Coastal Monitoring Network to Study Effects of Climate Change

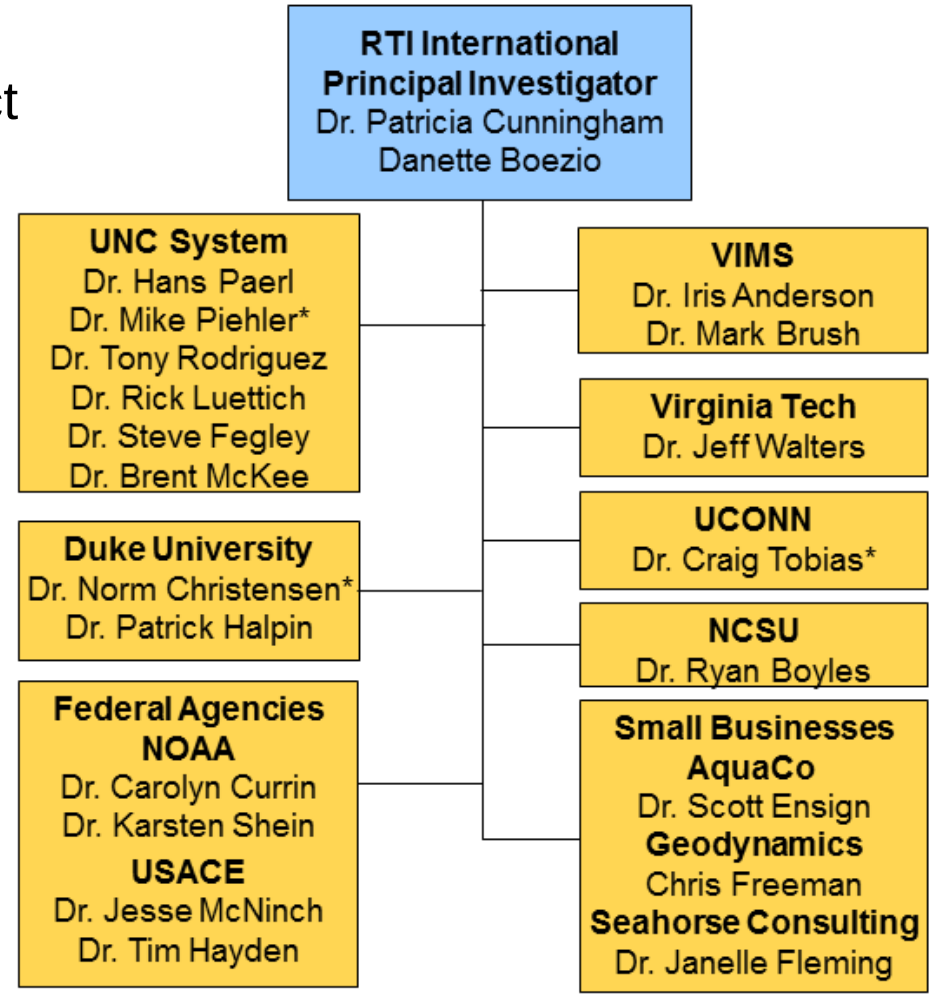
Defense Coastal/Estuarine Research Program (DCERP2)

April 2014

Kim Matthew

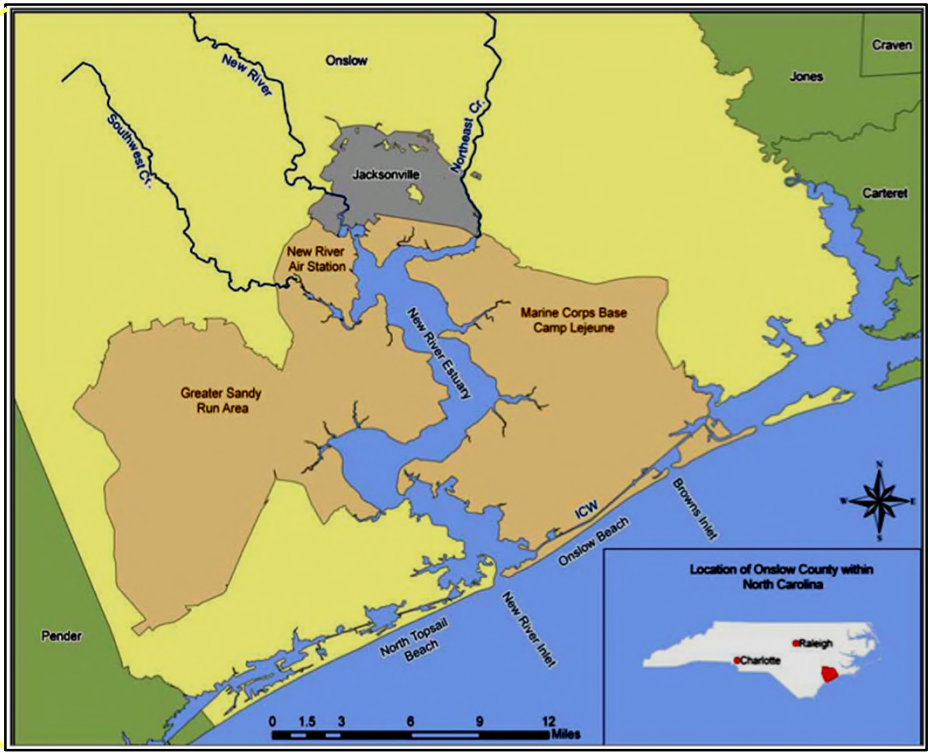
Program Overview

- 10-year, $24-million contract
  - DCERP1: 2006-2012
  - DCERP2: 2013-2017
- RTI is leading a multi-disciplinary team of researchers
  - 6 universities
  - 2 federal agencies
  - 3 small businesses



