Benthic Flux Projects:

Update on System-wide Benthic Flux Coring and Site Specific Benthic Flux Processes (Methods Comparison)

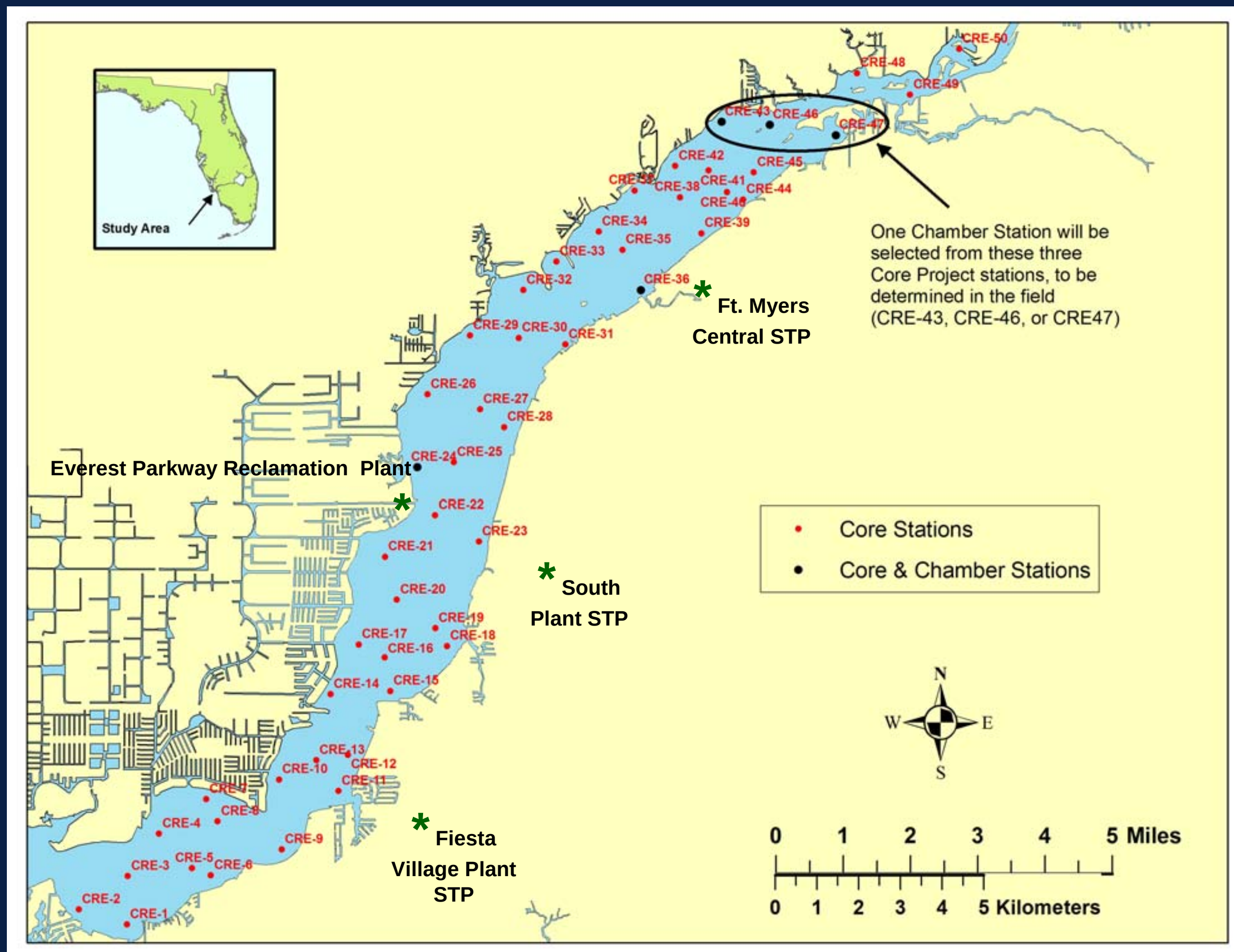
June 17, 2008

2 Projects: System-wide Cores (remote) and Chambers (in situ) vs. Cores (remote)

Objectives

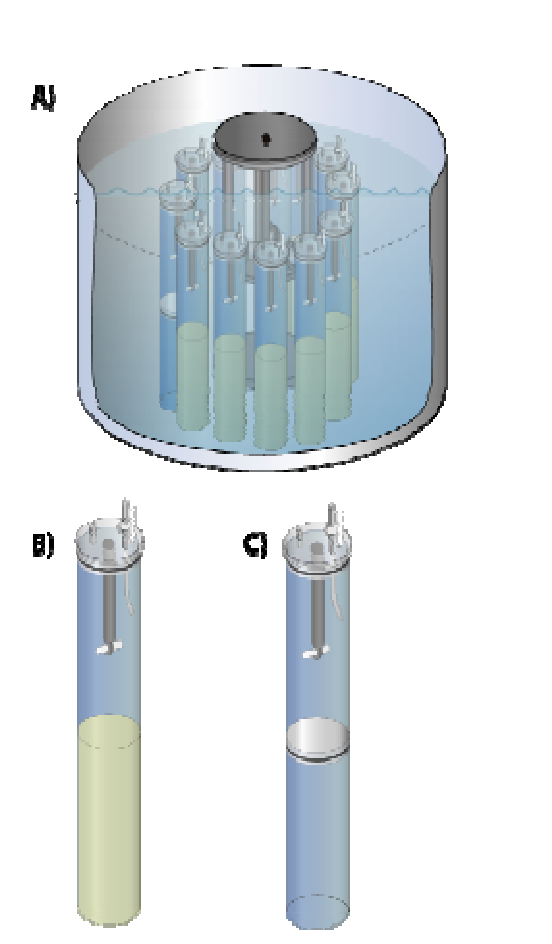
- Provide estimates representative of system-wide benthic nutrient (Nitrogen and Phosphorus) flux rates;
- Identify "hot spots" for these fluxes;
- Identify processes (and associated methodologies) driving fluxes in this system (i.e. diffusive vs. advective/groundwater).

50 Sites for SYSTEM-WIDE Core Incubation and 3 Sites for Chamber/Core Incubations of Benthic Nutrient Fluxes in the CRE



Sediment Chambers/Cores: Incubation Diagram

Remotely Incubated Cores



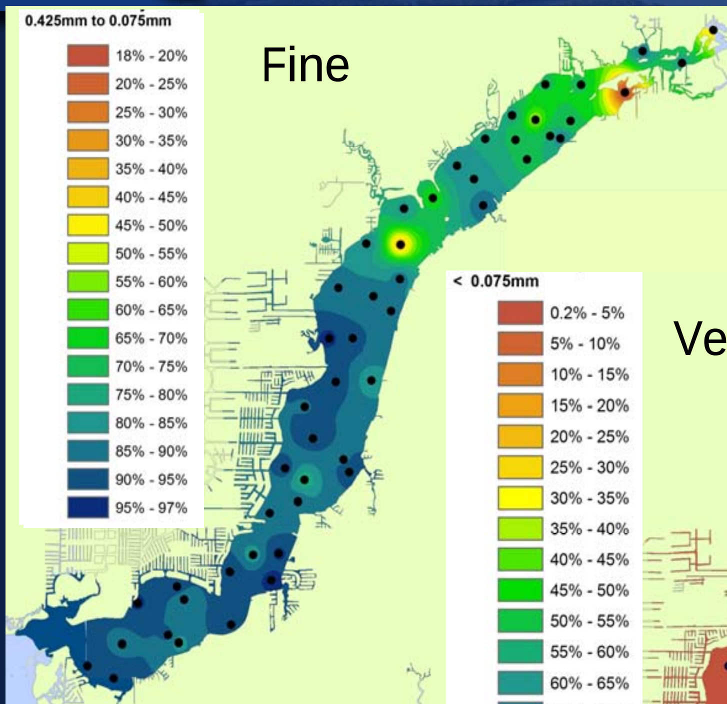
In Situ Chambers

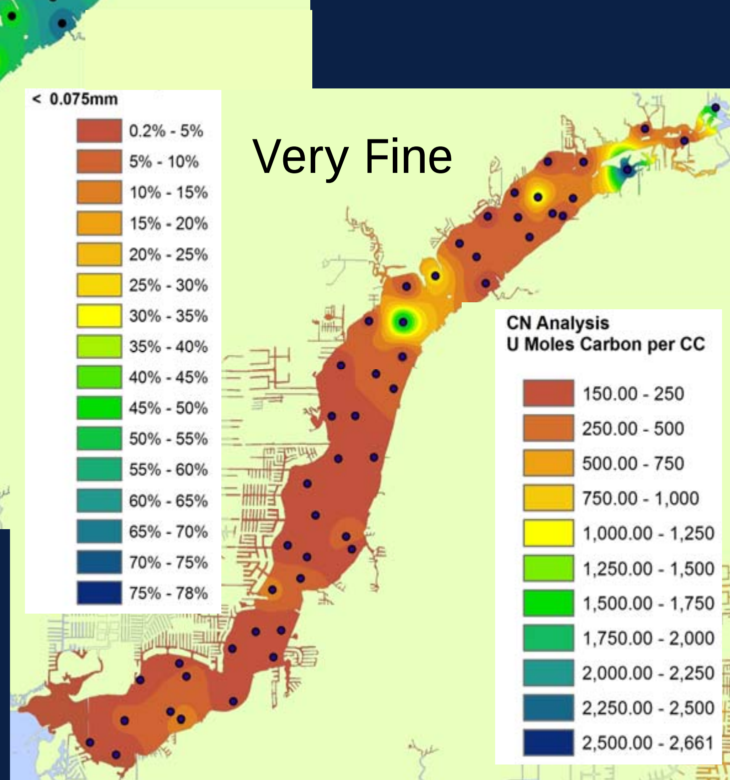
Analyses: 53 Stations

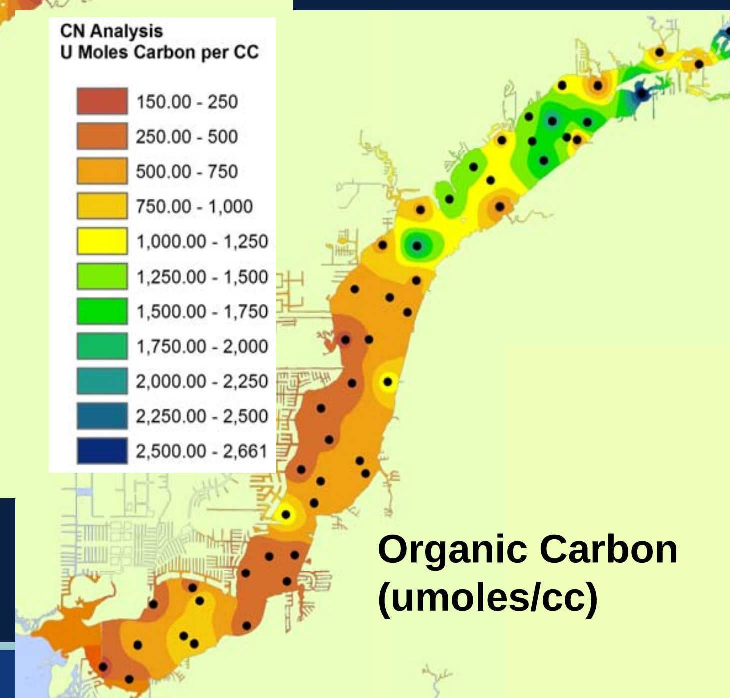
In Situ Water Column	Incubation Water Column	Incubation Pore Water	Core Sediment Surface
~800 dissolved nutrients and gases and particulates Depth Temperature Salinity PAR (Sediment Surface)	4500 dissolved nutrients/gases	350 dissolved nutrients	60 Chl *a* 60 CPN 60 Grain Size

Sediment Characteristics

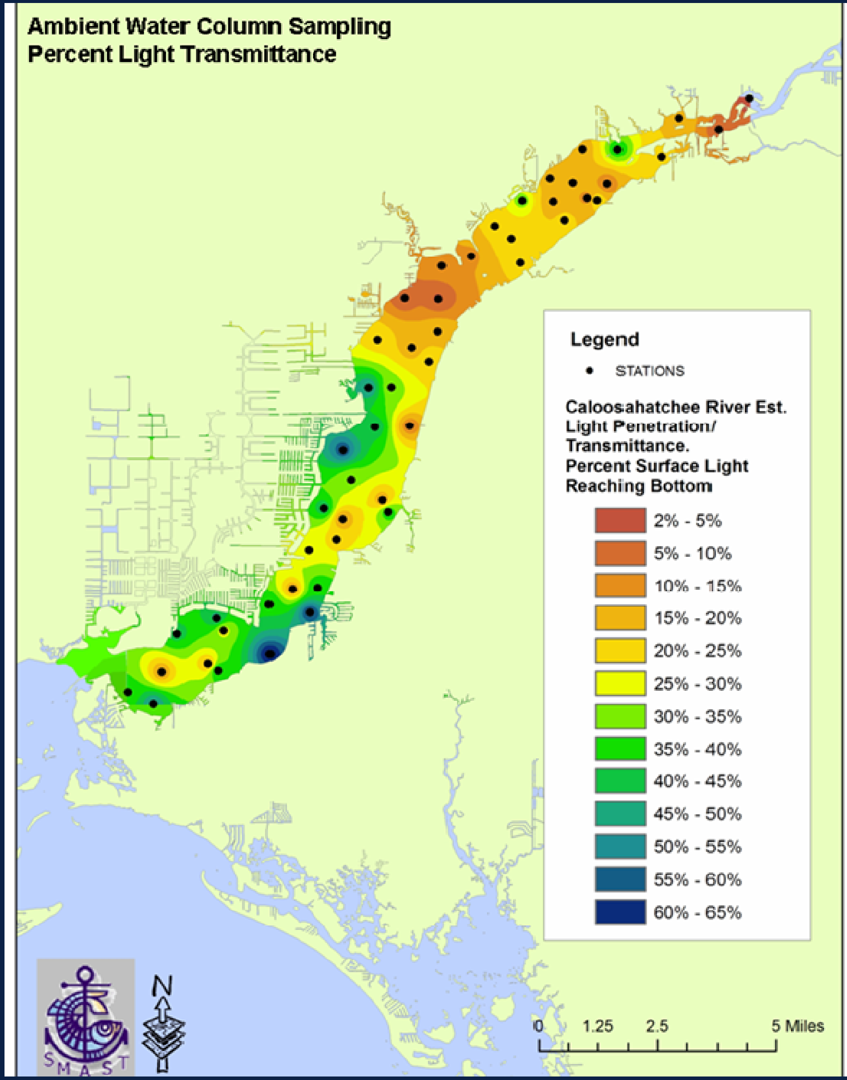
Caloosahatchee River and Estuary Sediment Grain-size & Carbon

