Benthic Flux Projects:

Update on Systemwide Benthic Flux Coring and Site Specific Benthic Flux Processes (Methods Comparison).

June 24, 2008

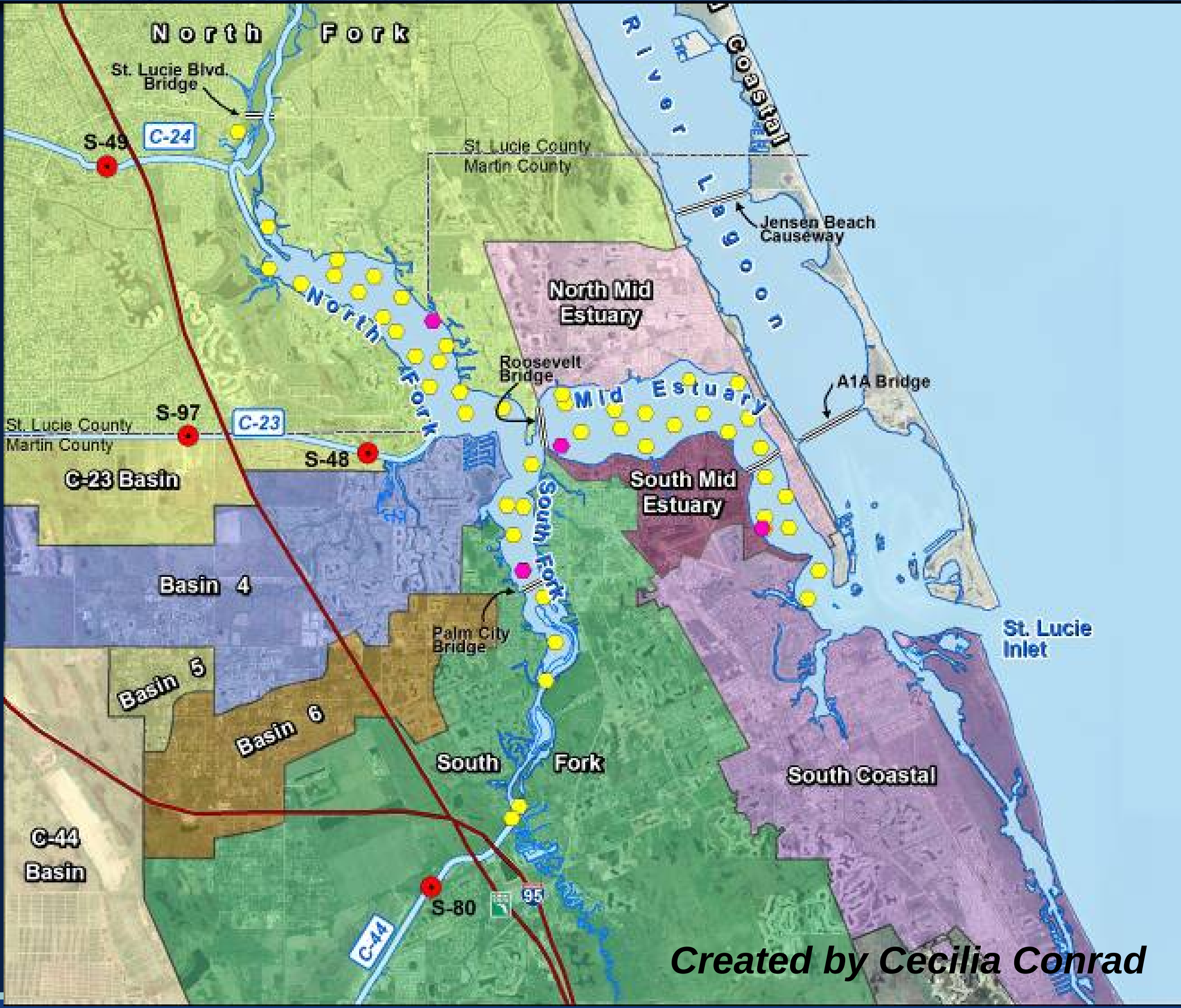
2 Projects: Systemwide Cores (remote) and Chambers (in situ) vs. Cores (remote)

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).

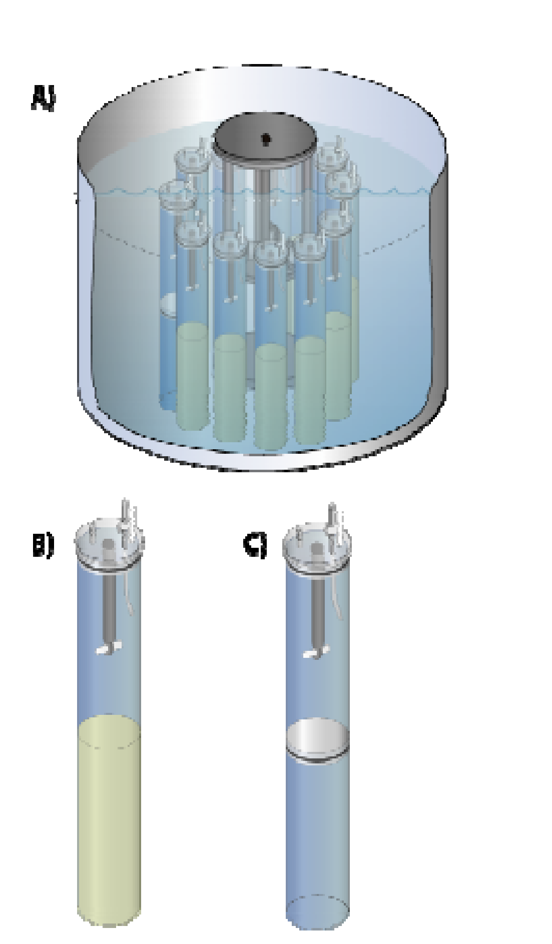
50 Sites for SYSTEMWIDE Core Incubation and 4 Sites for Chamber/Core Incubations of Benthic Nutrient Fluxes in the SLE

- SLE Benthic Flux Core Sites
- SLE Benthic Flux Chamber/Core Sites
- SFWMD Structure and WQM Sites



Sediment Chambers/Cores: Incubation Diagram

Remotely Incubated Cores

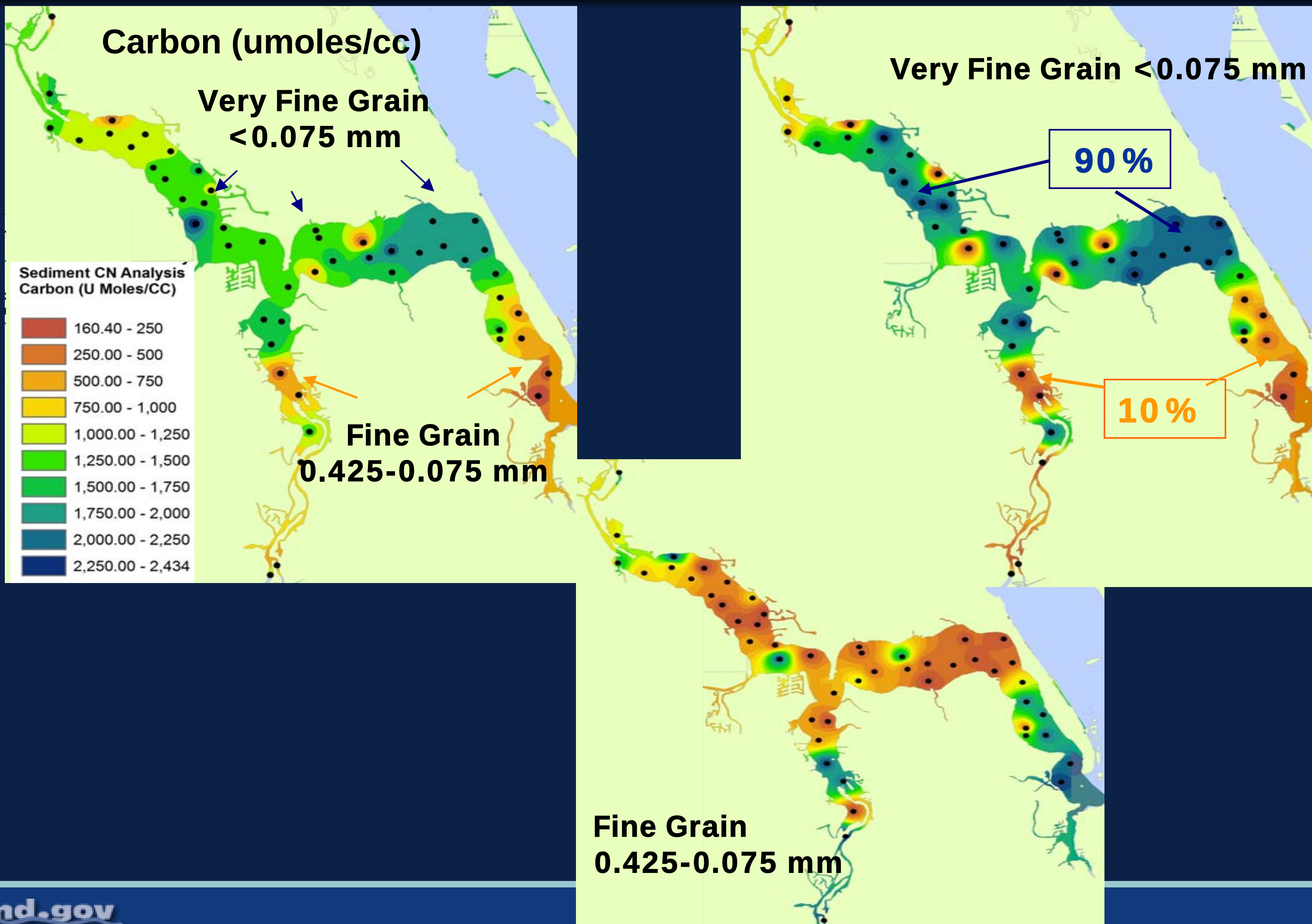


In Situ Chambers

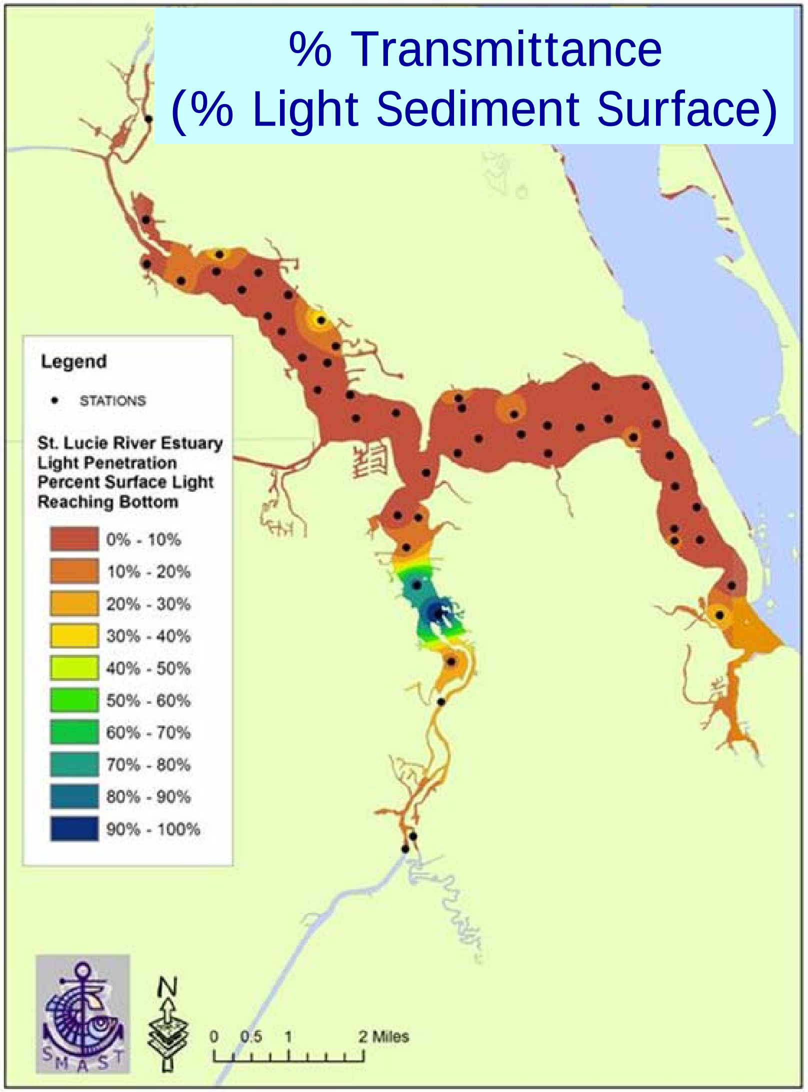
Analyses: 54 Stations

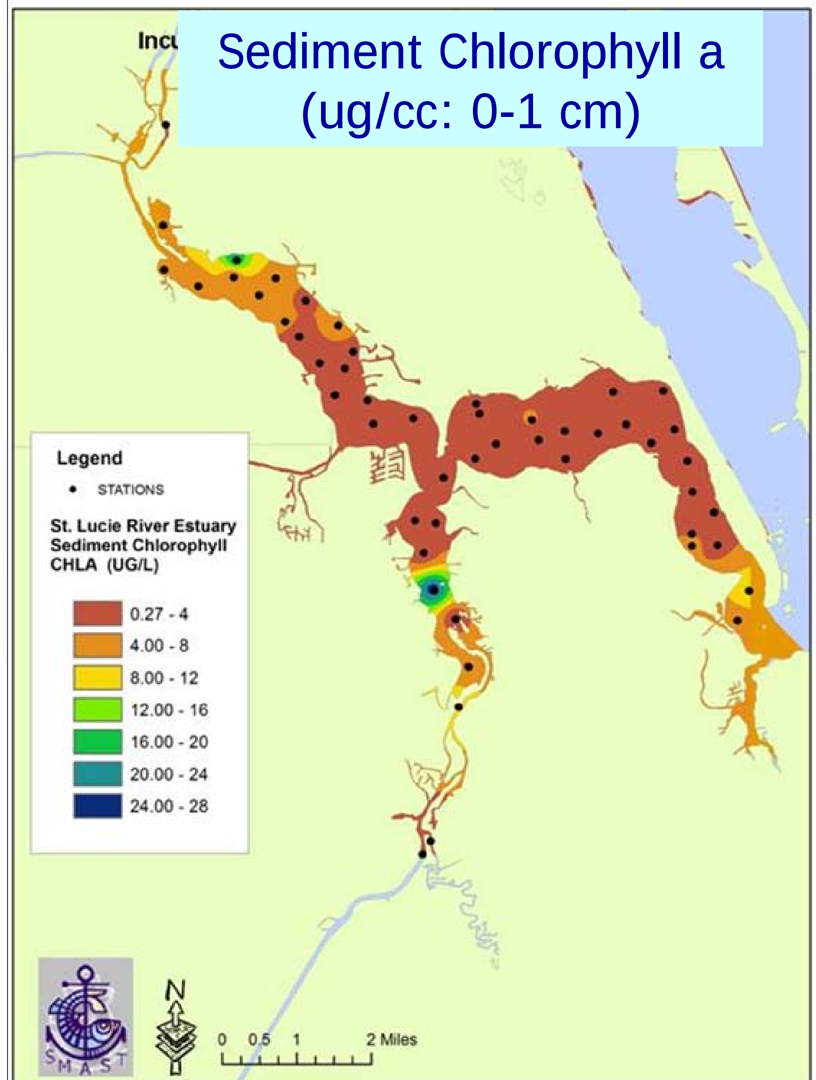
In Situ Water Column	Incubation Water Column	Incubation Pore Water	Core Sediment Surface
~800 dissolved nutrients and gases and particulates	5700 dissolved nutrients/gases	500 dissolved nutrients	68 Chl *a*
Depth			68 CPN
Temperature			68 Grain Size
Salinity			
PAR (Sediment Surface)			