DCERP2 Team

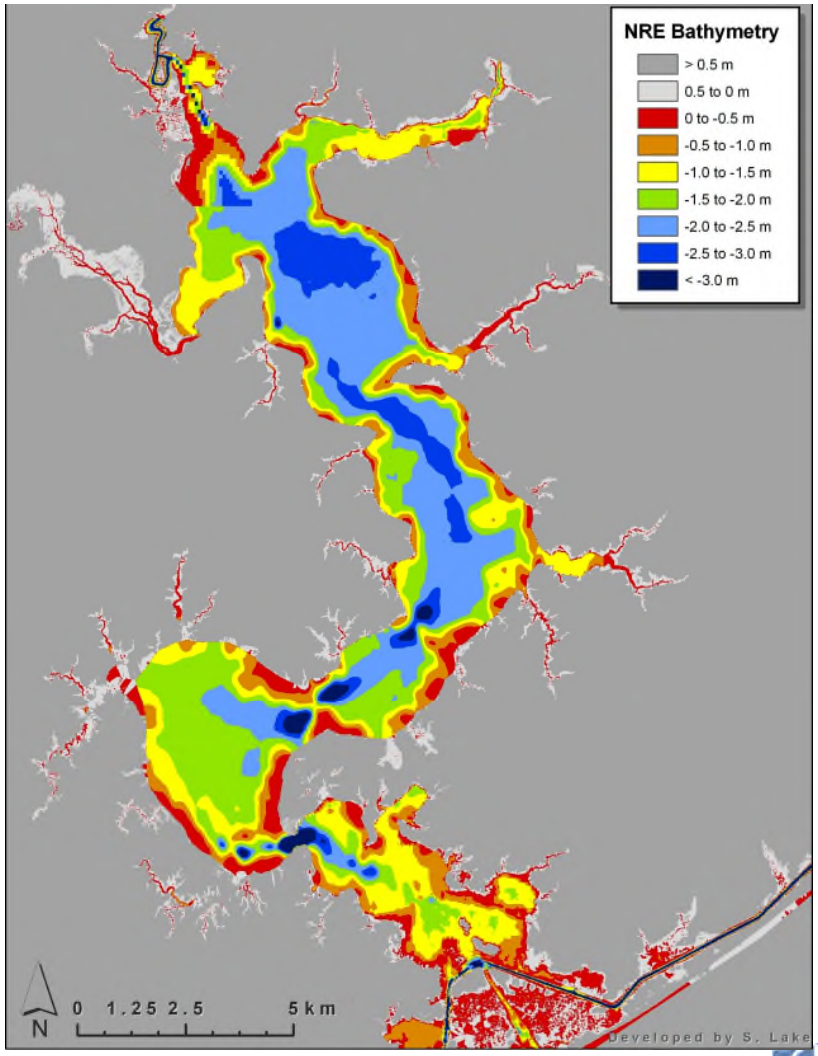
Location



Marine Corps Base Camp Lejeune, North Carolina

New River Estuary

- Relatively small (88 km^2)
  - 32 km long by 3 km wide (max)
- Semi-lagoonal with a flushing time of ~70 days
- Shallow estuary with 56% of the water column depth ≤ 2 meters
- Highly sensitive to nutrient inputs, periodic phytoplankton blooms and periods of seasonal bottom water hypoxia
- Land use
  - Agricultural in upper watershed
  - Urban near head of estuary
  - Forest surrounding estuary



Bathymetry of the New River Estuary

Climate Change Objective

Determine how ecosystem processes respond to climate change to understand the resiliency and adaptive capacity of the ecosystem.

