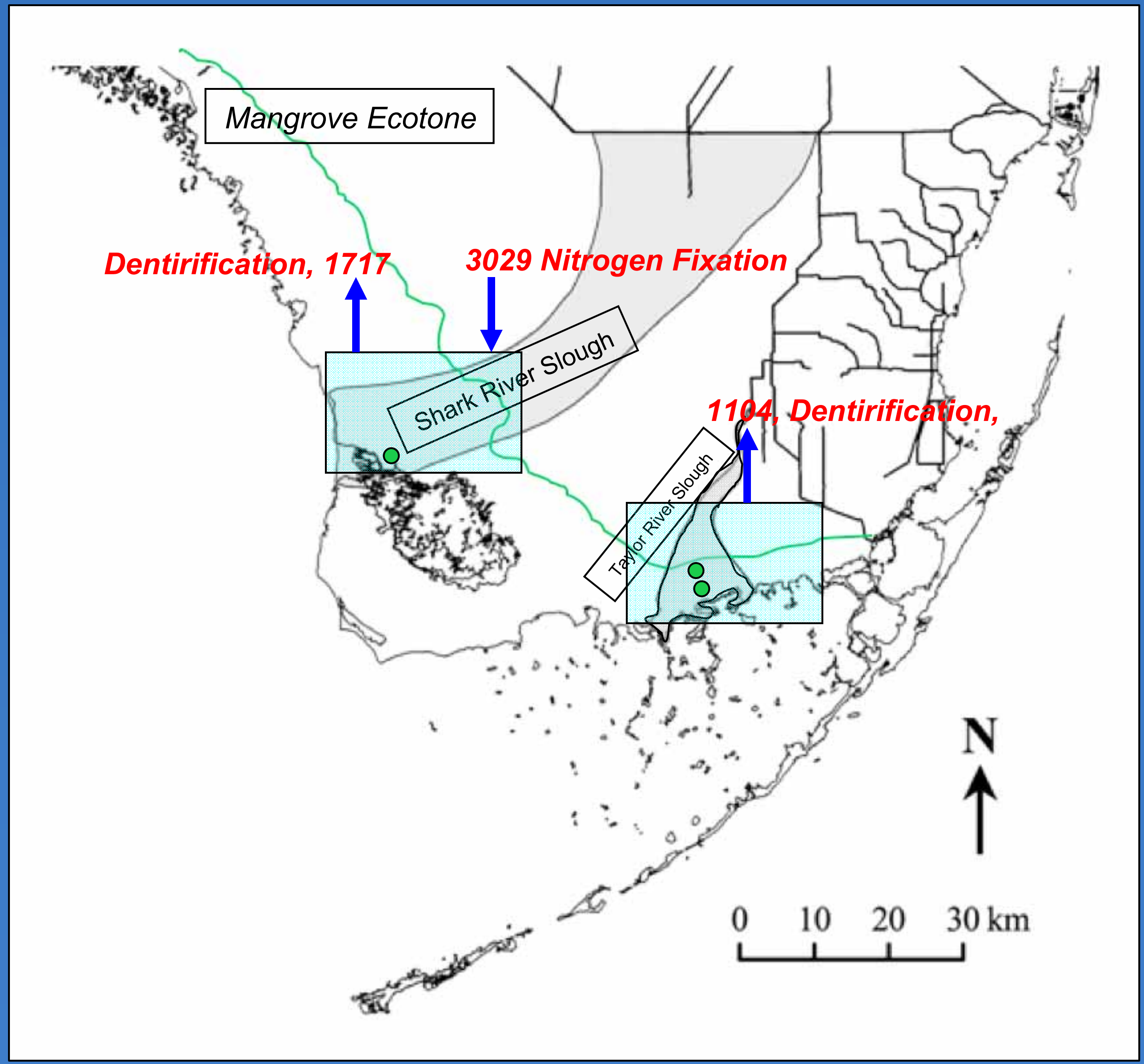
- Net import of N in Taylor Slough




Rudnick et al 1999; Sutula et al 2001, 2003

# Mangroves: Denitrification rates (mg N $m^{-2}$ $yr^{-1}$)

- Still uncertainty in budget (lack of in situ denitrification and N fixation studies)
- Denitrification rates are similar in Shark and Taylor Rivers
- Denitrification rates in Taylor River are [ $NO_3$] limited as result of low *in situ* concentrations
- Nitrification is limited by [$PO_4$] availability in soil pore waters