Sediment Characteristics

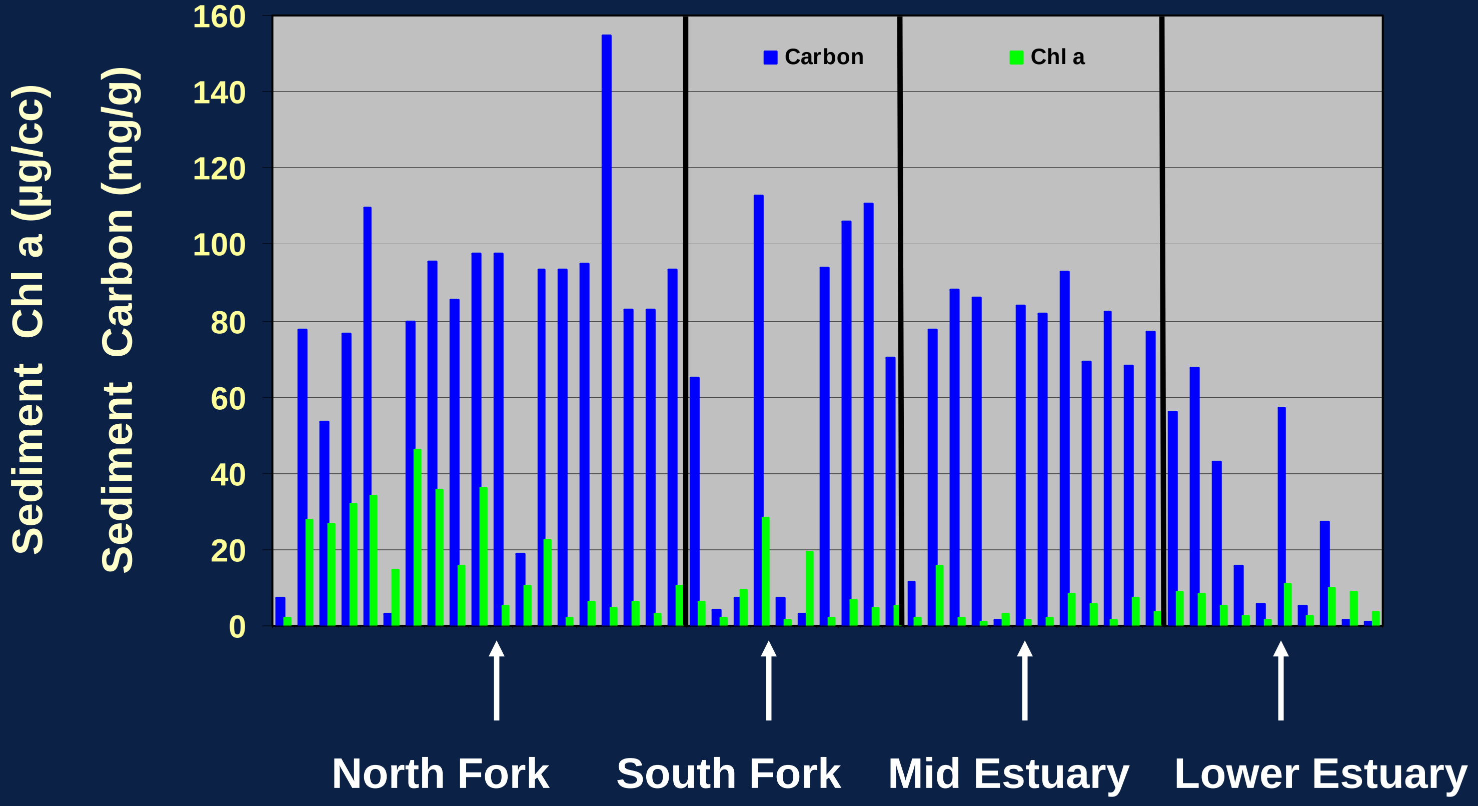


St. Lucie River Estuary: Light and Sediment Chlorophyll

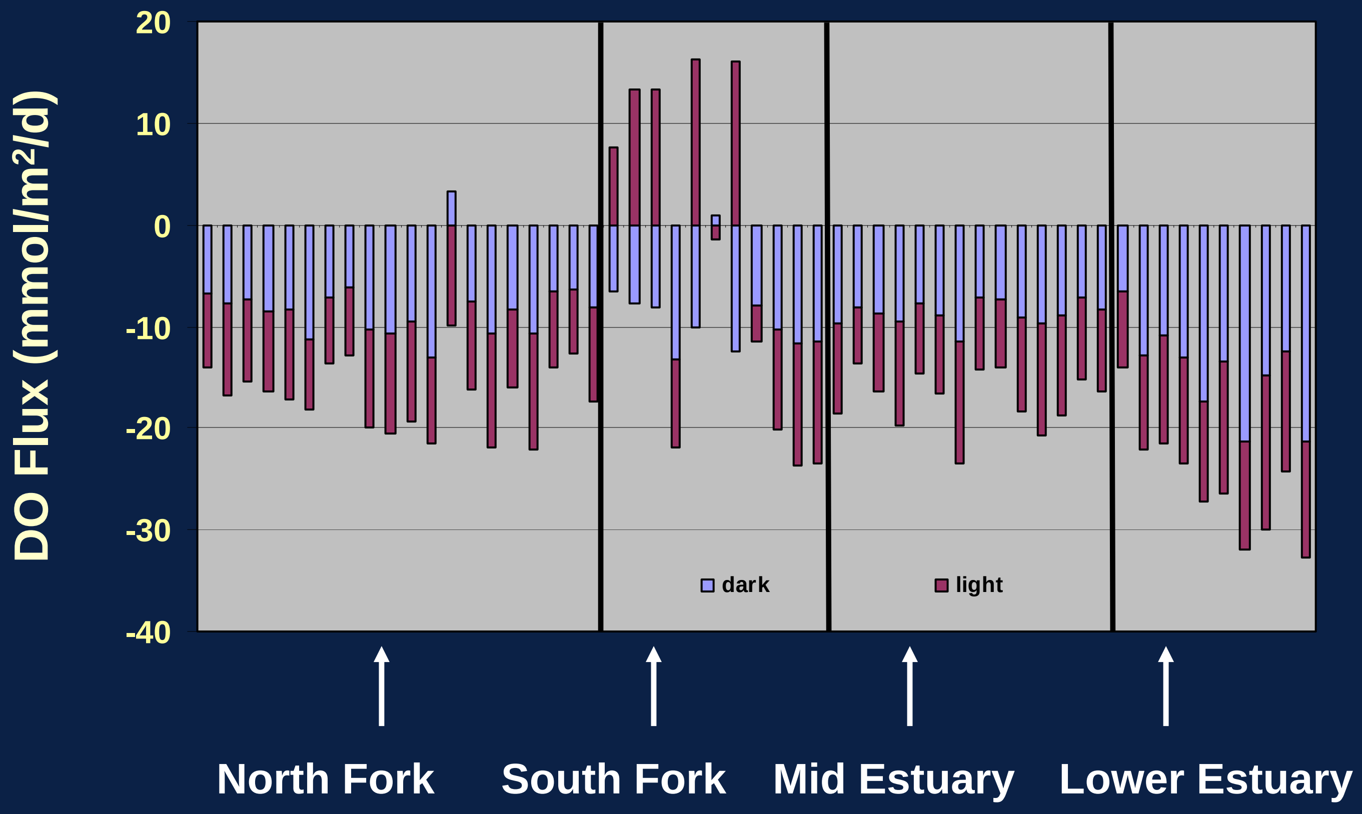




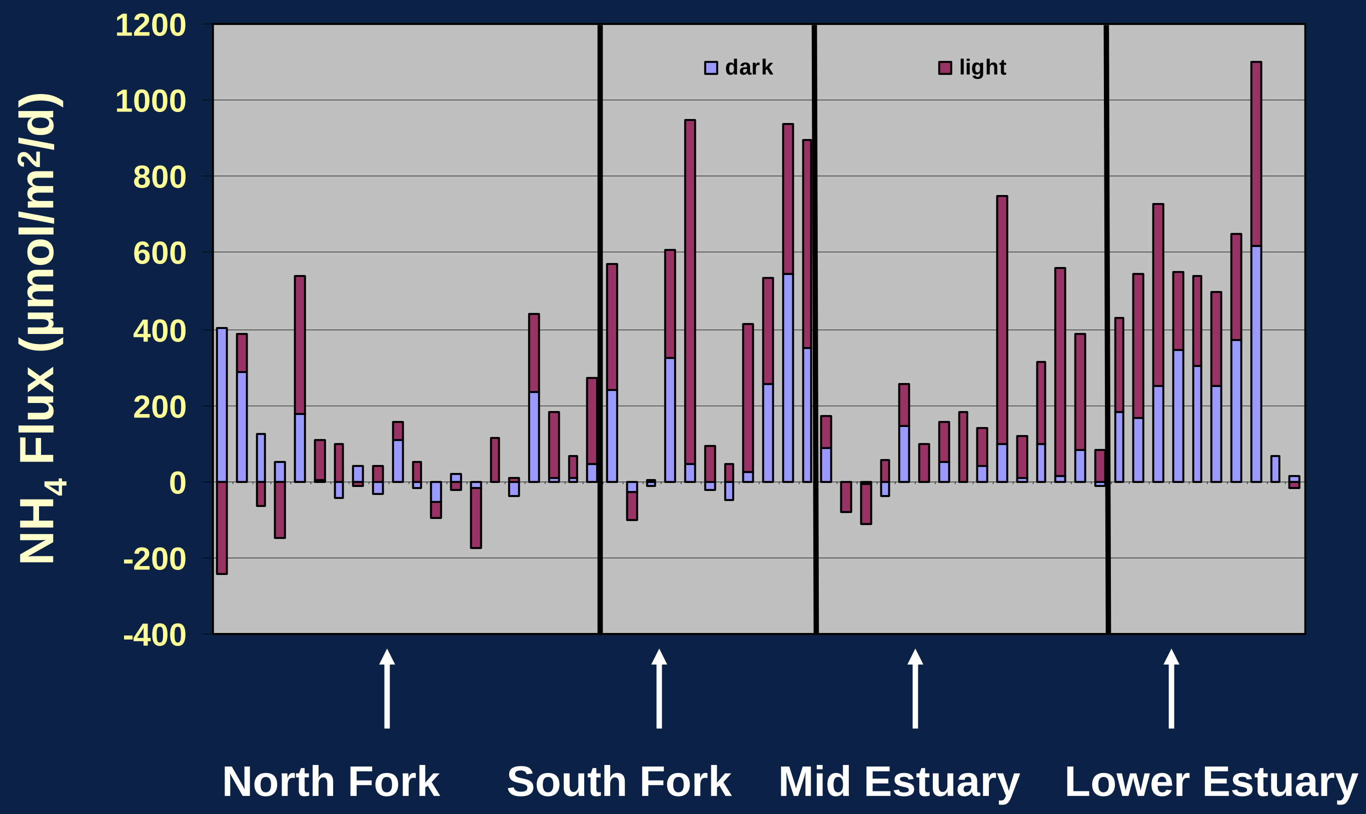
Sediment Chlorophyll and Carbon



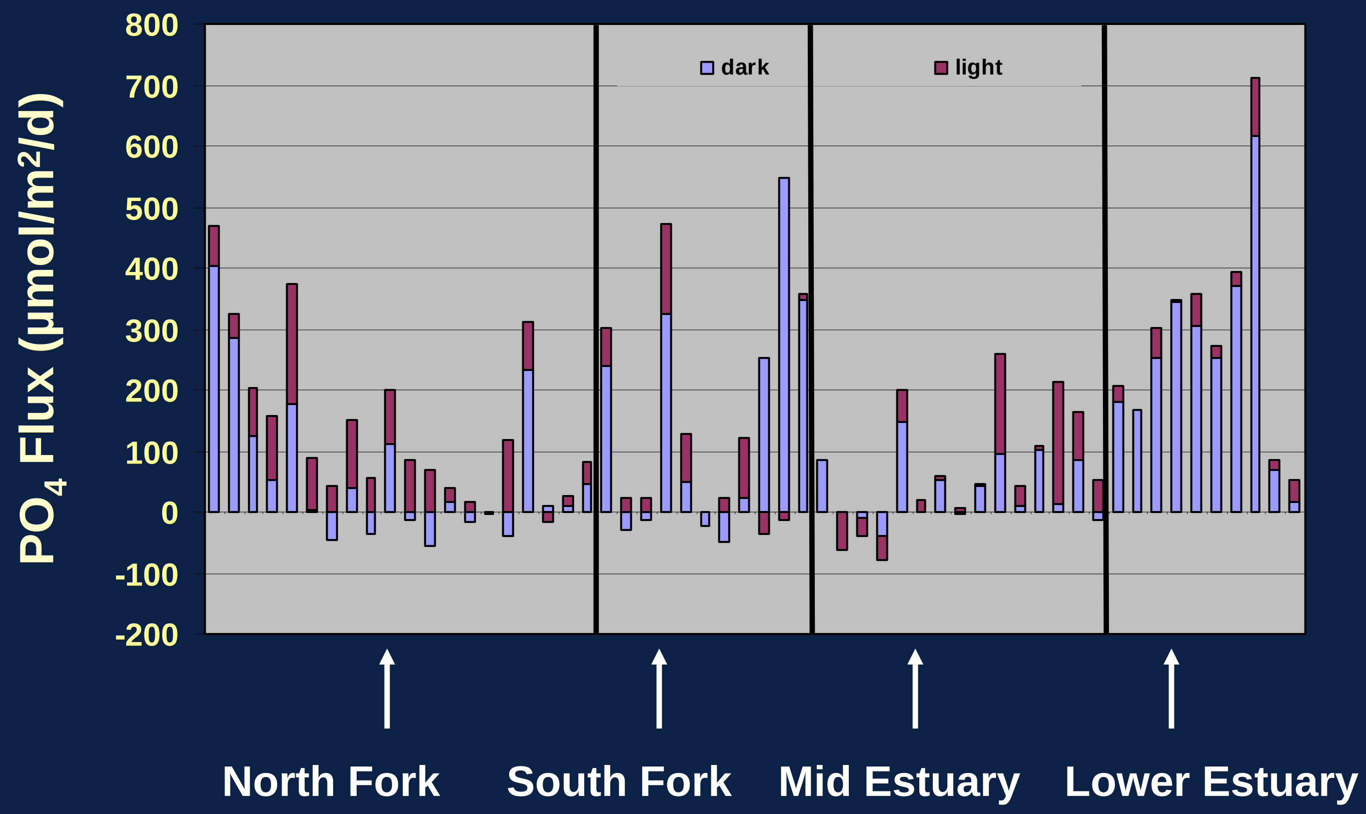
Systemwide Fluxes: DO



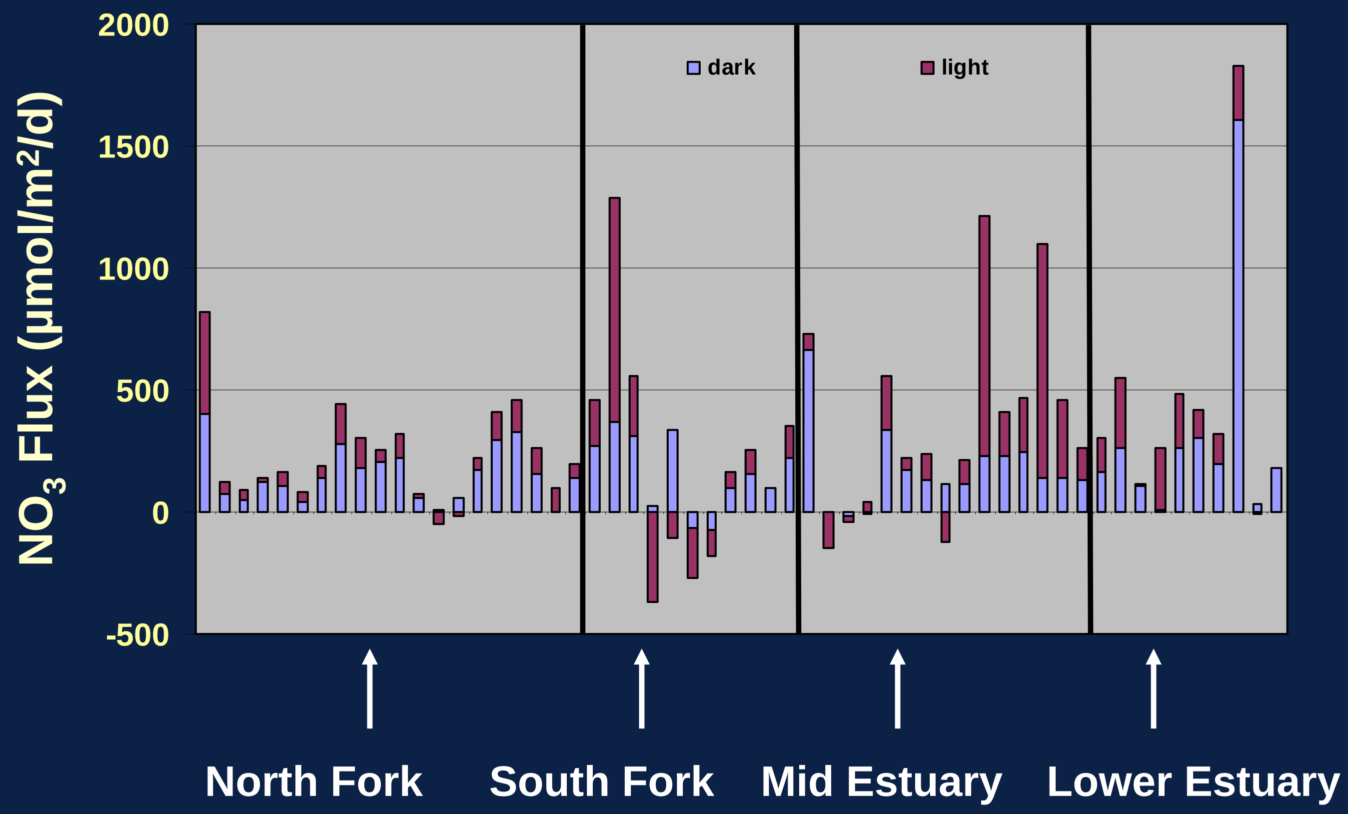
Systemwide Fluxes: Ammonium



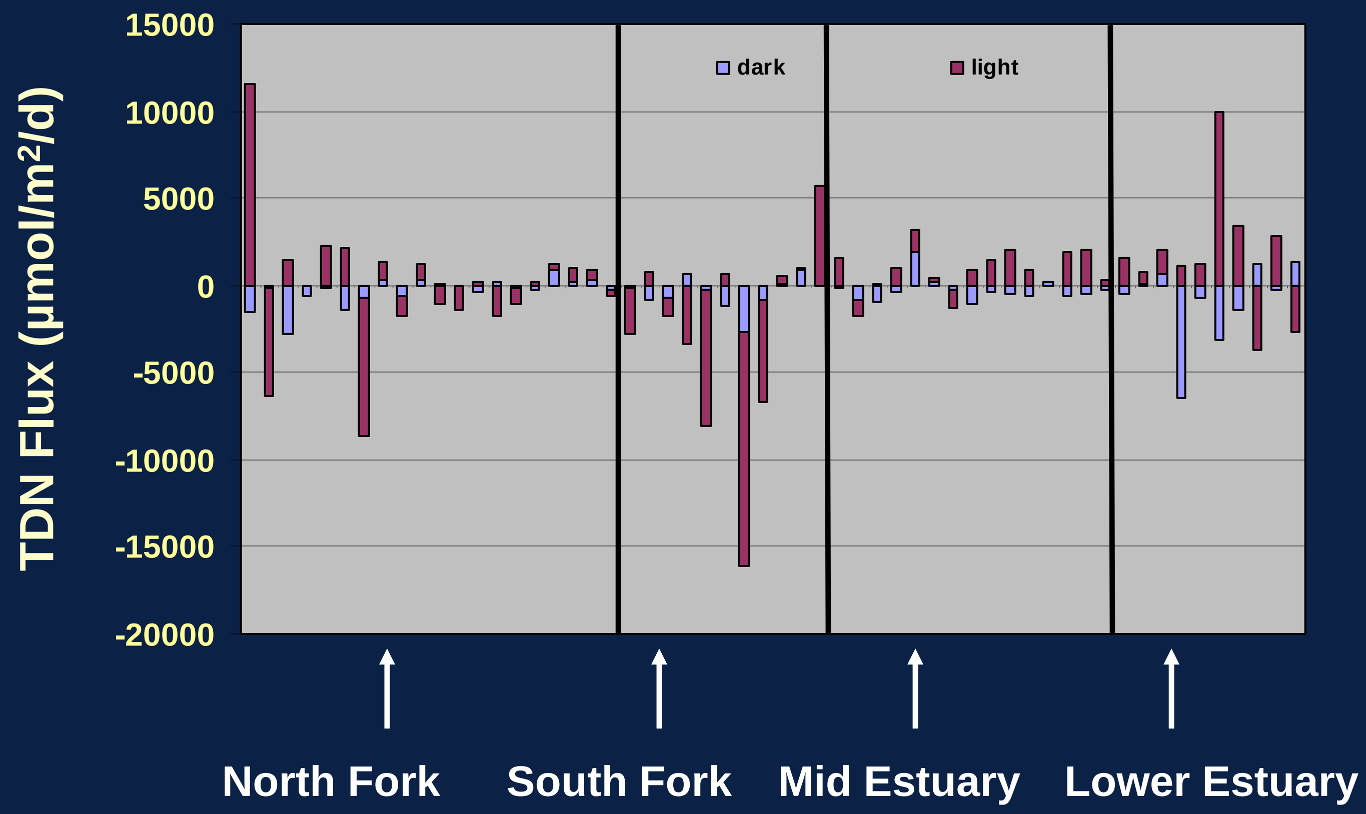
Systemwide Fluxes: Phosphate



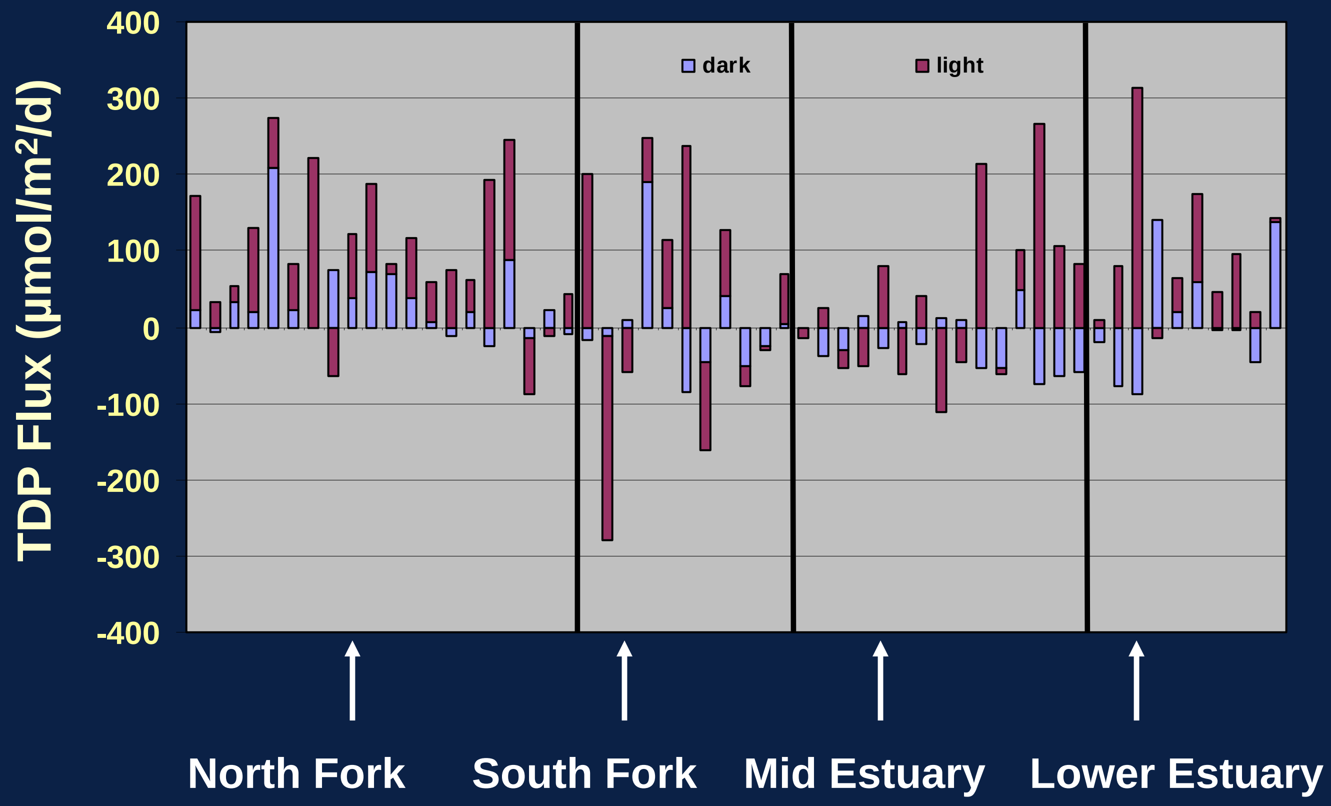
Systemwide Fluxes: Nitrate



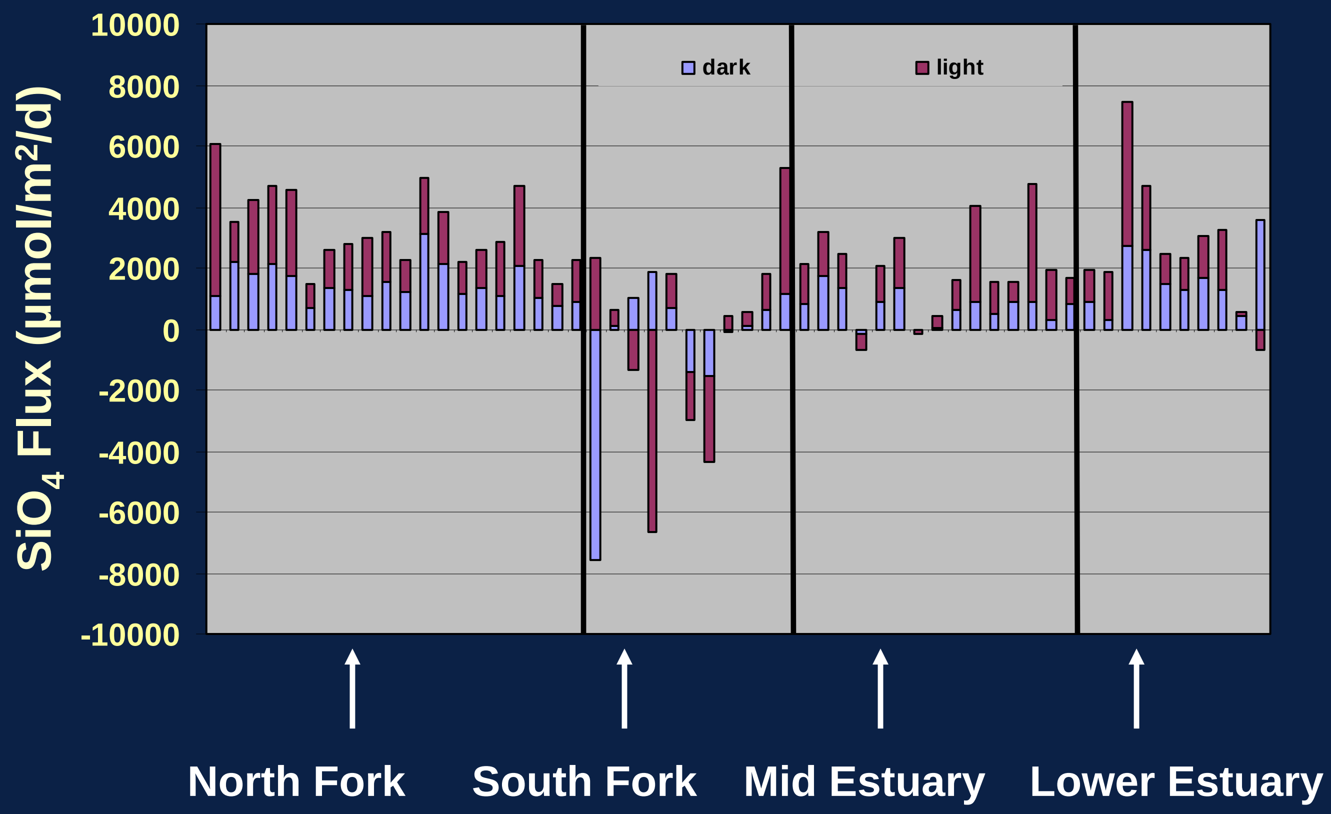
Systemwide Fluxes: Total Dissolved Nitrogen



Systemwide Fluxes: Total Dissolved Phosphorus

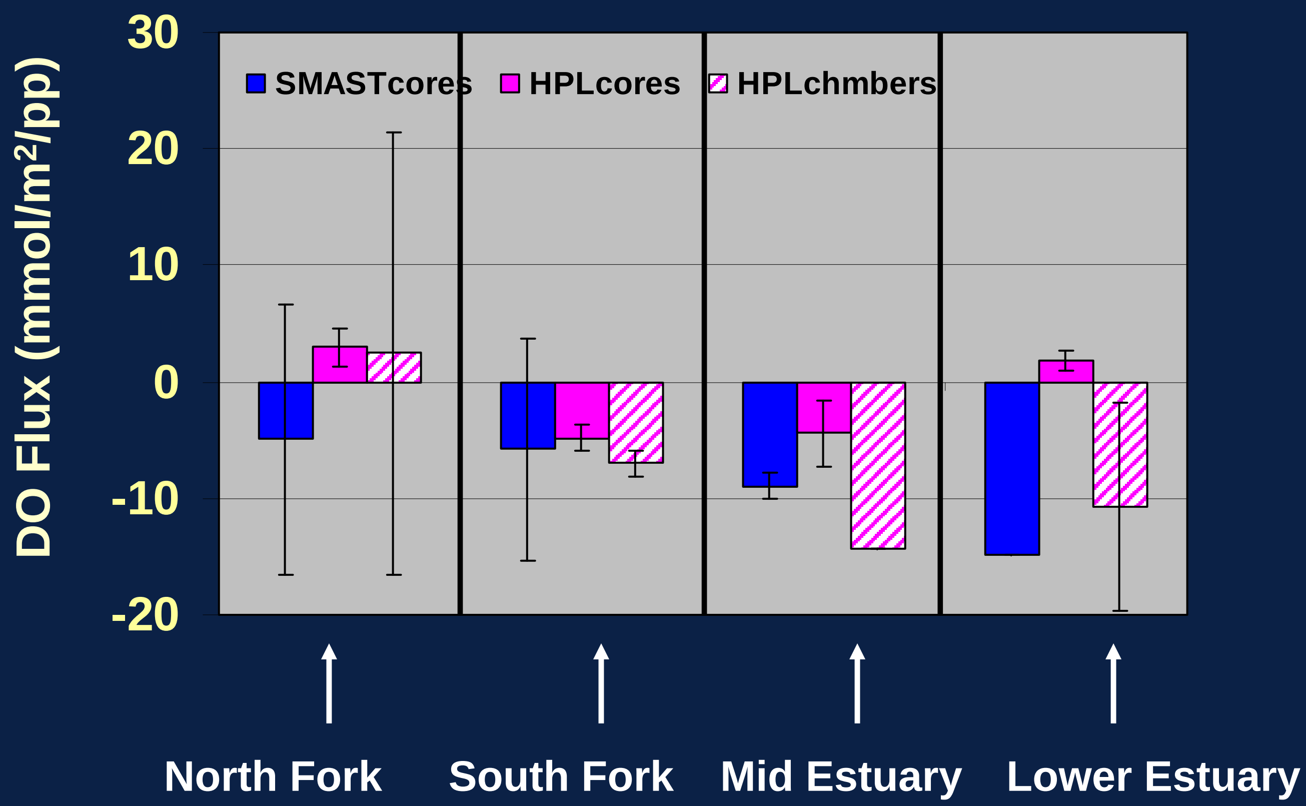


Systemwide Fluxes: Silicate



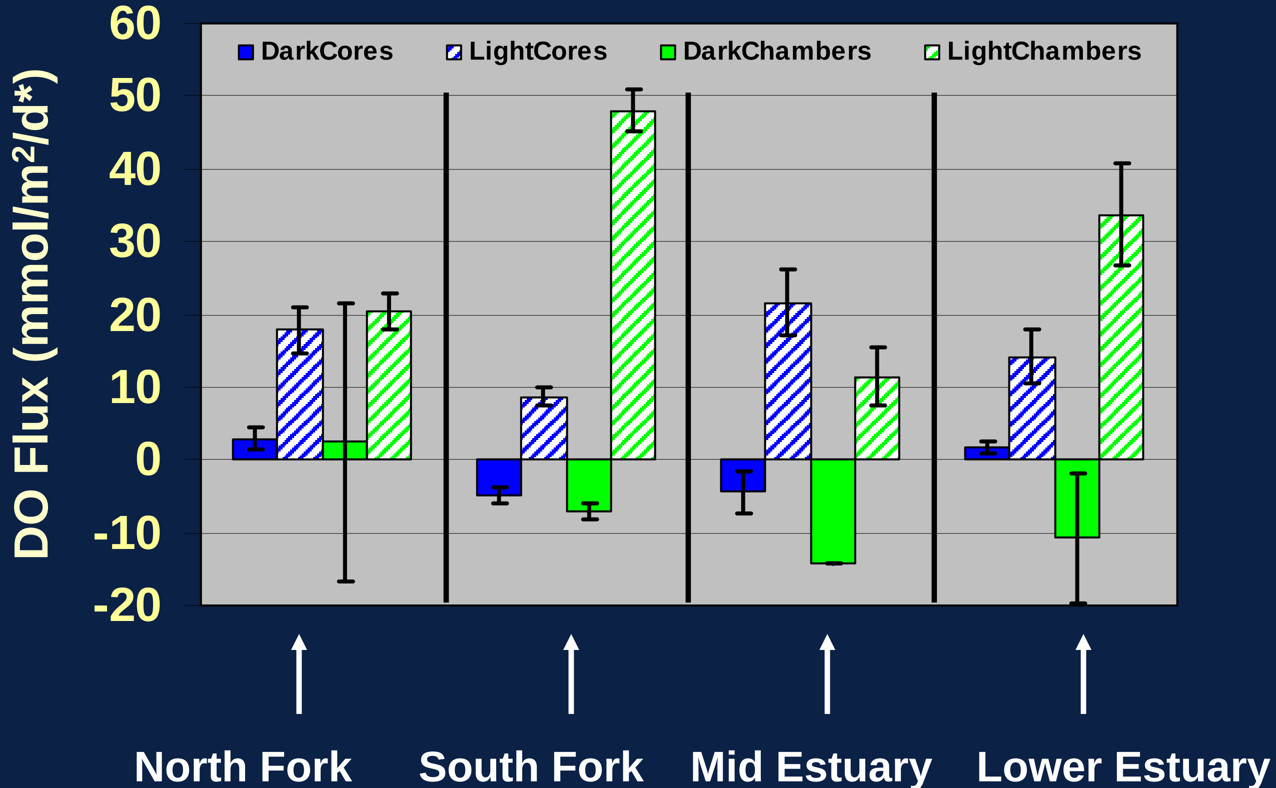
Comparisons: DO Fluxes

Reasonably Good Agreement In the *DARK*



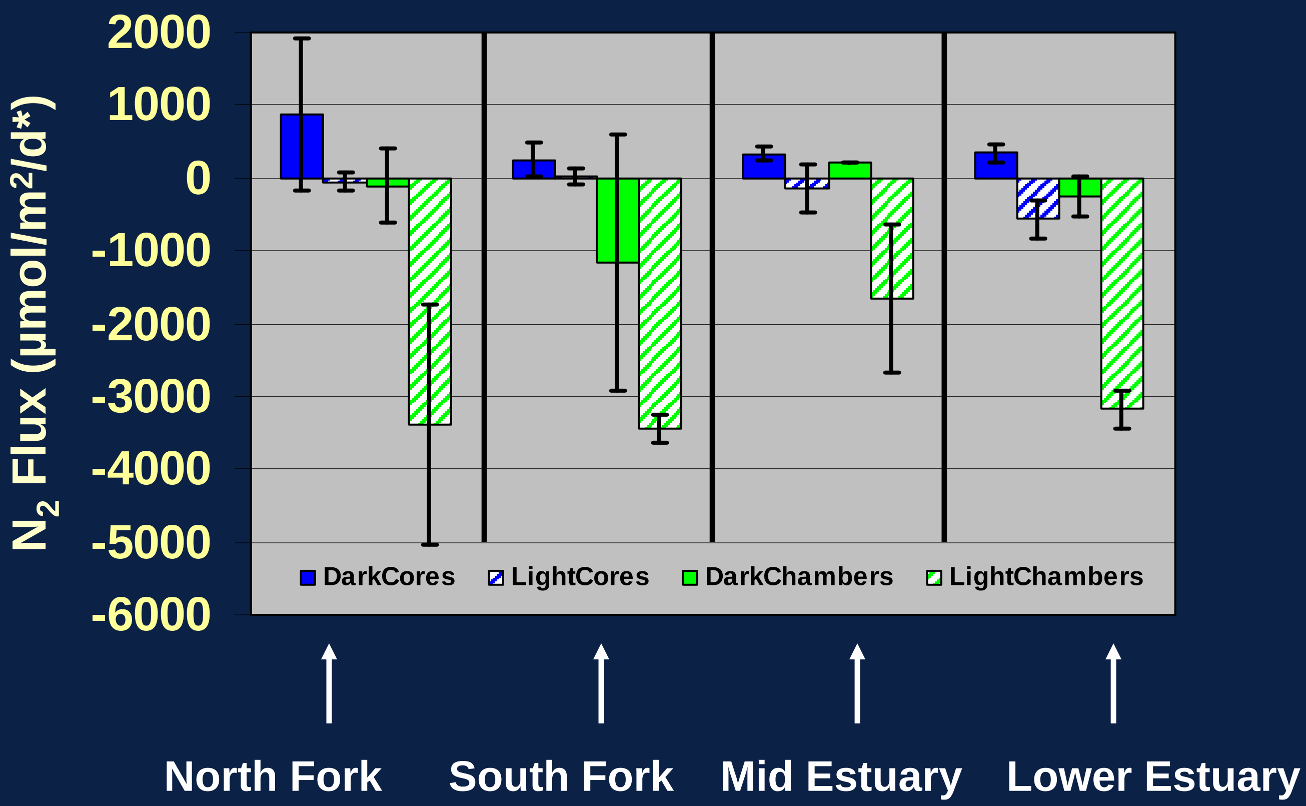
pp = photoperiod (12h)

Light and Dark DO Fluxes



pp = photoperiod (12h)