Warming

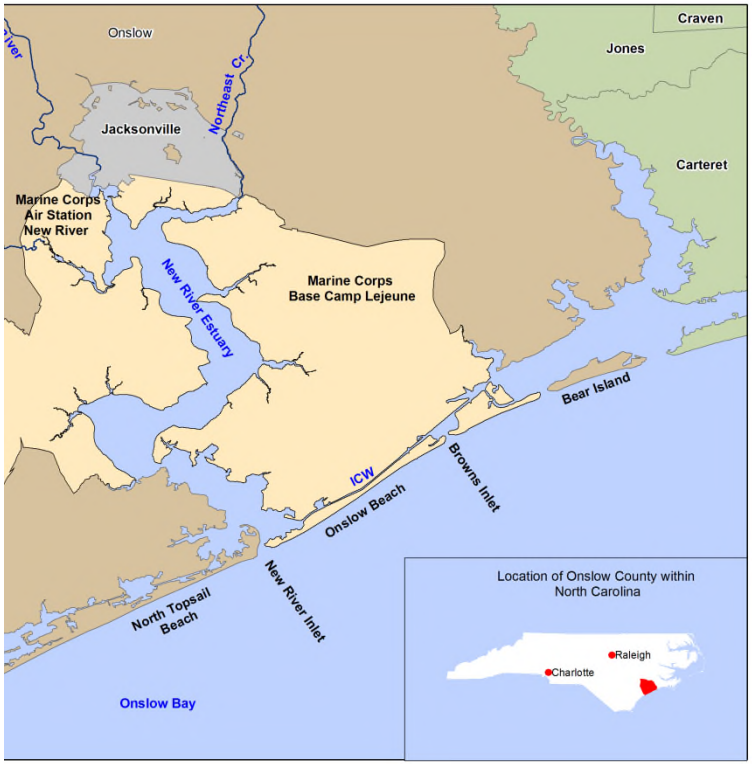
Wet/Dry Periods

Sea Level Rise

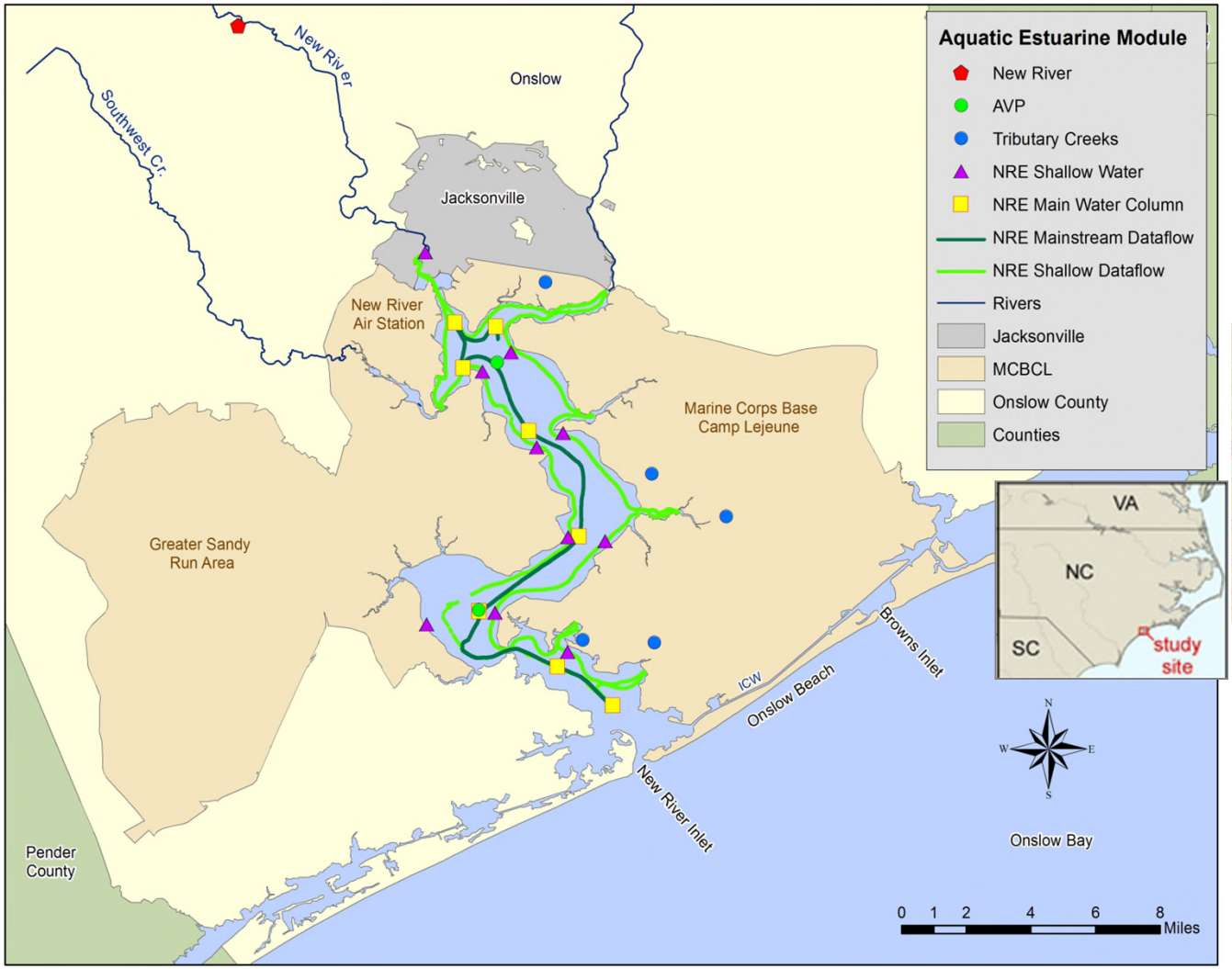
Episodic Events

Coastal Monitoring Network

- River and Creeks
  - New River (USGS Gage Stations)
  - Coastal Streams (on DOD lands)
- Estuary
  - Shallows (Benthos)
  - Channel (Water Column)
- Coastal Wetlands
  - Fringing marshes along ICW and estuary
- Barrier island
  - Onslow Island (DoD lands)



Rivers and Creeks



Rivers and Creeks

Climate and Land Use Affect Exports of Carbon, Sediments, and Nutrients from Coastal Subwatersheds

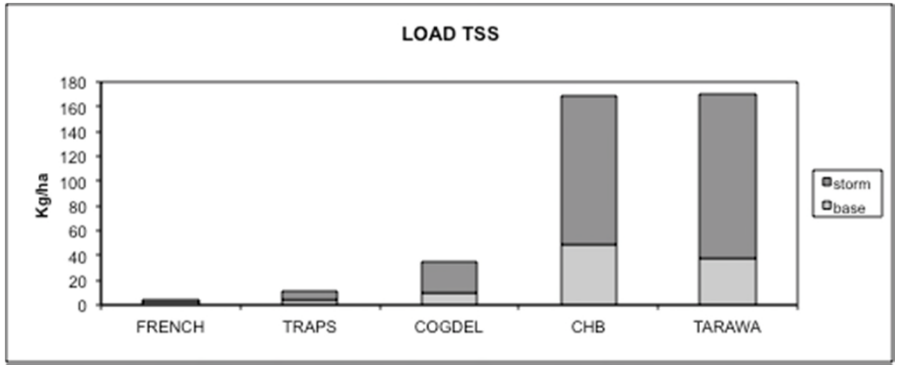
Deploy flow gauge and automated water sampler in streams with a range

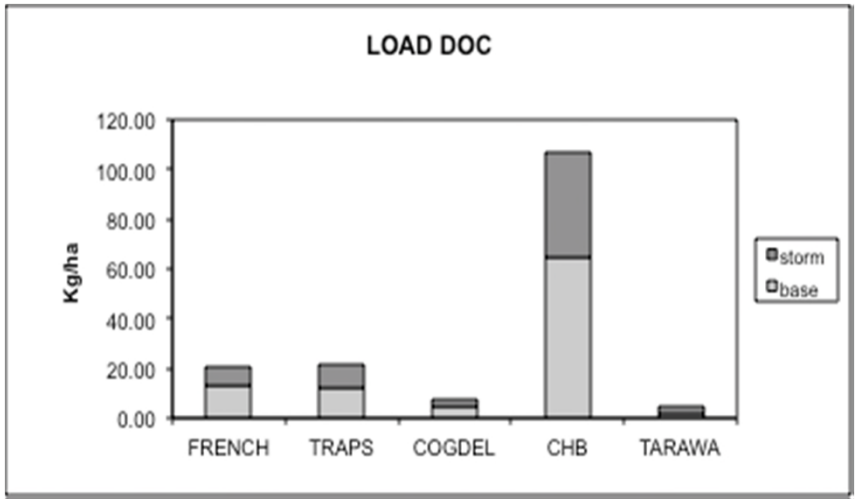
Continuous measurement of flow, temp., water level, conductivity