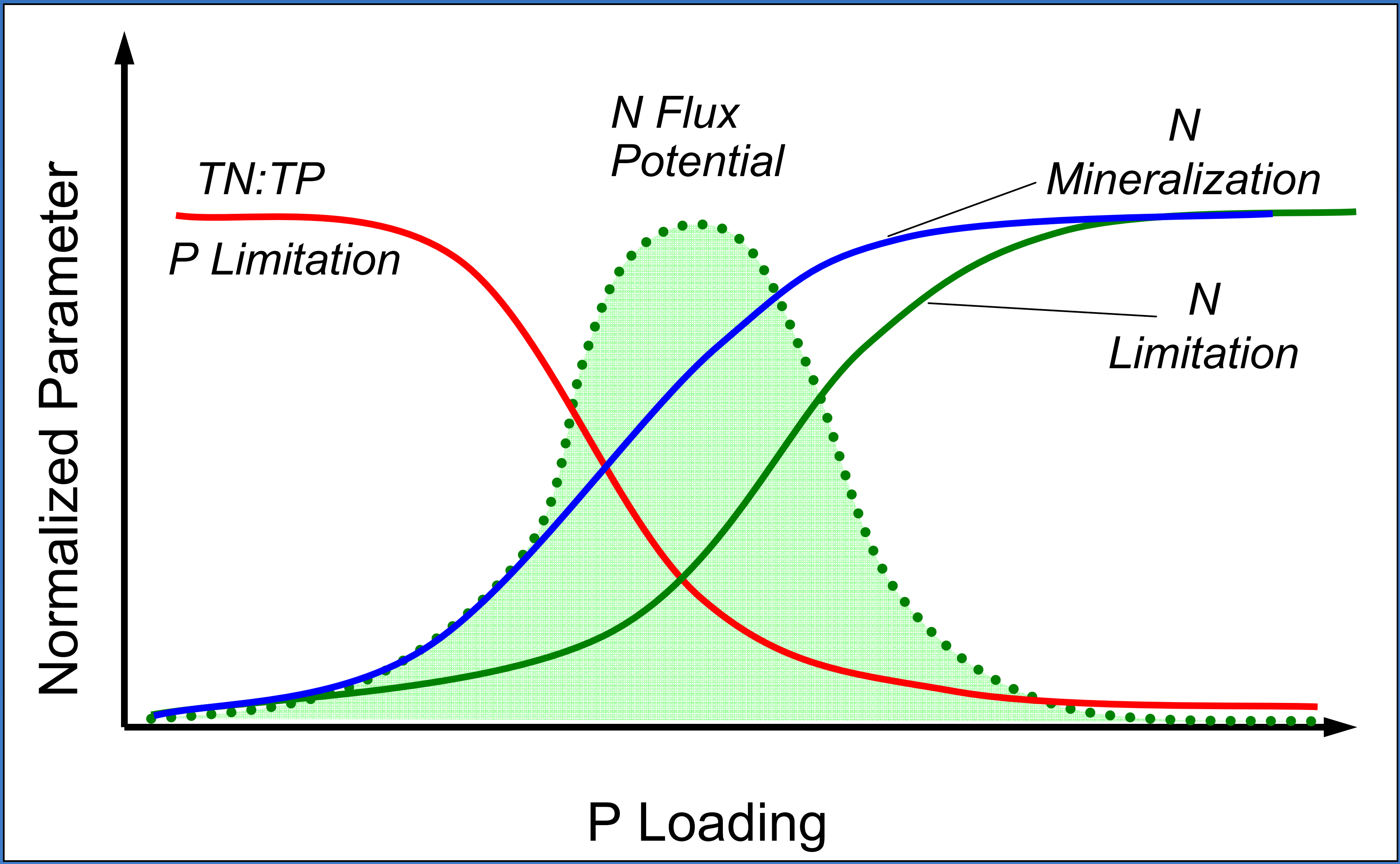



Rivera-Monroy, *in prep*

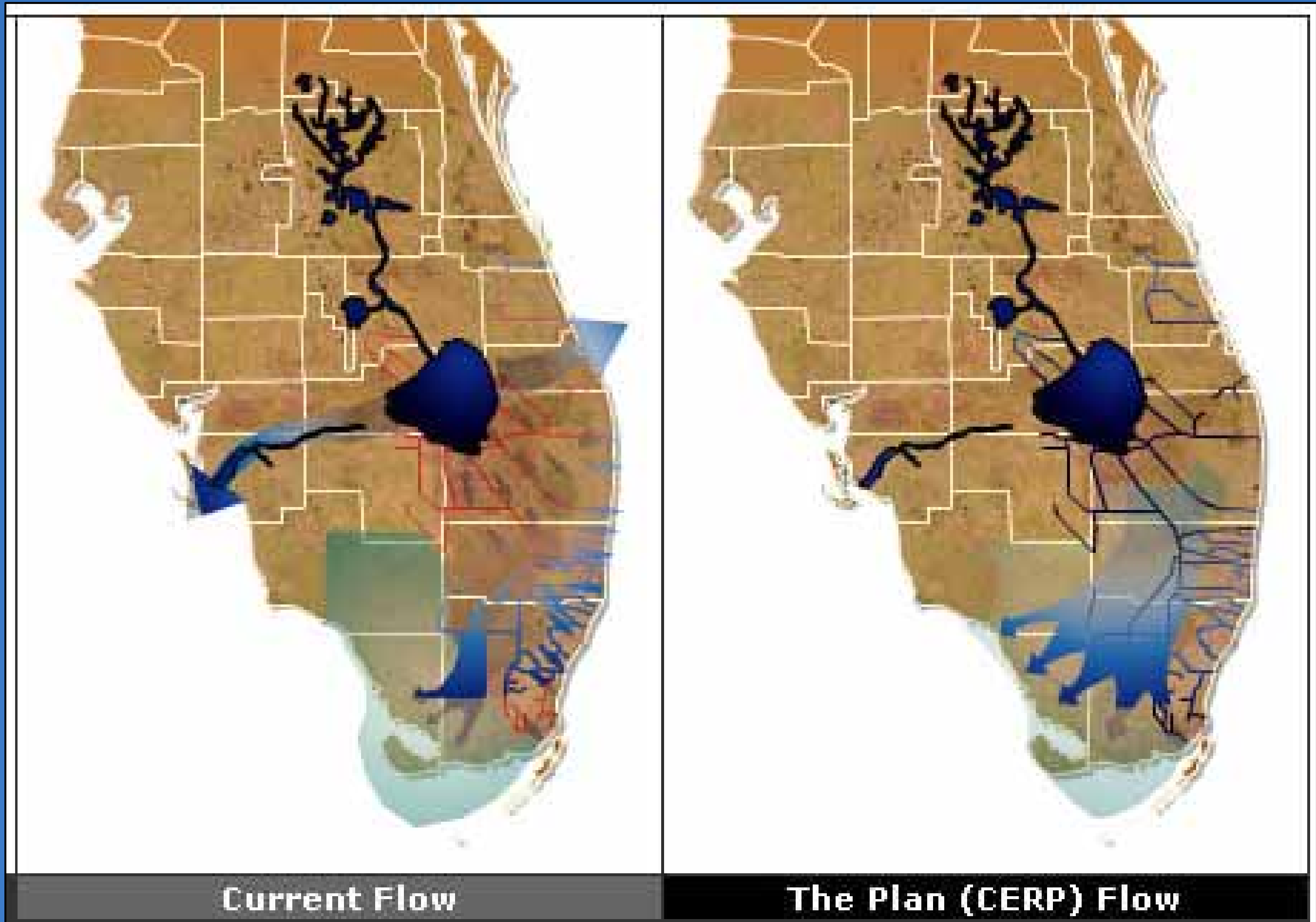
# Effects of Phosphorus Dosing

- Increase N mineralization (White and Reddy, 2000) N flux (e.g., Newman et al., 2001)
- Increased $NH_4^+$ increases potential nitrification (White and Reddy, 2003)
- Increases N demand
- Increases $N_2$ fixation (Inglett et al., 2008)

# P Influence on Soil N Dynamics



# Restoration?




SOURCE: WWW.EVERGLADESPLAN.ORG

# Restoration Goals

- Minimize EAA soil oxidation
- Reduce P export to WCA's
- Level out the hydrology/hydroperiod
- Increase freshwater flow to FL Bay/Gulf of Mexico

# Process-level Understanding

- Deposition/Inputs:
  - Quantifyable (managed/atmospheric)
- $N_2$ Fixation:
  - Significant process
  - Spatially variable
  - P-regulated, Hydrology?
- Mineralization
  - Key factor in N flux transport
  - P role established, but ecosystem linkages not investigated

# Process-level Understanding

- Nitrification/Denitrification:
  - Important for mass balance/budget
  - Largely undocumented (*in situ* rates)
  - Effect of P as yet undetermined
  - Role in periphyton mats?

# Process-level Understanding

- $NH_3$ Volatilization:
  - Conditions may exist…unverified
- Photolysis
  - Important determinant of N availability/fate
  - Poorly studied except in marine systems
- New processes
  - Anammox
  - Nitrate reduction coupled to $S/CH_4$ oxidation

# Thank you