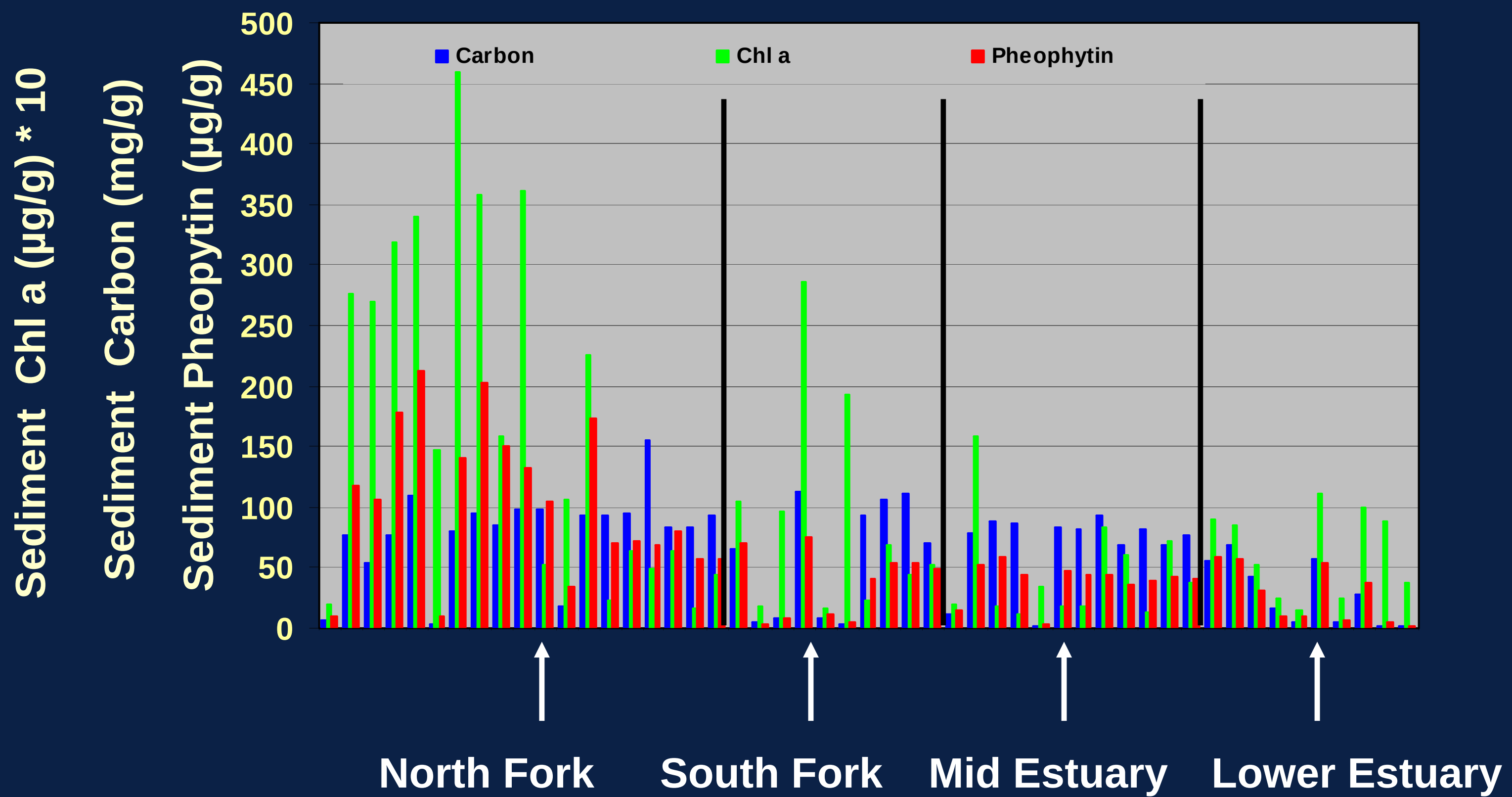
Light and Dark Denitrification



pp = photoperiod (12h)

Sediment Chlorophyll and Carbon

QUALITY of Sediment Organic Matter



High C/low Pheophytin Content
High Chl

Decreasing C/High Pheophytin Content
Low Chl

High C/High Pheophytin Content
High Chl

High C/Low Phaeophytin Content
Low Chl

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)
Systemwide Average	0.105	0.042	-0.564	0.012	-0.460	0.054
North Fork Average	0.038	0.037	-0.089	-0.001	-0.052	0.037
South Fork Average	0.019	0.005	-0.191	-0.002	-0.171	0.004
Mid-Lower Estuary Average	0.067	0.010	0.021	0.006	0.088	0.017

OBJECTIVES:

- Identify "hot spots" for these fluxes;

North Fork

SLE41: N OUT

SLE31/SLE33: P OUT

South Fork

SLE20: N OUT

SLE42: P OUT

Mid-Lower Estuary

SLE2/SLE4: N OUT

OBJECTIVES:

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

- No Evidence of Advection (only 4 sites)
- Evidence of Nitrogen Fixation
- LIGHT MATTERS!!!!!
- Quality/Lability of Sediment Organics 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

Northern Everglades

River Watershed Research & Water Quality

Monitoring Program

St. Lucie River Watershed

Dynamics of the Estuarine Turbidity Maximum (ETM) in the St. Lucie Estuary

June 2008

sfwmd.gov

Outline

Review :

- Estuarine Circulation
- ETMs
- Biological Significance

Results:

- Hydrodynamics
- ETM and Suspended Sediment
- DO, Chl a, and Pheophytin

Conclusions

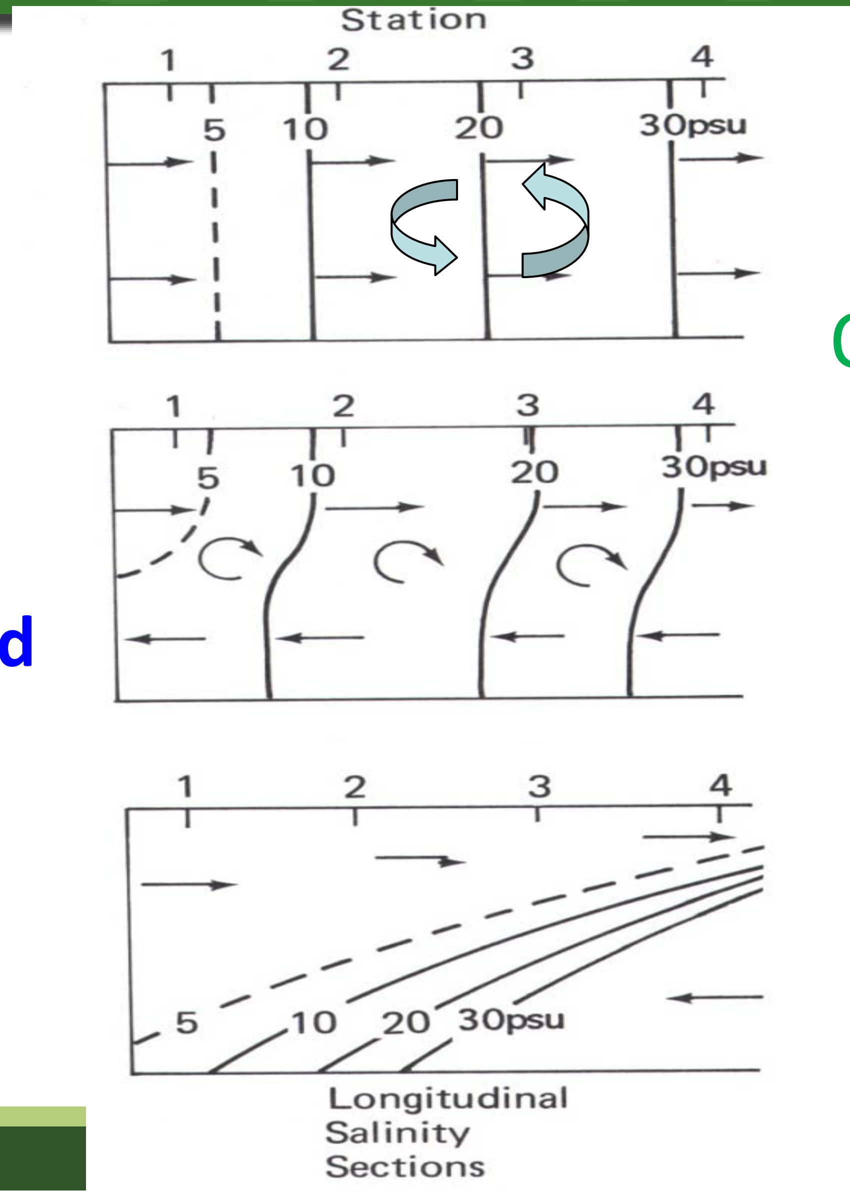
Residual or Net Circulation

Well-mixed

River

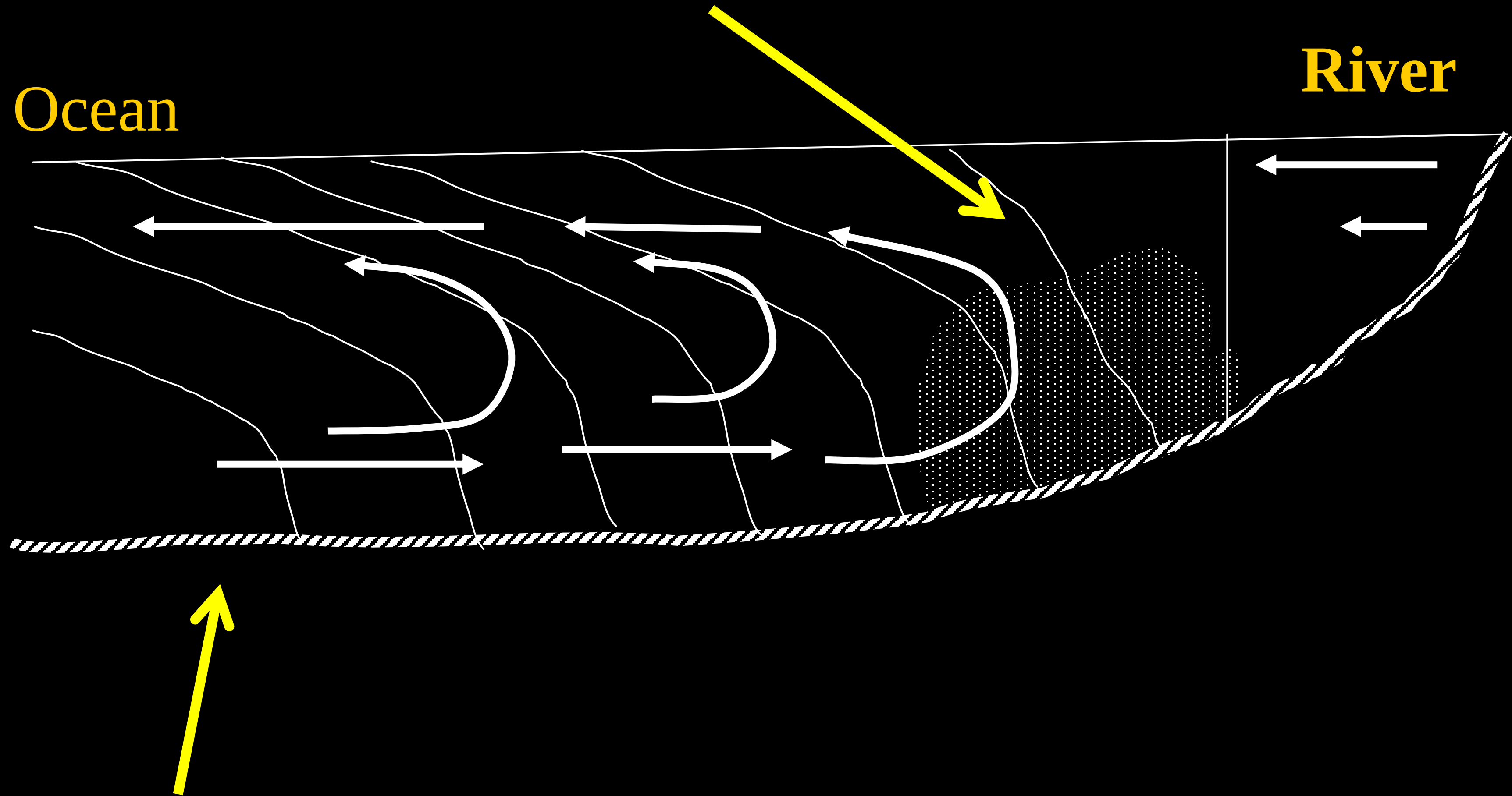
Partially-mixed

Salt wedge

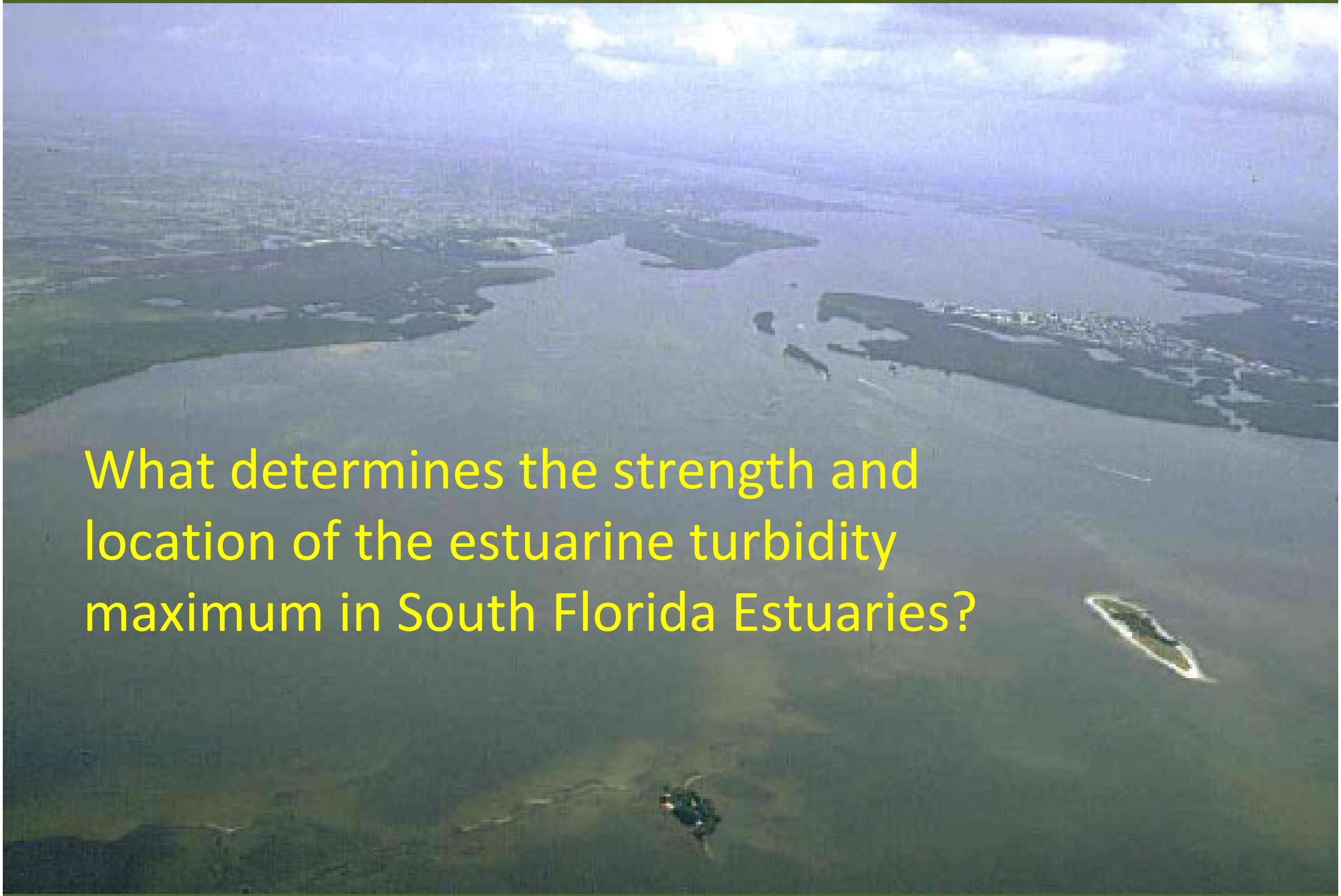


Ocean

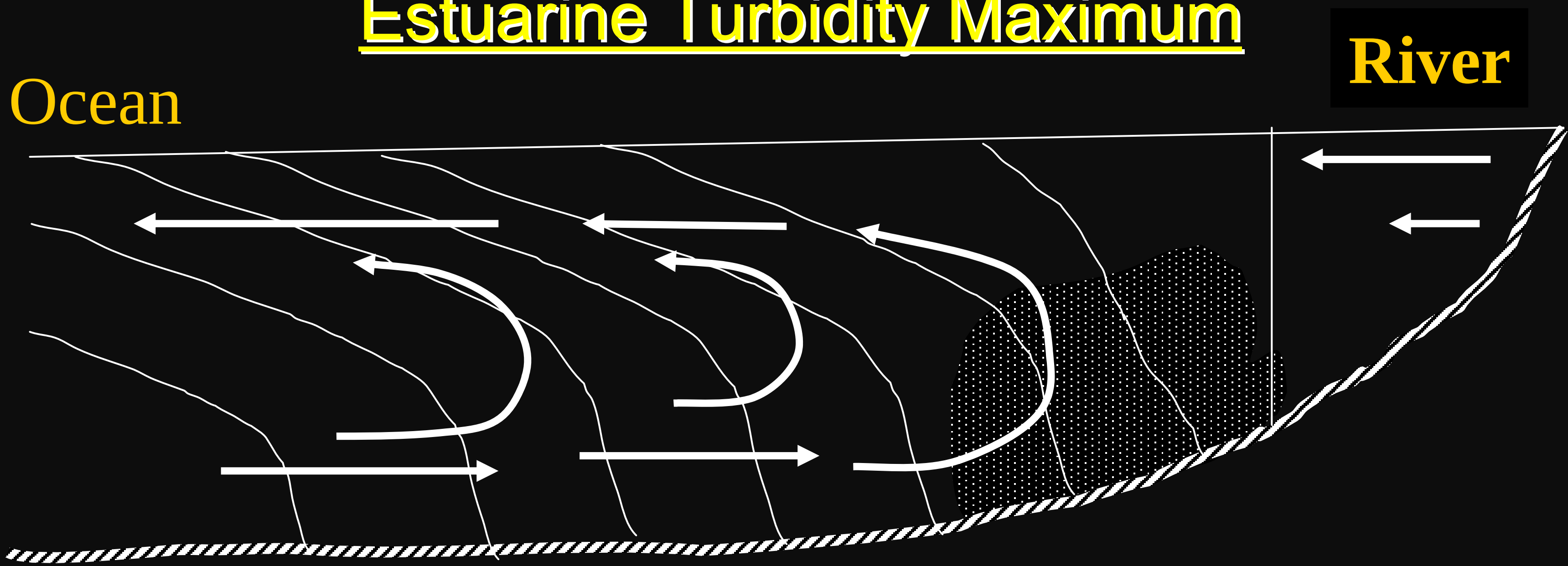
Estuarine Turbidity Maximum



Also called estuarine , gravitational, or density driven circulation


What determines the strength and
location of the estuarine turbidity
maximum in South Florida Estuaries?

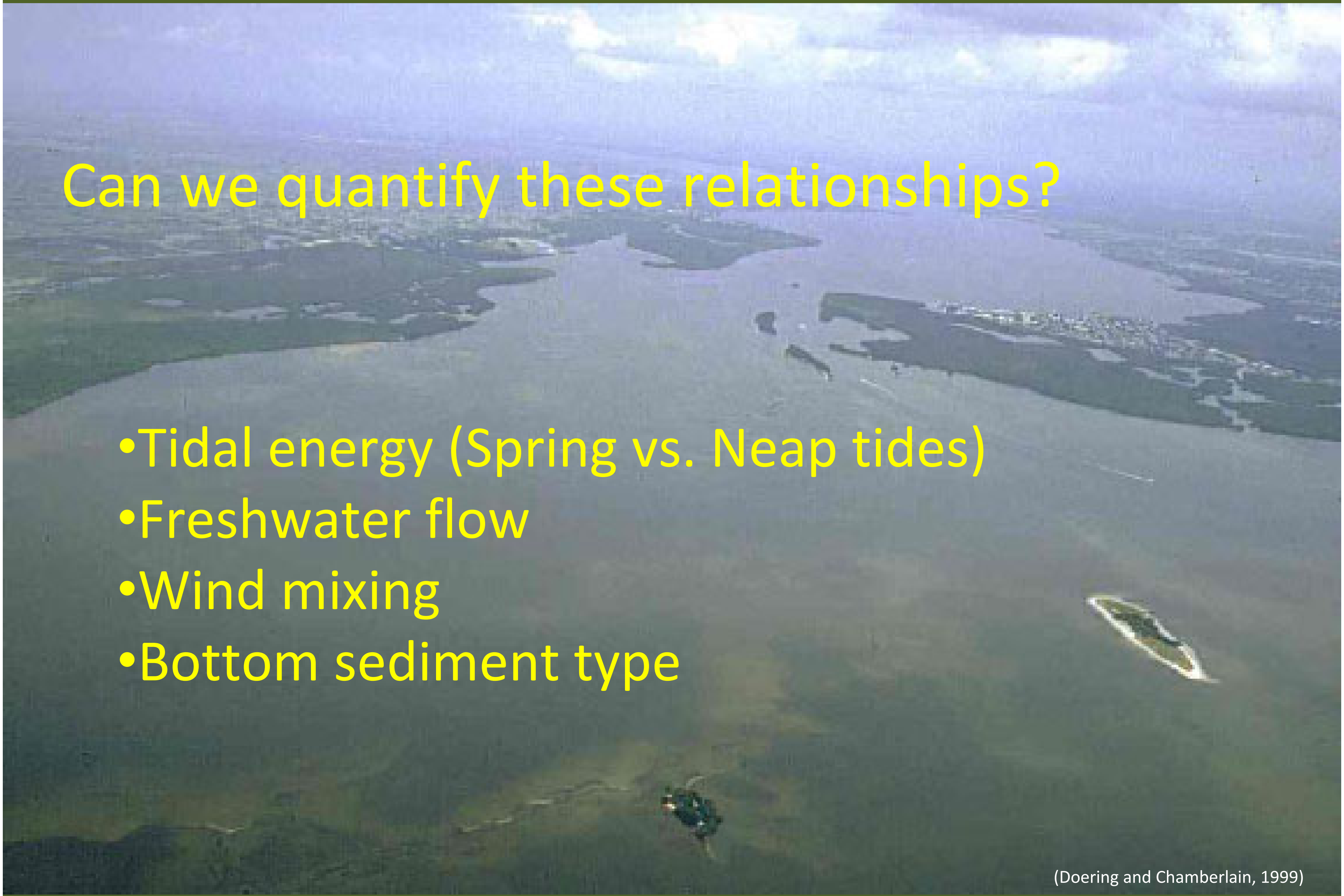
Estuarine Turbidity Maximum



•Increased stratification increases estuarine circulation

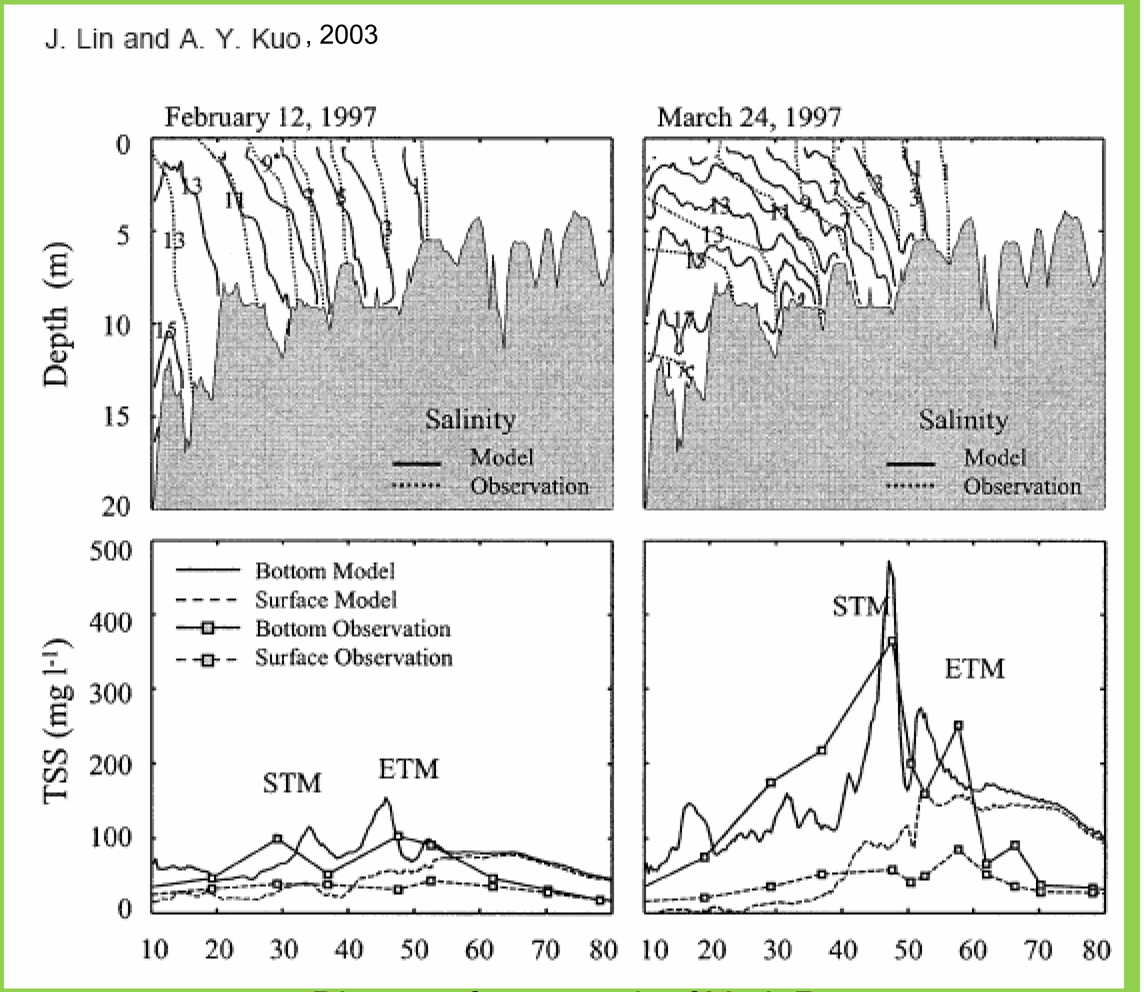
But..

•Increased stratification decreases sediment resuspension


Can we quantify these relationships?
•Tidal energy (Spring vs. Neap tides)
•Freshwater flow
•Wind mixing
•Bottom sediment type
(Doering and Chamberlain, 1999)

Other factors may produce ETMs, and sometimes secondary ETMs

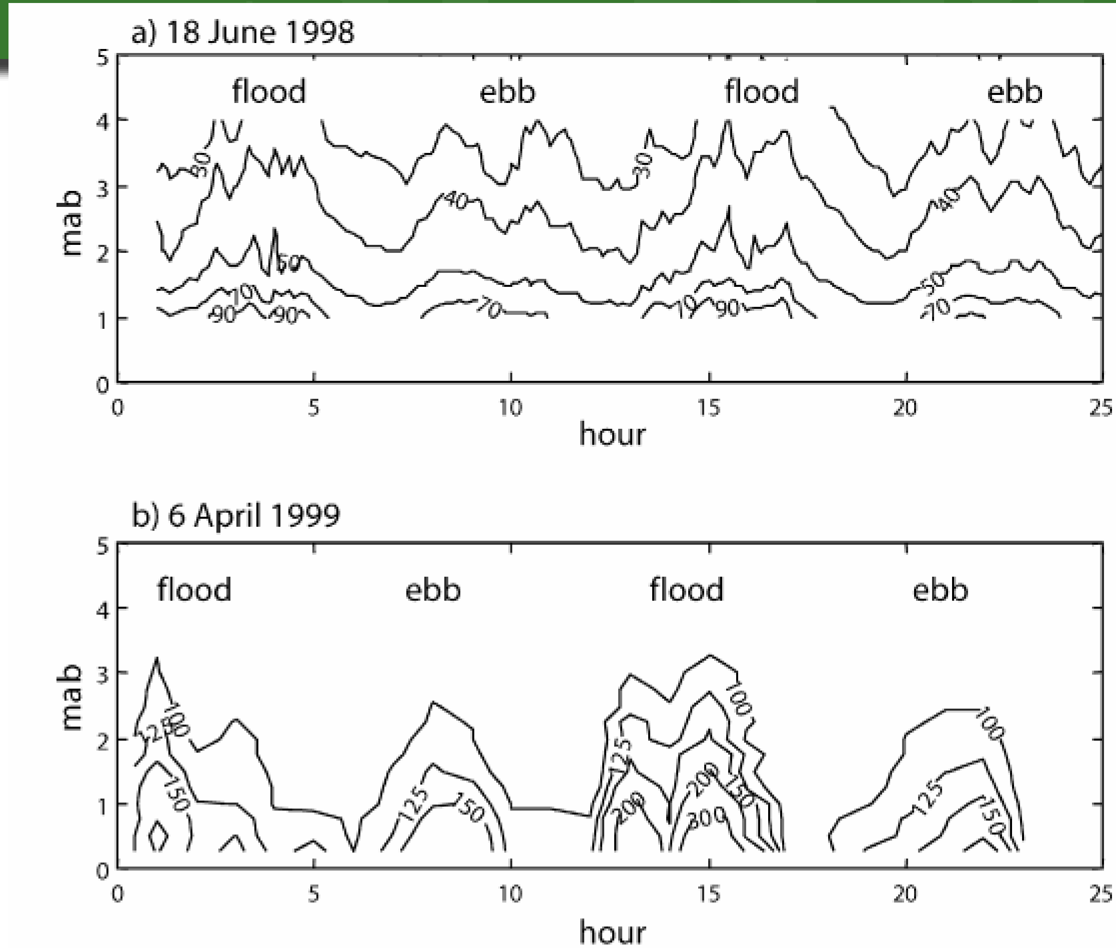
- Gradients in stratification
- Shallow bathymetry
- Shoal areas and secondary circulation



Distance from mouth of York R

How does SIPS affect Sediment Transport?