Storm and baseflow samples analyzed for DOC, POC, TSS, and nutrients

Analysis of landuse effects on stream carbon, nutrient and thermal loading

Results: Tributary input



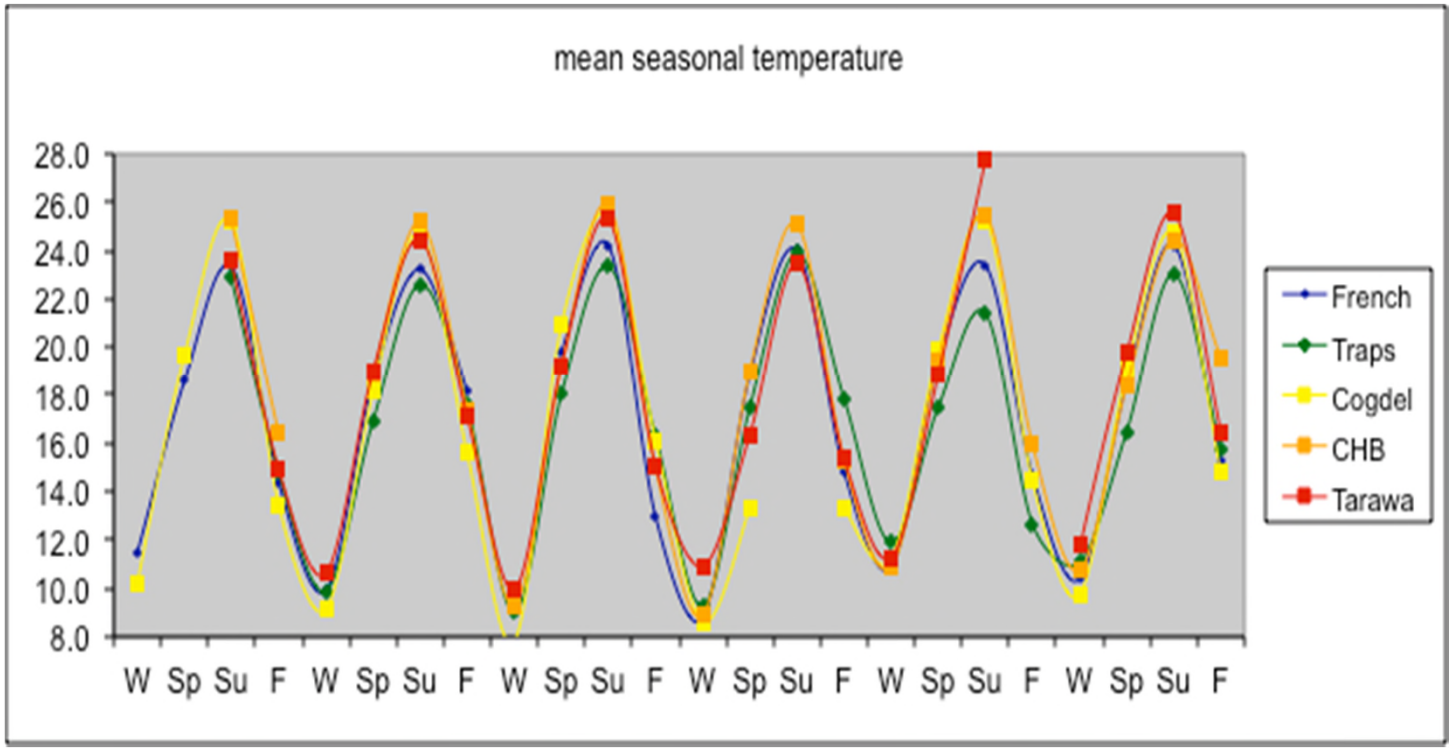


- TSS – Increase with increasing imperviousness
- DOC loading – decrease with increasing imperviousness

- Loading is in units of kilograms per hectare and is divided into carbon delivered during base and stormflow conditions. Sites are presented from least developed (left) to most developed (right) on the x-axis.

Studies by Dr. Mike Piehler, UNC-IMS

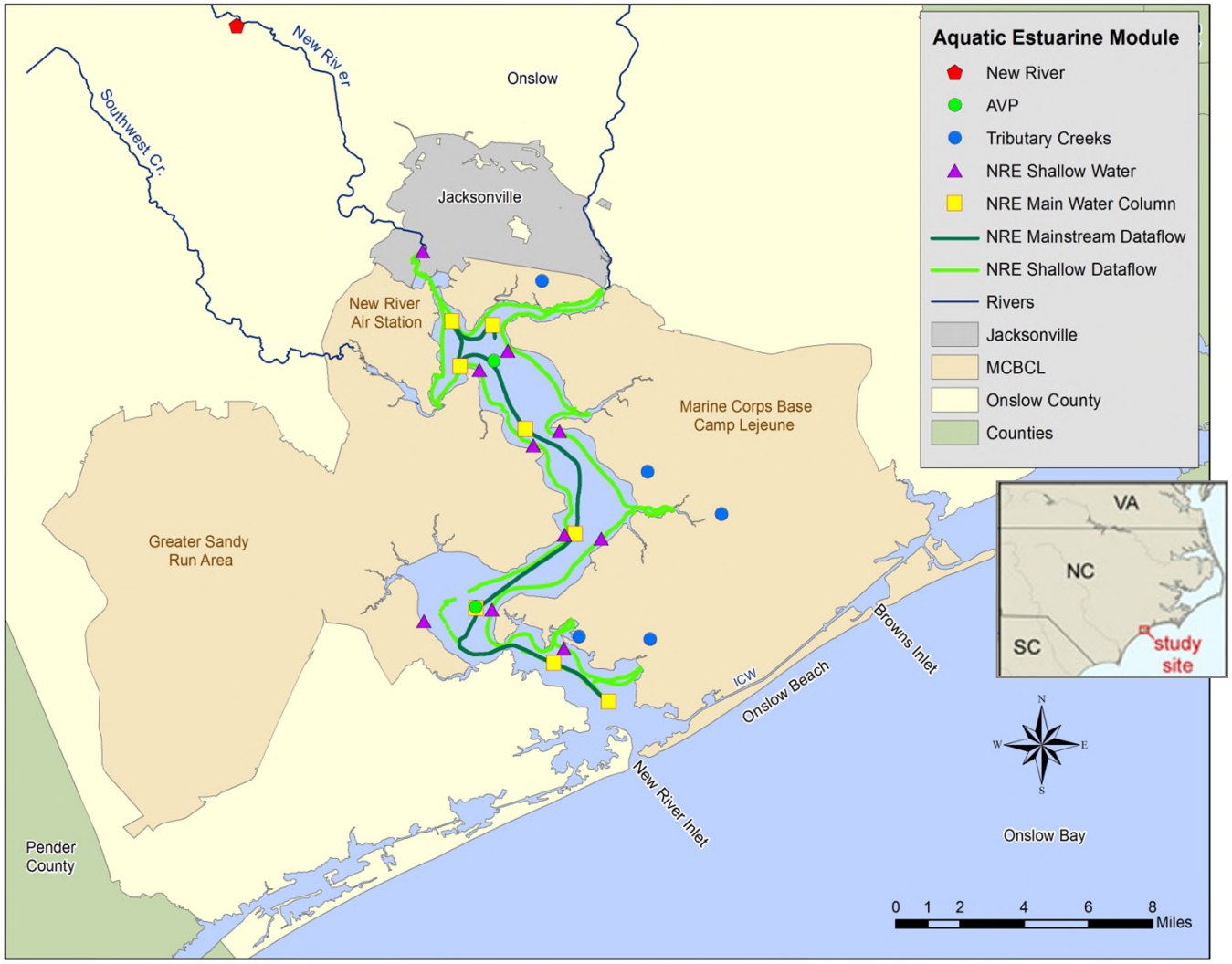
Results: Warming in Coastal Streams

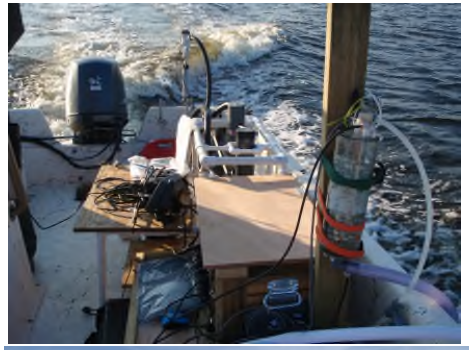


- Stream temperature in the five study streams.
- Temperature is in degrees C and is presented for each season since 2008. Sites are presented from least developed (cool colors) to most developed (warm colors).