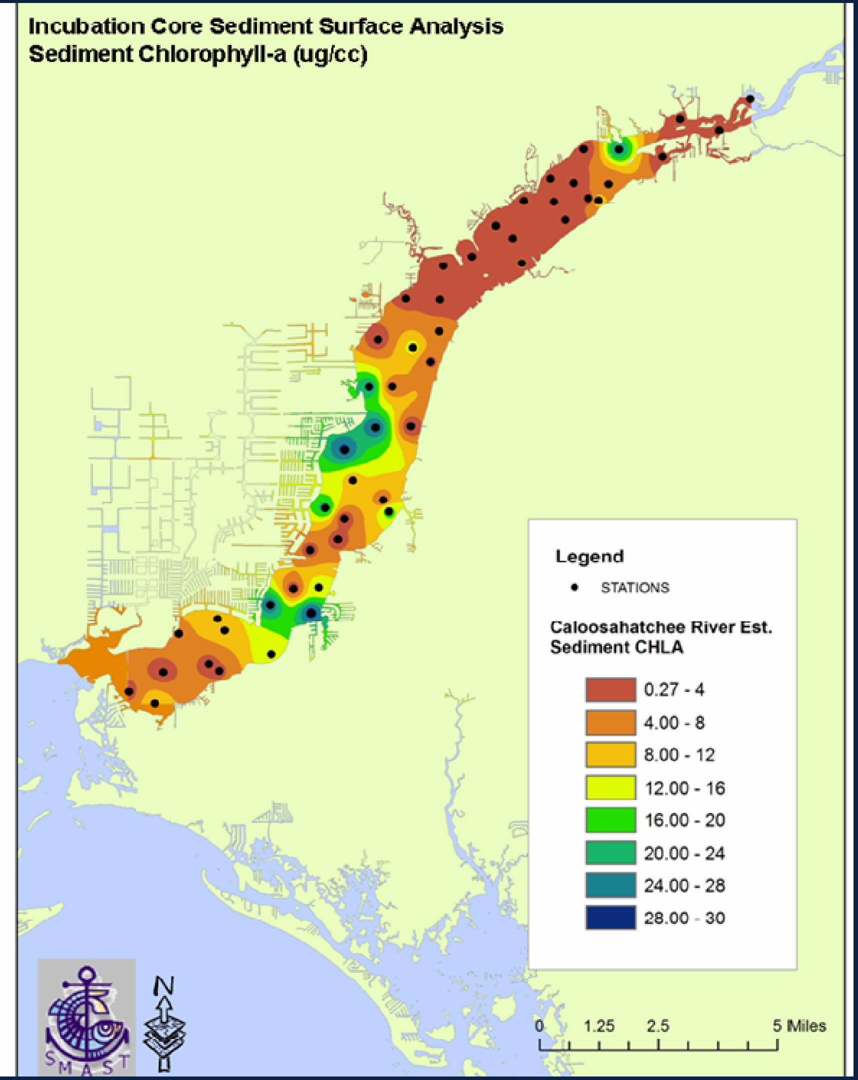




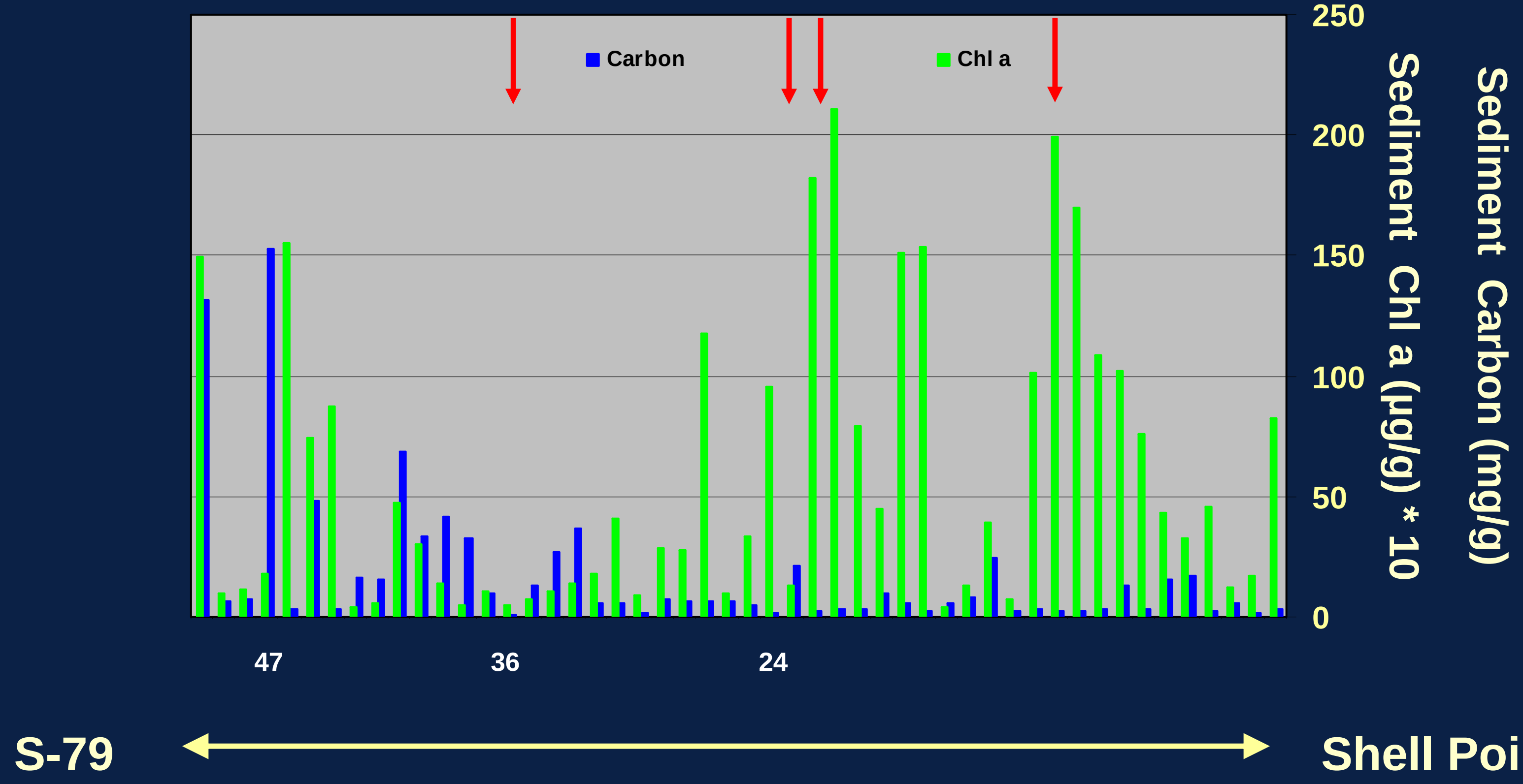


Caloosahatchee River Estuary: Light and Sediment Chlorophyll

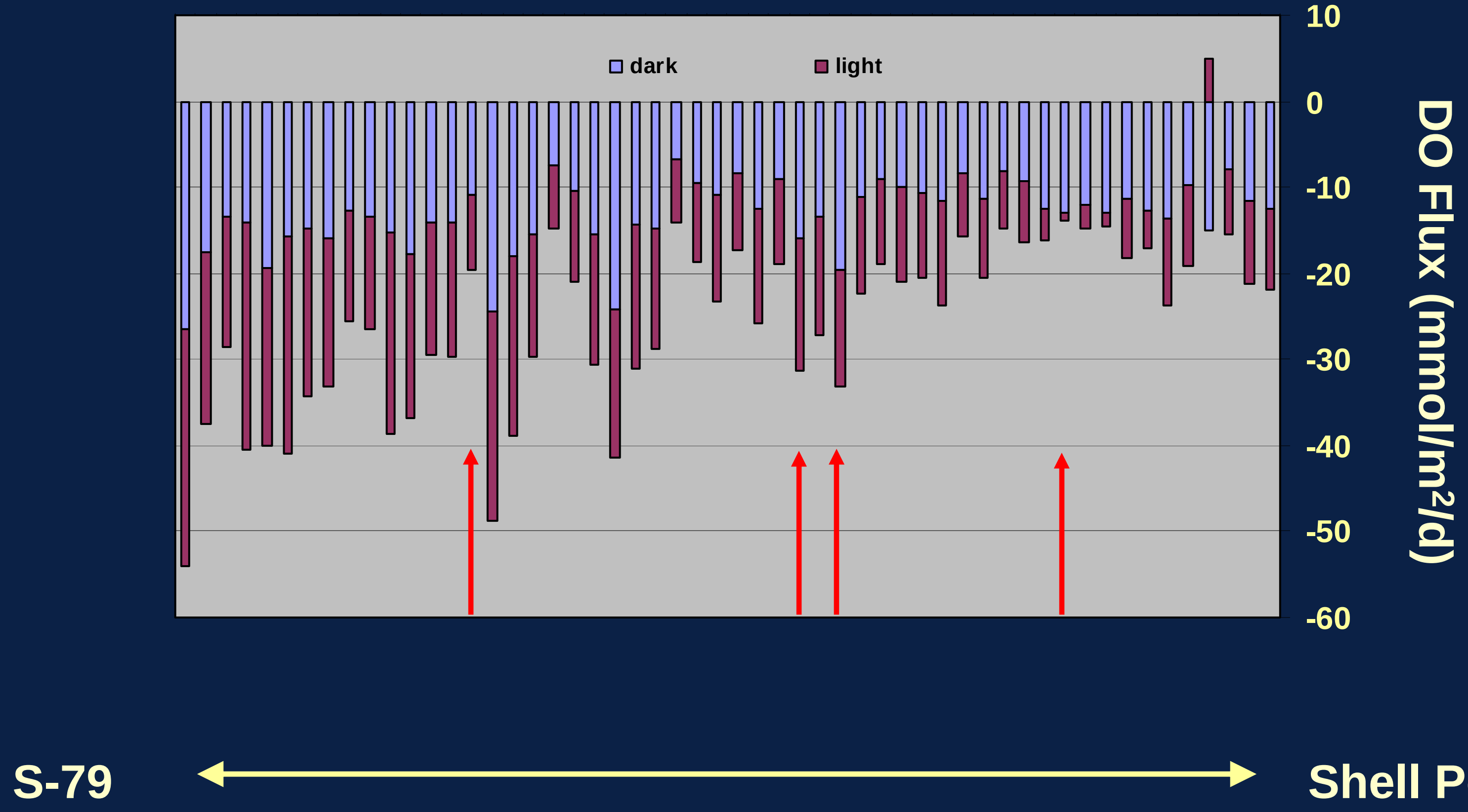




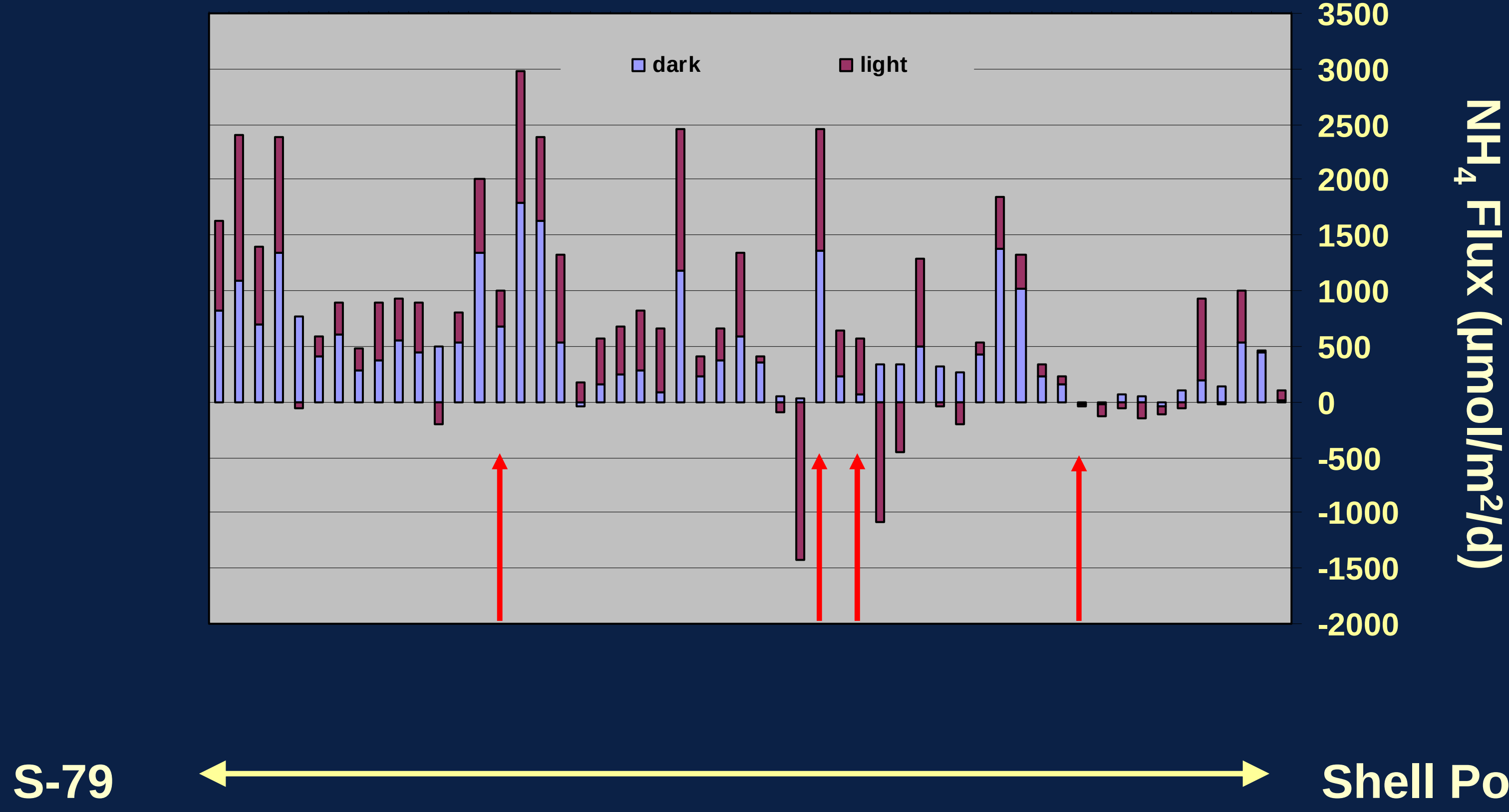
Sediment Chlorophyll and Carbon



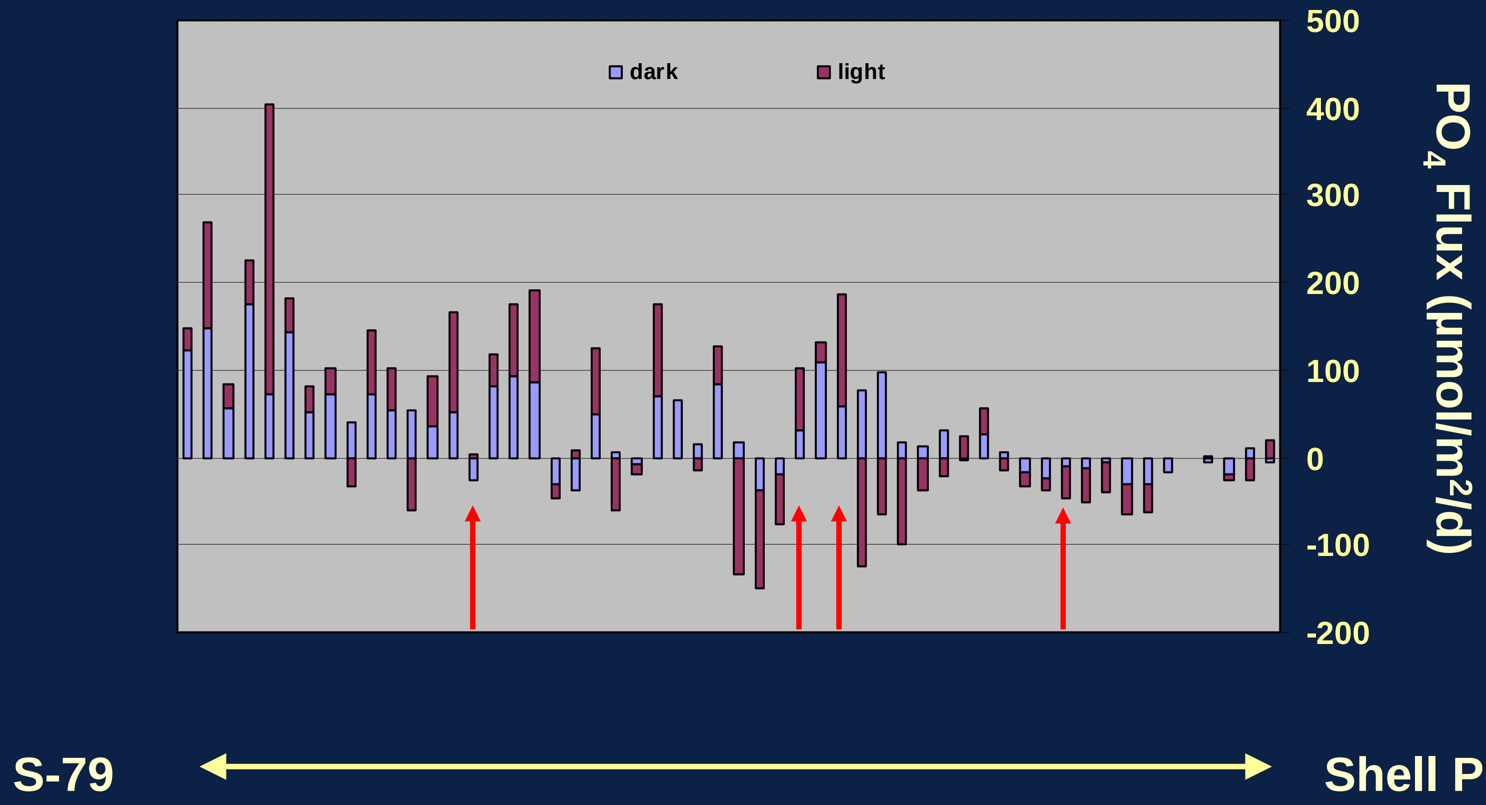
Systemwide Fluxes: DO



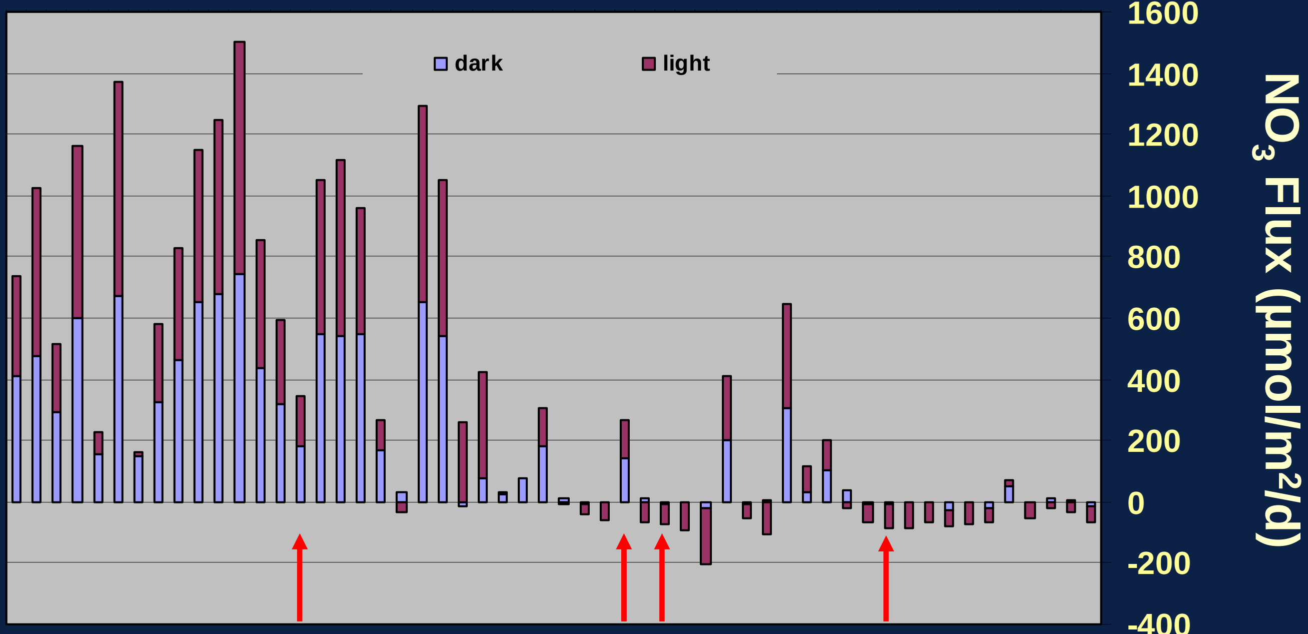
Systemwide Fluxes: Ammonium



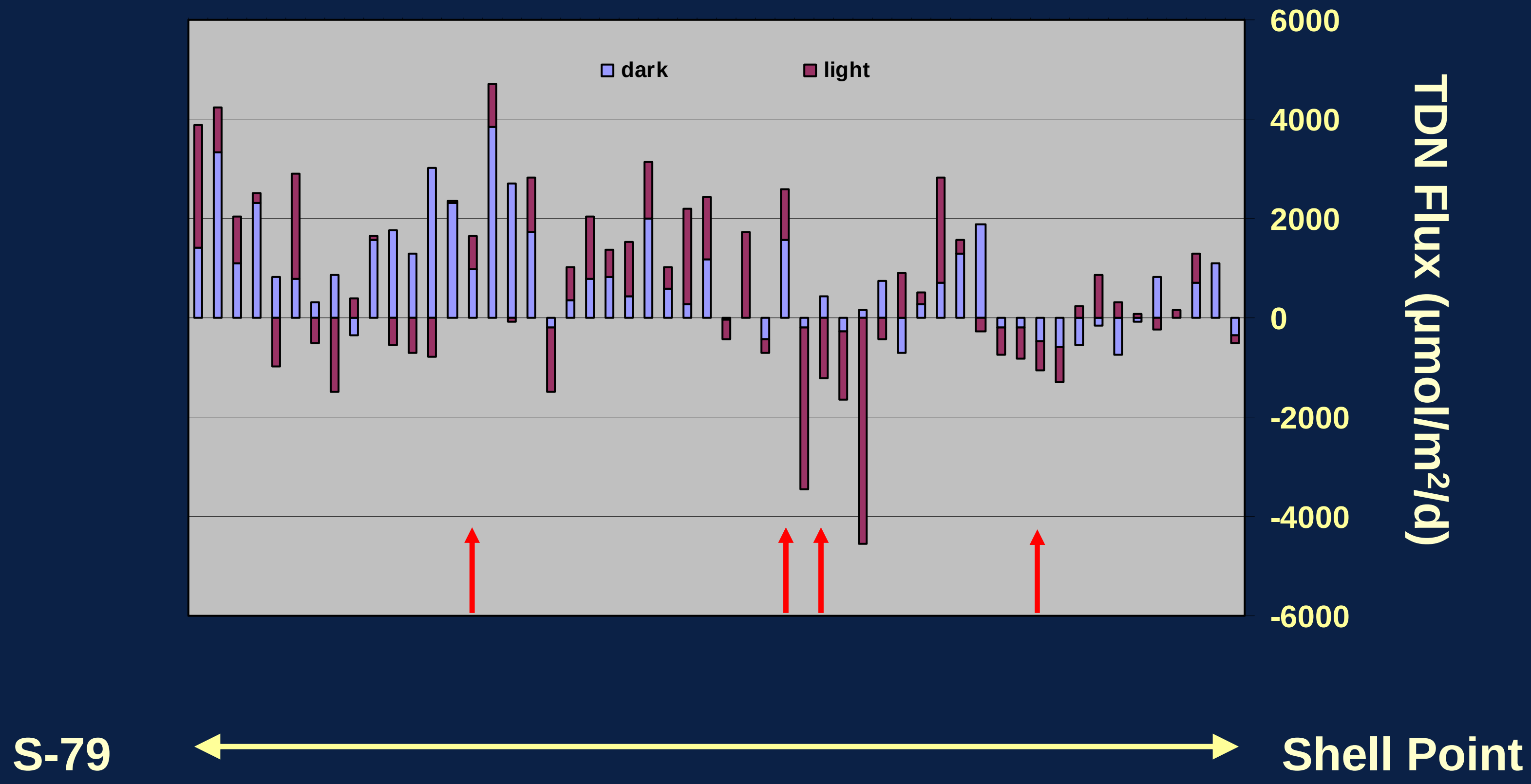