Fig. 3a, b Time series of observed total suspended solids profiles collected on a 18 June 1998 (from calibrated ADCP backscatter), and **b** 6 April 1999 (from calibrated OBS profiles). Contours are in mg l^{-1}

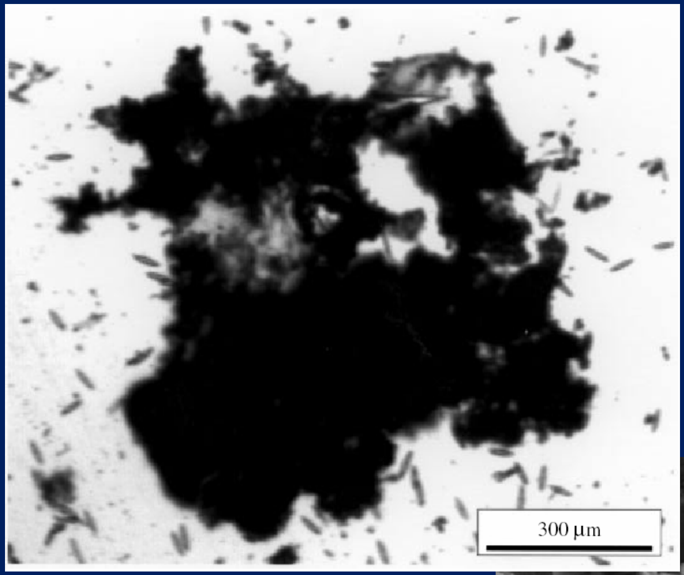


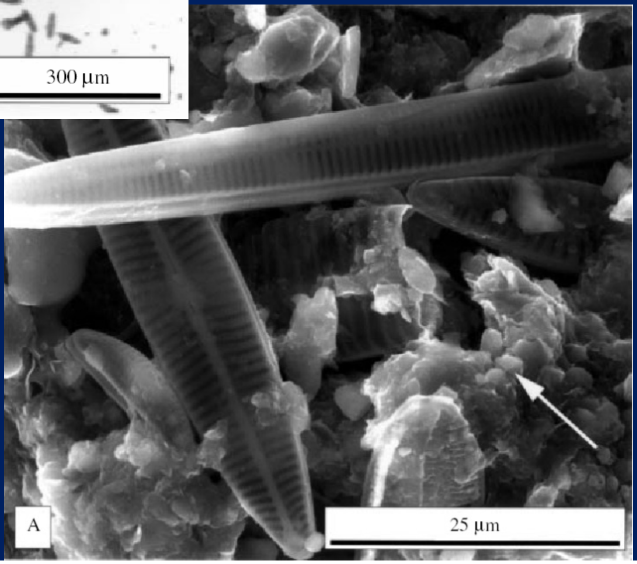
Sediment resuspension greater during flood and higher into the water column

(Scully and Friedrichs, 2002)

What are estuarine aggregates?

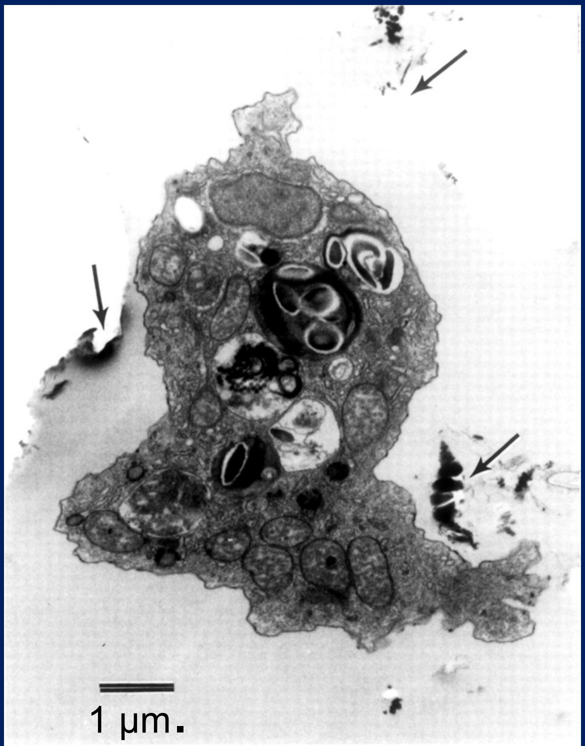
Aggregates, or flocs, are complex matrices of microbial organisms, organic material, inorganic material, and interfloc spaces or pores

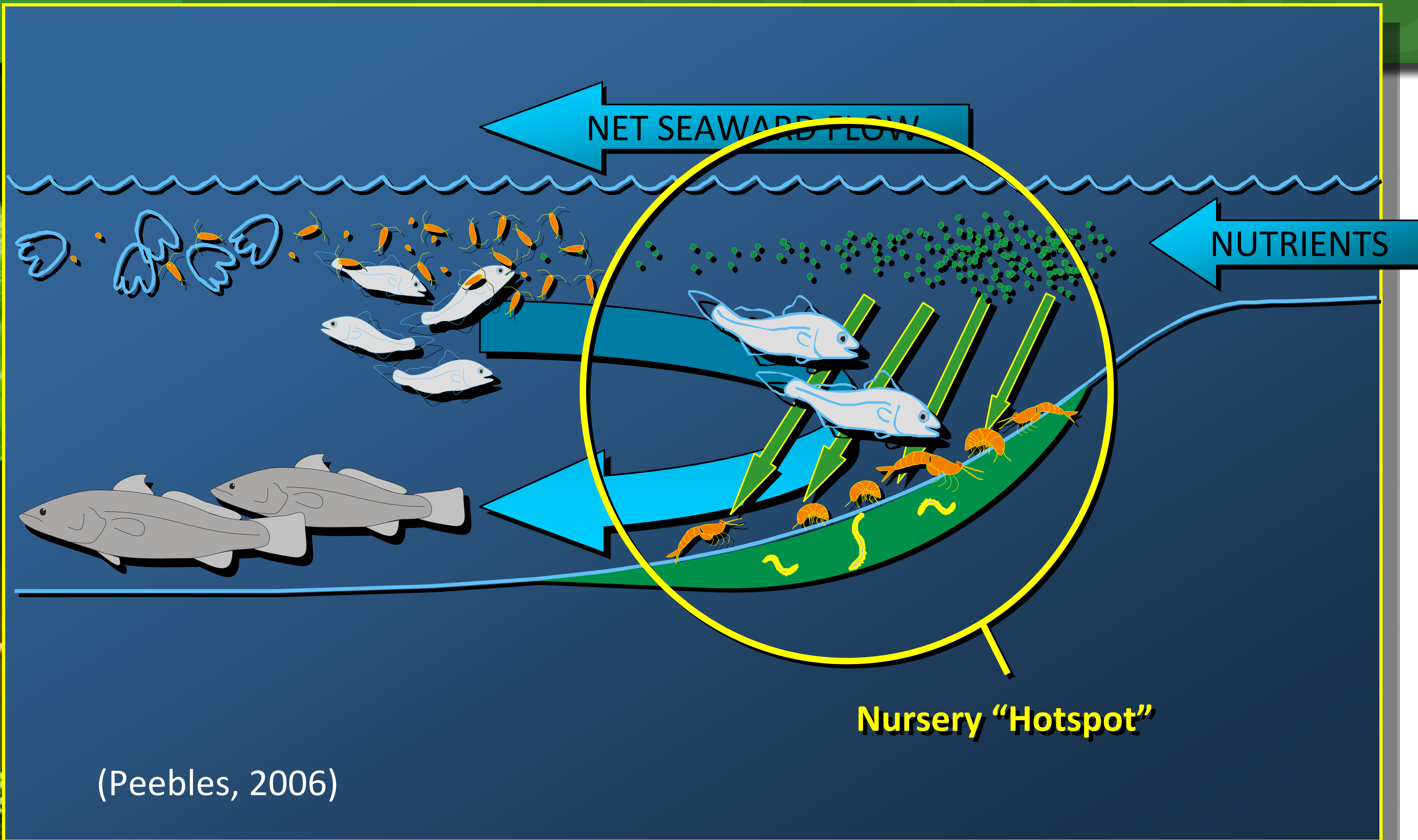




(Droppo, 2001)

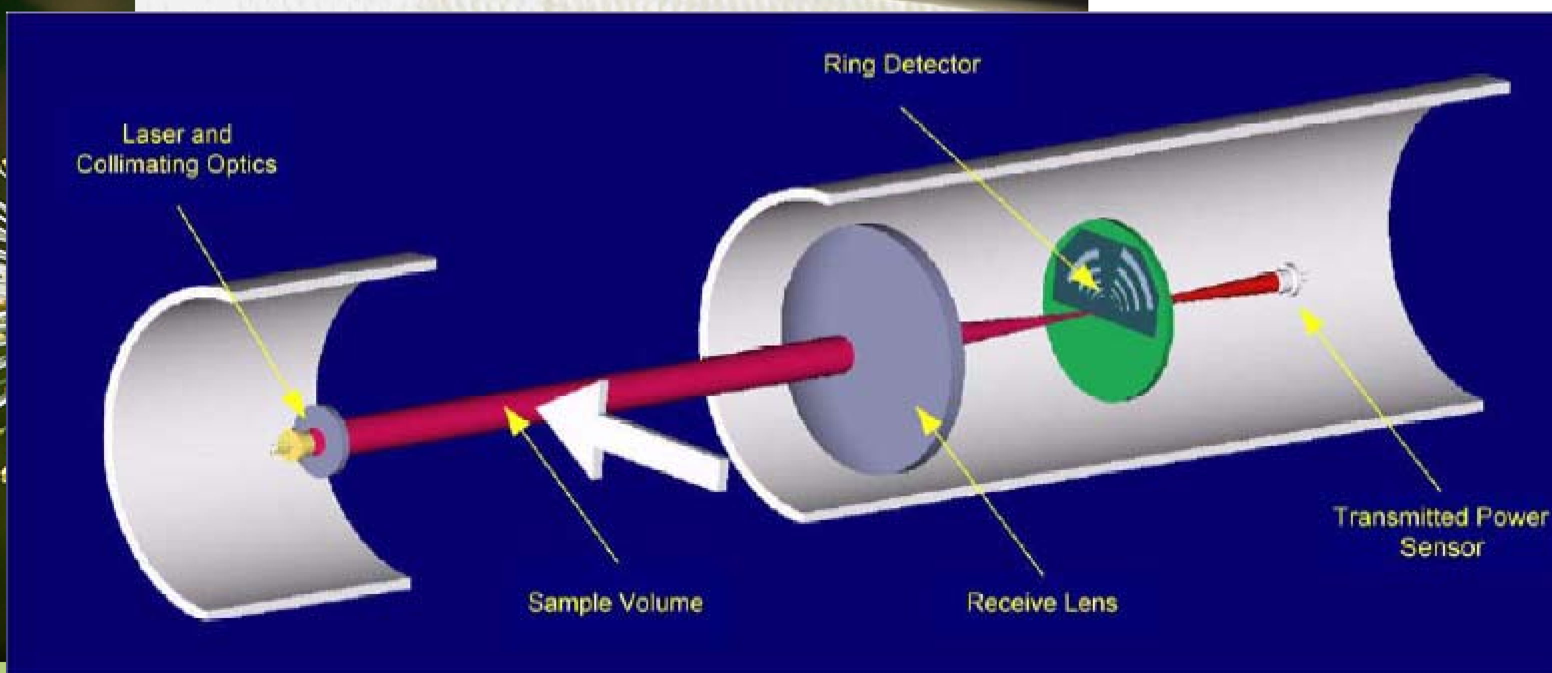
(Rogerson et al., 2003)





(Peebles, 2006)

LISST100x


Ring Detector
Laser and
Collimating Optics
Transmitted Power
Sensor
Sample Volume
Receive Lens

Methods

•Profiles with Seabird 19+ CTD and attached OBS

•Profiles with Sequoia Science LISST 100X

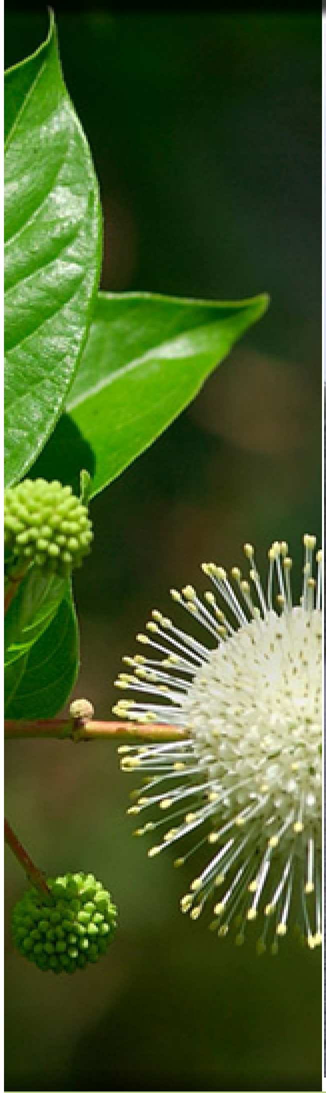
•YSI deployed at bottom and surface for DO, pH and to provide realtime estimates of salinity to guide location of profiles.

oin St Lucie from fresh to 5 ppt

when possible, regular intervals

•Pumped samples with Geosub pump attached to CTD

St. Lucie Results



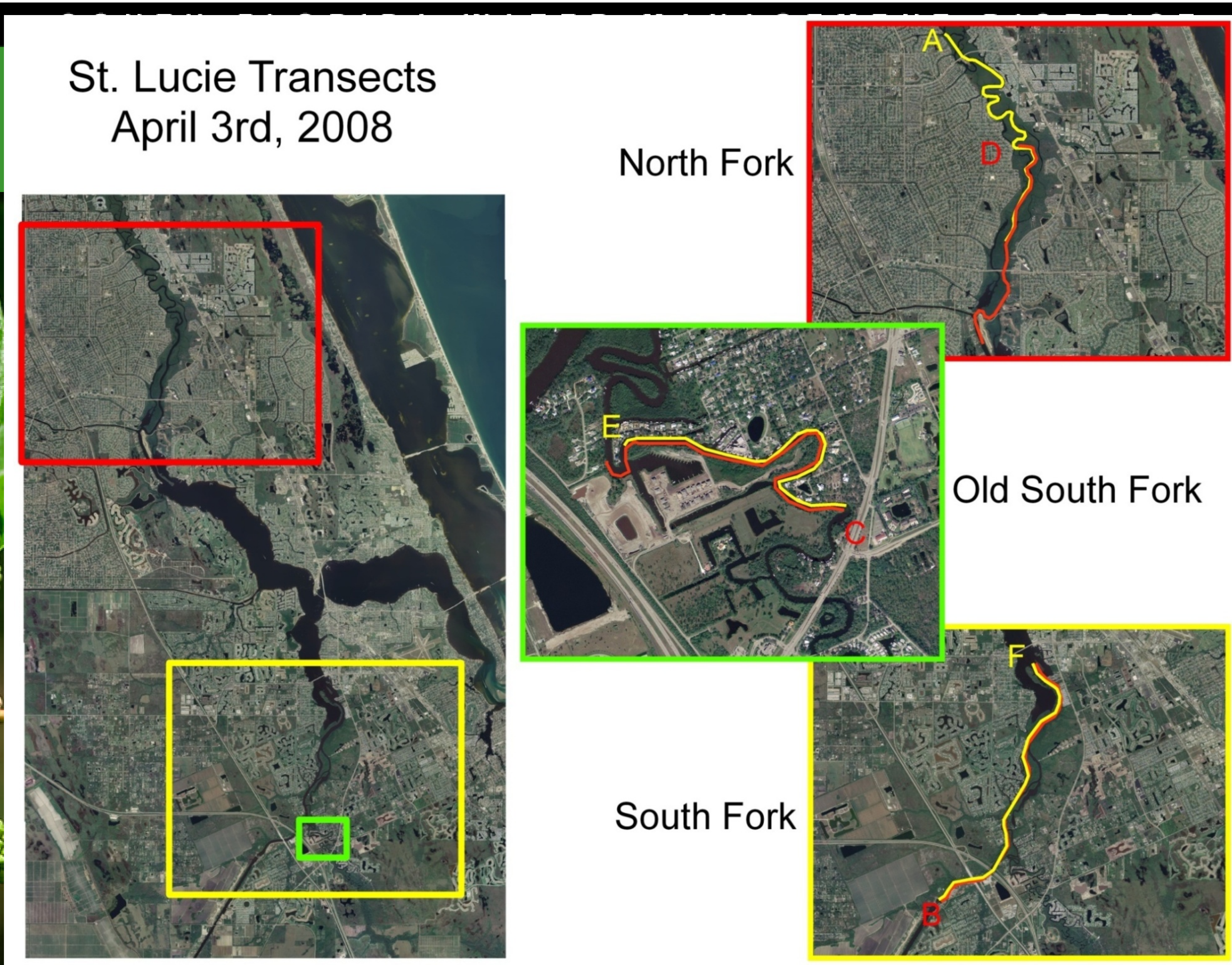
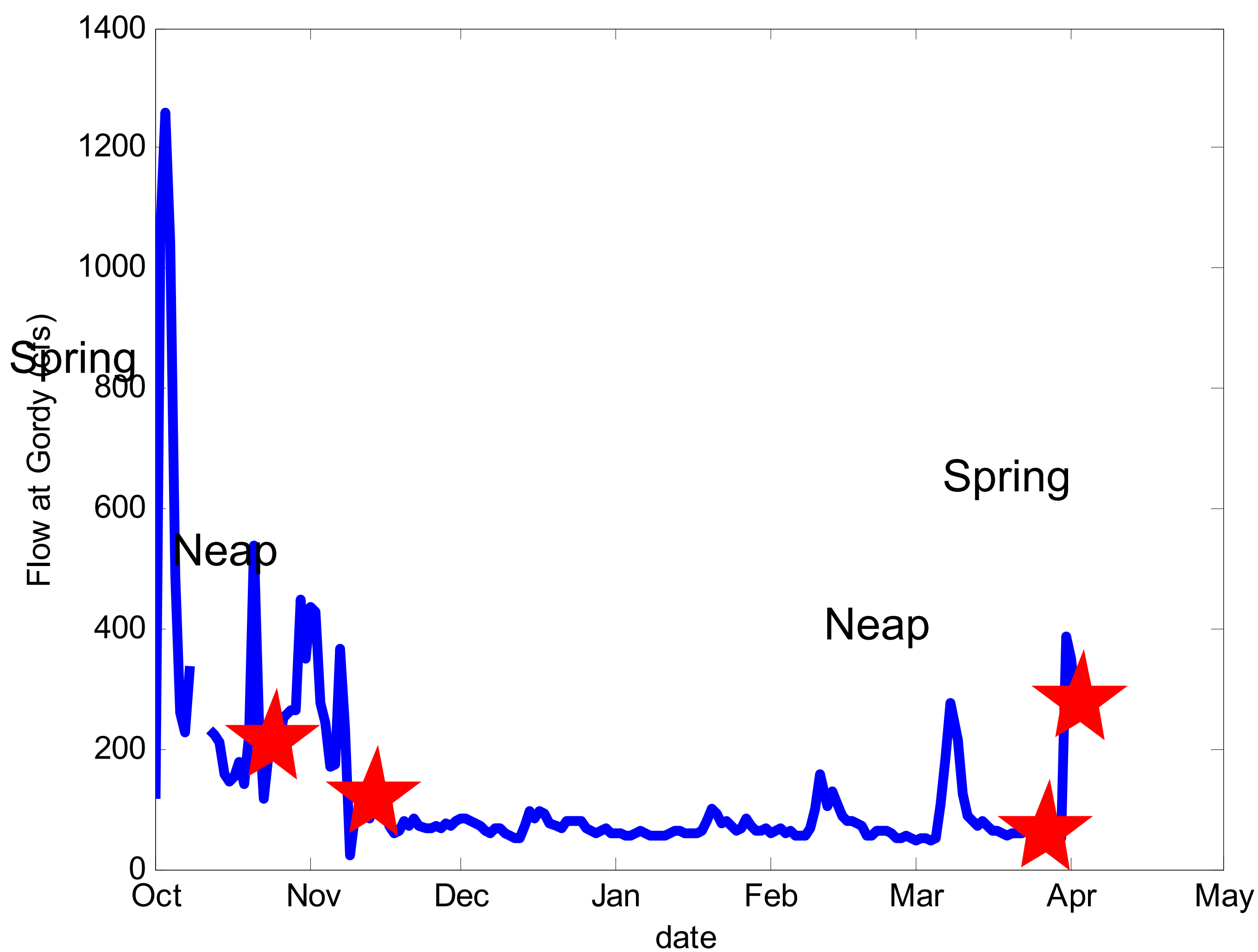


Figure DS1. Map of dry season, spring tide transects. Red box denotes location of North fork transects. Green box denotes location of Old South Fork transects. Yellow box denotes location of South Fork transects.

Survey Dates and Flow



(Flow over St Lucie Lock and Dam was zero for entire period)

Wet Spring

North Fork

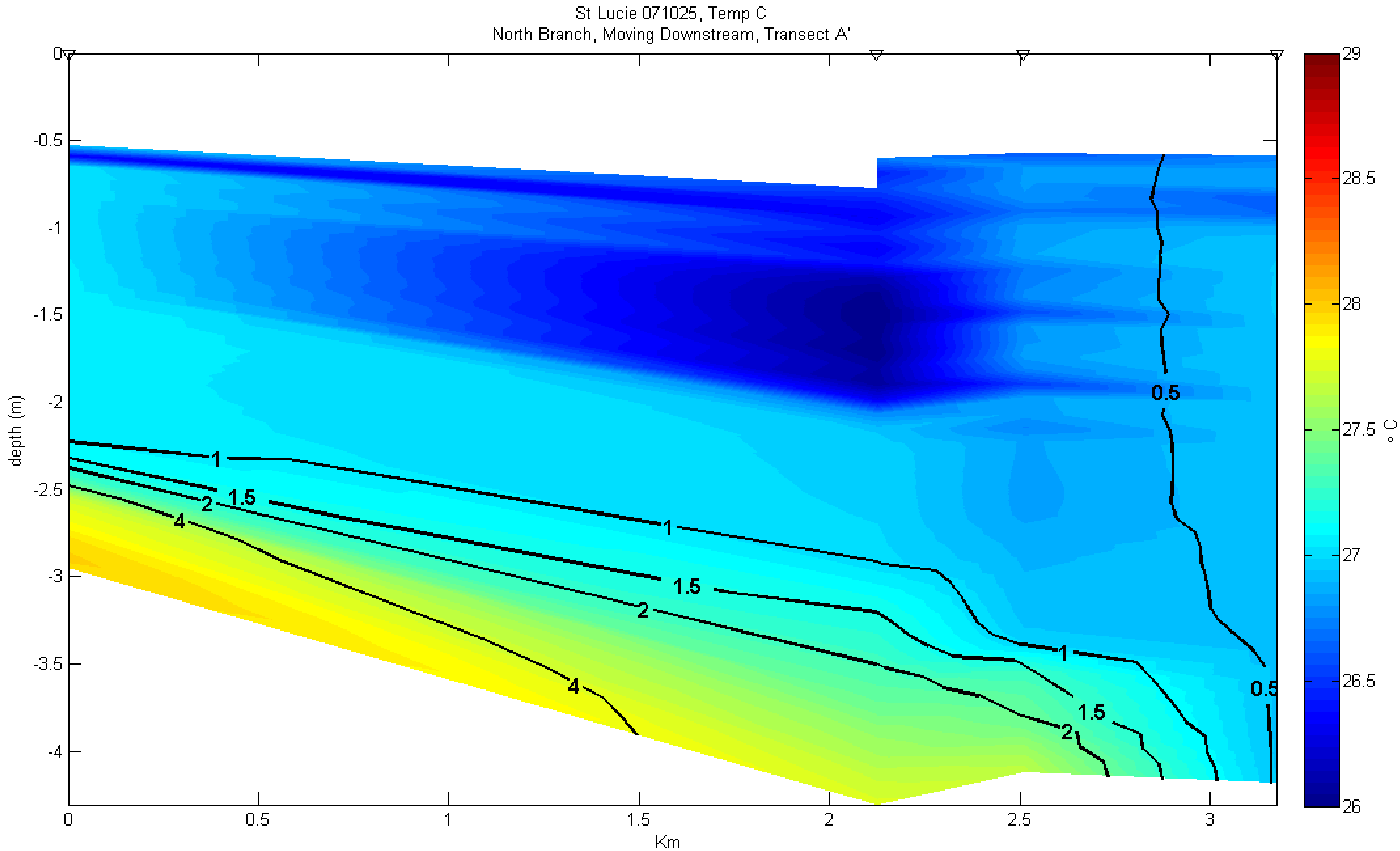


Figure WS11. Wet season, spring tide temperature profile. Transect A'. Black lines denote salinity contours.

North Fork

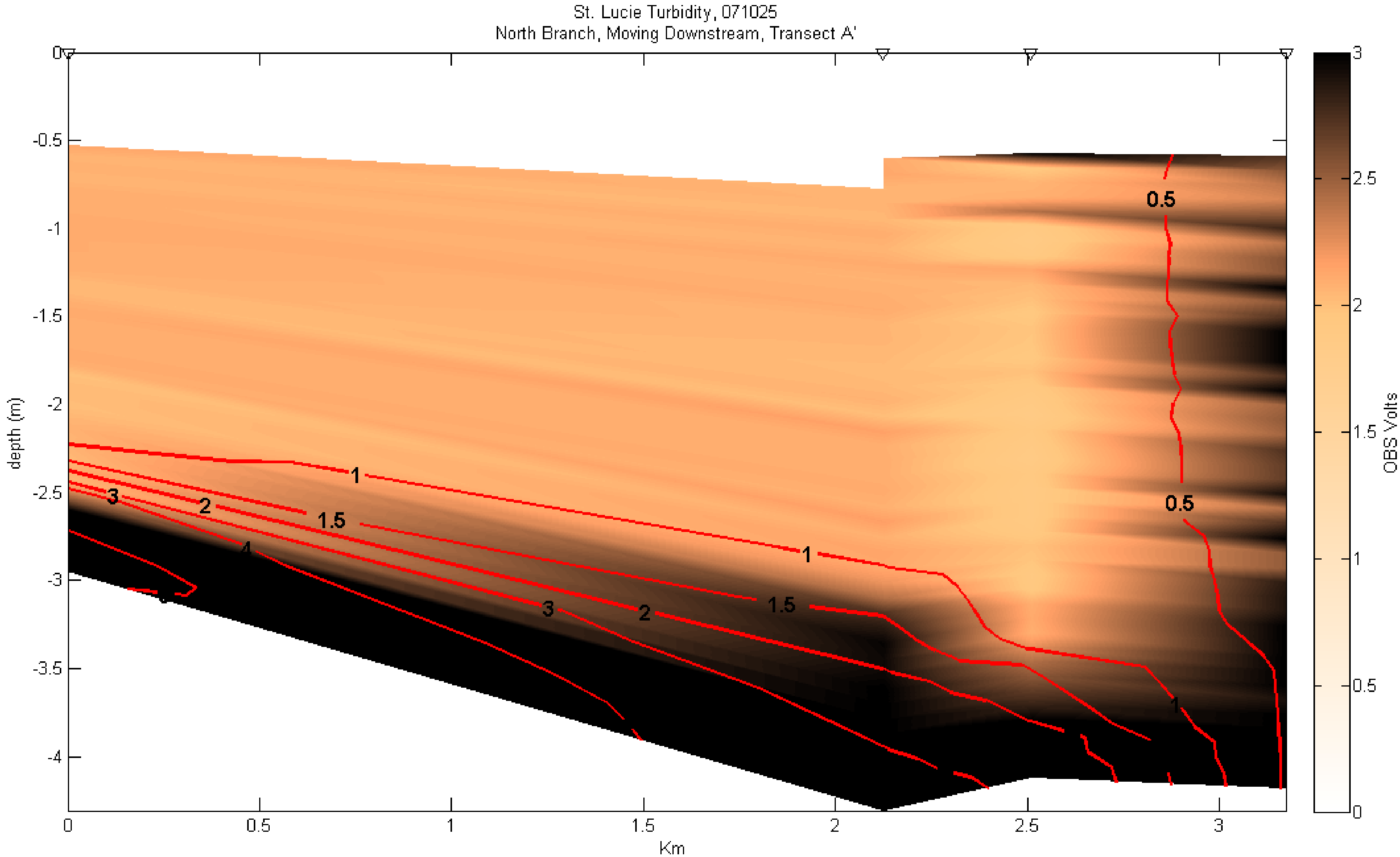


Figure WS12. Wet season, spring tide turbidity profile. Transect A'. Red lines denote salinity contours.