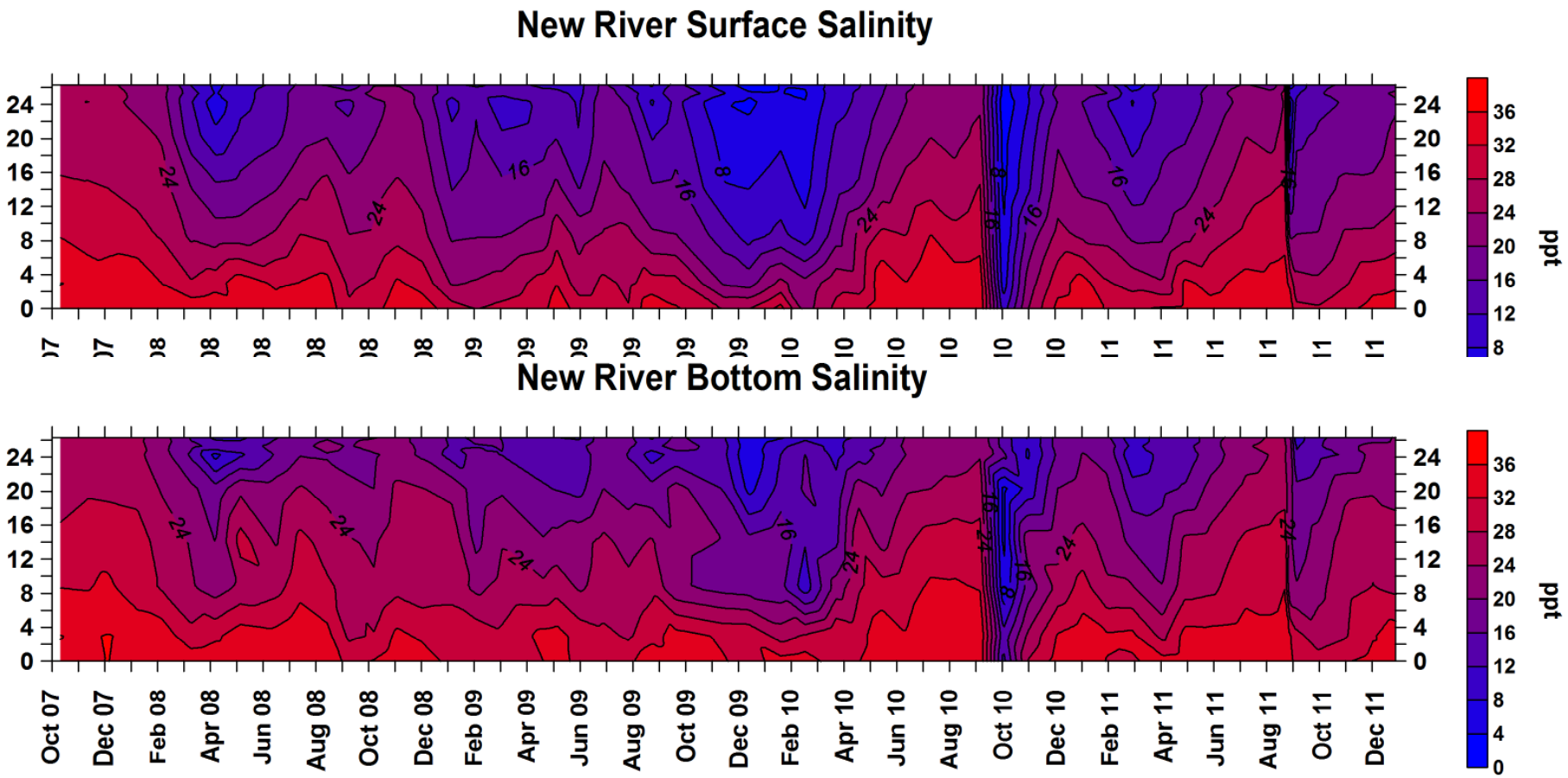
Studies by Dr. Mike Piehler, UNC-IMS

Estuarine Monitoring Program



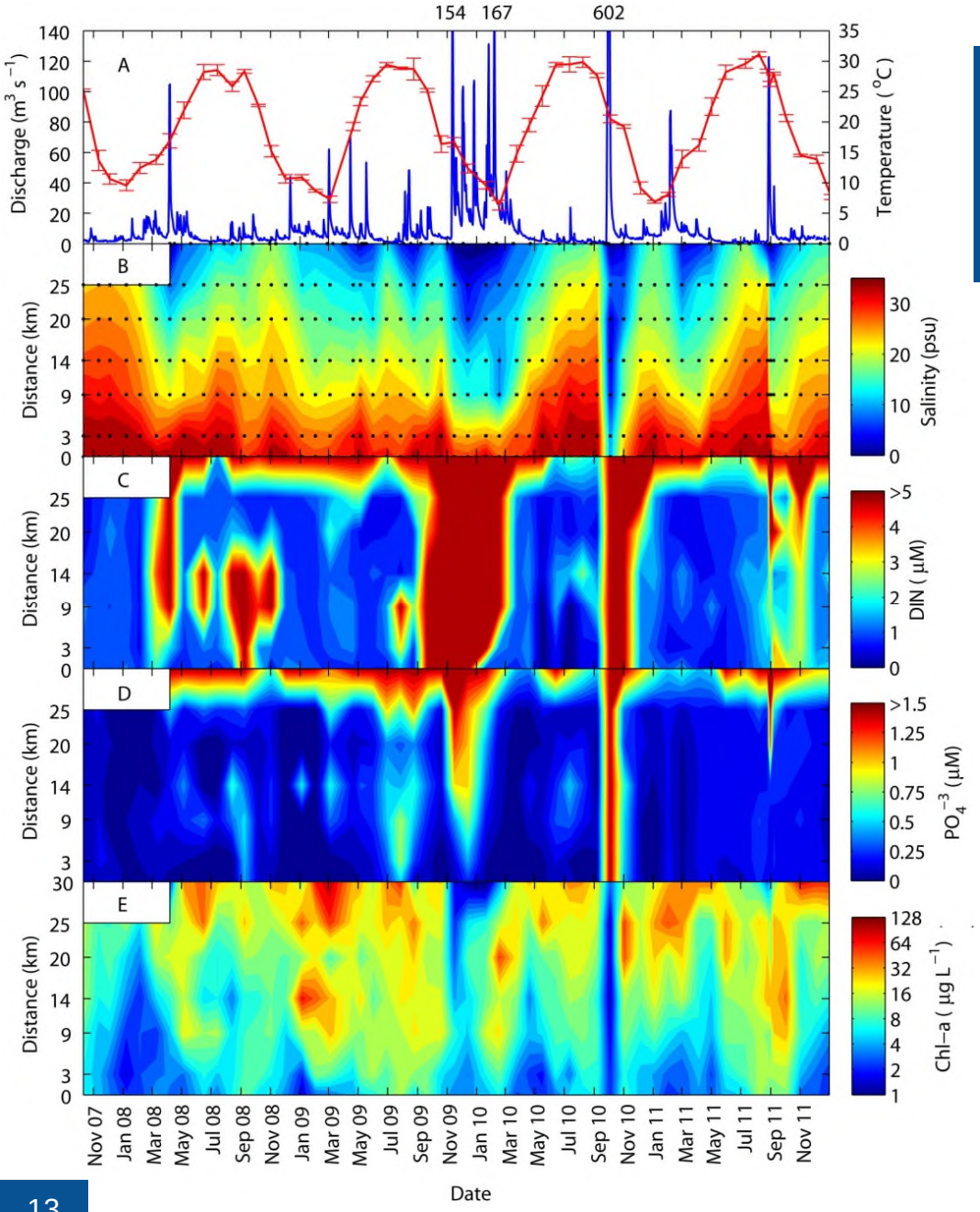


NRE – Surface and Bottom Water



New River Estuary surface and bottom water salinity (as psu) during the 2007-2011 sampling period. Upstream (microtidal) salinity is driven by storm events and droughts (i.e. episodic)