Systemwide Fluxes: Phosphate



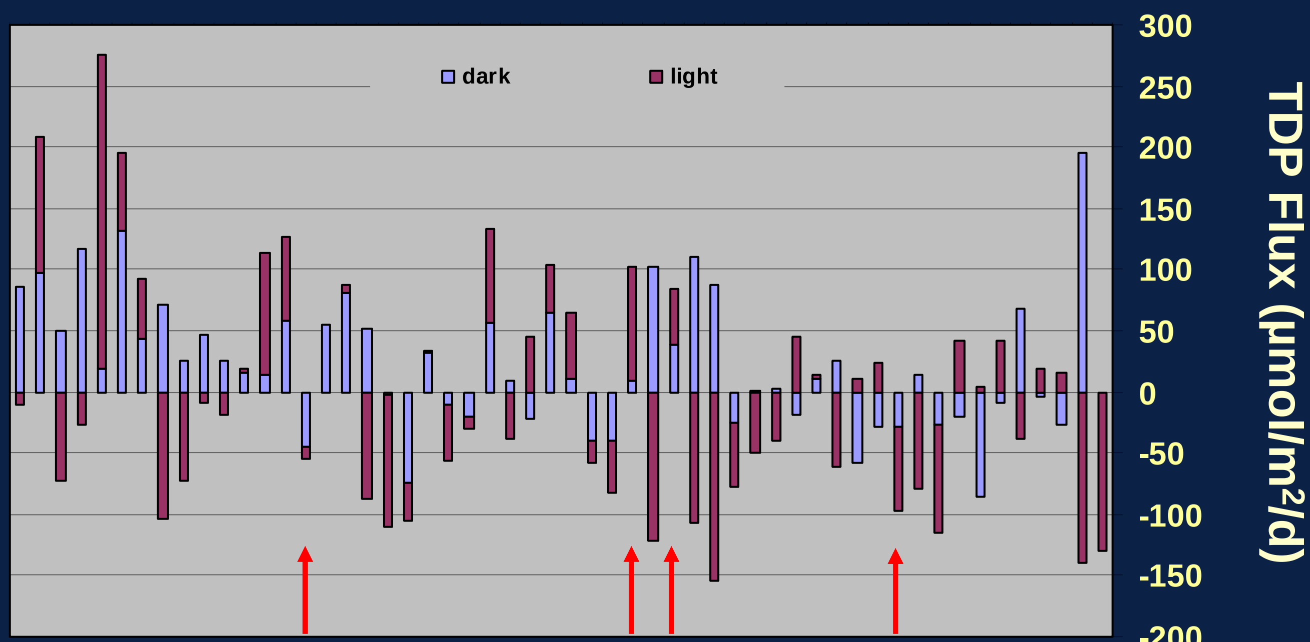
Systemwide Fluxes: Nitrate



Systemwide Fluxes: Total Dissolved Nitrogen

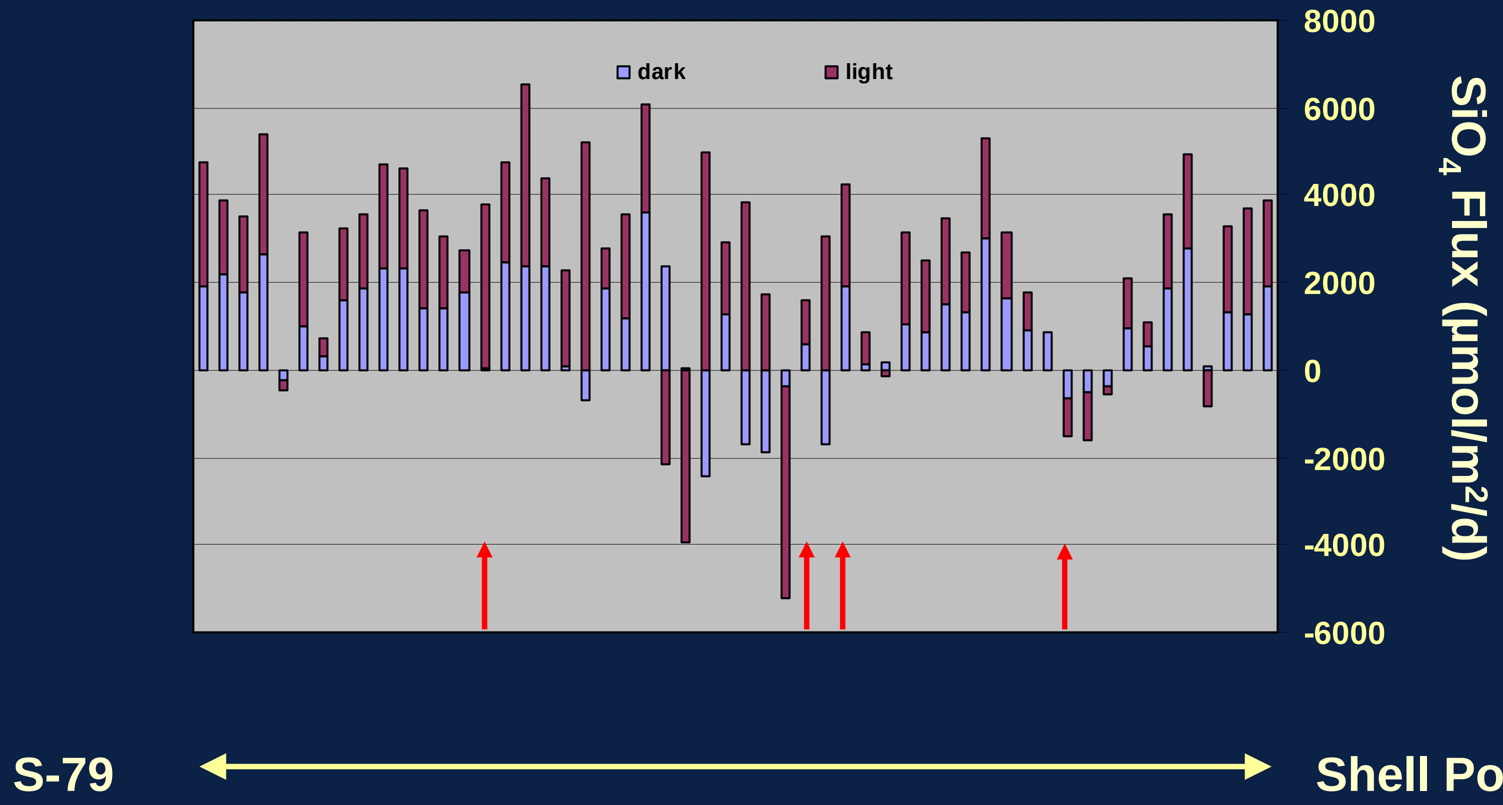


Systemwide Fluxes: Total Dissolved Phosphorus



S-79 ⟷ Shell Point

Systemwide Fluxes: Silicate



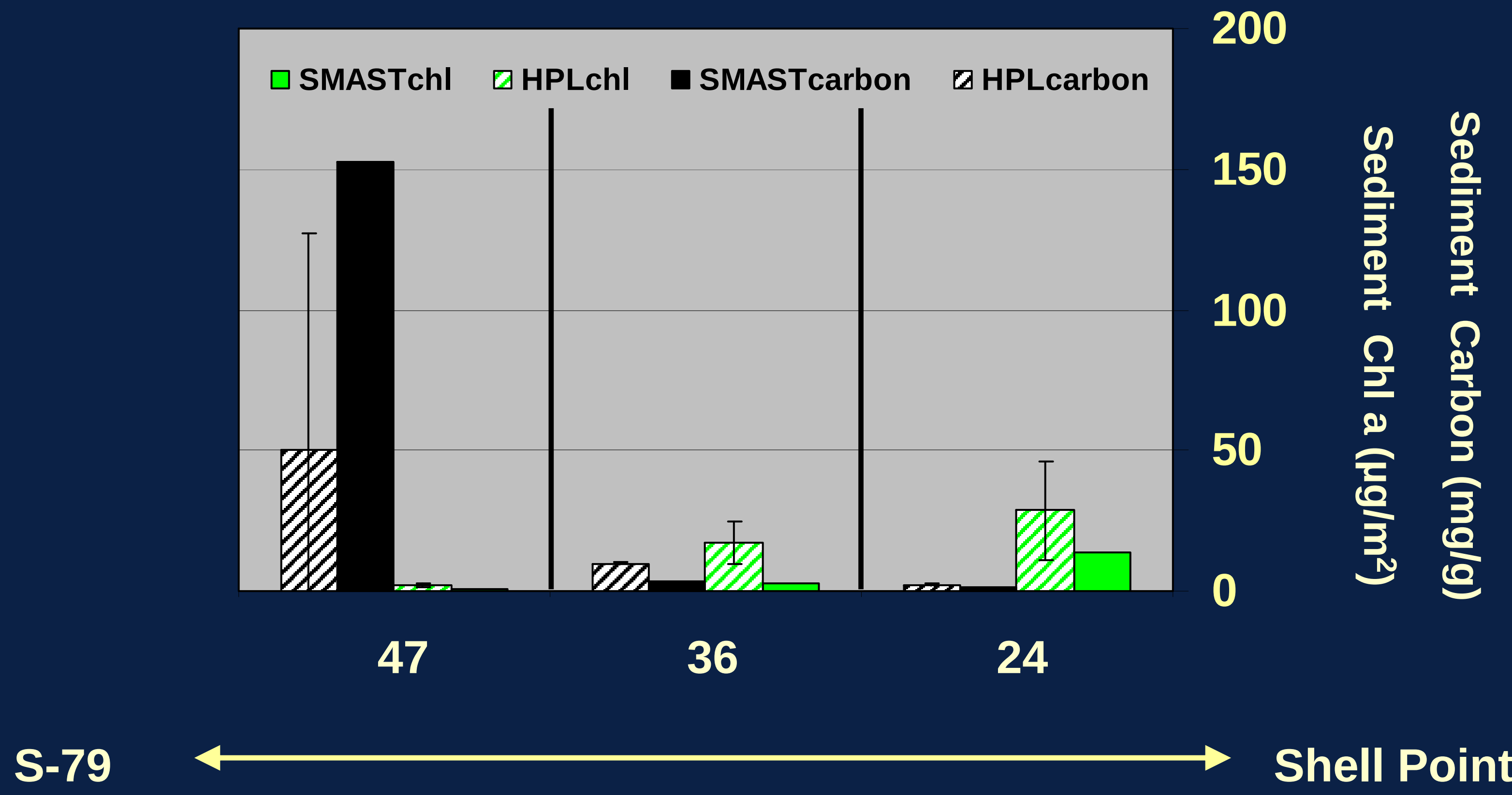
Comparisons: DO Fluxes

Reasonably Good Agreement In the *DARK*

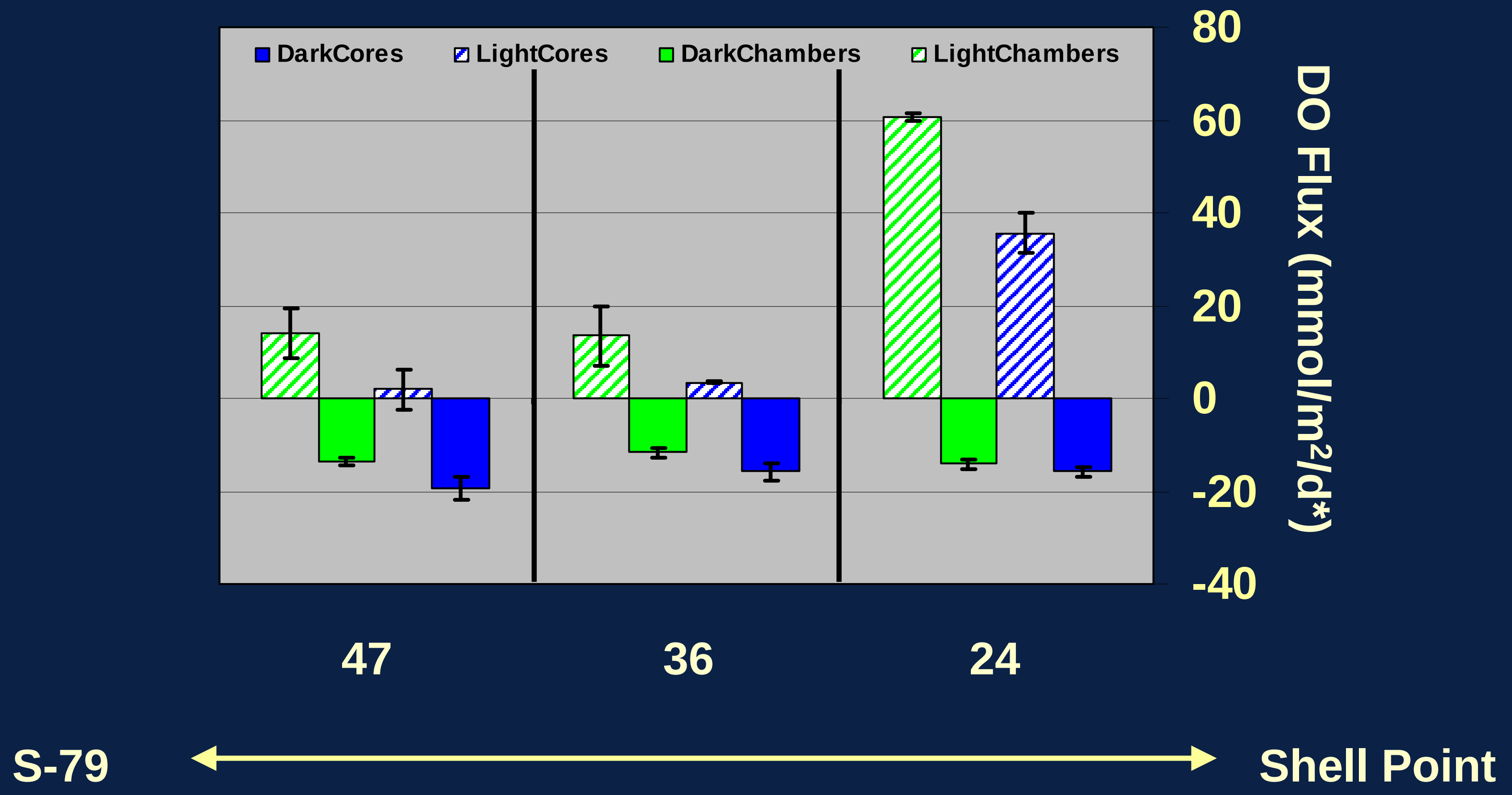
S-79 ⟷ Shell Point

pp = photoperiod (12h)