South Fork

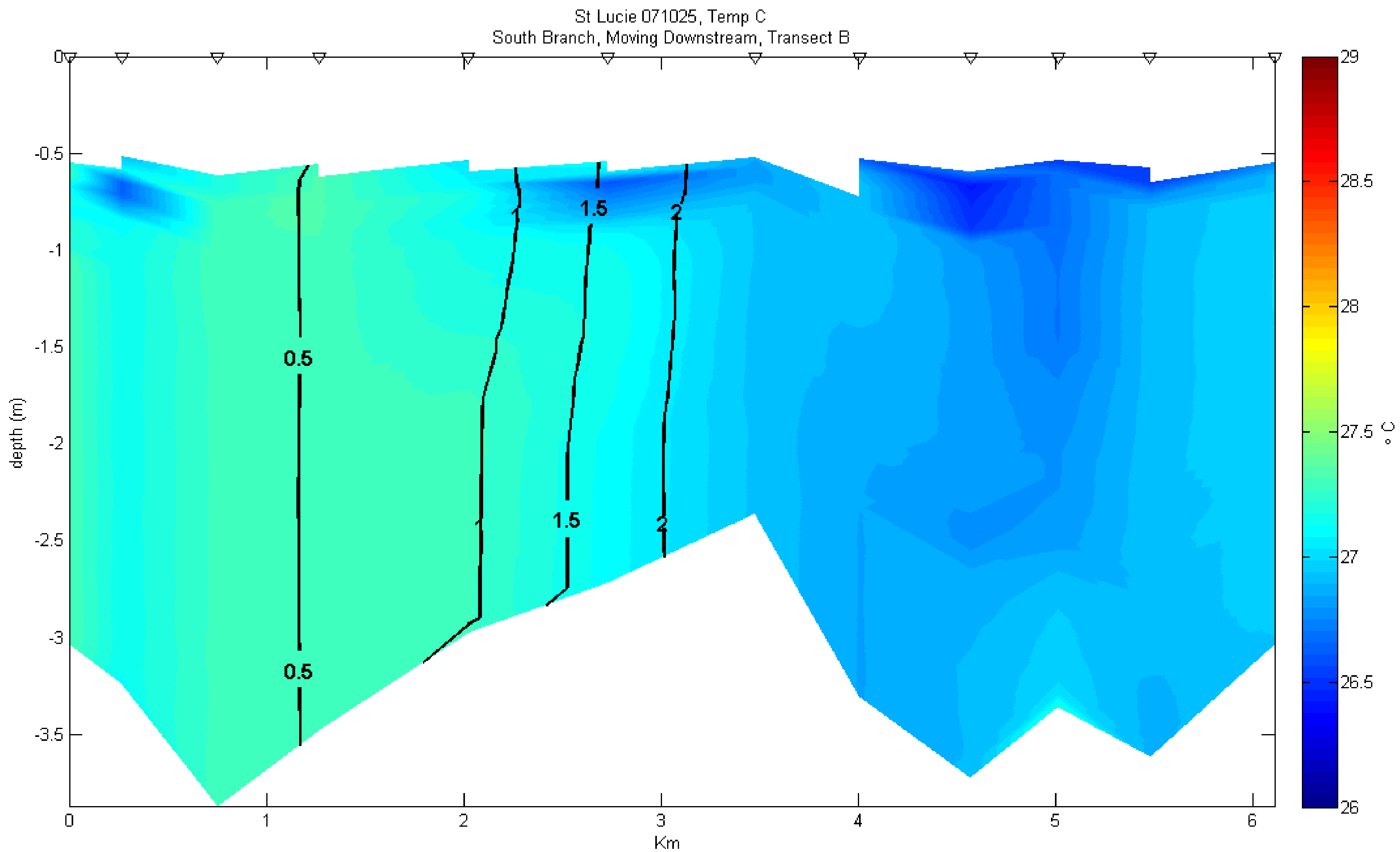


Figure WS17. Wet season, spring tide temperature profile. Transect B. Black lines denote salinity contours.

South Fork

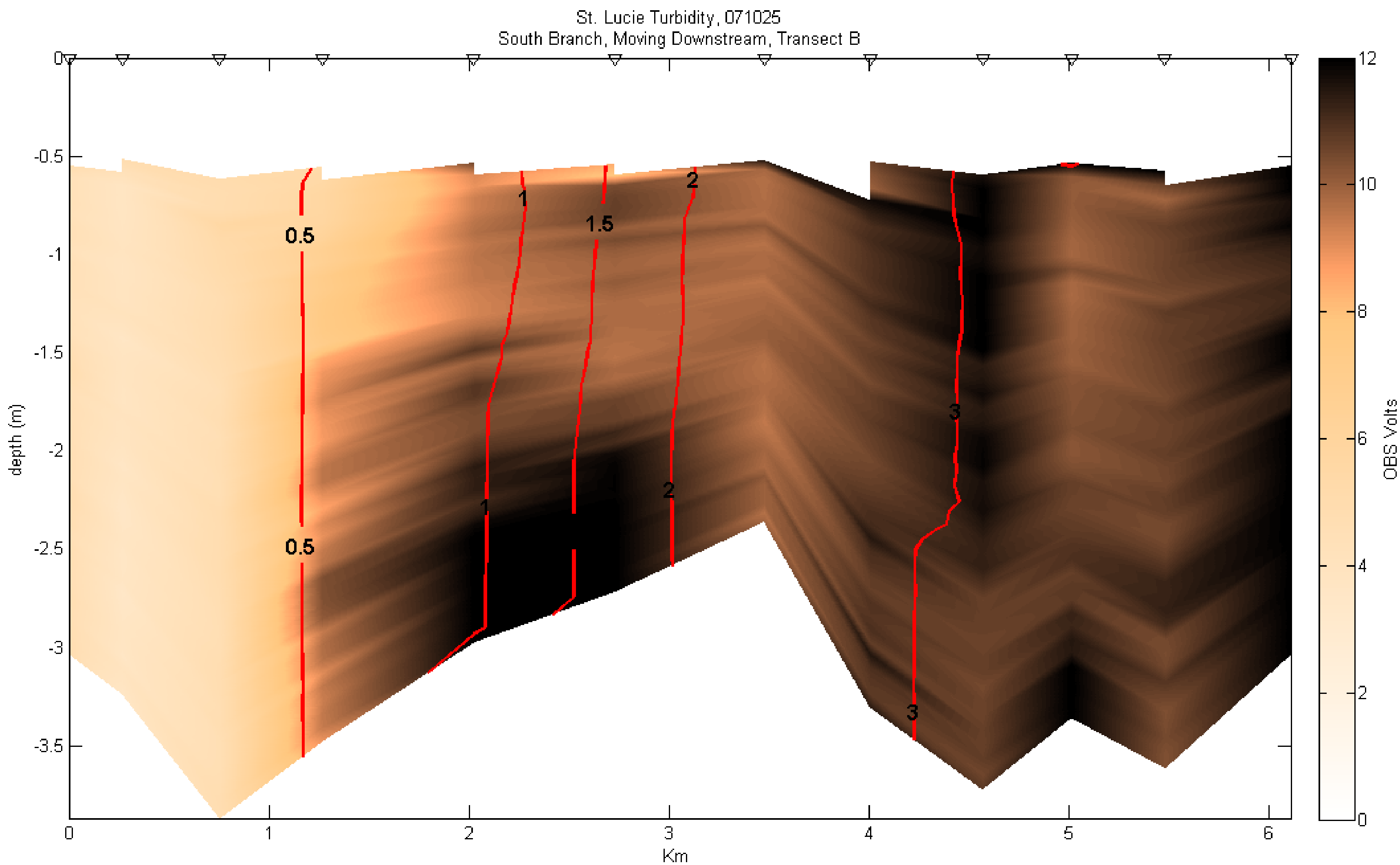


Figure WS18. Wet season, spring tide turbidity profile. Transect B. Red lines denote salinity contours.


C
D

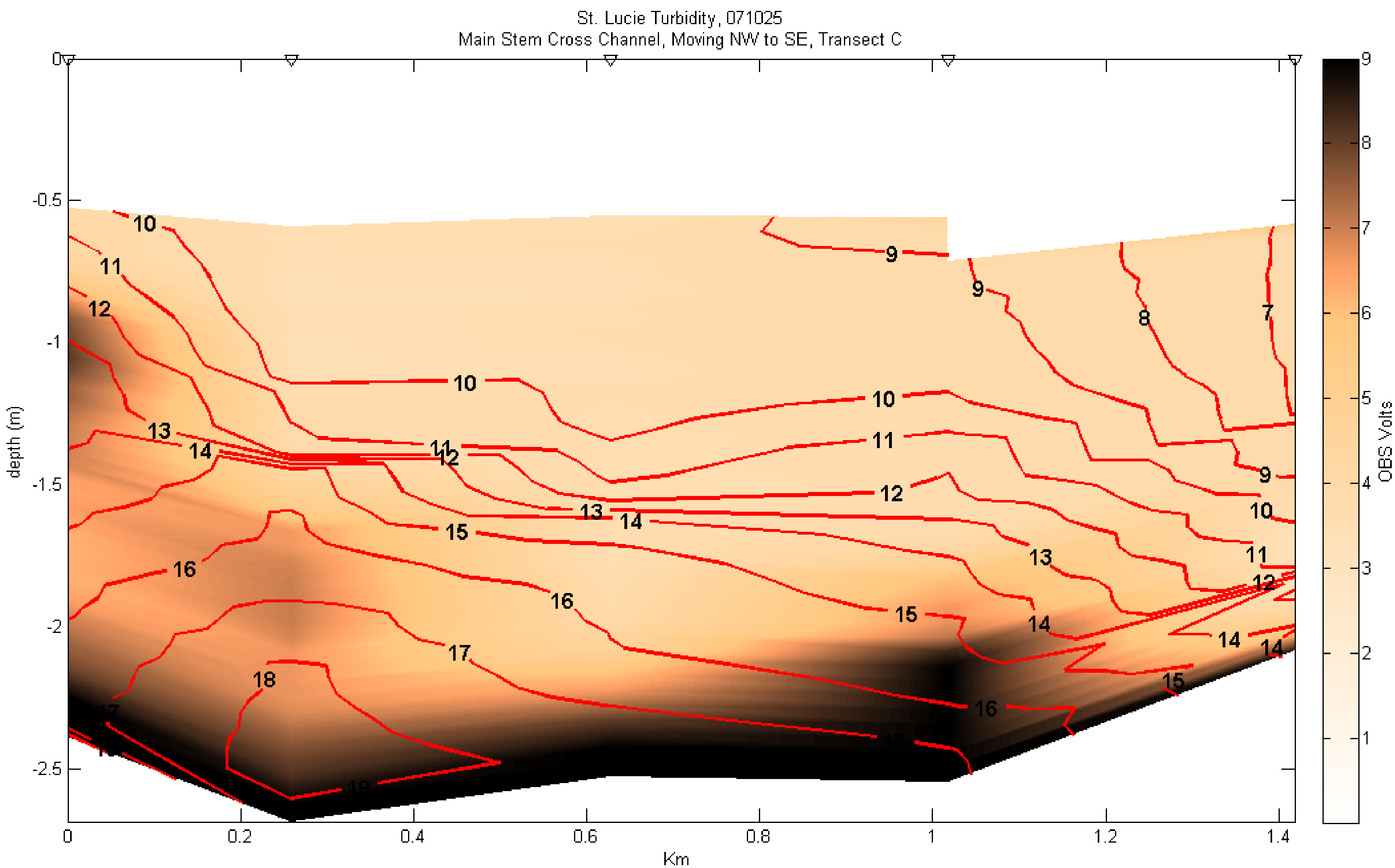


Figure WS25. Wet season, spring tide turbidity profile. Transect C. Red lines denote salinity contours.

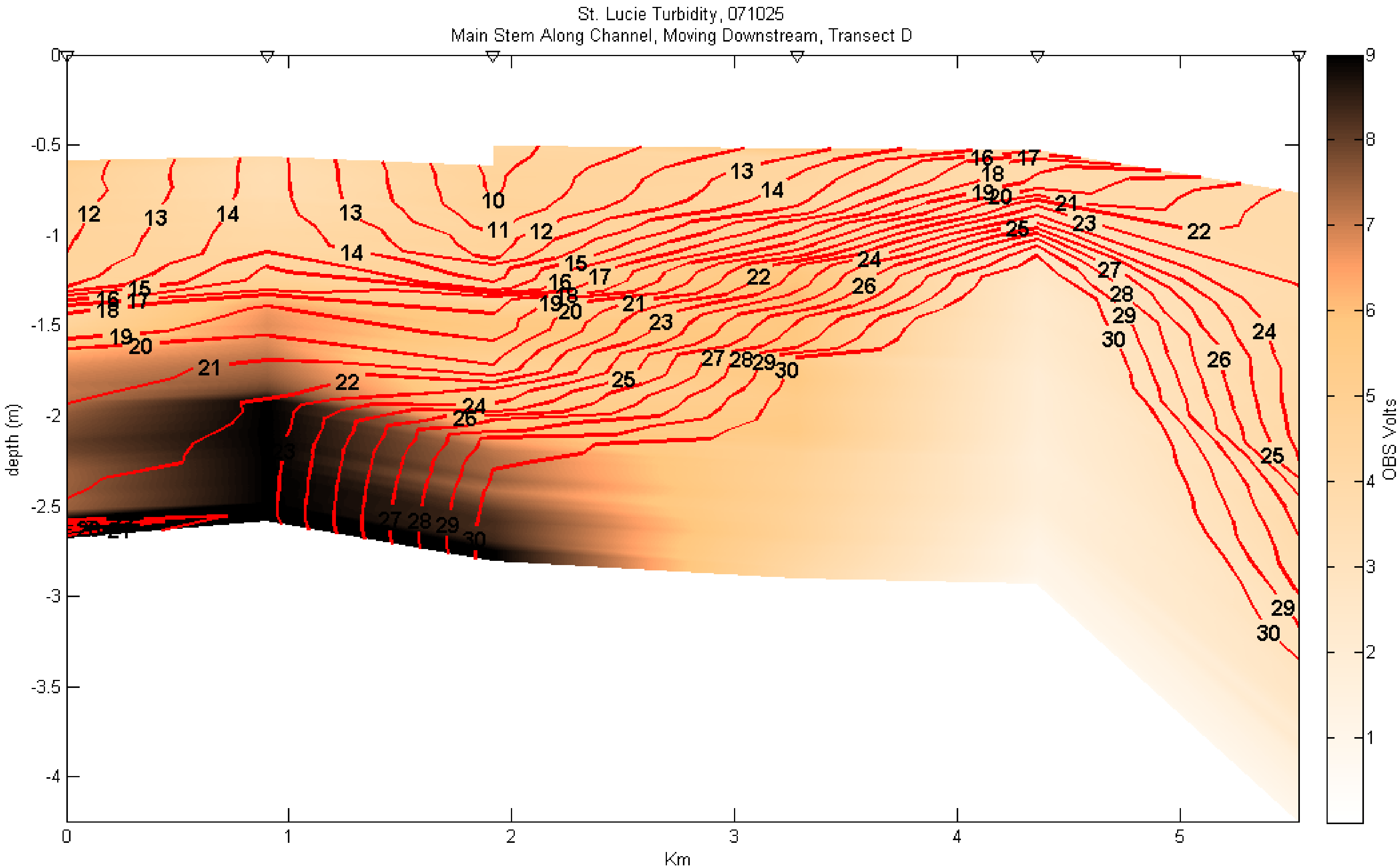


Figure WS31. Wet season, spring tide turbidity profile. Transect D. Red lines denote salinity contours.

S O U T H F L O R I D A W A T E R M A N A G E M E N T D I S T R I C T

South Fork

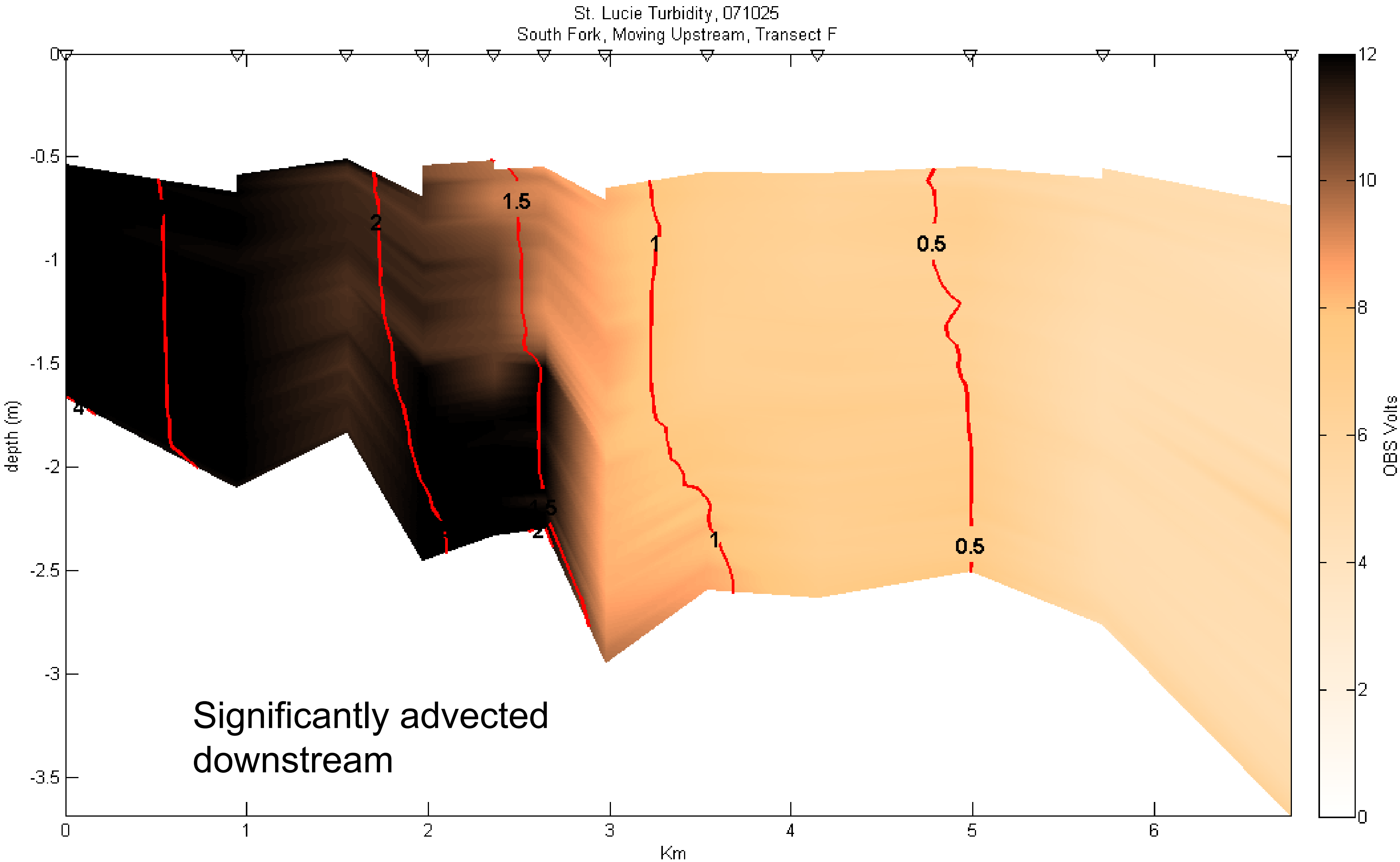


Figure WS44. Wet season, spring tide turbidity profile. Transect F. Red lines denote salinity contours.

Wet Neap

North Fork

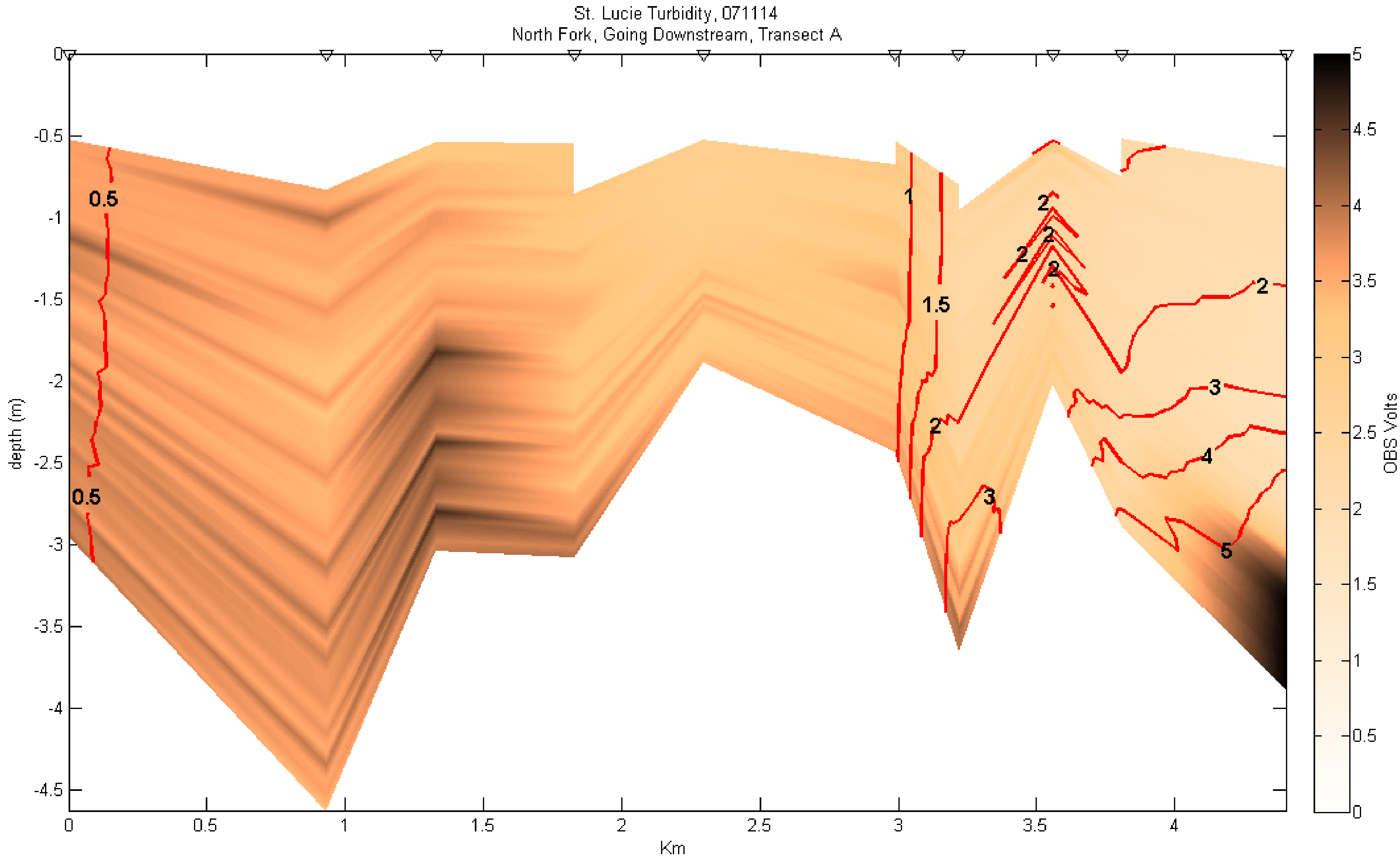


Figure WN5. Wet season, neap tide turbidity profile. Transect A. Red lines denote salinity contours.

North Fork

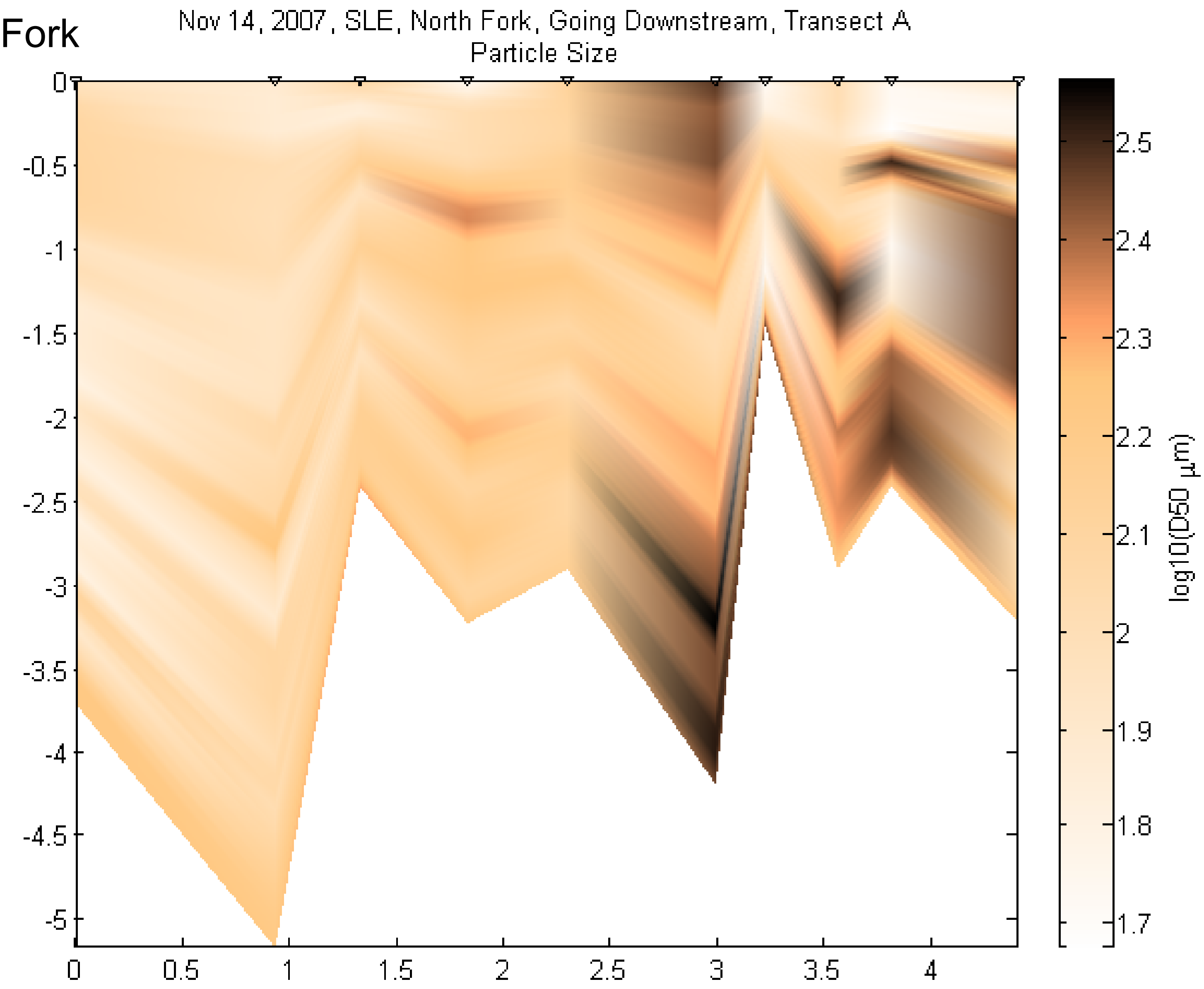


Figure WN9. Wet season, neap tide particle size distribution profile.
Transect A. Triangles denote location of each profiling cast.