Studies by Dr. Hans Paerl, UNC-IMS

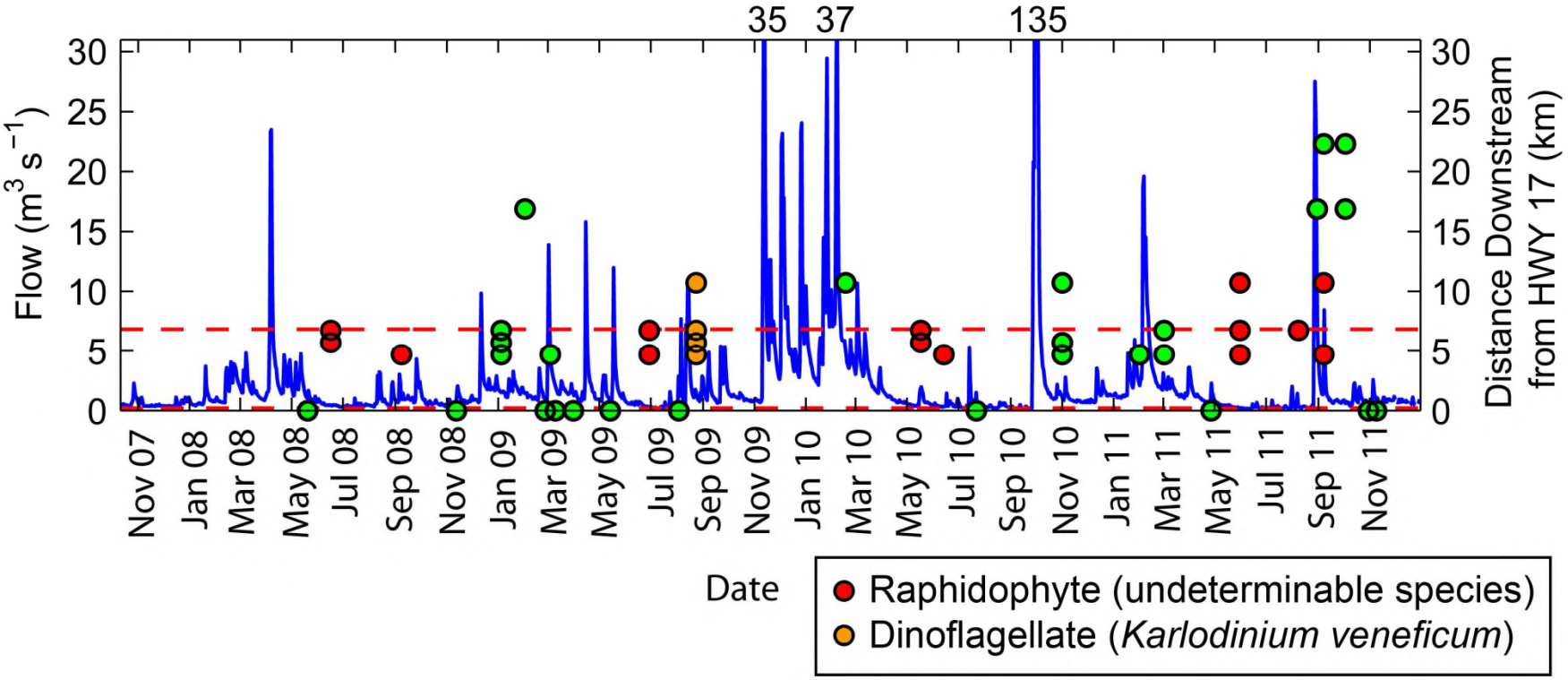


New River FW Discharge and NRE Nutrient Concentrations

- Ecosystem drivers
  - Temperature
  - River discharge
- Indicators
  - Salinity
  - Nutrients
  - Phytoplankton

Studies by Dr. Hans Paerl, UNC-IMS

Flow drives productivity

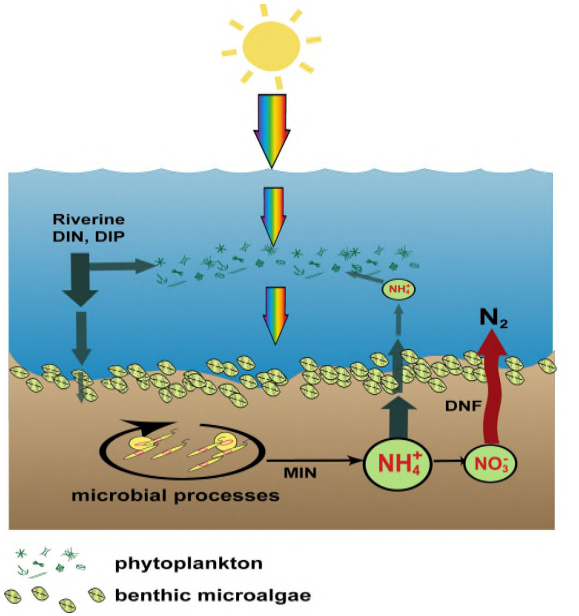


Flow strongly controls Chl a exceedances and blooms

- Biomass and blooms lowest during drought
- Blooms higher with moderate discharge and nutrient input
- Dominate by flagellates
- High flows flush the system

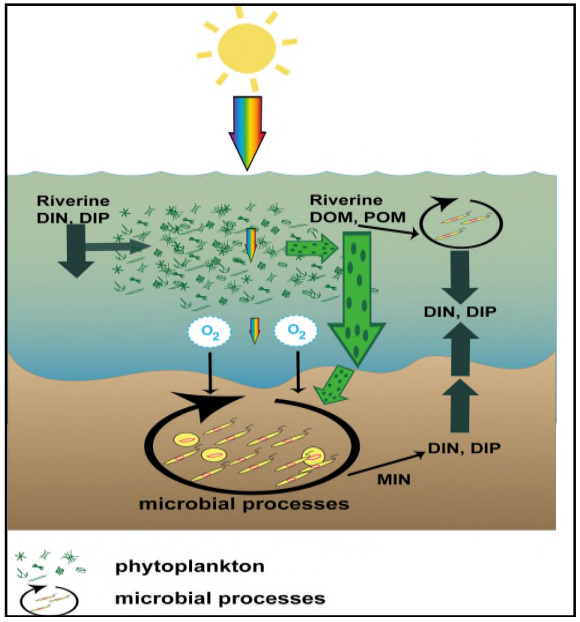
Studies by Dr. Hans Paerl, UNC-IMS

Shallow waters



- Shallow NRE acts as a nitrogen filter
- Dependent on light availability, temperature, and benthic chla, all affected by freshwater discharge.
- A net autotrophic benthos takes up N; a net heterotrophic benthos releases N.