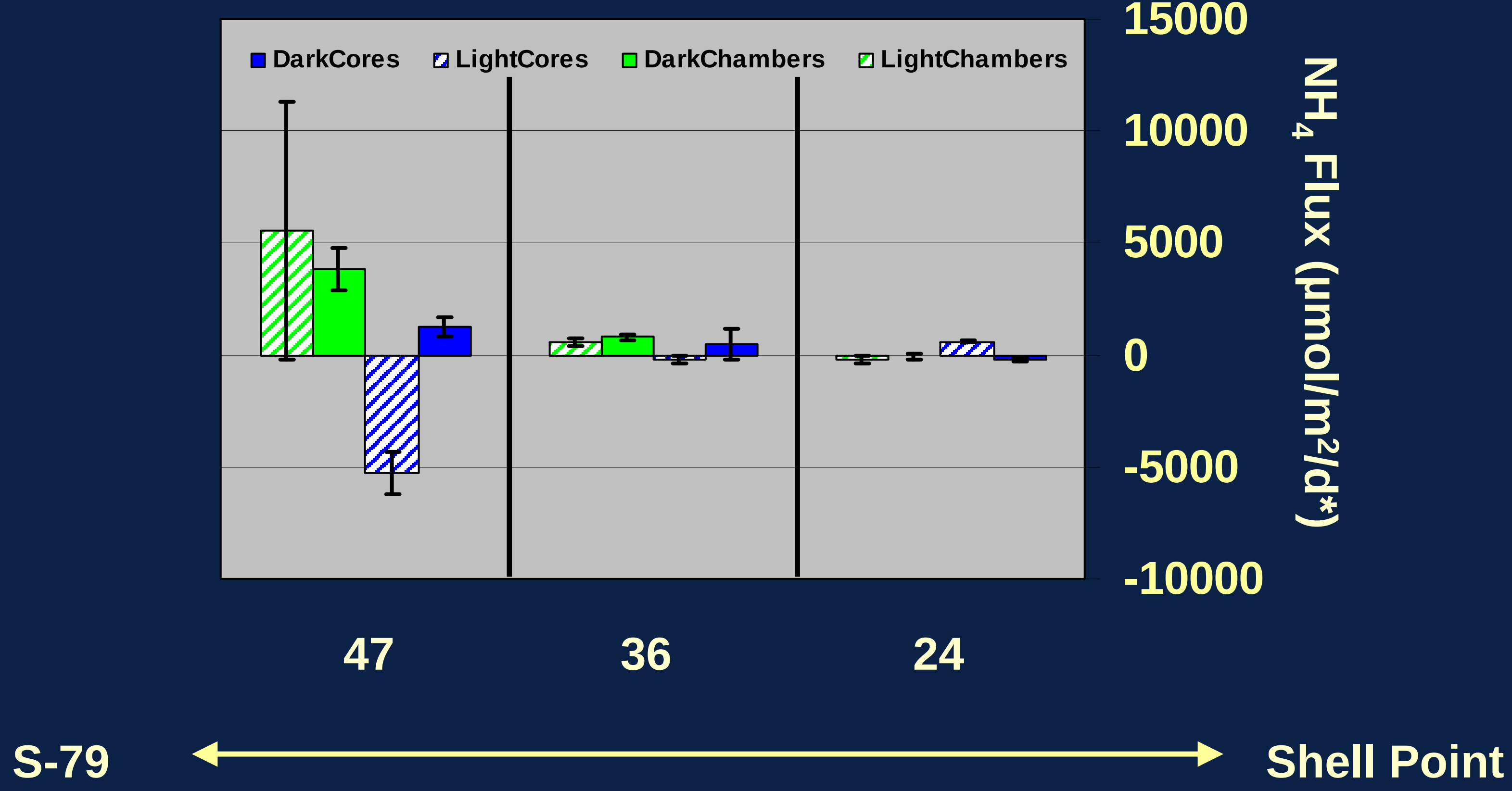
Sediment Chlorophyll and Carbon



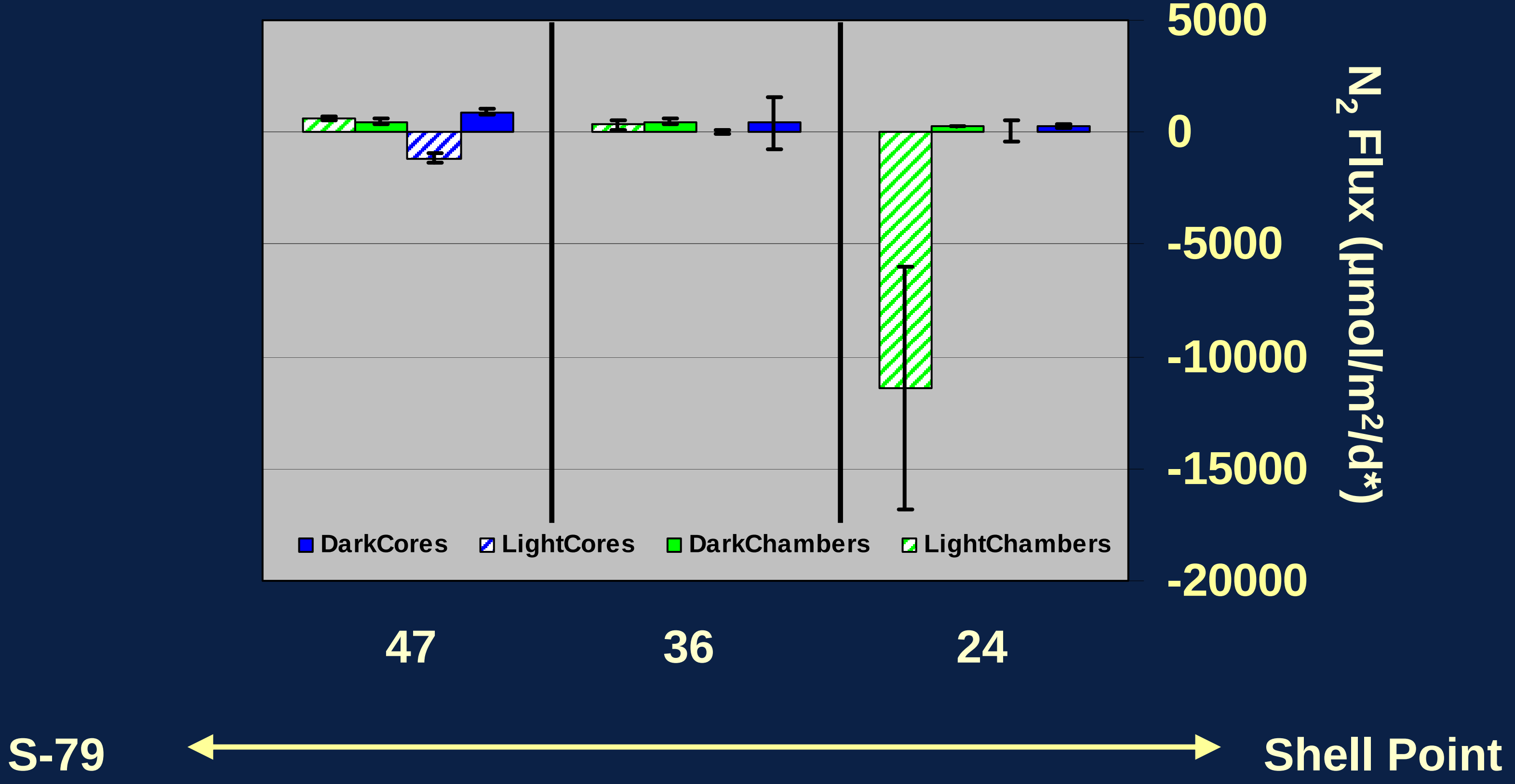
Light and Dark DO Fluxes



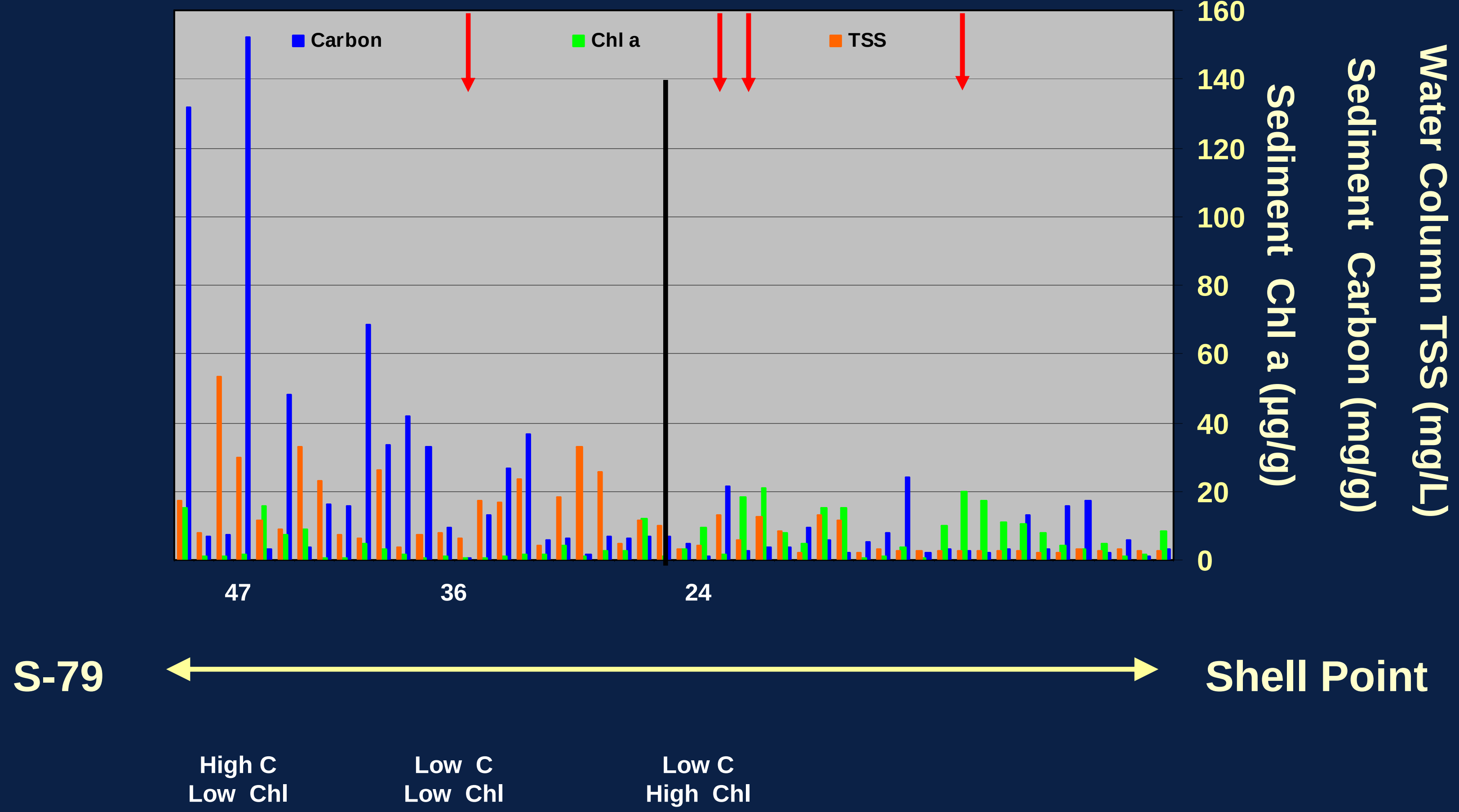
Light and Dark Ammonium Fluxes



Light and Dark Denitrification



Sediment Chlorophyll and Carbon



OBJECTIVES:

- Provide estimates representative of **system-wide benthic nutrient (Nitrogen and Phosphorus) flux rates;**

* Represents $1/10^6$ Percent of the System SA	DIN (MT/d)	DIP (MT/d)	DON (MT/d)	DOP (MT/d)	TDN (MT/d)	TDP (MT/d)
System-wide Average	1.30	0.12	-0.31	-0.10	0.98	0.03
Upper Estuary Average	1.08	0.13	-0.07	-0.08	1.01	0.05
Lower Estuary Average	0.22	-0.02	-0.25	-0.01	-0.03	-0.02

OBJECTIVES:

- Identify "hot spots" for these fluxes;

UPPER ESTUARY

CRE35: DIN OUT (med C)

CRE46: DIP OUT

CRE50: DON OUT (high C)

CRE39: DOP OUT (med C)

CRE32: DIN/DON IN (med C)

CRE30: DIP IN (med C)

CRE33: DOP IN (med C)

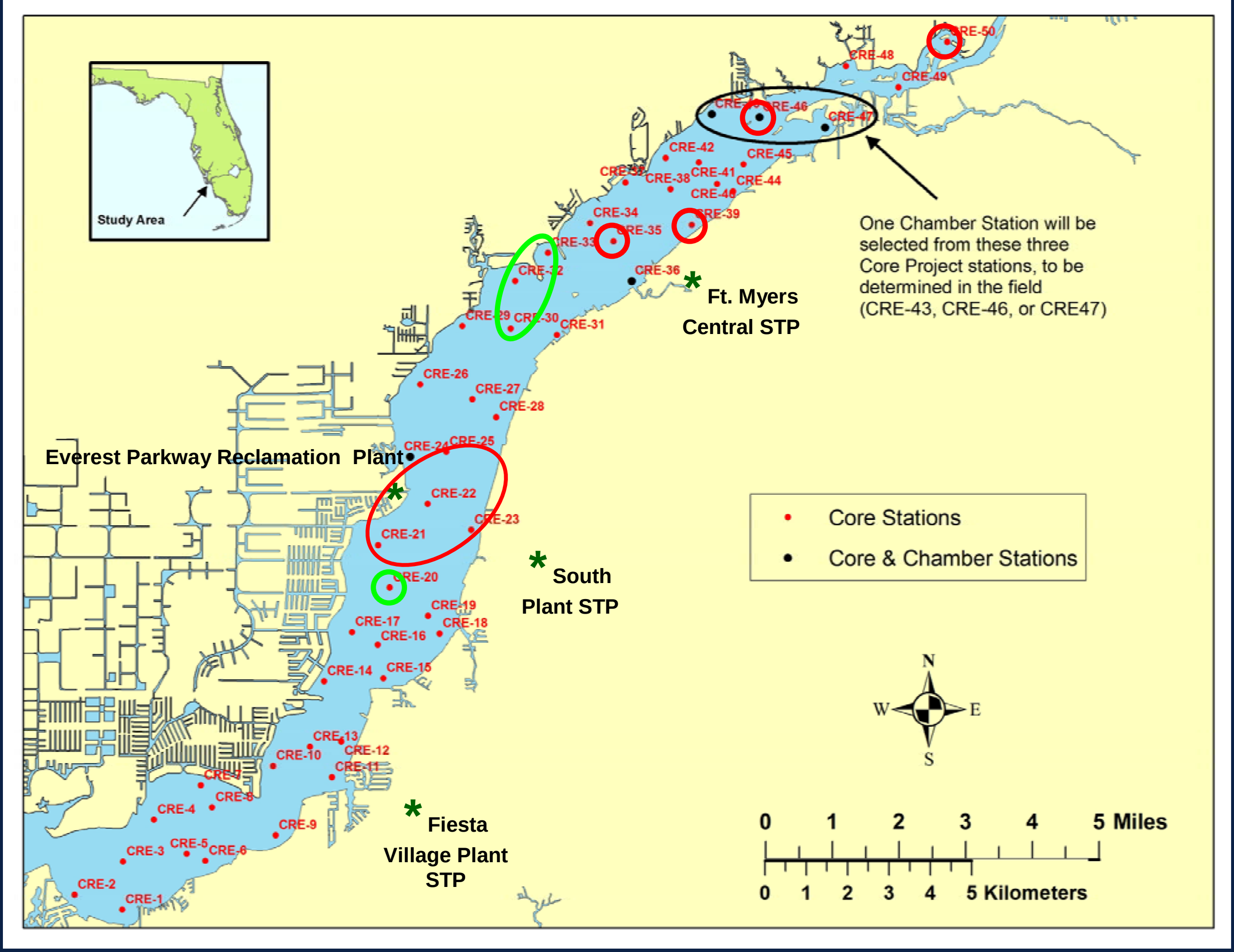
LOWER ESTUARY

All 4 Stations High Chl

CRE 21/23: Inorganics OUT

CRE 24: Organics OUT /Inorganics IN

CRE20: Organics IN



OBJECTIVES:

- Identify processes (and associated methodologies) driving fluxes in this system (i.e. diffusive vs. advective/groundwater).