South Fork

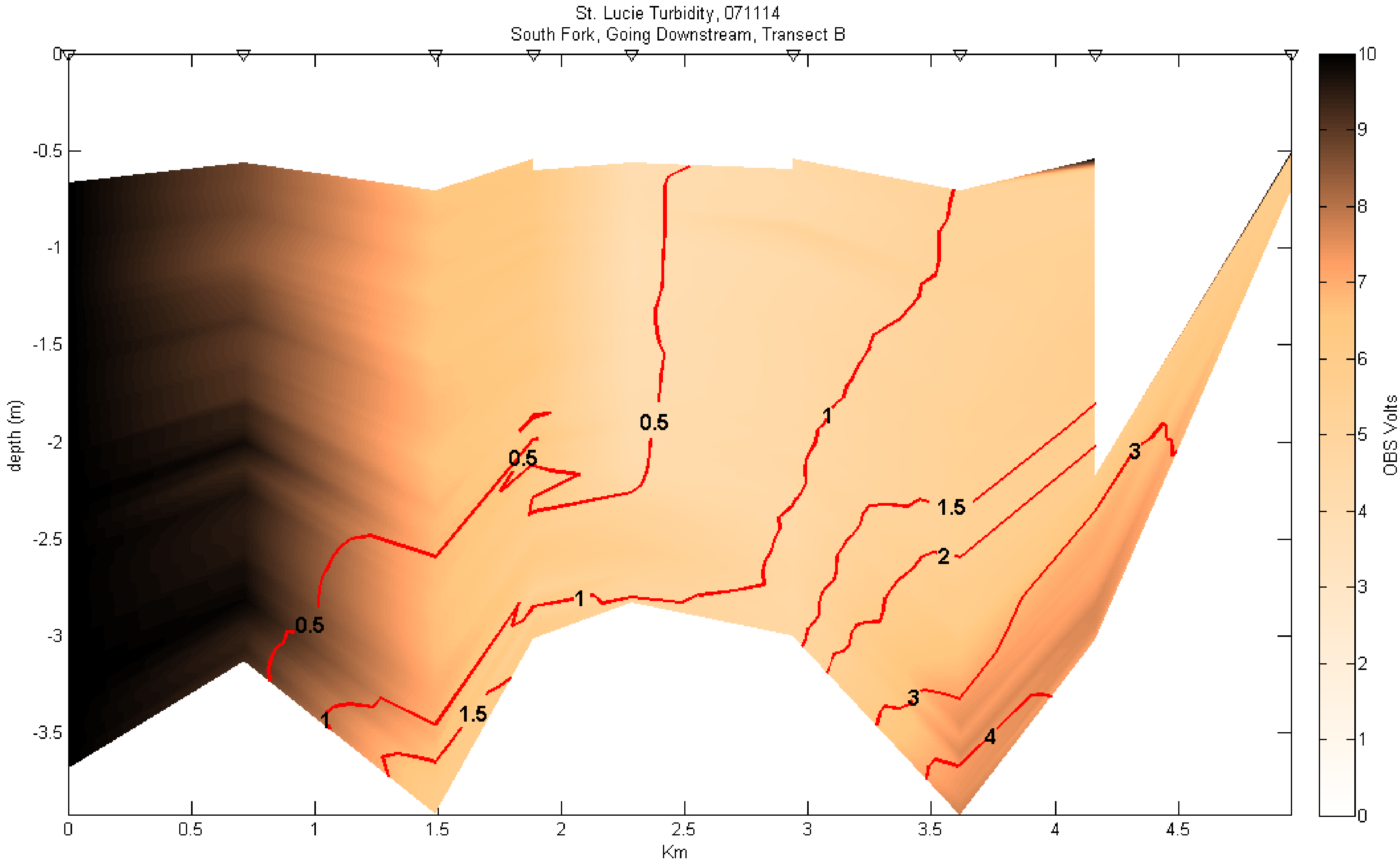


Figure WN13. Wet season, neap tide turbidity profile. Transect B. Red lines denote salinity contours.

South Fork

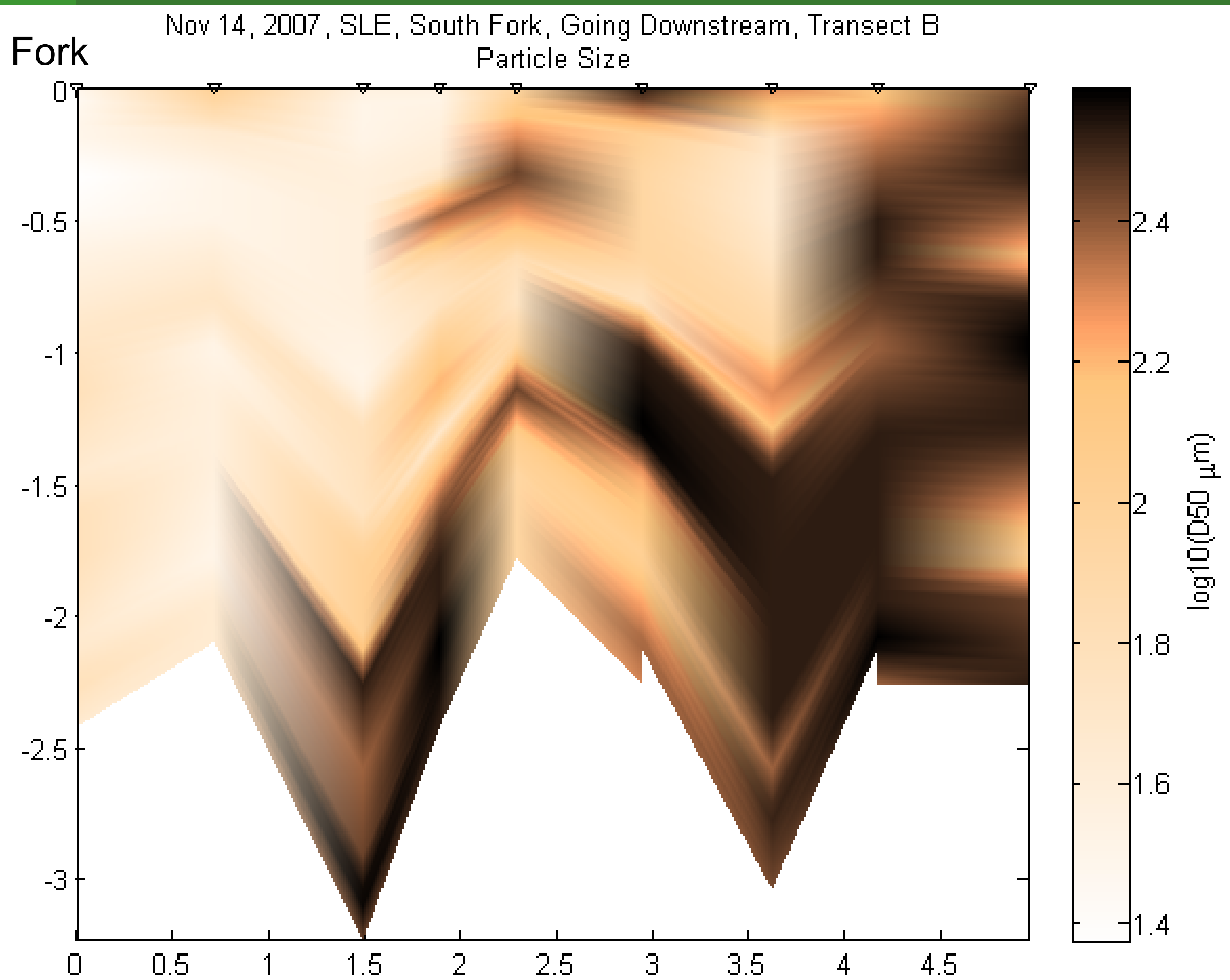


Figure WN17. Wet season, neap tide particle size distribution profile. Transect B. Triangles denote location of each profiling cast.

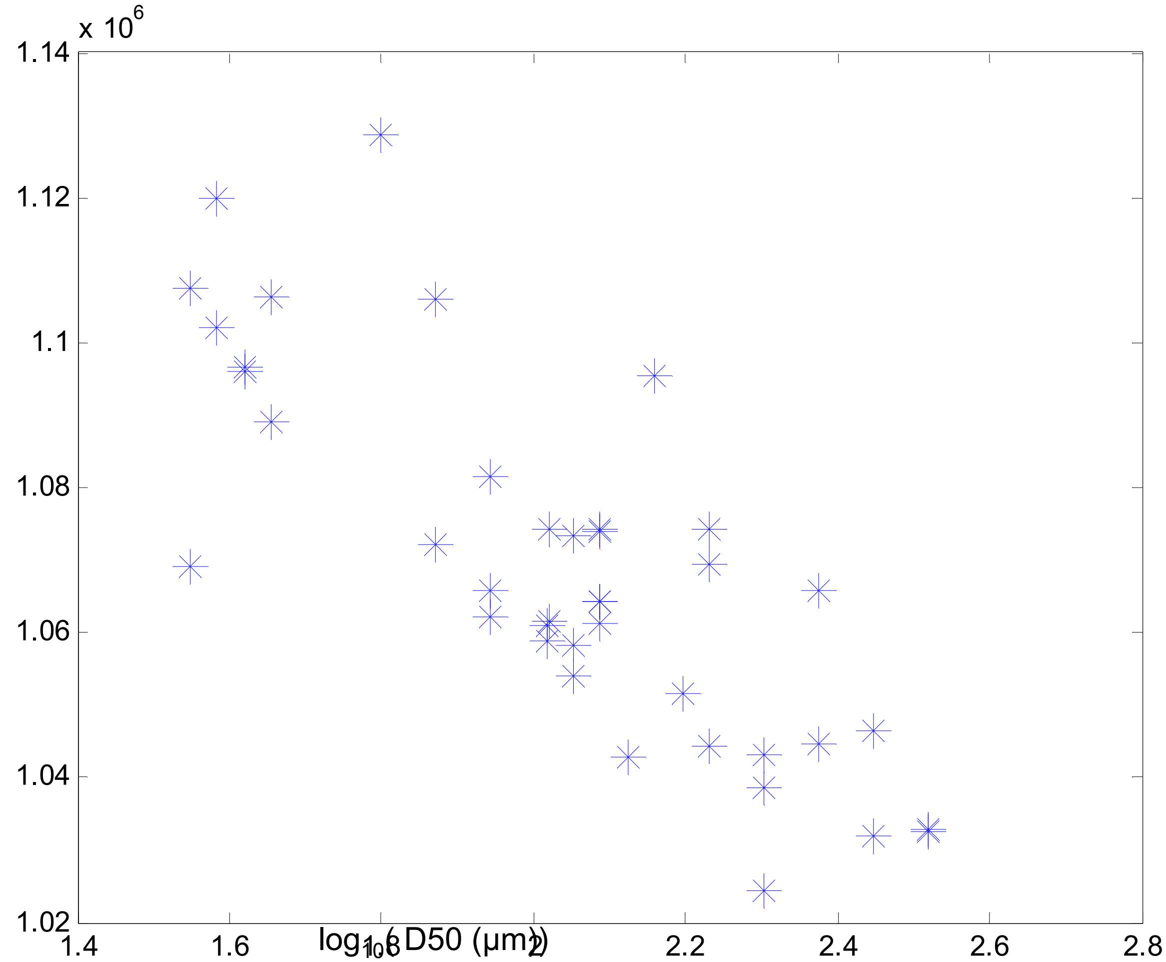


Figure WN43. Wet season, neap tide plot of estimated aggregate density by aggregate size.

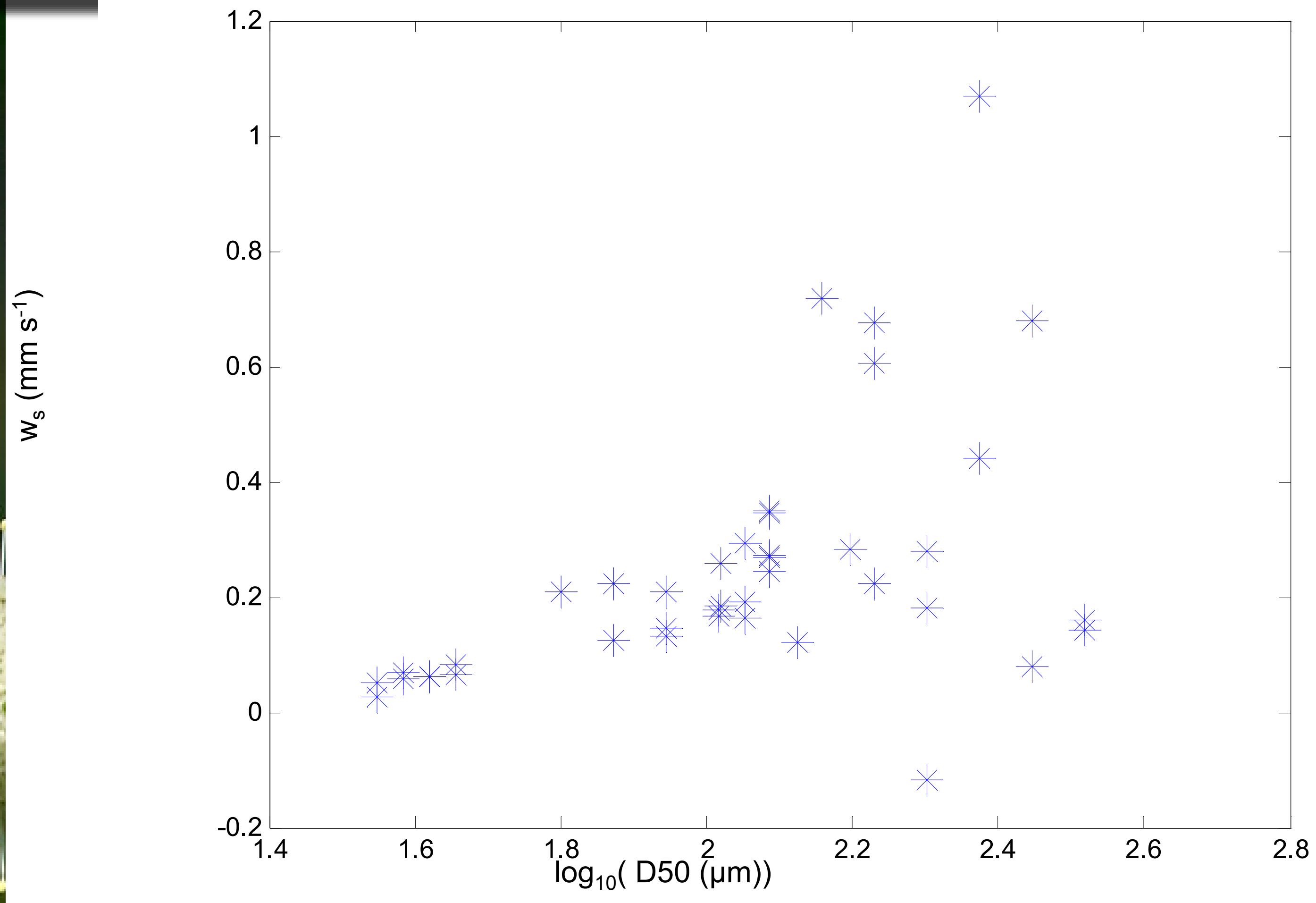


Figure WN44. Wet season, neap tide plot of estimated settling velocity by aggregate size.

Dry Neap

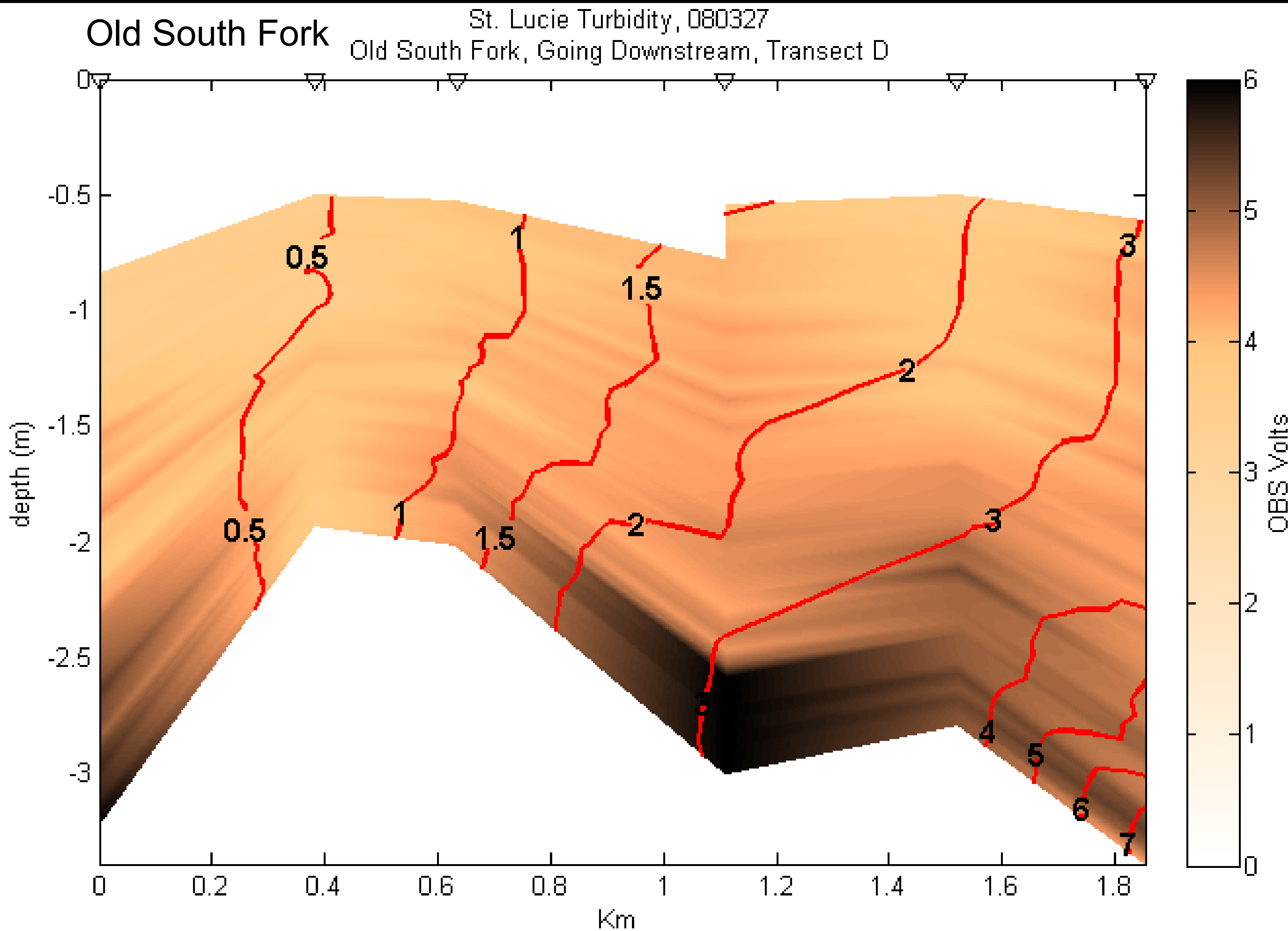


Figure DN29. Dry season, neap tide turbidity profile. Transect D. Red lines denote salinity contours.

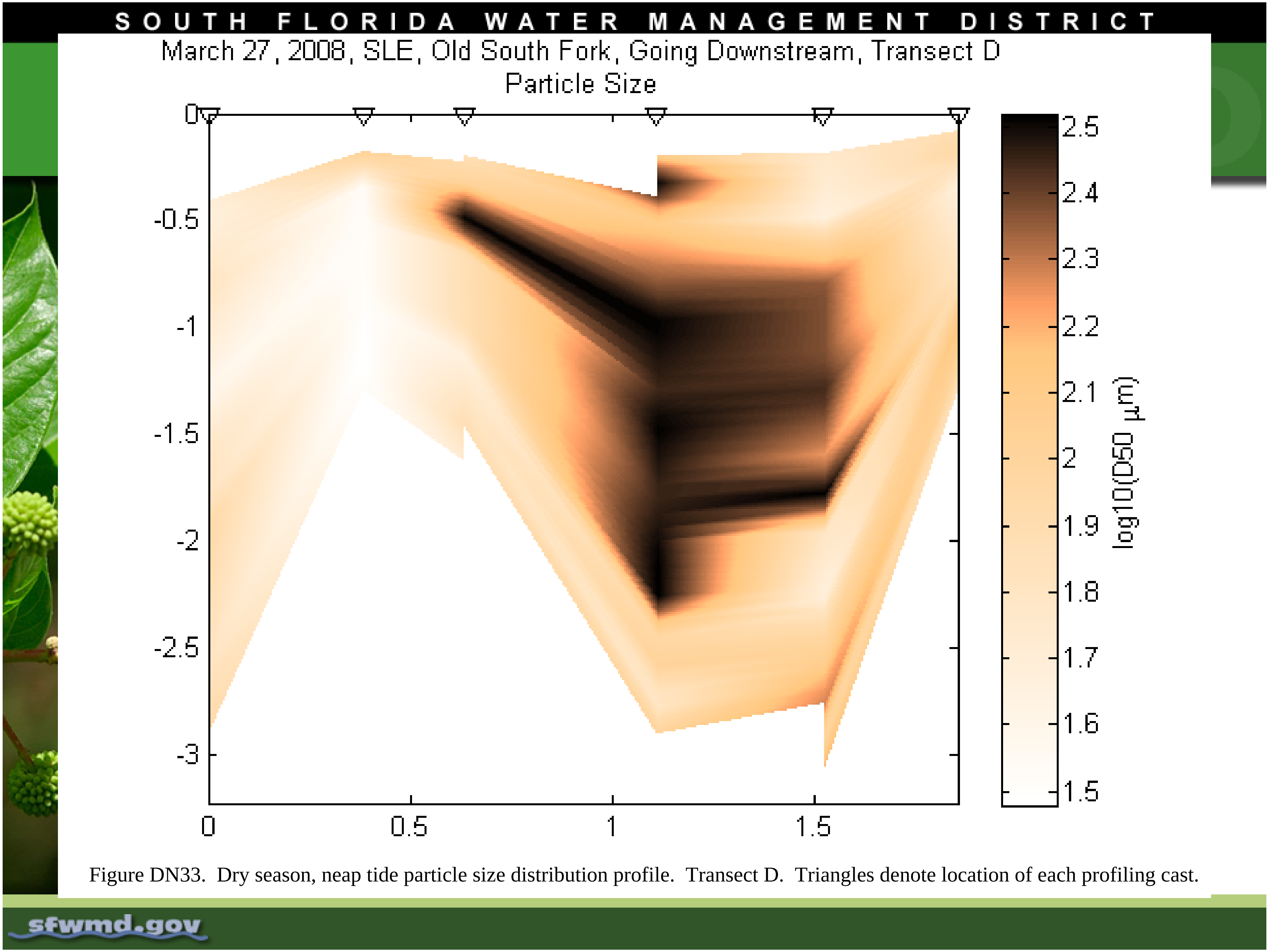


Figure DN33. Dry season, neap tide particle size distribution profile. Transect D. Triangles denote location of each profiling cast.

South Fork

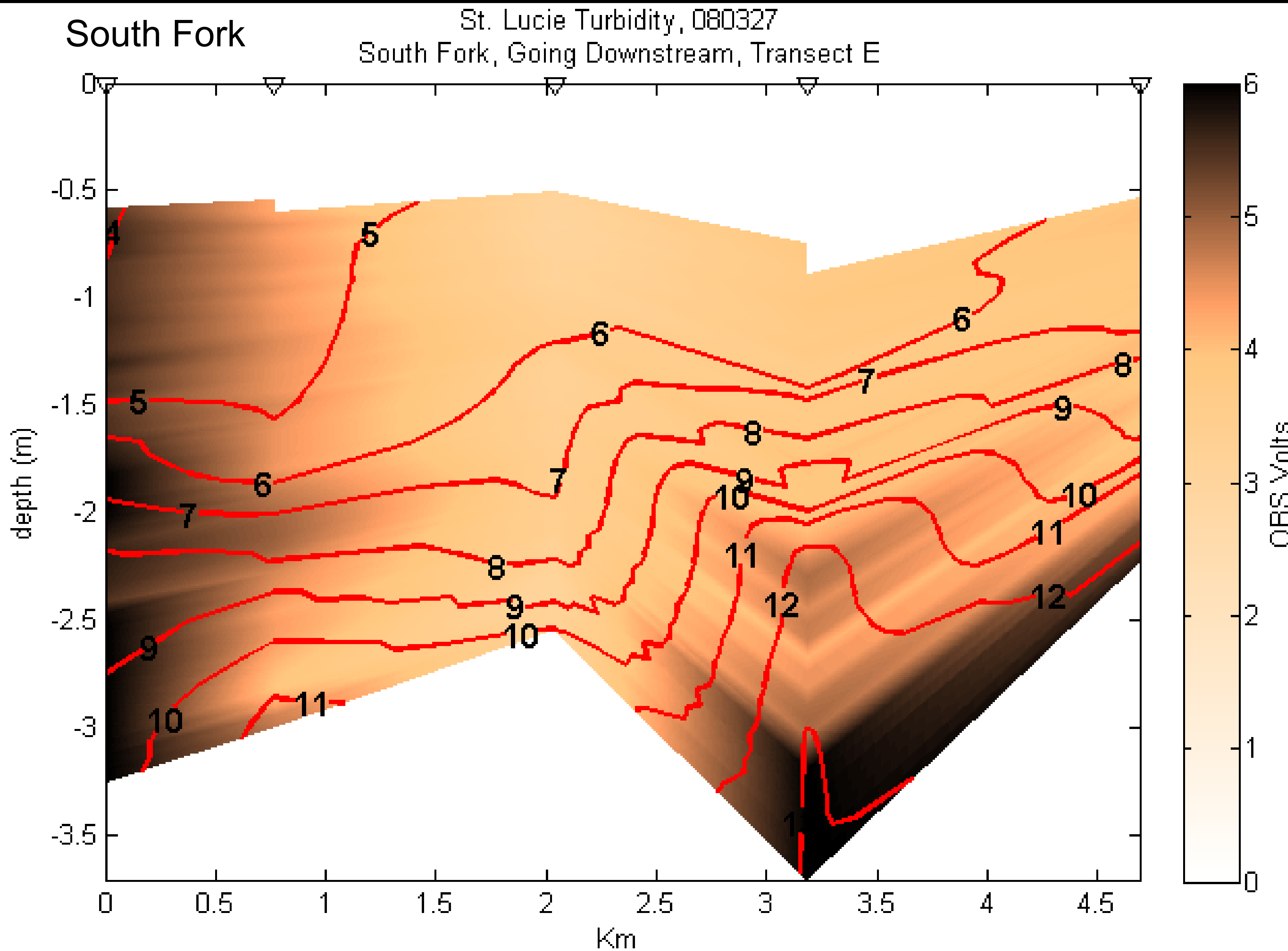


Figure DN37. Dry season, neap tide turbidity profile. Transect E. Red lines denote salinity contours.