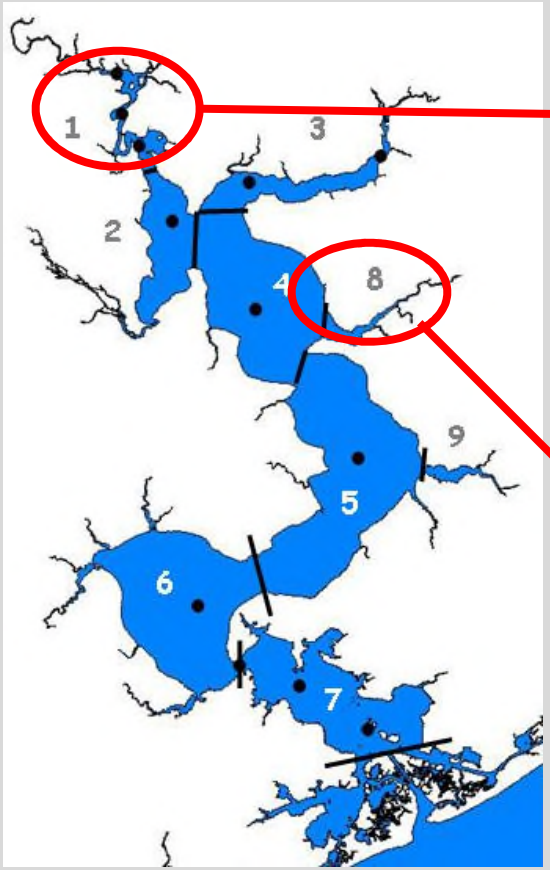
This

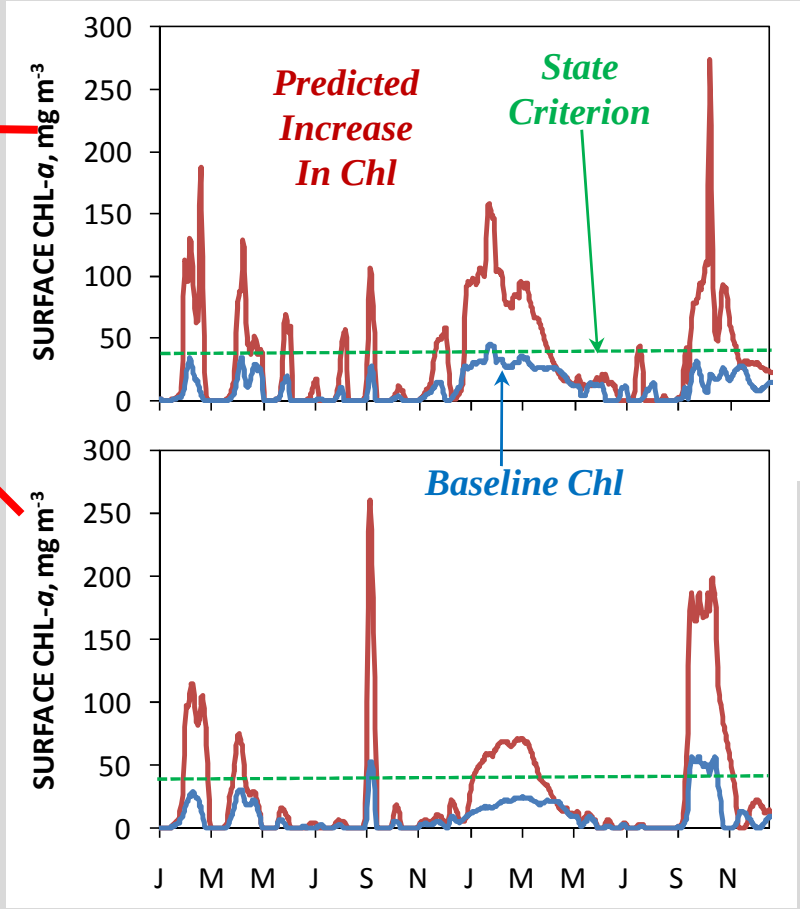


Studies by Dr. Iris Anderson, VIMS

Estuarine Simulation Model

Model Output (e.g. criteria attainment)