    - No Evidence of Advection (only 3 sites)
    - Evidence of Nitrogen Fixation
    - LIGHT MATTERS!!!!!

What's Next: Modeling Needs

- Spatial Analyses Of Systemwide Data To Identify Subregions (i.e. minimum number of monitoring stations)
- Contour Analysis Of Systemwide Data To Determine More Accurate Subregion Load/Removal Rates
- Temporal Variability: Wet Season Sampling, Selected Monitoring In NON-Drought Conditions
- N_2 Component – Nitrogen Fixation/Denitrification
- Determine How To Apply Light During Incubation

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Dynamics of Estuarine Turbidity Maxima (ETM) in the Caloosahatchee Estuary

Investigator: David Fugate, FGCU

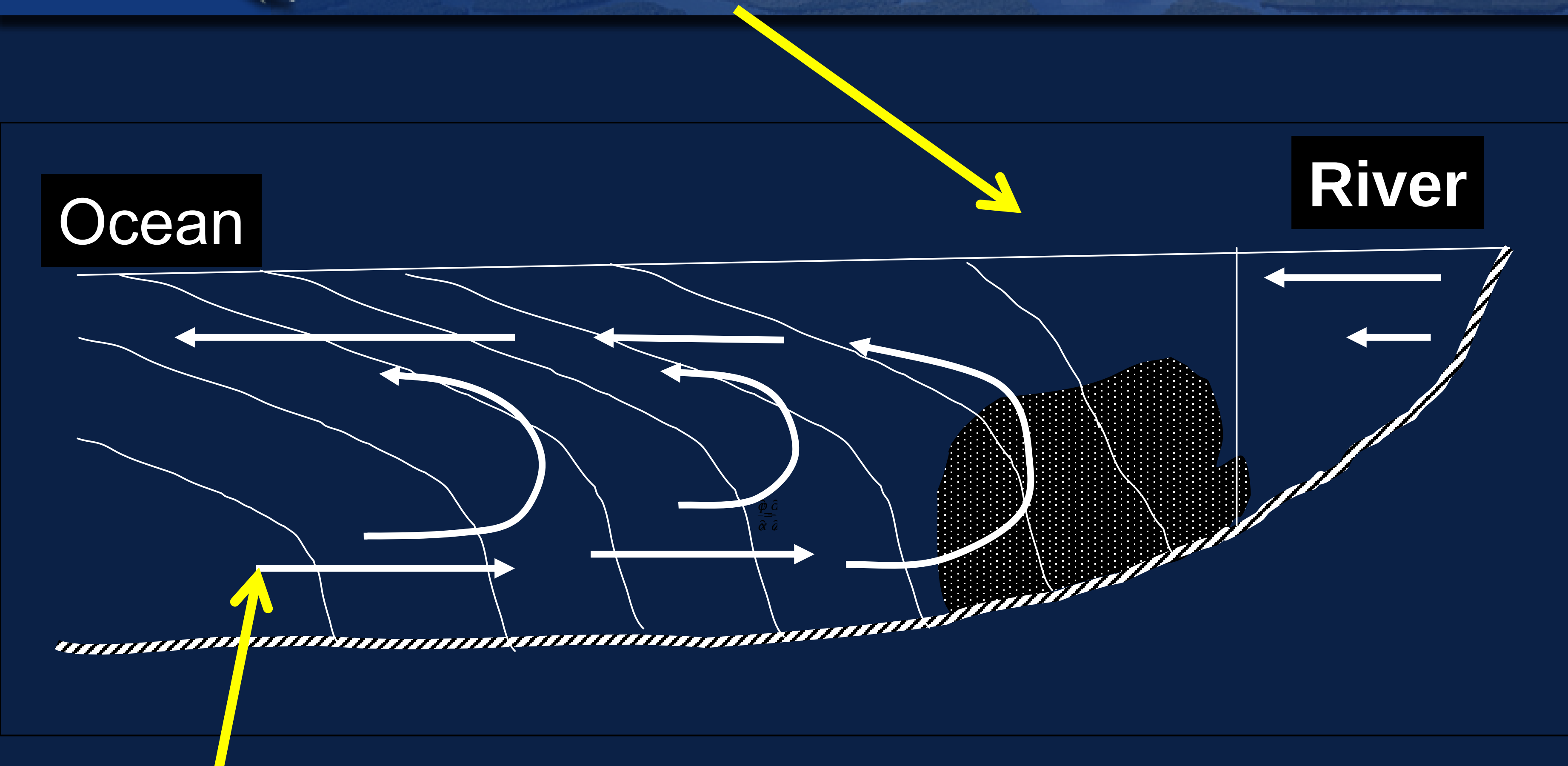
Coastal Ecosystems Division
SFWMD
June 2008

sfwmd.gov

What is (Estuarine Turbidity Maximum) ETM ?

Strong tidal forces push salinity upriver beneath the outflowing river water. The turbulence caused by this tidal forcing results in resuspension of sediment and other particulate material present on the river bed. Concurrently, dissolved material in the river water flocculates when it comes into contact with the salt wedge pushing its way upriver.

Estuarine Turbidity Maximum



Also called estuarine gravitational, or density driven circulation

Importance of ETM

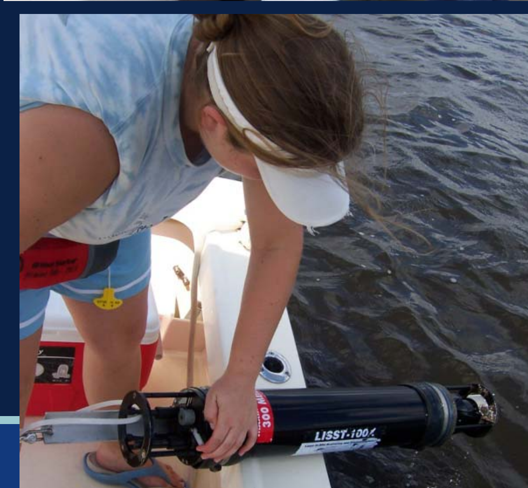
- Abundant food and stable stratification in the ETM enhance feeding conditions and production of zooplankton and fish larvae.
- Excessive turbidity can be detrimental to the ecosystem by shading and killing sea grasses or adversely affect filter-feeding organisms such as oysters.
- ETM dynamics are a result of complex interactions between hydrodynamic tidal processes, freshwater discharge, nutrient loading and mobile pools of sediment within an estuary.

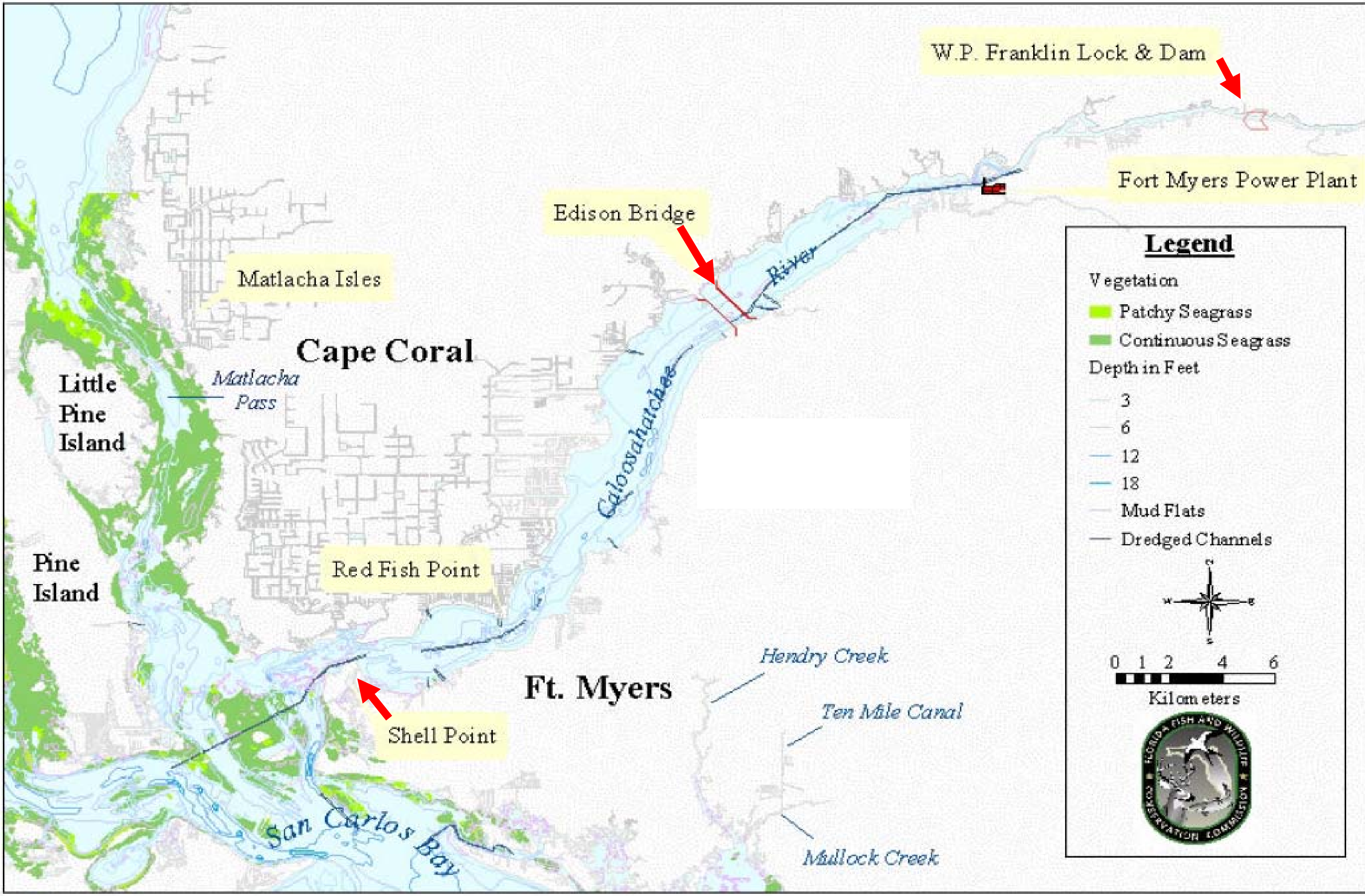
Objectives

- **The goal is to identify and evaluate the vertical and horizontal density and turbidity structure(s) with respect to DO, salinity, and/or Chl-a stratification.**
- **The results of this project can be used for the calibration of a numerical sediment transport model to evaluate light conditions in the estuary.**
- **The project also has implications in environmental operations for better management of freshwater release to improve the ecosystem health in the Low Salinity Zone.**

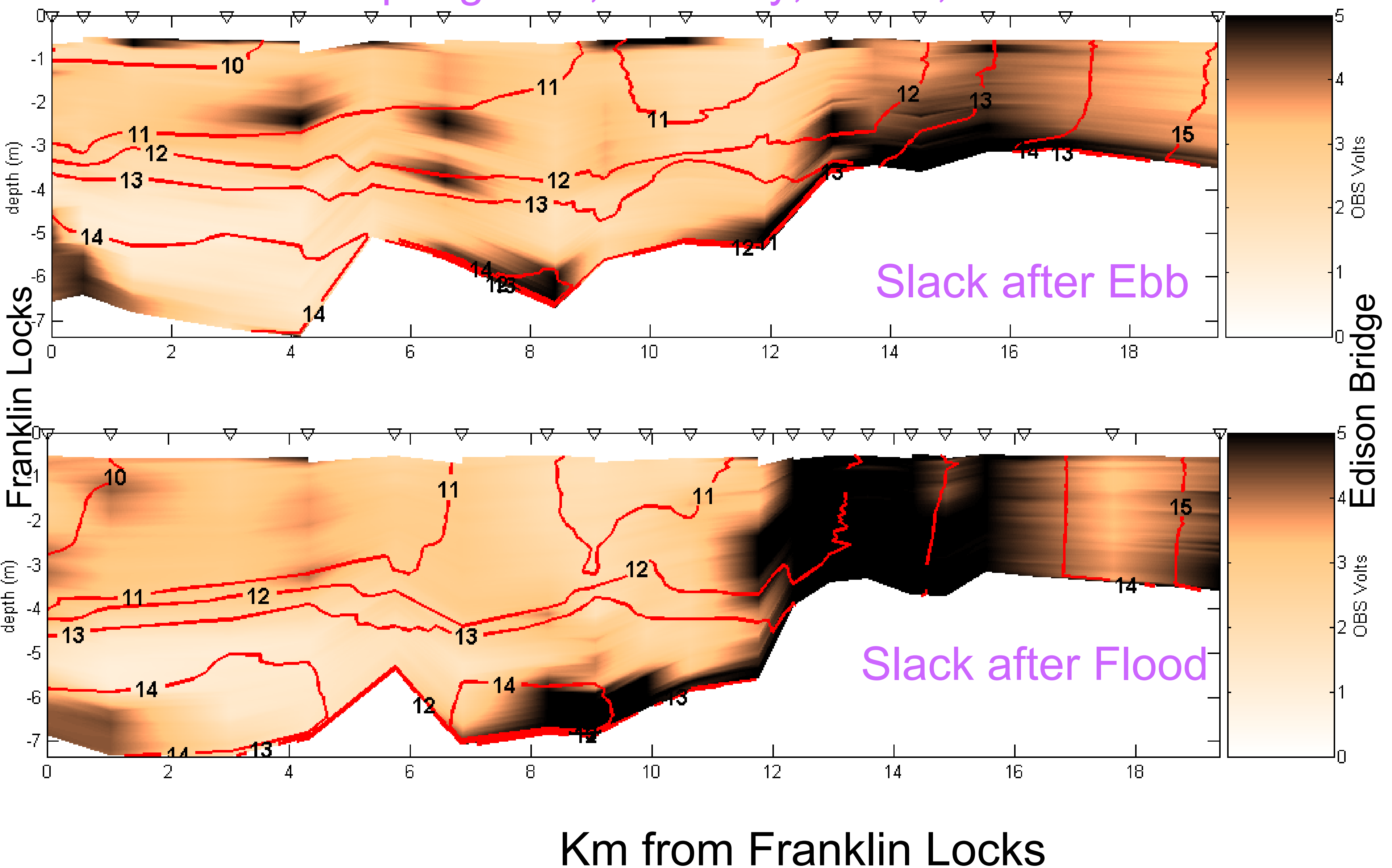
Methods

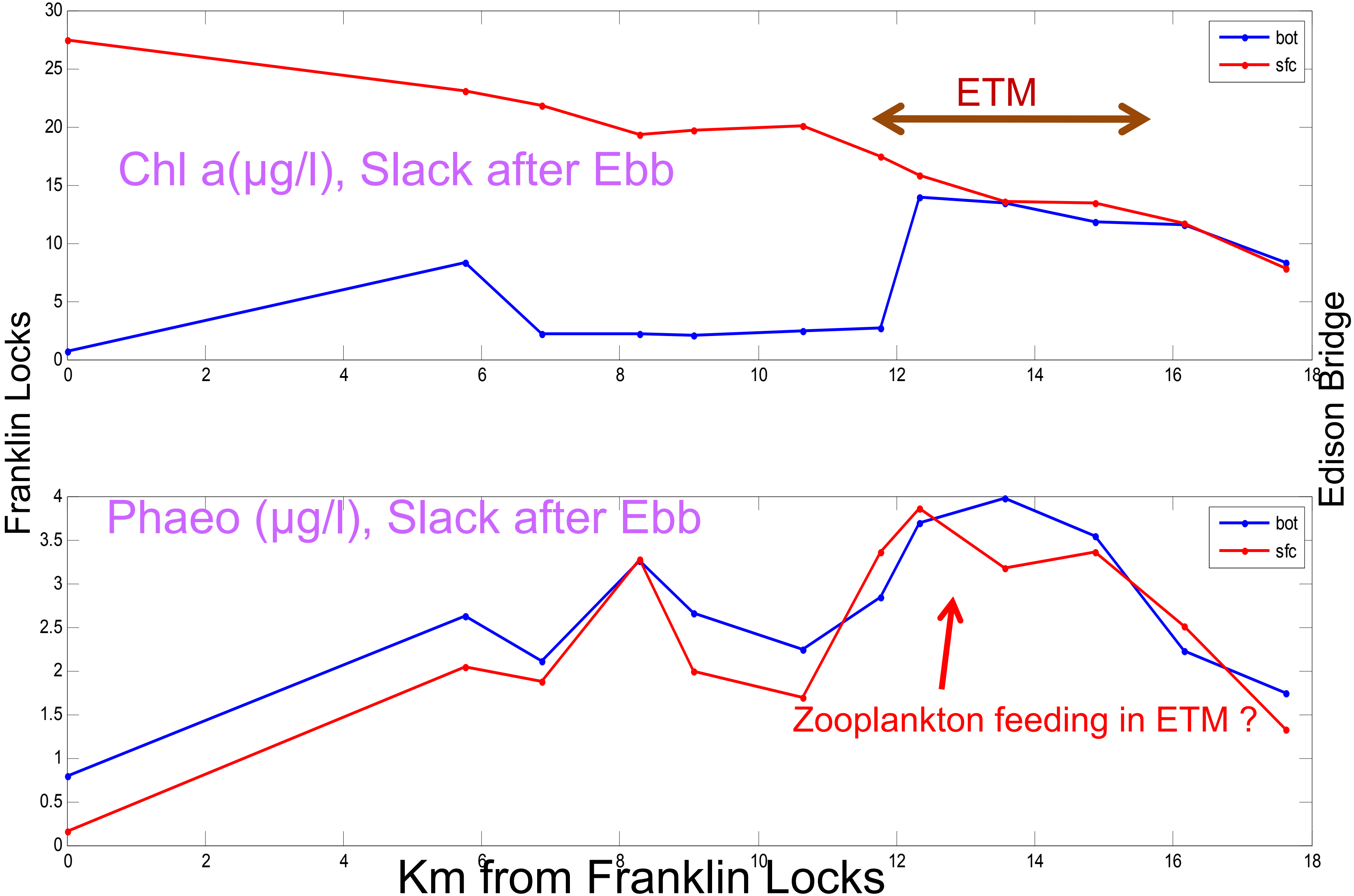
- Profiles with Seabird 19+ CTD and attached OBS
- Profiles with Sequoia Science LISST 100X (measure suspended particle size distribution)
- YSI deployed at bottom and surface for DO, pH and to provide realtime estimates of salinity to guide location of profiles.
- Pumped samples with Geosub pump attached to CTD
- Measurement was conducted from Franklin Locks to well mixed and salty region