Dry Spring

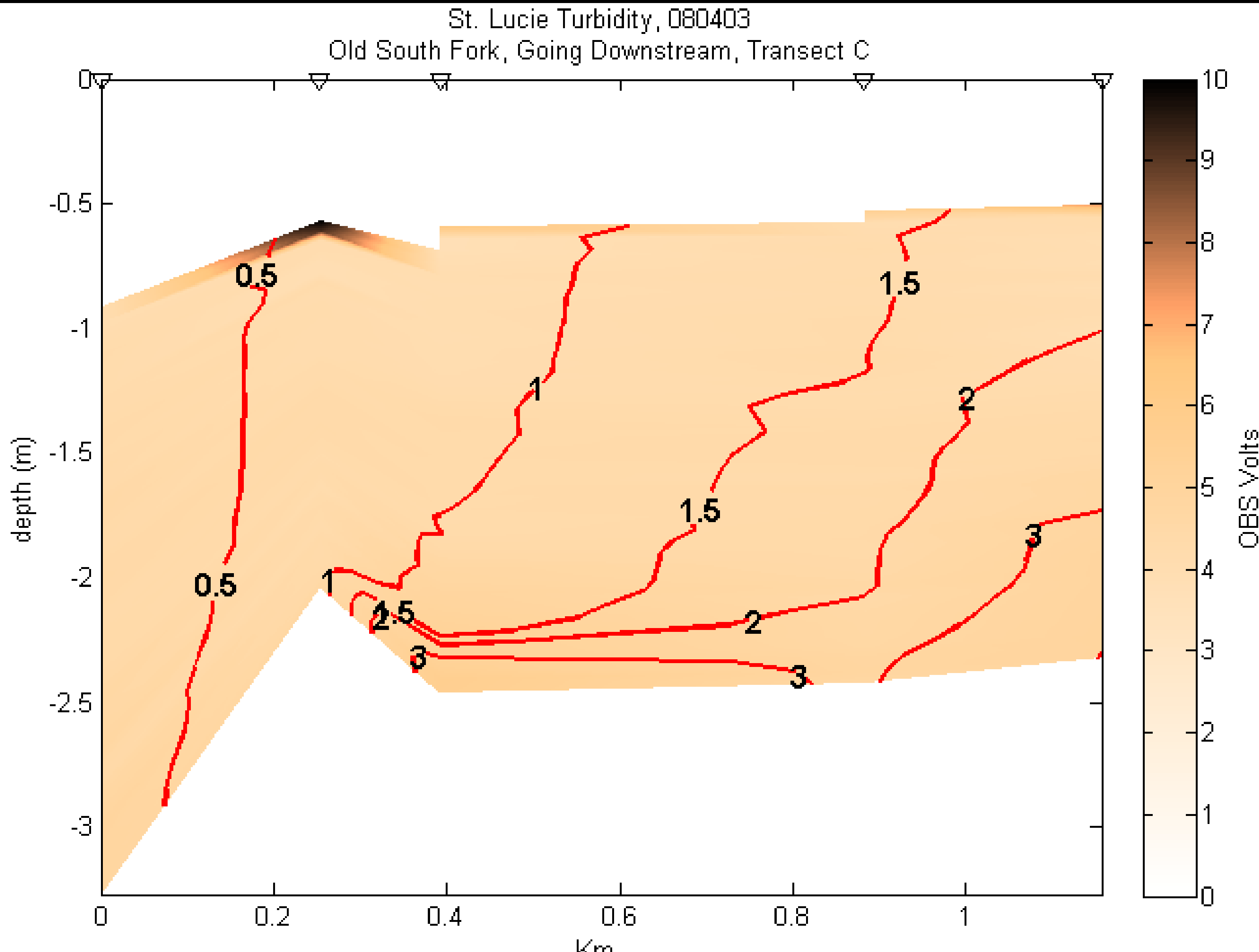


Figure DS21. Dry season, spring tide turbidity profile. Transect C. Red lines denote salinity contours.

Residual or Net Circulation

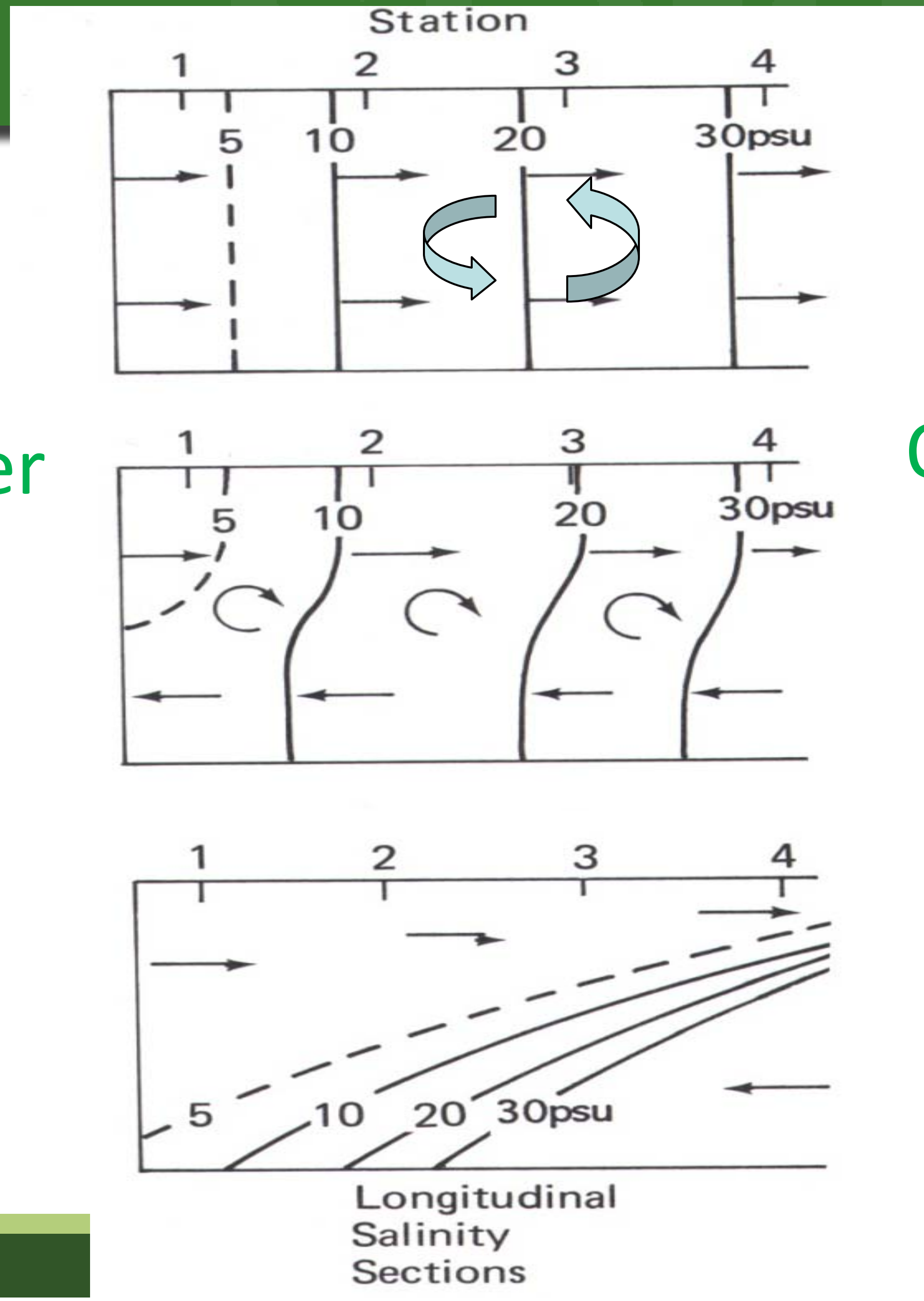
Well-mixed

Partially-mixed

Salt wedge

River

Ocean



Residual or Net Circulation Classification

Season	Tide	North Fork	South Fork	Old South Fork
Wet	Spring	Salt Wedge	Well Mixed	Well Mixed (fresh)
	Neap	Partially Mixed	Partially Mixed	Well Mixed (<1 ppt)
Dry	Spring	Partially Mixed	Strongly Stratified	Partially Mixed
	Neap	Partially Mixed	Strongly Stratified	Partially Mixed

Dissolved Oxygen

Chlorophyll *a*

Phaeophytin

North Fork, Partially Mixed

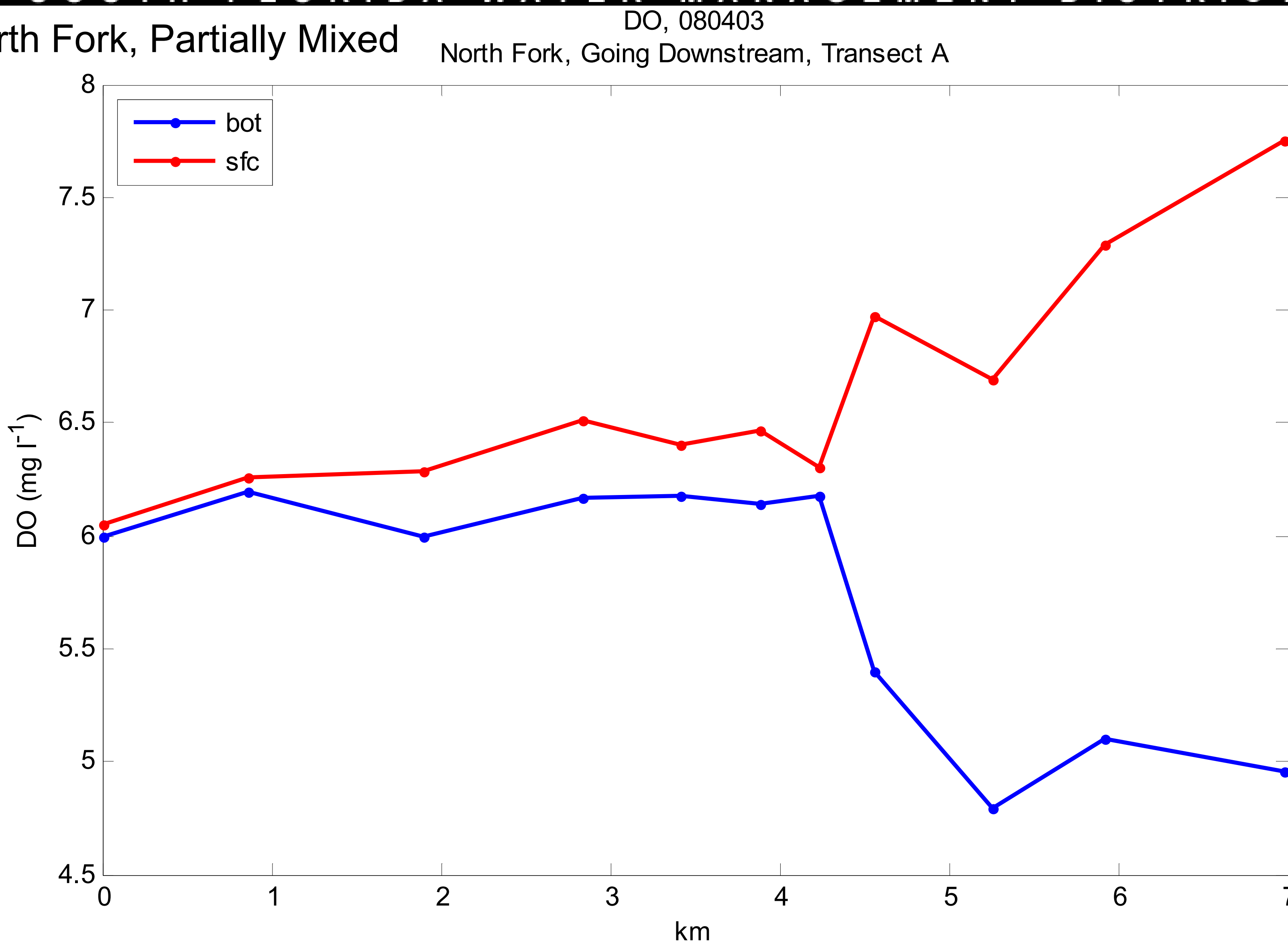


Figure DS6. Dry season, spring tide dissolved oxygen concentration profile. Transect A. Blue line denotes bottom values and red line denotes surface values.

S O U T H   F L O R I D A   W A T E R   M A N A G E M E N T   D I S T R I C T

North Fork, Salt Wedge condition

a)

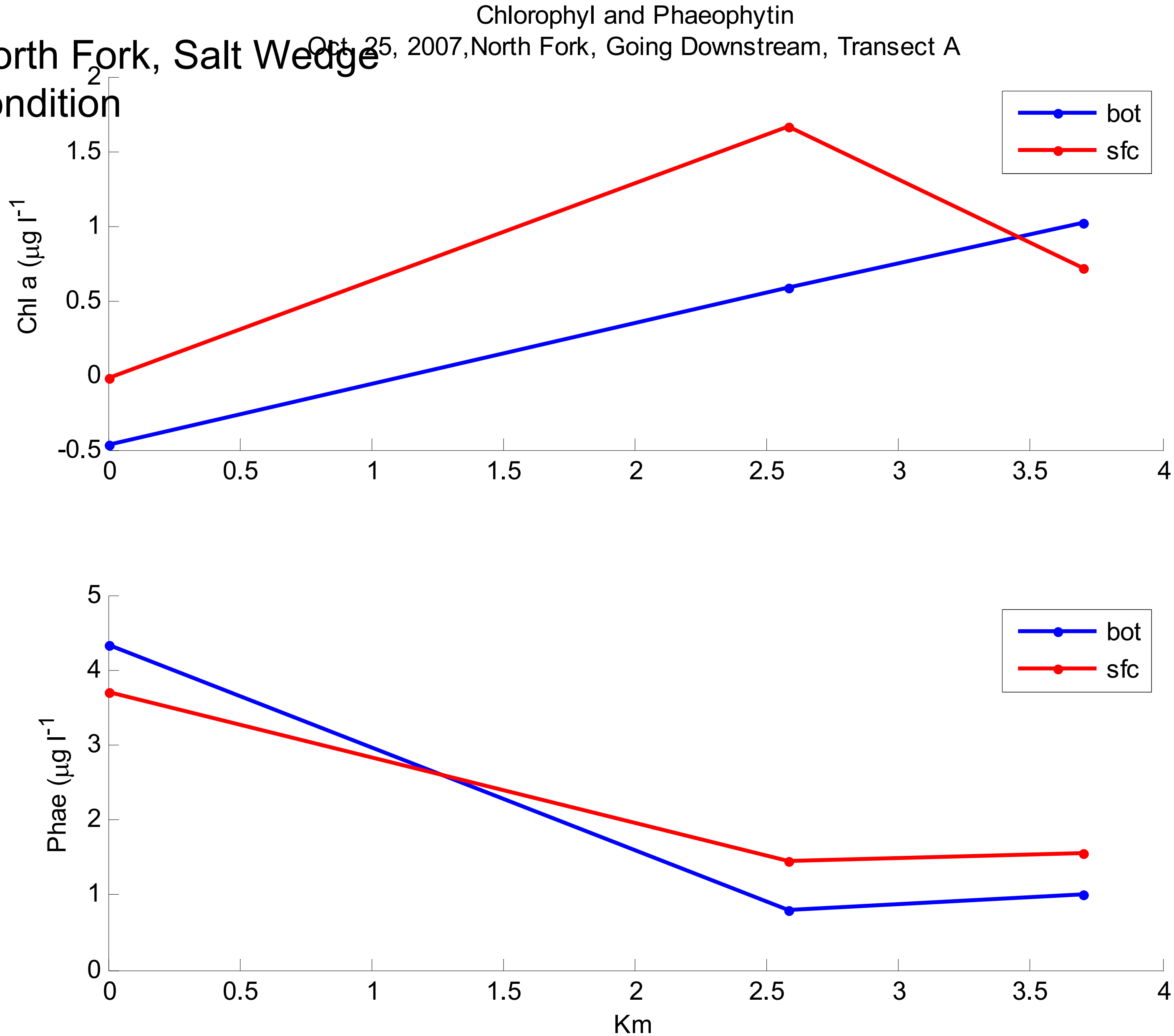


Figure WS9. Wet season, spring tide a) chlorophyll *a* and b) phaeophytin concentration profiles. Transect A. Blue line denotes bottom values and red line denotes surface values.

South Fork, Well mixed condition

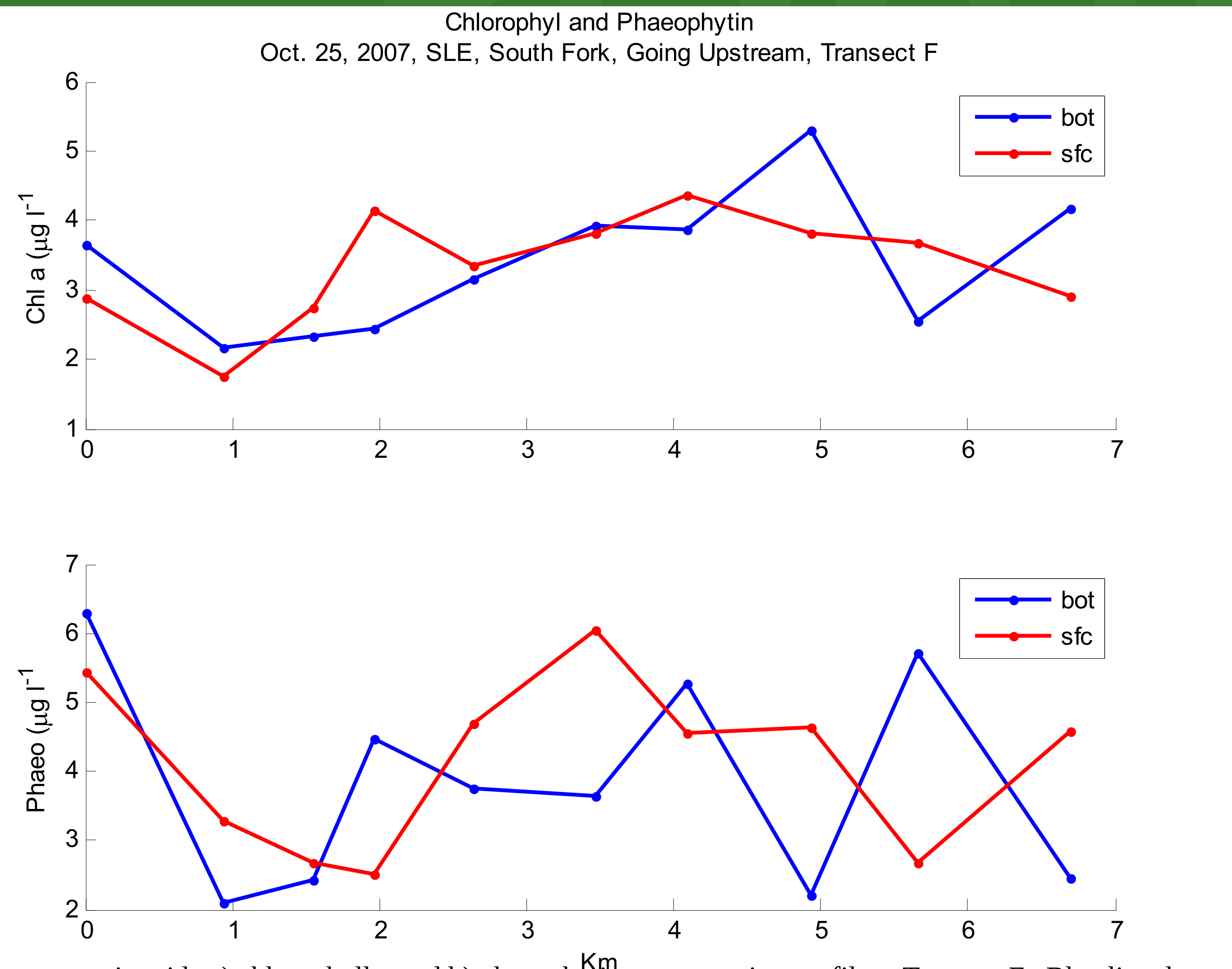


Figure WS48. Wet season, spring tide a) chlorophyll *a* and b) phaeophytin concentration profiles. Transect F. Blue line denotes bottom v and red line denotes surface values.

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130 R. J. Uncles and J. A. Stephens (1993)

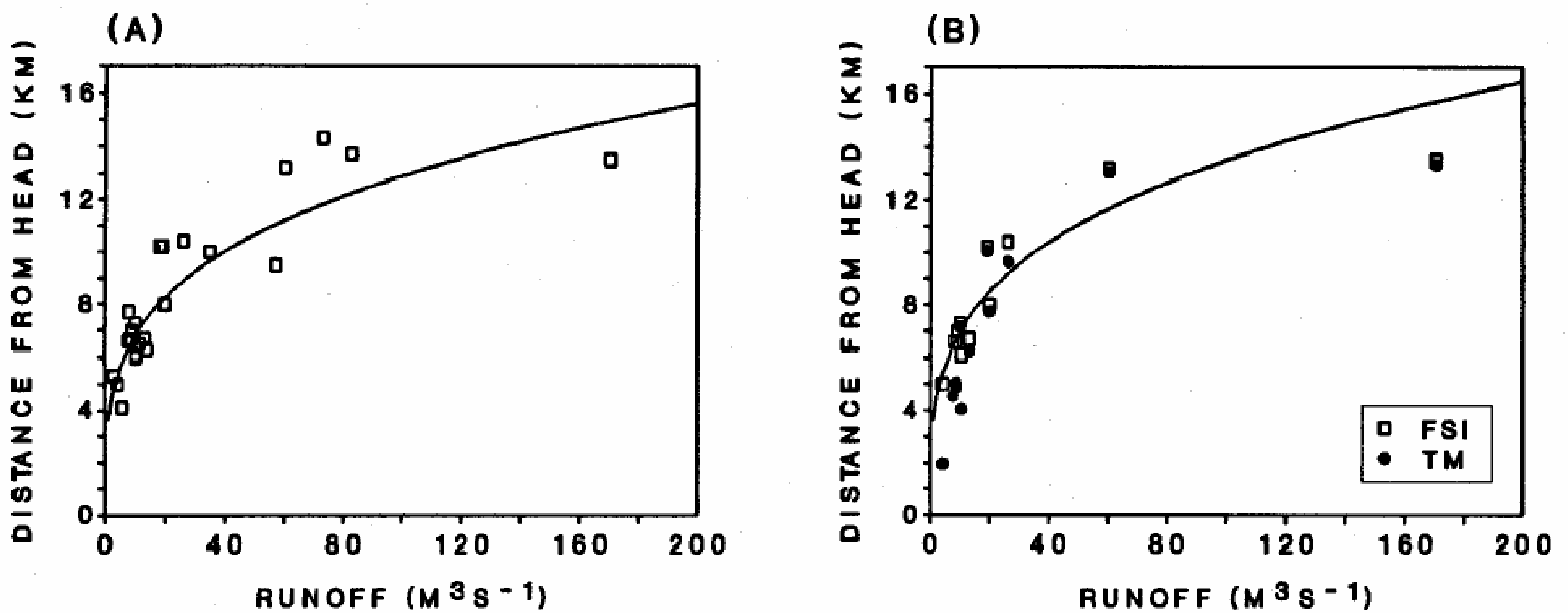

Fig. 4. Locations of the freshwater-saltwater interface (FSI) and turbidity maximum (TM). (A) Measured locations of FSI at high water during some spring and neap tides relative to the head (open squares, km) as functions of freshwater runoff, together with a curve describing the power-law regressional relationship. (B) As (A) but showing the measured locations of the FSI and the TM (black circles) at high water of spring tides.

Conclusions:

•The density structure in the North Fork usually resembled a partially mixed estuary, however, during strong tidal flow and freshwater discharge it more closely resembled a salt wedge

•The density structure in the South Fork varied from well and partially mixed during the wet season to strongly stratified during the dry season

•The Old South Fork was completely fresh during the wet season and partially mixed during the dry season

Conclusions, cont.:

- ETMs were found to be produced from convergence of barotropic and baroclinic flows at the extent of the salinity intrusion, and also in regions of strong longitudinal density gradients.

- ETMs were often found in the fresh well mixed regions of the estuaries and probably consisted of small, easily resuspended primary aggregates

- Estimated settling velocities were an order of magnitude smaller than in the Caloosahatchee River, probably related to the abundance of small primary aggregates in the freshwater regions

- The most significant variation in particle size is related to salinity

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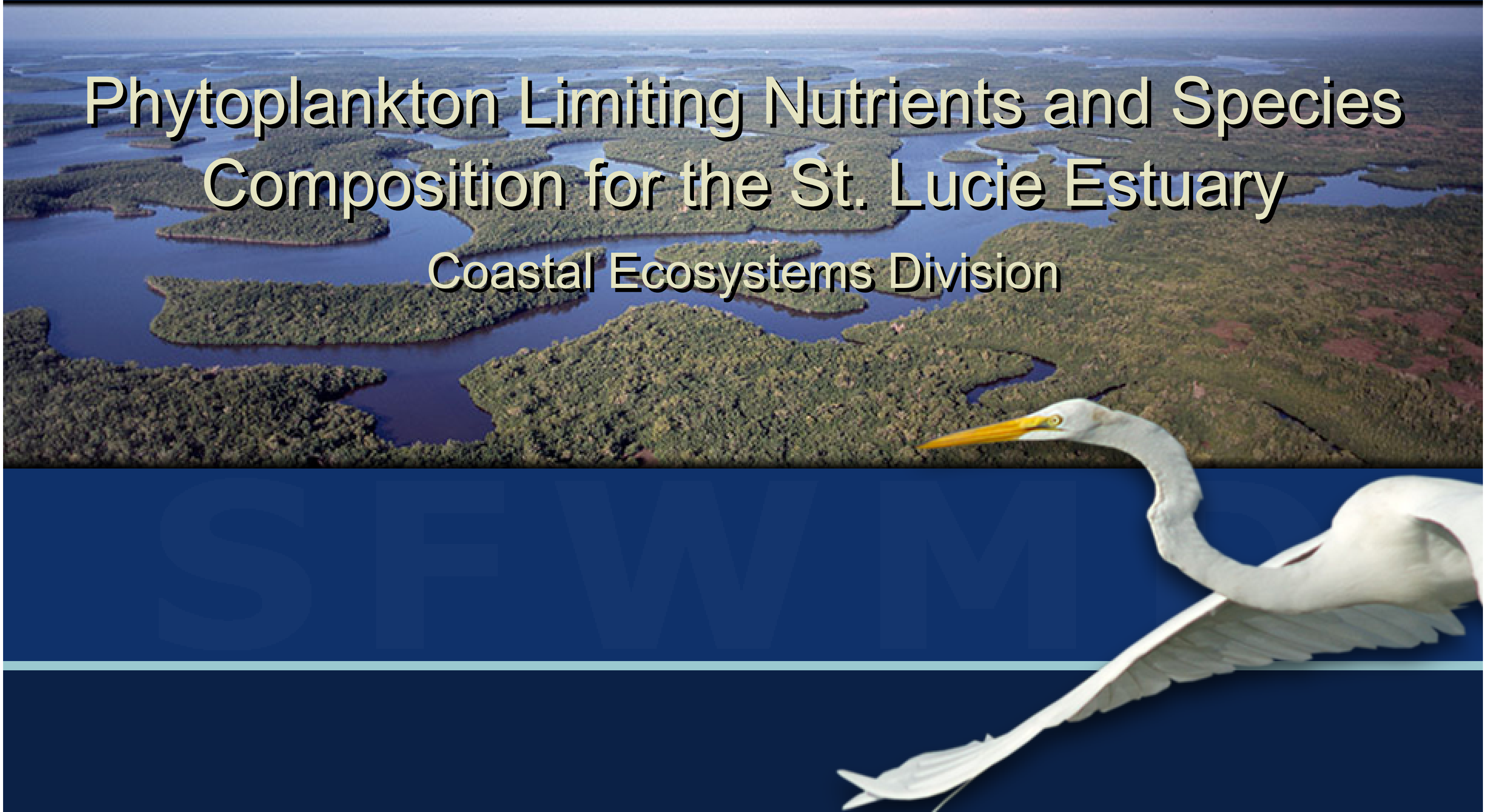


Phytoplankton Limiting Nutrients and Species Composition for the St. Lucie Estuary

Coastal Ecosystems Division

June 24, 2008

sfwmd.gov

Purpose

- The purpose of this study is to determine spatial and temporal patterns in the abundance and composition of the phytoplankton community in relation to nutrient elements (N, P, Si) and variability in salinity, temperature and light availability.
- In order to evaluate the potential responsiveness of the phytoplankton community to changes in nutrient load, the nutrient limiting status of the community was determined in controlled bioassay experiments.

Journal of Environmental Monitoring

Temporal and spatial variations of nutrients in the Ten Mile Creek of South Florida, USA and effects on phytoplankton biomass

Yuangen Yang,ab Zhenli He, Youjian Lin, Edward J. Phlips, Jinyan Yang, Guochao Chen,Peter J. Stoffellaa and Charles A. Powell

"Principal component analysis and the ratios of DIN/DP and TN/TP in the water suggest that N is the limiting nutrient factor for phytoplankton growth in the TMC"

IFAS Ten Mile Creek and North Fork Narrows Sampling Stations

St. Lucie Estuary Limiting Nutrient Sampling Locations

Methods

- The five sites were sampled for phytoplankton weekly from April 22 through September 28, 2007.
- Temperature, DO, and salinity were measured at the surface and near the bottom at each site.
- Light attenuation was determined by measuring light flux at depth intervals with quantum PAR probes (Li-cor).
- Water samples for chemical and phytoplankton analysis were collected with a vertical integrating sampling tube that captures water from the surface to within 0.1 m of the bottom

Methods (Cont.)

- Nutrient limitation/growth bioassay experiments for phytoplankton were performed on a monthly basis for the five specified sampling sites.