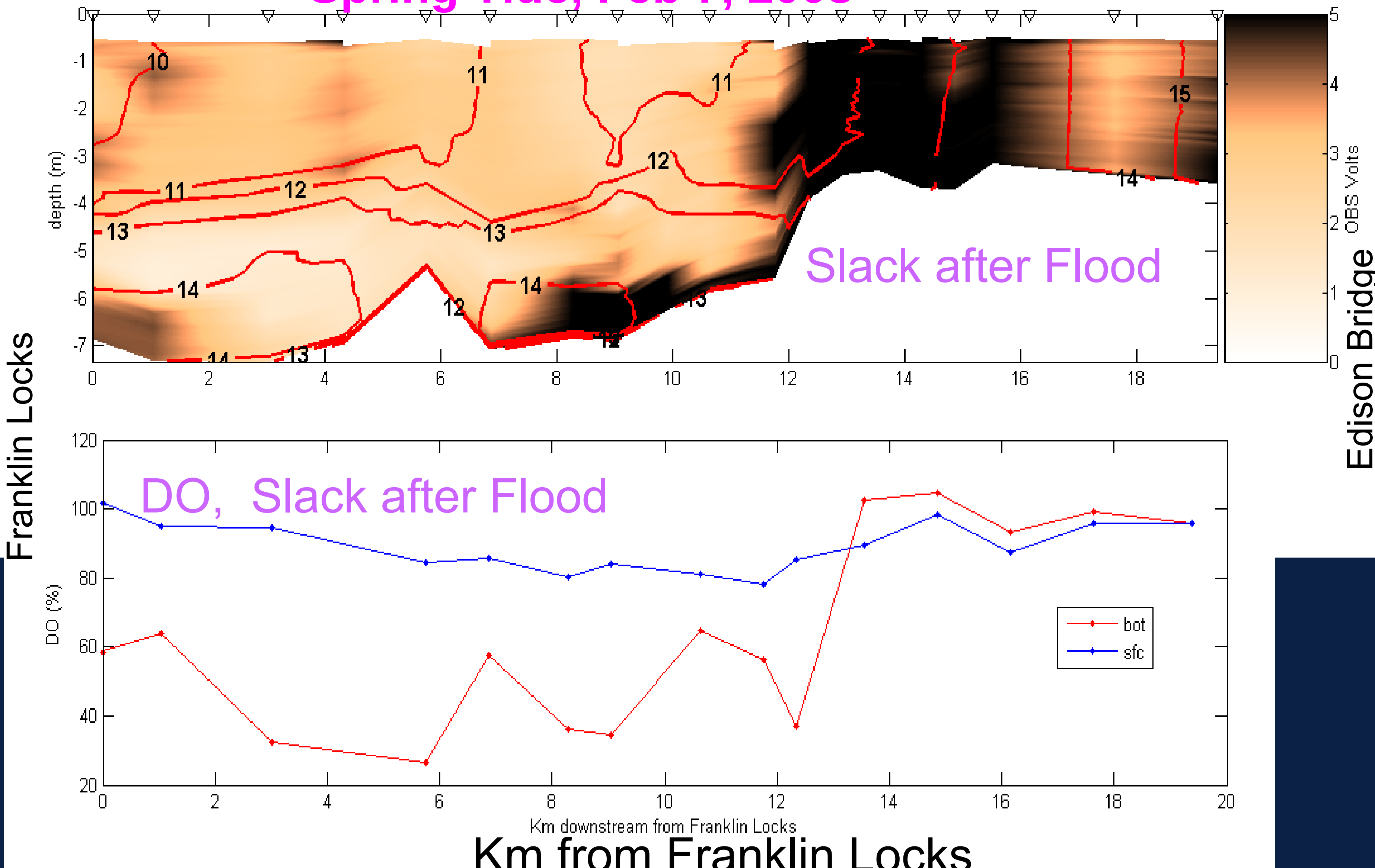

W.P. Franklin Lock & Dam
Fort Myers Power Plant
Edison Bridge
River
Matlacha Isles
Cape Coral
Little Pine Island
Matlacha Pass
Caloosahatchee
Pine Island
Red Fish Point
Hendry Creek
Ft. Myers
Ten Mile Canal
Shell Point
San Carlos Bay
Mullock Creek
Legend
Vegetation
Patchy Seagrass
Continuous Seagrass
Depth in Feet
3
6
12
18
Mud Flats
Dredged Channels
0 1 2 4 6
Kilometers

Spring Tide, Turbidity, Feb 7, 2008

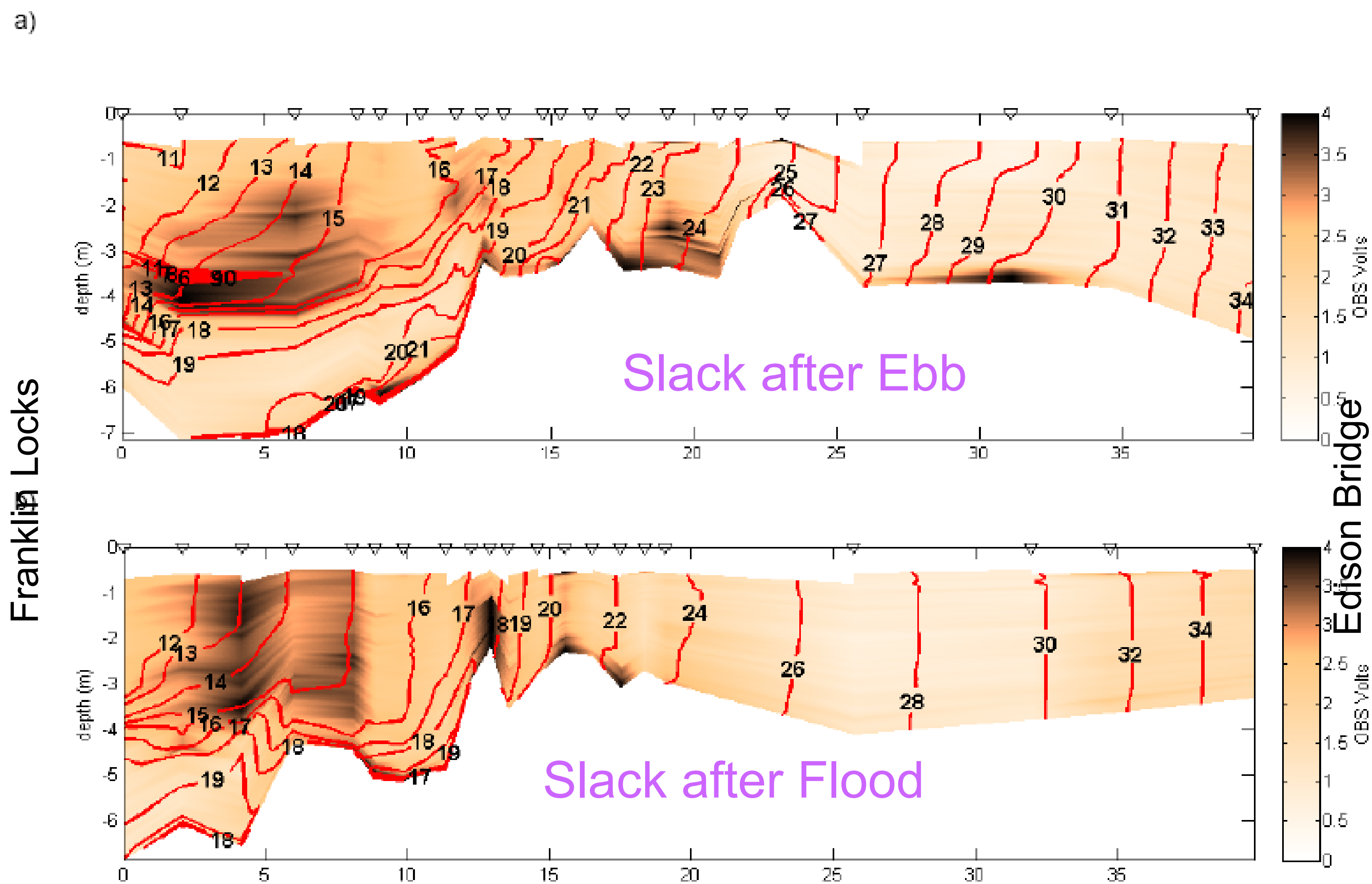



Chl a(µg/l), Slack after Ebb
ETM
bot
sfc
Phaeo (µg/l), Slack after Ebb
bot
sfc
Zooplankton feeding in ETM ?
Franklin Locks
Edison Bridge
Km from Franklin Locks

Spring Tide, Feb 7, 2008



Neap Tide, Turbidity, March 16th, 2008



Conclusions

- This study produced some of the first high spatial resolution contemporaneous measurements of turbidity, DO and chlorophyll *a* in the Caloosahatchee River.
- During low to no discharge, the deeper waters upstream are dynamically isolated from the tidal energy, while surface waters and shallower downstream waters can be well mixed.
- This upstream deepwater isolation results in low DO and suspensions of large low density aggregates in the lower water column.
- During low discharge periods, the ETM is located upstream around 14-18 km from the Franklin Locks.

Mixing and Degradation of Riverine Dissolved Organic Nitrogen in the Caloosahatchee Estuary

June 17, 2008

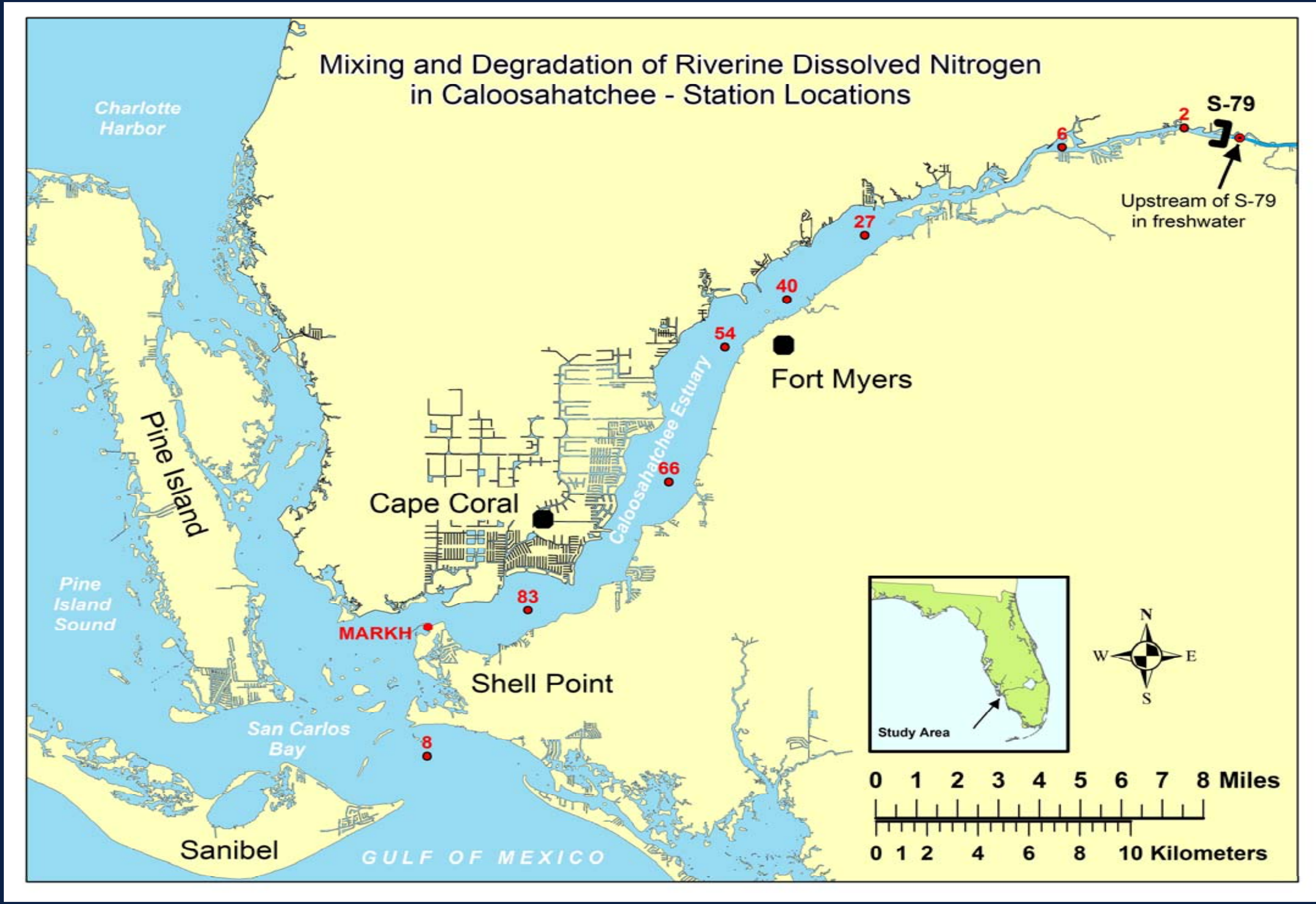
Nutrient Limitation in CRE

- Bioassay experiments conducted during the FDNR study (DeGrove, 1981) indicated:
  - nitrogen limitation in the upper estuary
  - phosphorus limitation in the lower estuary
- Indirect evidence summarized by Doering and Chamberlain (2005) and Doering et al (2006) indicates:
  - nitrogen predominately limits micro-algal growth in the Caloosahatchee, although depending on location, phosphorus can also be limiting

Objectives

- This study builds on the previous work by
  - Characterizing the DON from the freshwater Caloosahatchee River
  - Examining the estuarine mixing behavior of river borne DON in laboratory experiments and in the field
  - Determining the susceptibility of river borne DON from the freshwater Caloosahatchee River to:
    - a) Remineralization by estuarine bacteria
    - b) Photolysis

Station Locations in the CRE

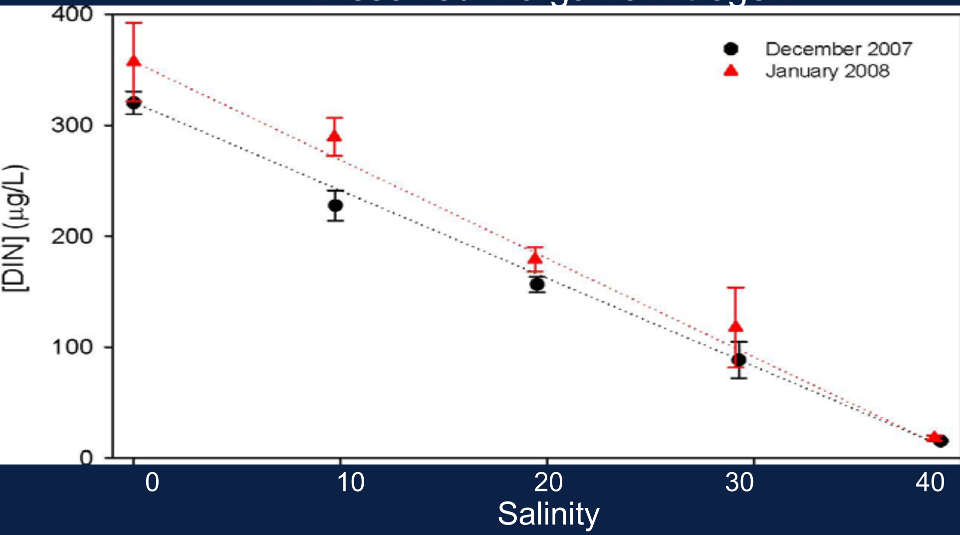


Project Components

- ***Synoptic Field Surveys:*** **Three synoptic field surveys - December 2007, January and February 2008**
- ***Laboratory Mixing Experiments***
  - **Water for mixing experiments was collected in December 2007 and January 2008 surveys.**
  - **These experiments examined the transformation of organic nitrogen from the dissolved to particulate phase strictly as a function of physics (i.e. mixing) (Sholkovitz 1976; Sholkovitz et al. 1978); Acts as a abiotic “control” for the Field Surveys**
- ***Bacterial Degradation Experiments***
  - **Two experiments were conducted in January and February 2008 upstream of S-79.**
  - **Examined the susceptibility of river borne DON to degradation by estuarine bacterial communities**
- ***Photochemical Degradation Experiments***
  - **One experiment was done in February 2008 upstream of S-79**
  - **Examined the susceptibility of river borne DON to photochemical degradation by natural sunlight**

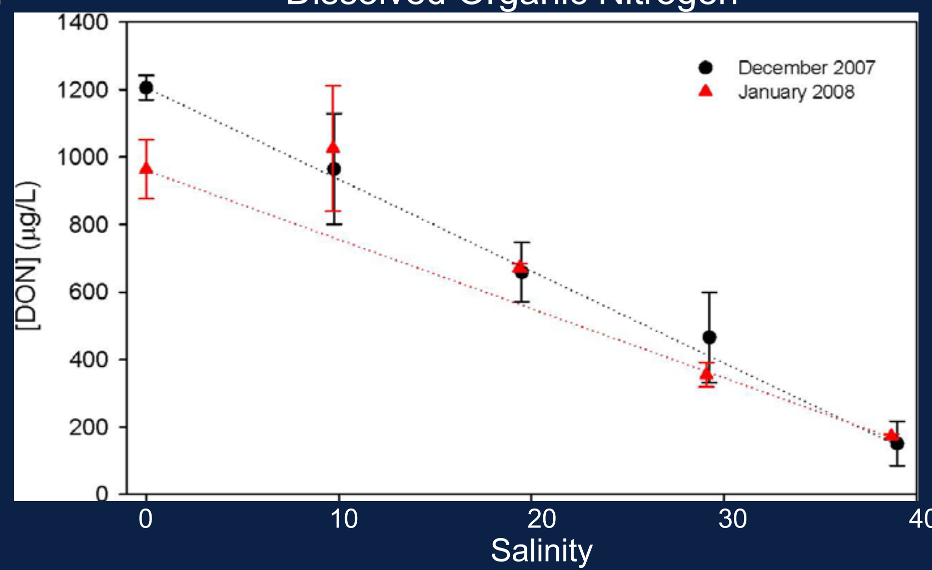
Laboratory Mixing Experiments

Dissolved Inorganic Nitrogen

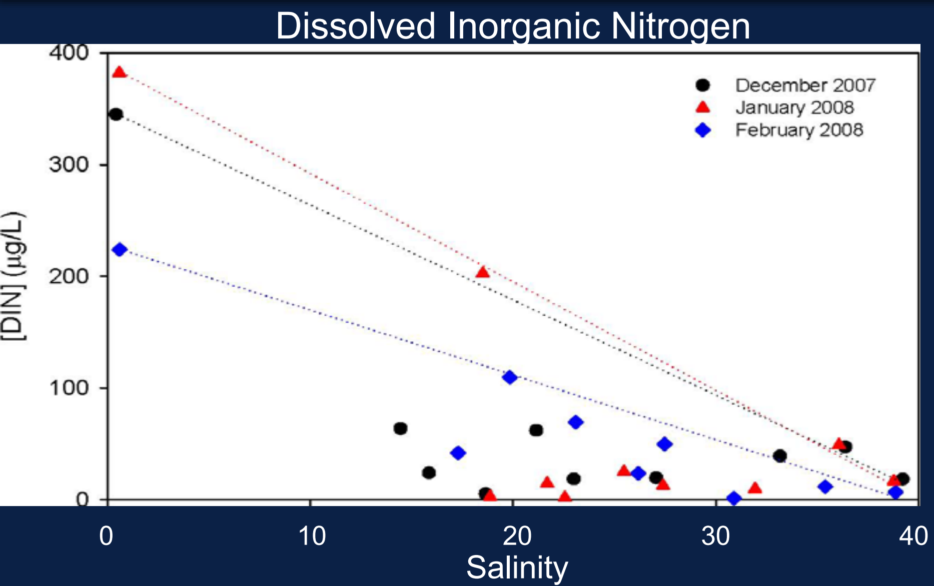


Conservative mixing of both DIN and DON

Dissolved Organic Nitrogen

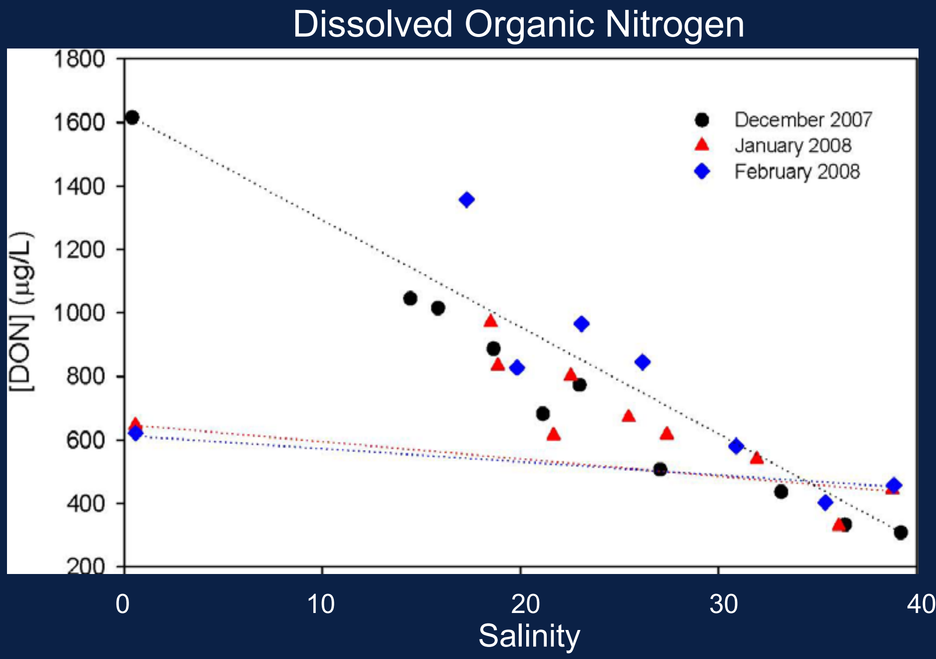


Synoptic Field Surveys



Sink for DIN during all three surveys

Possible utilization of DIN within the estuary



Conservative mixing of DON during the December 2007 survey, while a possible source of DON during the January and February 2008 survey

DON Degradation Experiments

- ***Bacterial Degradation Experiments***
- ***Photochemical Degradation Experiments***
  - **Data Analyses in progress; preliminary results indicate limited DON degradation: dry season, drought year DON may be refractory**

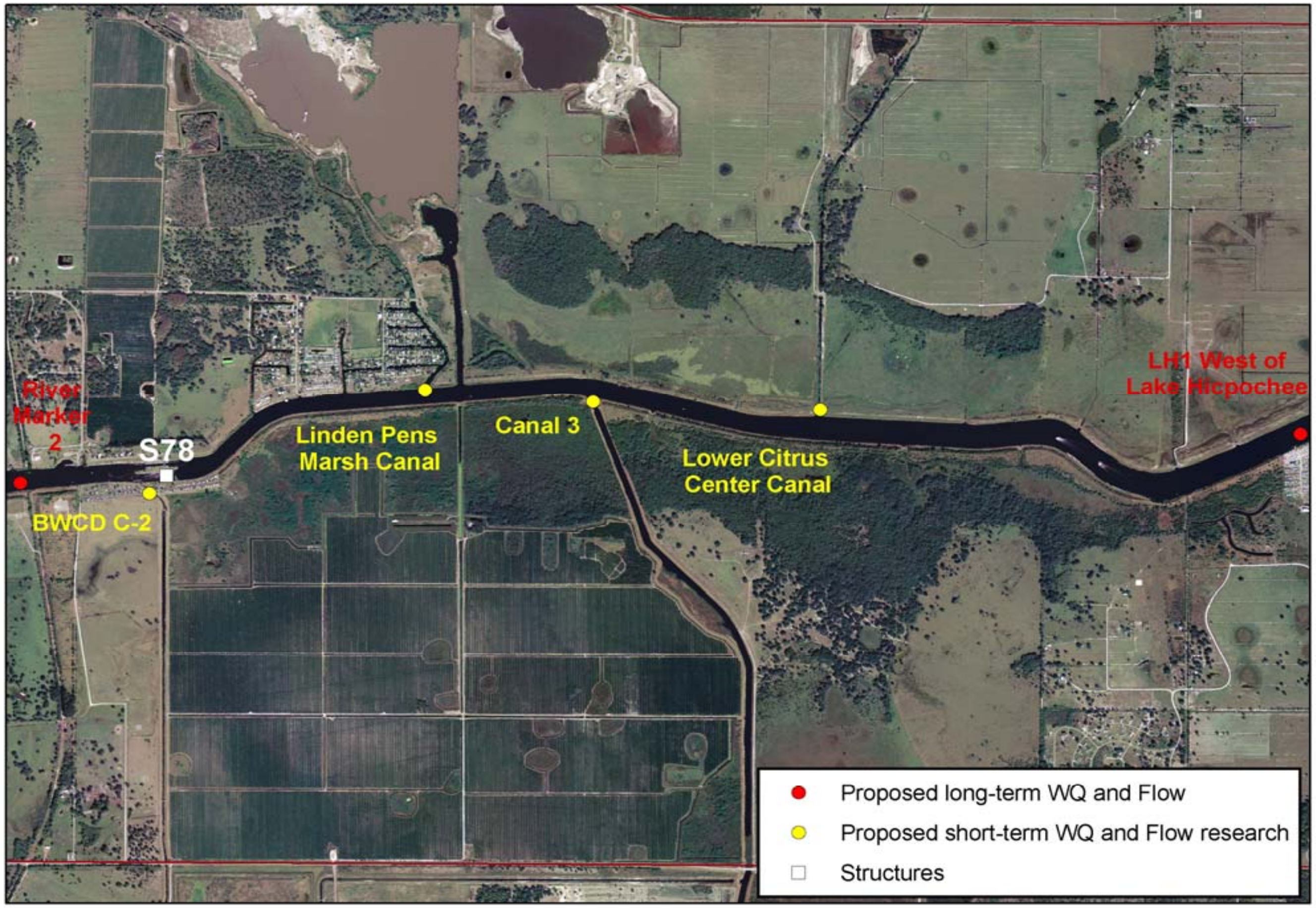
Update on Short-Term WQ and Flow Monitoring

June 2008

Water Quality Monitoring Assessment Summary- ReCap

- **East of S-79**
  - Proposed to add eight long-term water quality and flow monitoring sites
    - Monthly water quality (Group A parameters) and continuous flow monitoring stations upstream and downstream of major tributary basins coming into the River to quantify the load contribution from these tributaries.
  - Proposed to add four short-term water quality and flow monitoring sites in canal tributaries flowing into C-43:
    - 3 years study, one-two month dry season and one-two month wet season in each year.
    - May rotate different reaches in the future.

Short-term Monitoring Stations (in yellow)



Annual Cost Estimate for Proposed Water Quality Monitoring in Caloosahatchee

	East of S-79		West of S-79
	Long-Term Stations (8)	Short-Term Stations (4)	Long-Term Stations (4)
Labor	$85,585	$29,779	$28,037
Vehicle/Boat/Other Equipment Useage	$38,826	$12,437	$12,437
Supplies	$2,500	$1,250	$1,250
Analytical Cost*	$40,639	24,383	$24,383
Sub-Total	$167,550	$67,849	$66,106
Total (10% Contingency)	$184,305	$74,634	$72,717
TOTAL COST/YR			**$331,656**

* Cost estimated for 'Group A' constituents

Cost Estimate for Flow Monitoring[1]

		East of S-79	
		Long-Term Stations (8)	Short-Term Stations (4)
Construction and Instrumentation	Labor	$14,071	$7,035
	Gage House construction	$37,177	$19,089
	Instrumentation	$107,741	$53,871
	Total Direct Cost	$158,989	$79,995
	Total Indirect Cost[2]	$43,436	$21,855
	Total	$202,425	$101,850
Data Collection/ Processing	Labor[3]	$149,763	74,882
	Field Work and Logistics	$8,955	$4,478
	Field Supplies	$2,857	$1,429
	Total Direct Cost	$161,575	$80,789
	Total Indirect Cost[4]	$87,945.27	$43,973.45
	Total	$249,520	$124,762
TOTAL Cost (Instrumentation + Data Coll)		**$451,945**	**$226,612**

[1] Rates estimated using FDEP/USGS flow monitoring contract
[2] 27.32% of net cost (overhead rate on instrumentation)
[3] including 12 field trips to inspect field instruments, QA/QC of data, data processing, review)
[4] 54.43% of total cost (overhead rate)

Summary

- **East of S-79:** Eight long-term stations within the C-43 and four short-term monitoring stations in tributaries to test mass balance approach for loading
- Discussions continue with the District's source control program to identify overlapping needs of monitoring

Proposed Pollutant Source Control Program in support of the Northern Everglades and Estuaries Protection Program

Everglades Regulation Division
June 17, 2008

Proposed Pollutant Source Control Program in support of the Northern Everglades and Estuaries Protection Program

- **Objective:**

  To develop a pollutant source control program as a component of the overall River Watershed restoration program.

Pollutant Source Control Programs (performance measure: Pollutants reduction targets) → Regional Projects (STAs, Reservoirs, etc.) (performance measure: Project targets) → Water Body: CR Estuary (performance measure: CRE TMDLs targets)

Water Quality Treatment Train

Program History

- Surface Water Improvement and Management (SWIM) Act -1987
  - Chapter 40E-61 – Lake Okeechobee Works of the District rule - 1989
- The Lake Okeechobee Protection Act (LOPA) – 2000
- The Northern Everglades and Estuaries Protection Program (NEEPP) - 2007

District Mandates

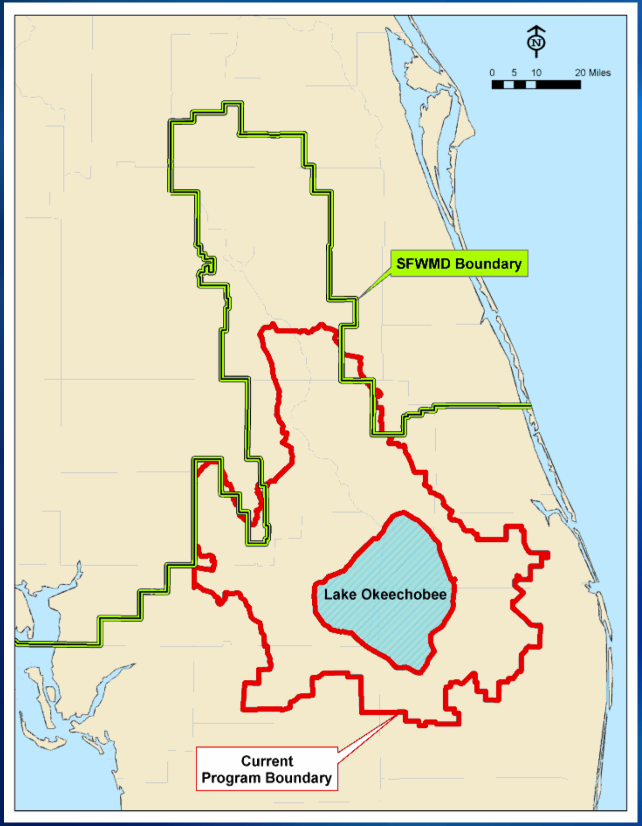
- The Lake Okeechobee Protection Act (LOPA) and the Northern Everglades and Estuaries Legislation
  - Establish relationship of coordinating agencies
    - Florida Dept. of Environmental Protection
    - Florida Dept. of Agriculture and Consumer Services
    - South Florida Water Management District
  - Expand the restoration boundaries
  - Develop protection plans for the estuaries by January 1, 2009

District Mandates – Caloosahatchee River Watershed (CRW) Protection Plan

- **CRW Construction Project (2012)**
- **CRW Pollutant Control Program (expedited)**
  - **Implement non-point source Best Management Practices (BMPs)**
  - **Promote local environmental restoration projects**
  - **Assess current water management practices – recommendations**
  - **Regulate disposal of Domestic Wastewater Residuals (FDEP) and Septage (FDoH)**
  - **Regulate animal manure land-application (FDACS)**
- **CRW Research and Water Quality Monitoring Program**
  - ***… sufficient to carry out, comply with, or assess the plans, program, and other responsibilities …***