Mean (yellow) and Standard Deviations (white) of Nutrient Concentrations

	Site				
	7	8	9	10	11
TN	0.968	1.074	0.859	0.632	0.538
	(0.325)	(0.290)	(0.271)	(0.249)	(0.215)
NO2,3	0.032	0.045	0.040	0.022	0.021
	(0.041)	(0.049)	(0.042)	(0.025)	(0.025)
NH4	0.125	0.241	0.183	0.122	0.060
	(0.148)	(0.297)	(0.151)	(0.053)	(0.037)
TP	0.208	0.218	0.183	0.095	0.044
	(0.057)	(0.048)	(0.056)	(0.041)	(0.029)
SRP	0.153	0.160	0.131	0.062	0.021
	(0.056)	(0.044)	(0.055)	(0.033)	(0.018)
Si	1.64	2.21	1.67	1.02	0.59
	(1.09)	(1.21)	(0.63)	(0.23)	(0.26)

Mean (yellow) and Standard Deviation. (white)

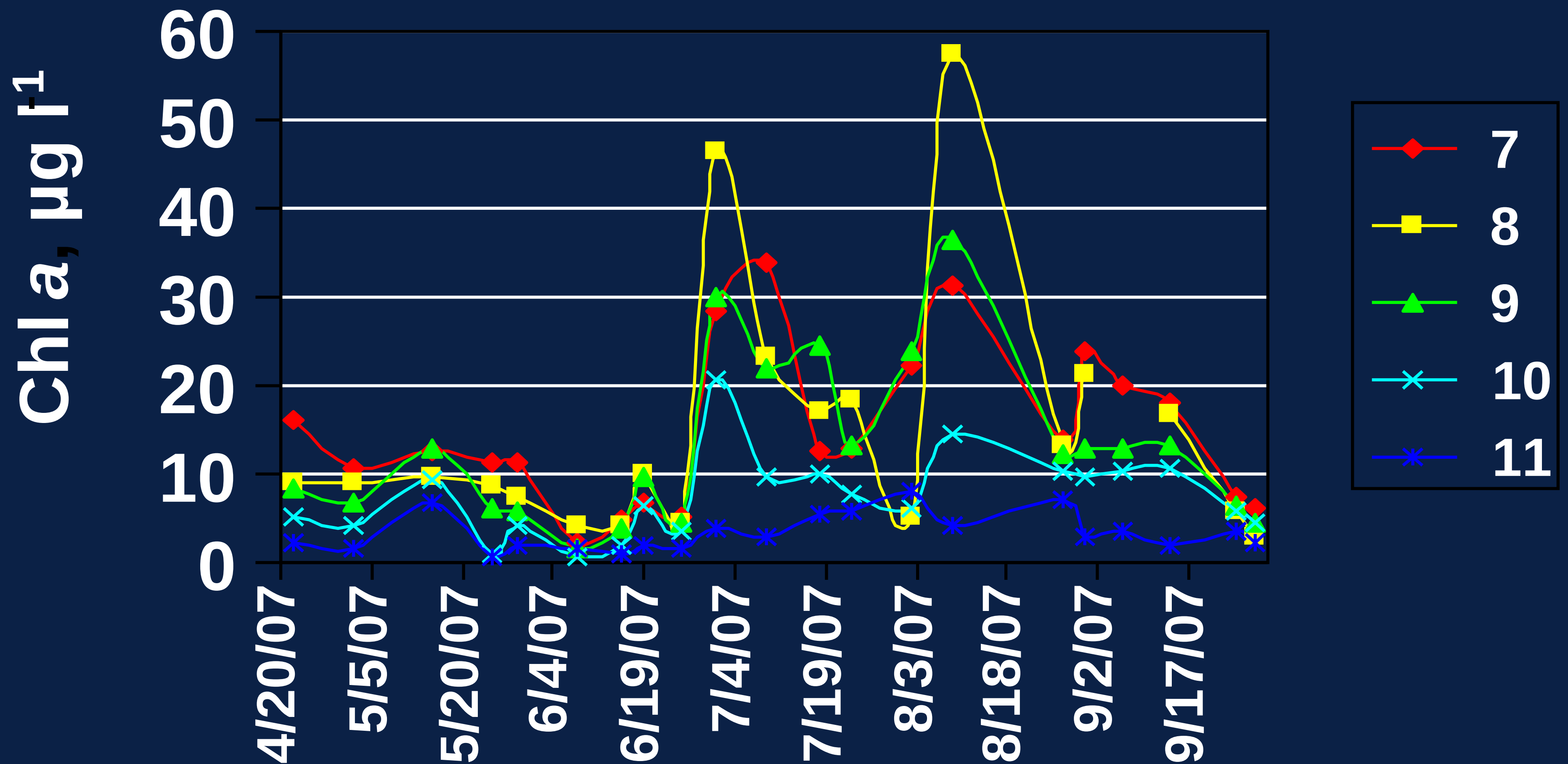
	Site				
	7	8	9	10	11
CHLa	14.55	14.69	12.95	7.46	3.37
	(9.10)	(14.18)	(9.33)	(4.70)	(2.10)
TURB	7.46	10.55	10.35	7.40	5.60
	(3.25)	(3.93)	(6.93)	(3.43)	(2.11)
CDOM	63.7	75.2	53.6	32.1	13.7
	(40.1)	(47.4)	(33.3)	(22.2)	(6.9)
Ke	2.852	3.487	3.104	2.381	1.375
	(0.971)	(1.139)	(0.902)	(0.908)	(0.763)
SECCHI	0.61	0.77	0.62	0.86	1.57
	(0.31)	(1.03)	(0.27)	(0.25)	(0.82)

Results of Limiting Nutrient Bioassays

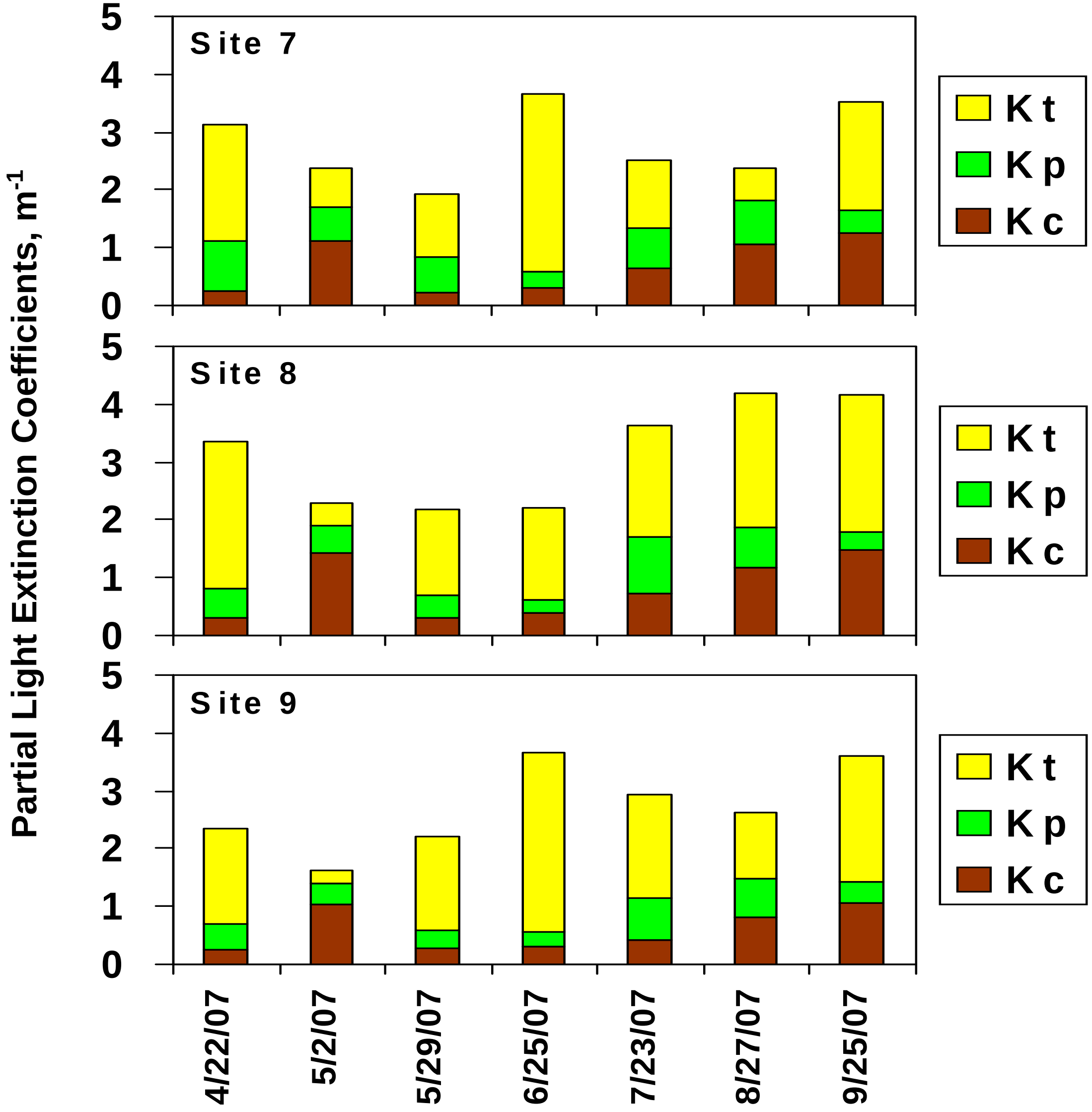
- Sites

Date	7	8	9	10	11
5/2/2007	N	N	N	U	NP
	Si		*Si*	*N*	
5/29/2007	N	U	N	N	NP
		N		*Si*	*Si*
6/25/2007	N	U	U	N	NP
	P	*N*	*N*		
7/23/2007	N	U	U	U	U
		N	*N*	*N*	*NP*
8/27/2007	U	U	U	U	P
	N	*N*	*N*	*N*	*Si*
9/25/2007	U	U	U	U	U
	N	*N*	*N*	*N*	*NSi*

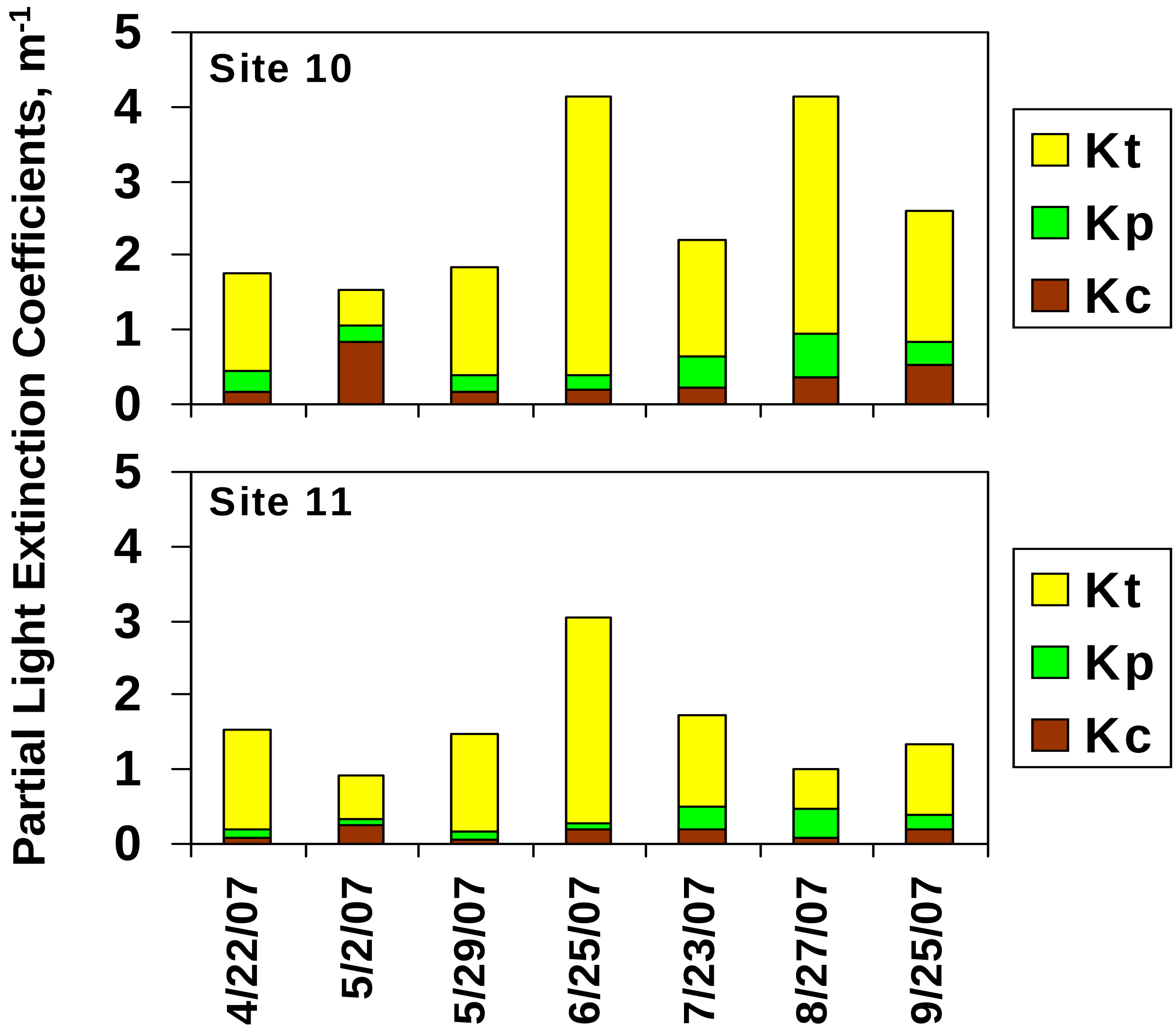
Chlorophyll *a* (Chl) concentrations over the study period at the five sampling sites.



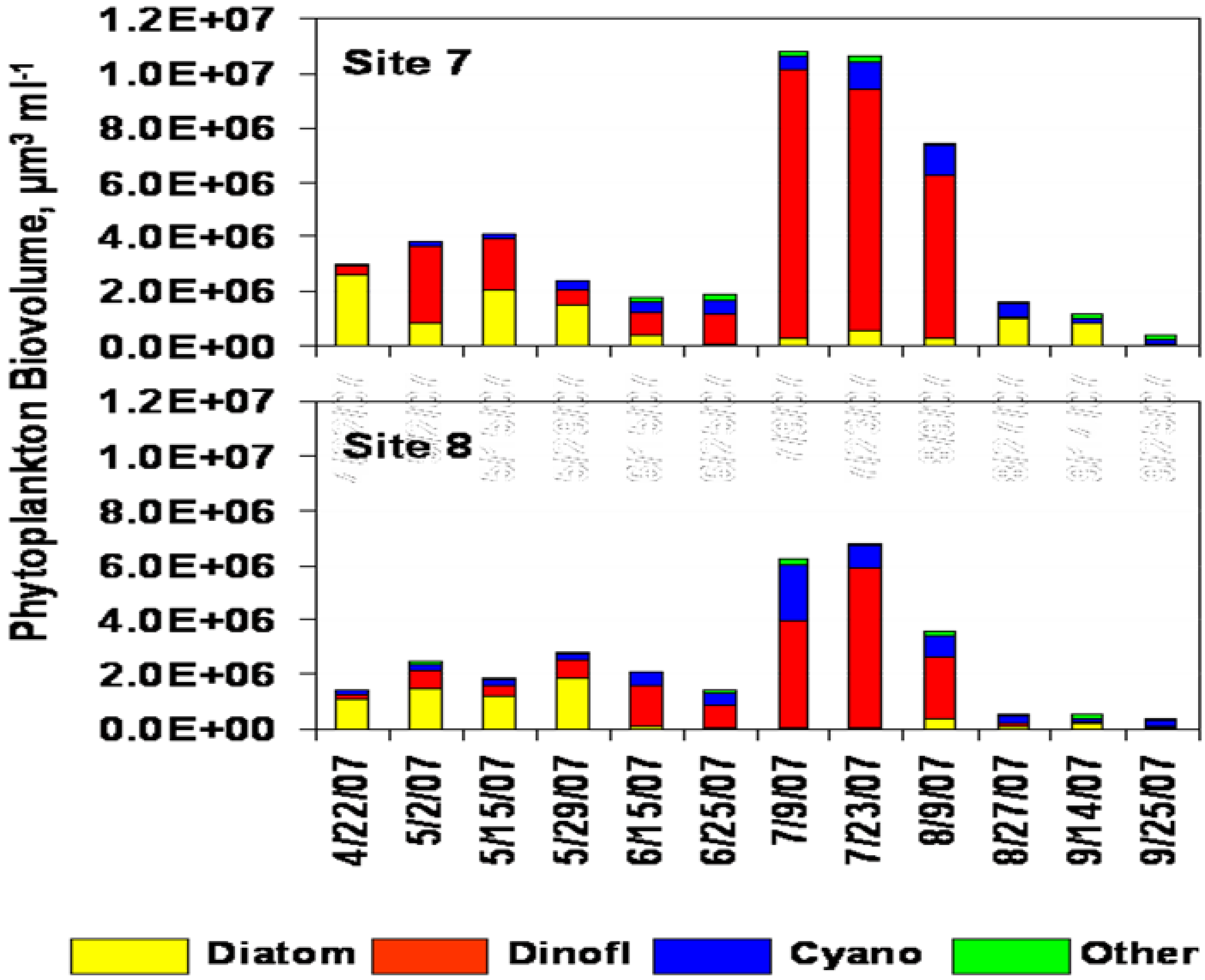
Partial light extinction coefficients: Kc represents the contribution of colored dissolved organic matter (CDOM), Kp represents the contribution of phytoplankton, and Kt represents the contribution of non-algal suspended solids



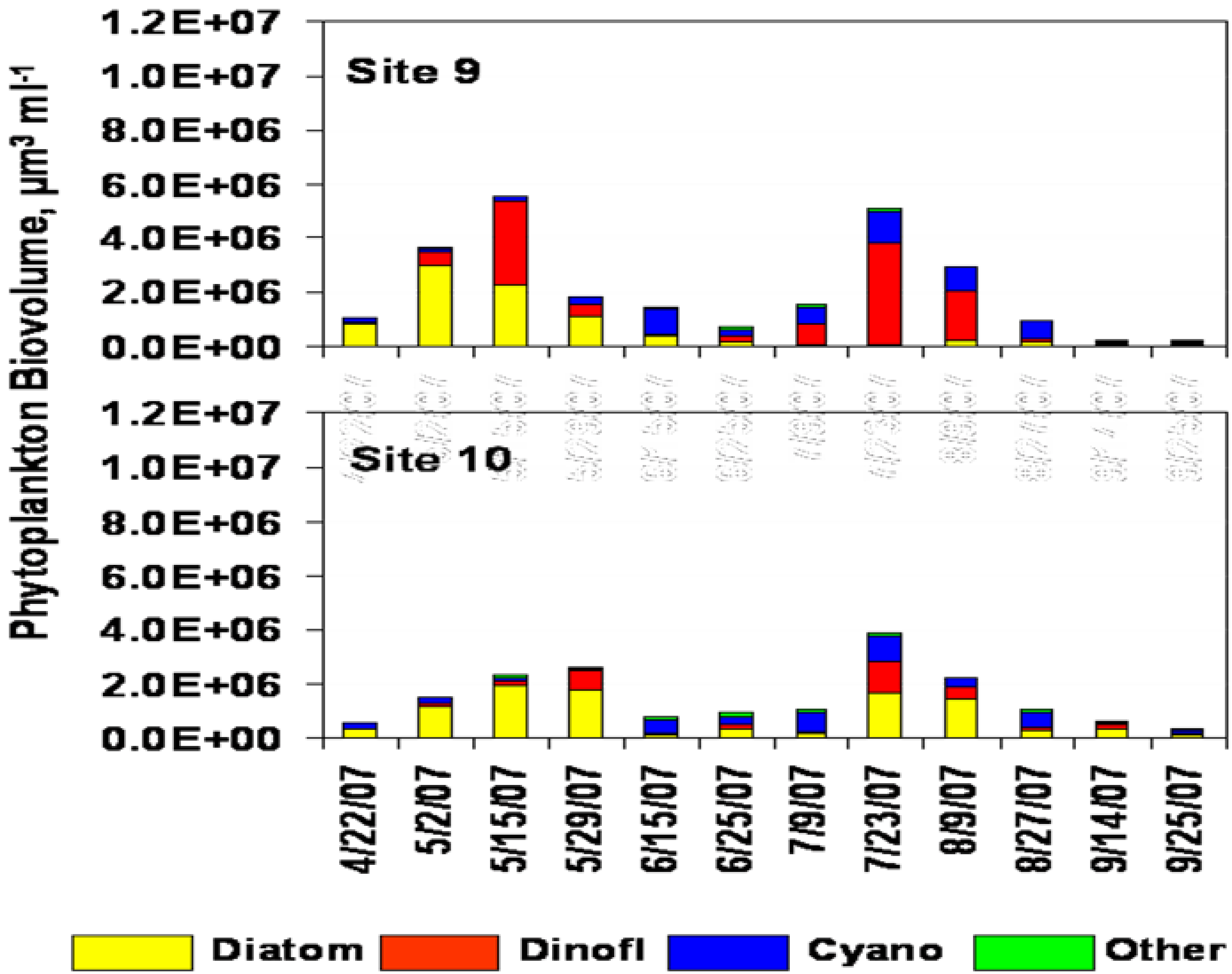
Partial light extinction coefficients: Kc represents the contribution of colored dissolved organic matter (CDOM), Kp represents the contribution of phytoplankton, and Kt represents the contribution of non-algal suspended solids



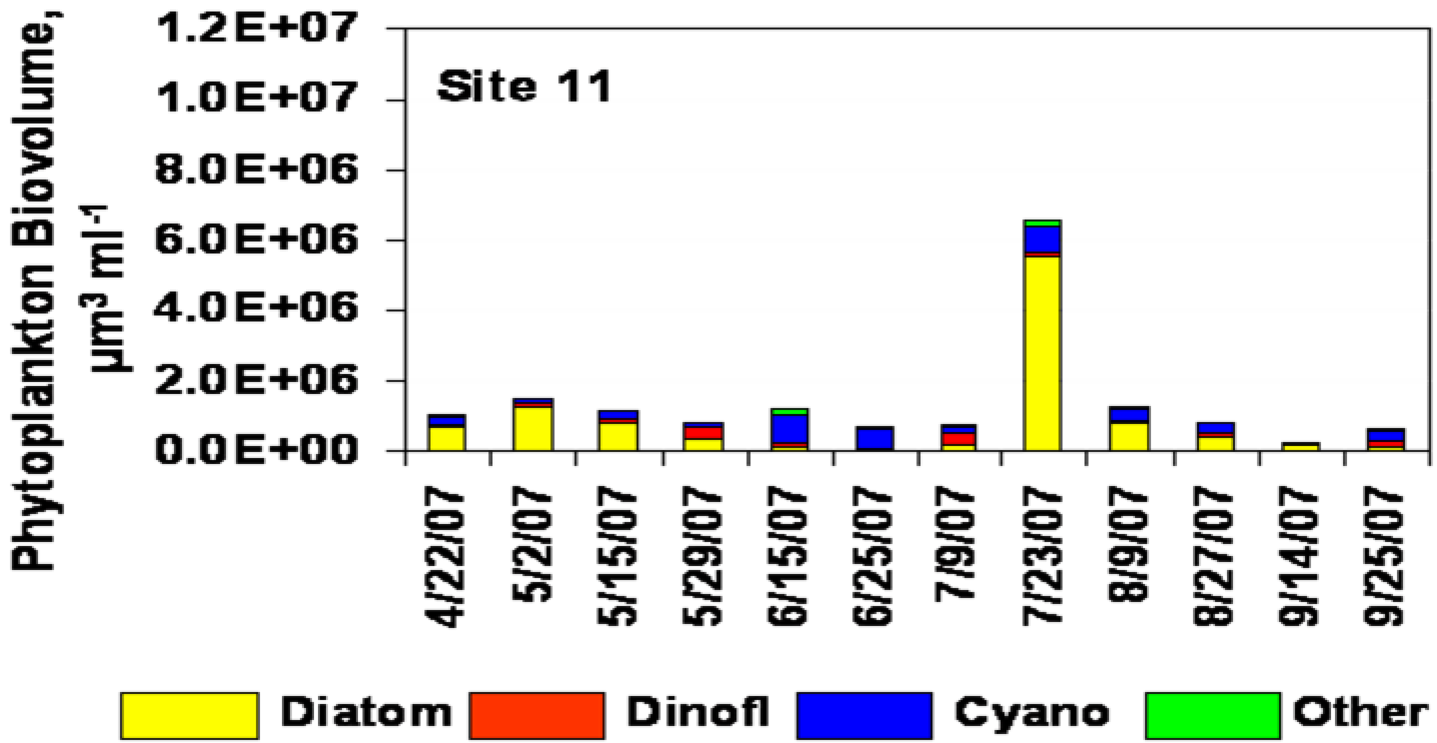
Biovolume of major algal groups over the study period at the five sampling sites. Diatoms, dinoflagellates, cyanobacteria



Biovolume of major algal groups over the study period at the five sampling sites. Diatoms, dinoflagellates, cyanobacteria



Biovolume of major algal groups over the study period at the five sampling sites. Diatoms, dinoflagellates, cyanobacteria



Status of Project

Samples were collected from October 2007 to May 2008

Data presently being compiled and will be incorporated into Northern Everglades St. Lucie Estuary Plan

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St. Lucie River Watershed Research and Water Quality Monitoring Plan Research Projects

June 24, 2008

St. Lucie Research Projects

- Nutrient Budget
- Dissolved Oxygen Dynamics
- Low Salinity Zone - Nursery Function

St. Lucie
#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 St. Lucie Estuary.
- Terms in the nutrient budget will be determined by a variety of methods: Input, Cycling, Output.

St. Lucie
#1 Estuarine Nutrient Budget

Estuarine Nutrient Budget - Nitrogen

Inputs

- Structures S-80, S-48, S-49, Gordy Road
- Tidal Basin
  - Surface Flows
  - Ground Water
  - Point Sources
- Atlantic Ocean
- Atmospheric Deposition
- Nitrogen Fixation

Cycle

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

Outputs

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

St. Lucie
#1 Estuarine Nutrient Budget

INPUTS

Structures……………	Data Available (could be better)
Tidal Basin -	
Surface Flows…..	Modeling Project (Storm Water Event data needed)
Ground Water…..	Modeling Project (data analyses needed)
Atlantic Ocean…………….	Modeling Project
Atmospheric Deposition….	Data Available
Nitrogen Fixation………..	New Measurements

St. Lucie
#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

St. Lucie
#1 Estuarine Nutrient Budget

OUTPUTS

Denitrification…………..	Some Data Exist/ Need More
Export to Ocean………..	Modeling Project
Burial in Sediments……..	Some Sedimentation Rate Data Exist
Biomass	
Migration………	Data????
Harvesting…….	Data ???

St. Lucie
#2 Dissolved Oxygen Dynamics

- In order to determine if proposed TMDLs for nutrients will improve DO concentrations in the St. Lucie Estuary it is necessary to identify the important factors that control dissolved oxygen and how they interact to exert that control.
- The St. Lucie 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.

St. Lucie
#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

St. Lucie
#2 Dissolved Oxygen Dynamics

SOURCES

Aeration…………………	No data – Literature Value/ Model
Watershed Load..……..	Need Measurements, Watershed Model Available
Oceanic Load………….	Need Concentrations, 3D Model Needs Calibration
Photosynthesis……….	Need Measurements

PHYSICS

Transport………..	Hydrodynamic Model Available
Mixing…………….	Hydrodynamic Model Available
Stratification……	Hydrodynamic Model Available

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

St. Lucie
#3 Low Salinity Zone

- One of the goals of the St. Lucie River Watershed Protection Plan is to minimize the occurrence of undesirable salinity ranges in the St. Lucie 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 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 St. Lucie Estuary.
- Results of this study will be used to refine flow and salinity envelopes and to provide guidelines for delivery of freshwater to the St. Lucie Estuary.

St. Lucie
#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, Spawning
Benthic Fauna

St. Lucie
#3 Low Salinity Zone

SOURCES

Riverine Load………….	Need Measurements, Watershed Model Available
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, Spawning Benthic	Measure Time Series Along Salinity Gradient

St. Lucie Research Projects

Proposed Three Year Projects (Rough Annual Cost Estimate)

- **Watershed load - $150,000**
  - Measurement at Structures
  - 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, Algal Blooms
- **Biomass - $100,000**
  - Phytoplankton, Chl-a, 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 Ocean, Physics, Stratification, Transport, Mixing, Sediment Resuspension.