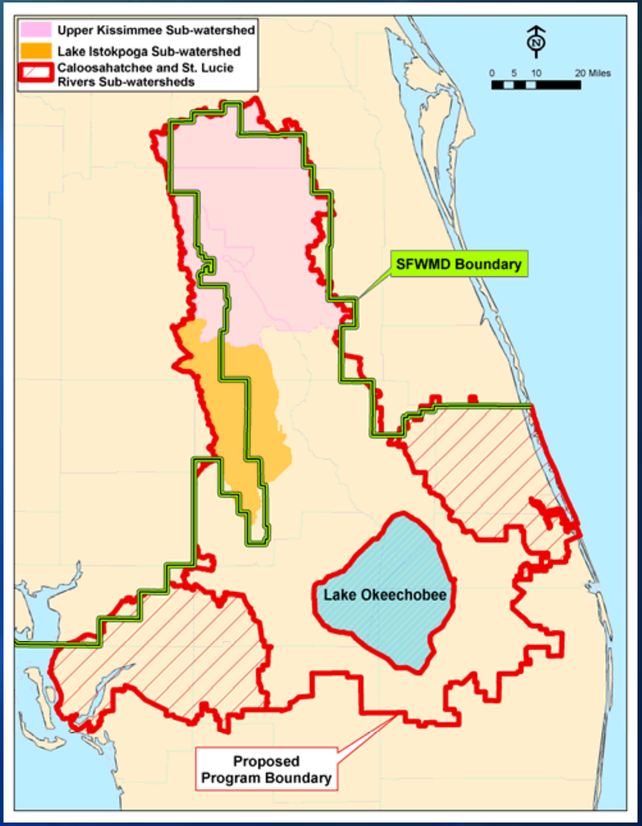
Expanded Program Boundary

Source Control Program Boundary



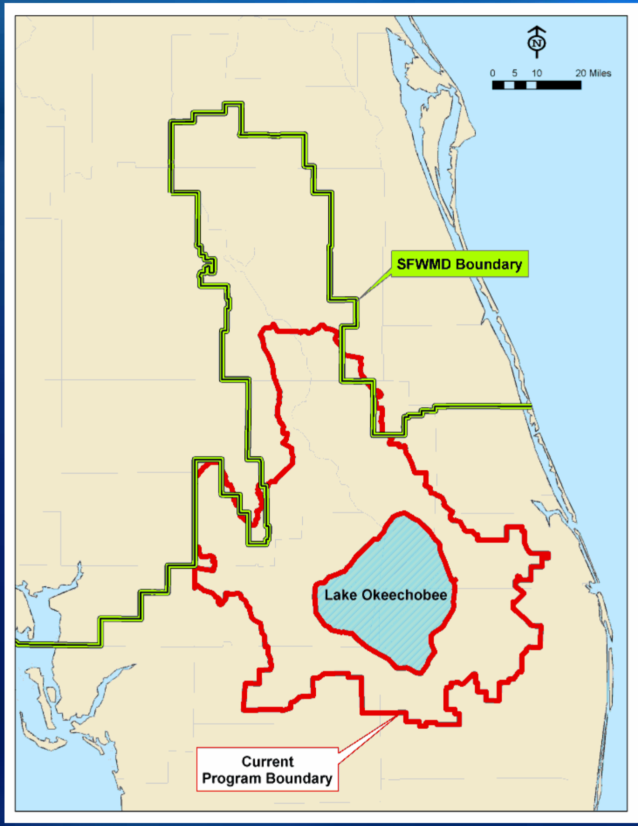
- Upper Kissimmee Sub-watershed
- Lake Istokpoga Sub-watershed
- Caloosahatchee River Sub-watershed
- St. Lucie River Sub-Watershed

Proposed Source Control Boundary



Expanded Program Boundary: Lake Okeechobee Watershed

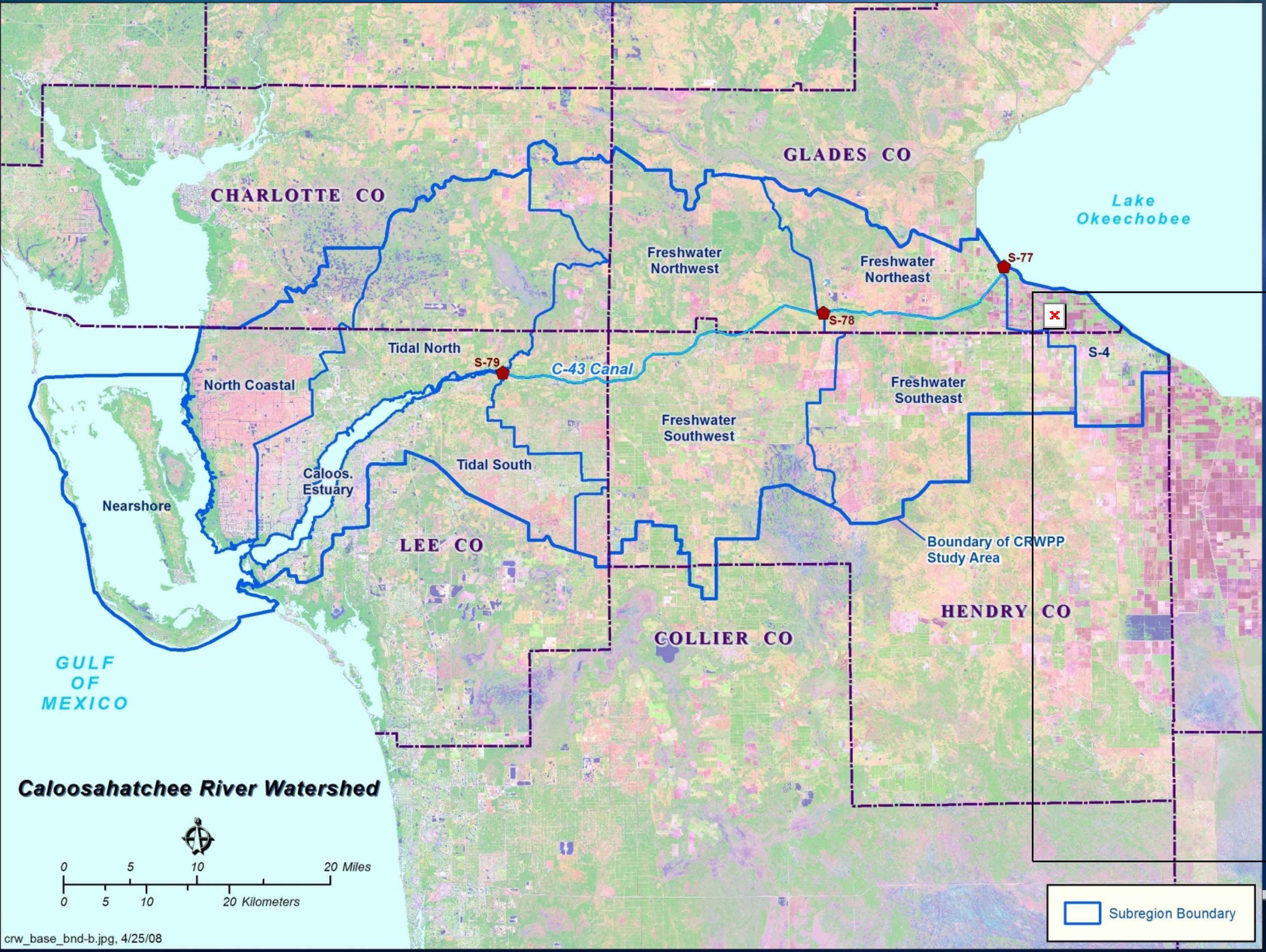
Current Lake O. Works of the District Program Boundary



Proposed Lake O. Phosphorus Source Control Program Boundary

Expanded Program Boundary: Caloosahatchee River Watershed (CRW)

Proposed Pollutant Source Control Program Boundary: CRW



Steps to expand the Source Control Program to the CRW

- **Develop and implement a pollutant source control program using BMPs for all existing and future land uses within the CRW**
  - **Develop a timeline for Amending Chapter 40E-61 FAC to include Estuary Watersheds**
  - **Request notice of rule development for the river watersheds from the District's Governing Board**

The CRW Pollutant Source Control Program Concept

- **Implement BMPs for all lands within the watershed**
- **Ensure complementary efforts by agencies, e.g. Include a provision for agricultural land uses participating with FDACS to meet District regulatory requirements**
- **Establish incentives for Demonstration Projects**
- **Establish a plan for verifying implementation and program effectiveness**

Define the monitoring network necessary to:

- Monitor collective source control program effectiveness
- Use performance measures for the combined BMP source control programs
- Optimize the BMP programs if WQ problems are detected
- Identify priority areas of water quality concern (“hot spots”)
- Provide data to enhance performance of downstream treatment facilities

Summary

- All land uses (ag and non-ag) in the CR Watershed to implement Pollutant Source Control BMPs
- Pollutant Source Control Program to include monitoring of water quality at:
  - Watershed/Basin level to determine: Collective effectiveness of program, compliance with pollution reduction targets, and need of additional BMPs and/or BMP Optimization activities
  - Local level to detect: “hot spots” and priority areas

Questions?

Caloosahatchee River Watershed Research and Water Quality Monitoring Plan Research Projects

June 17, 2008

Caloosahatchee Research Projects

- Nutrient Budget
- Dissolved Oxygen Dynamics
- Low Salinity Zone- Nursery Function
- Light Attenuation in San Carlos Bay

Caloosahatchee
#1 Estuarine Nutrient Budget

- A well constrained nutrient budget is an important aspect of TMDL/BMAP implementation and assessment.
- Nutrient budgets assist with determining appropriate nutrient reduction approaches and with evaluating and optimizing project effectiveness.
- This project will construct nutrient budgets of nitrogen and phosphorus for the Caloosahatchee Estuary.
- Terms in the nutrient budget will be determined by a variety of methods: Input, Cycling, Output.

Caloosahatchee #1 Estuarine Nutrient Budget

Estuarine Nutrient Budget - Nitrogen

Inputs

- Franklin Locks
- Tidal Basin
  - Surface Flows
  - Ground Water
  - Point Sources-WWTF
- Gulf of Mexico
- Atmospheric Deposition
- Nitrogen Fixation

Cycle

- Primary Productivity
- Water Column Respiration
- Organic Matter Degradation
- Benthic Nutrient Flux

Outputs

- Denitrification
- Export to Gulf
- Burial in Sediments
- Biomass
  - Migration
  - Harvesting

Caloosahatchee #1 Estuarine Nutrient Budget

INPUTS

Franklin Locks……………	Data Available (could be better)
Tidal Basin - $100K	
Surface Flows…..	Modeling Project (Storm Water Event data needed)
Ground Water…..	Modeling Project (data analyses needed)
WWTF………….	Data Available
Gulf of Mexico…………….	Modeling Project
Atmospheric Deposition….	Data From Estero (Lee County)
Nitrogen Fixation………..	New Measurements

Caloosahatchee
#1 Estuarine Nutrient Budget

CYCLE

Primary Productivity……………….	New Measurements
Water Column Respiration………..	New Measurements
Organic Matter Degradation………	New Measurements
Benthic Nutrient Flux………………	One time Dry Season Data Exist, Need More

Caloosahatchee #1 Estuarine Nutrient Budget

OUTPUTS

Denitrification…………..	Some Data Exist/ Need More
Export to Gulf…………….	Modeling Project (USGS Measurements?)
Burial in Sediments………	Some Sedimentation Rate Data Exist
Biomass	
Migration………	Data????
Harvesting…….	Data ???

Caloosahatchee
#2 Dissolved Oxygen Dynamics

- In order to determine if proposed TMDLs for nutrients will improve DO concentrations in the Caloosahatchee Estuary it is necessary to identify the important factors that control dissolved oxygen and how they interact to exert that control.
- The Caloosahatchee Estuary has been listed as impaired for dissolved oxygen and nutrients.
- This study will examine the role of internal and external factors in determining the concentration of dissolved oxygen.
- These include stratification, algal blooms, sediment oxygen demand, and BOD loading.

Caloosahatchee
#2 Dissolved Oxygen Dynamics

Dissolved Oxygen Dynamics

Sources
- Aeration
- Riverine Load
- Oceanic Load
- Photosynthesis

Physics
- Transport
- Mixing
- Stratification

Sinks
- Out-gassing
- Water Column Respiration
- Organic Matter Degradation
- Sediment Oxygen Demand

Concentration Time Series
- Dissolved Oxygen
- Chlorophyll *a*
- Light Extinction

Caloosahatchee
#2 Dissolved Oxygen Dynamics

SOURCES

Aeration…………………	No data –Literature Value/ Model
Watershed Load………	Need Measurements or Watershed Model
Oceanic Load…………	Need Concentrations and Hydrodynamic Model
Photosynthesis……….	Need Measurements

PHYSICS

Transport……….	Hydrodynamic Model
Mixing……………	Hydrodynamic Model
Stratification……	Measure or Model

SINKS

Out-Gassing……………………	Literature Value/ Model
Water Column Respiration…..	Need Measurements
Organic Matter Degradation…	Need Measurements/Literature Value
Sediment Oxygen Demand…..	Need Measurements

CONCENTRATION TIME SERIES

Dissolved Oxygen..................	Need Measurements
Chlorophyll *a*…………………	Need Measurements
Light Extinction……………….	Need Measurements

Caloosahatchee
#3 Low Salinity Zone

- One of the goals of the Caloosahatchee River Watershed Protection Plan is to minimize the occurrence of undesirable salinity ranges in the Caloosahatchee Estuary:
- Constructing and operating facilities designed to store and subsequently release freshwater to the estuary.
- One of the primary ecological services provided by an estuary is to serve as a nursery area, occurring in low salinity zones, for early life stages of economically important fish and shell fish.
- This project examines the effects of freshwater discharge on production of fish larvae in the low salinity zone of the Caloosahatchee Estuary.
- Results of this study will be used to refine flow and salinity envelopes and to provide guidelines for delivery of freshwater to the Caloosahatchee Estuary.

Caloosahatchee
#3 Low Salinity Zone

Low Salinity Nursery Zone

Sources
- Watershed Load
- Oceanic Load
- Primary Productivity (Color, Turbidity, Chla)

Physics
- Transport
- Mixing
- Stratification

Time Series Measurements

Water Quality
- Freshwater Inflow
- Nutrients, Color
- Turbidity, Salinity,
- Temp, DO, TSS

Biota
- Phytoplankton
- Chlorophyll *a*
- Zooplankton
- Larval/Juvenile Fish
- Benthic Fauna

Caloosahatchee
#3 Low Salinity Zone

SOURCES

Riverine Load…………..	Need Measurements or Watershed Model
Oceanic Load…………..	Need Concentrations and Hydrodynamic Model
Primary Productivity….	Need Measurements (Color, Turbidity, Chlorophyll a)

PHYSICS

Transport………..	Hydrodynamic Model
Mixing……………	Hydrodynamic Model
Stratification…...	Measure or Model

WATER QUALITY

Freshwater Inflow……	Measure/ Model
Nutrients, Color Turbidity, Salinity, Temp, DO, TSS	Measure

BIOTA

Phytoplankton Chlorophyll a Zooplankton Larval & Juvenile Fish Benthic	Measure Time Series Along Salinity Gradient

Caloosahatchee
#4 Light Attenuation in San Carlos Bay

- A resource based method may be employed to establish a nutrient TMDL in the Caloosahatchee Estuary.
- Achieving a water clarity in San Carlos Bay that allows enough light for seagrasses to grow to a depth of 2.2 meters.
- Another major attenuator of light in the Caloosahatchee estuarine system is colored dissolved organic matter (CDOM).
- Some years CDOM may account for most of the light attenuation, while in other years, chlorophyll may dominate. This suggests that in some years a TMDL might meet its resource goal and in others it would not.
- This study will determine how the relative contributions to total light attenuation of chlorophyll, CDOM and turbidity, vary with season and freshwater inflow in San Carlos Bay.

Light Attenuation In San Carlos Bay

Sources

Watershed Load
Oceanic Load
Primary Productivity
(Color, Turbidity, Chla)

Physics

Transport
Mixing
Sediment Resuspension

Time Series Measurements

Fresh Water Inflow
Color
Turbidity
Chlorophyll *a*
Light Extinction

Caloosahatchee
#4 Light Attenuation in San Carlos Bay

SOURCES

Riverine Load………..	Need Measurements or Watershed Model
Oceanic Load………..	Need Concentrations and Hydrodynamic Model
Primary Productivity….	Need Measurements (Color, Turbidity, Chlorophyll a)

PHYSICS

Transport……………………	Hydrodynamic Model
Mixing………………………	Hydrodynamic Model
Sediment Resuspension….	Measure or Model

TIME SERIES

Color......................................	Need Measurements
Turbidity................................	Need Measurements
Chlorophyll *a*…………………..	Need Measurements
Light Extinction………………..	Need Measurements
Freshwater Inflow……………..	Measure or Model

Caloosahatchee Research Projects

Proposed three year projects (Rough Annual Cost Estimate)

- **Watershed load - $150,000**
  - Measurement at Franklin Locks
  - Stormwater Event Based Measurement
  - Ground water Measurement Data Analyses
- **Internal Load/Benthic Fluxes - $150,000**
  - Nutrient Flux, SOD, Denitrification, Sediment Burial
- **Primary Productivity - $100,000**
  - Primary Productivity, Photosynthesis, Water Column Respiration, Organic Matter Degradation
- **Biomass - $100,000**
  - Photoplankton, Chla, Zooplankton, Larval & Juvenile Fish, Benthic
- **Time Series Concentration Measurement - $100,000**
  - Color, Turbidity, Light, DO, Nutrients, TSS, BOD, Salinity
- **Modeling Tools - $150,000**
  - Ecological Responses – Seagrass Model , WQ cycling, Watershed Load, Oceanic Loads, Export to Gulf, Physics, Stratification, Transport, Mixing, Sediment Resuspension.