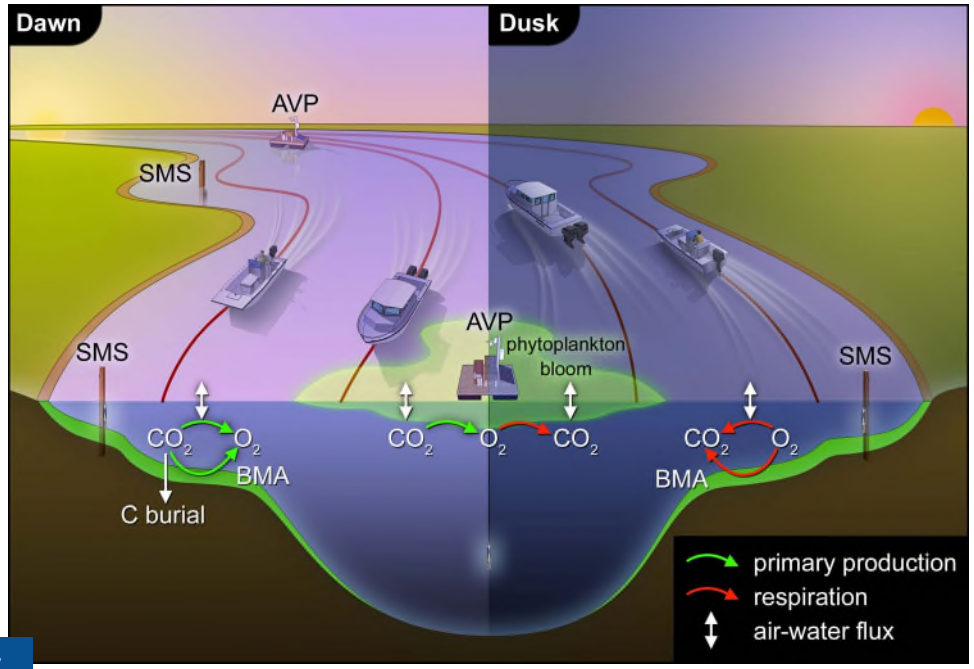


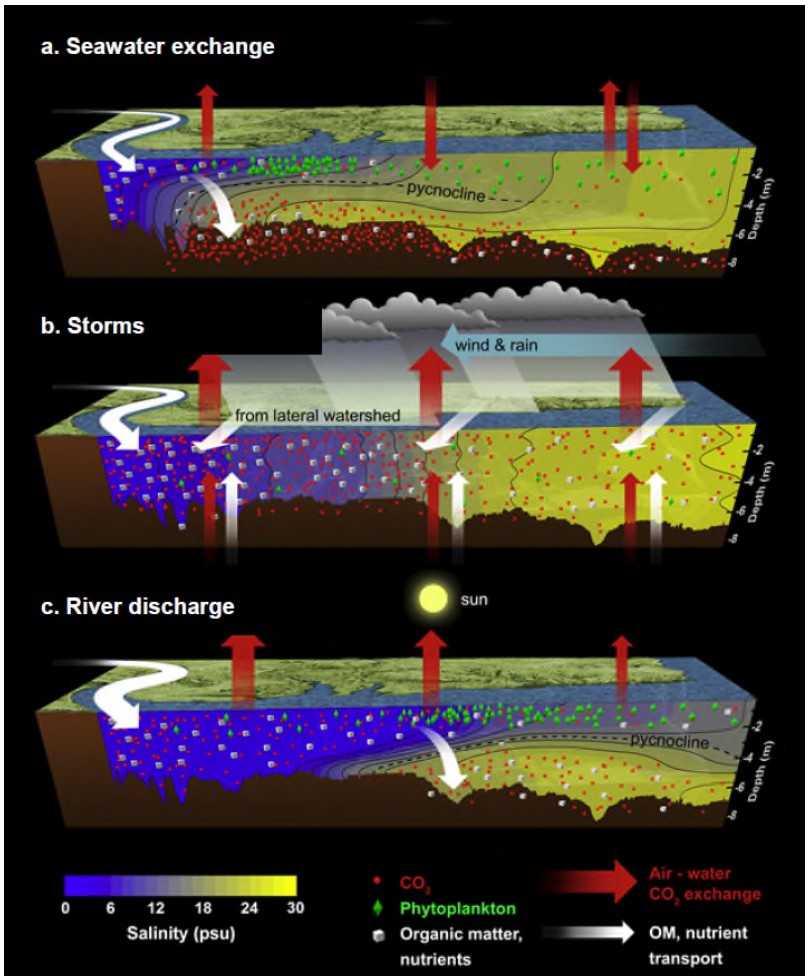
Develop by Dr. Mark Brush, VIMS

Climate-related research

Aquatic/Estuarine Module

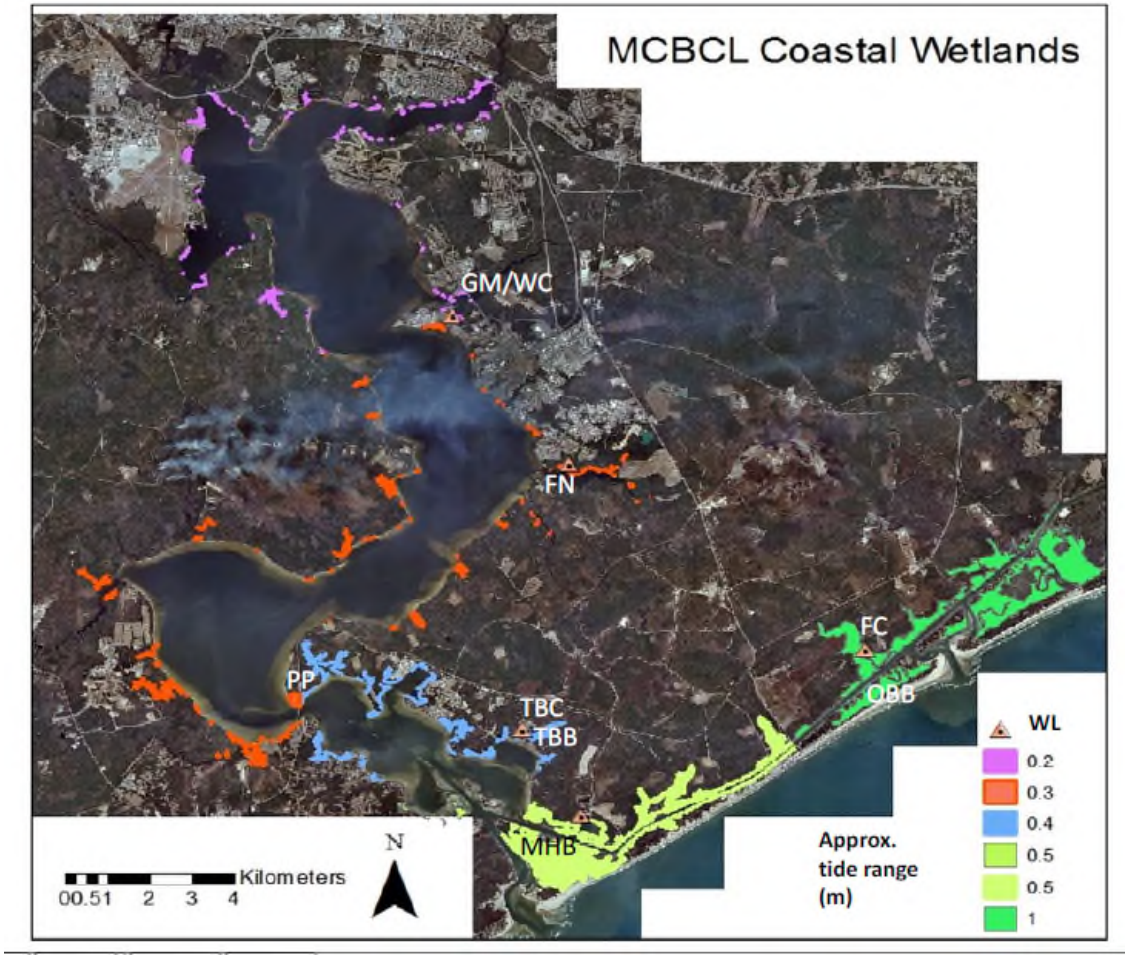
- Changes to phytoplankton production and respiration and pCO_2 flux between water and air under different salinity conditions
- Assess changes in benthic microalgal production under different temperature and salinity regimes using mesocosm studies.





Coastal Wetlands

Objective: Examine factors controlling marsh response to SLR and carbon sequestration.

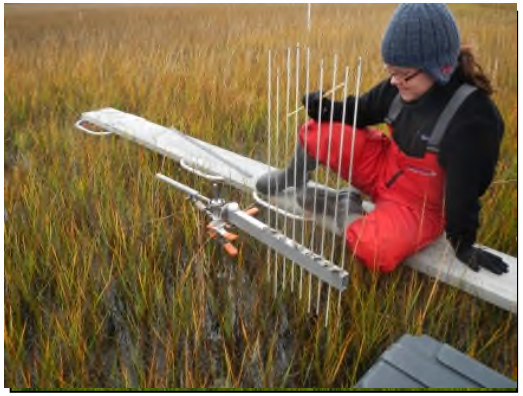


Coastal Wetlands Monitoring

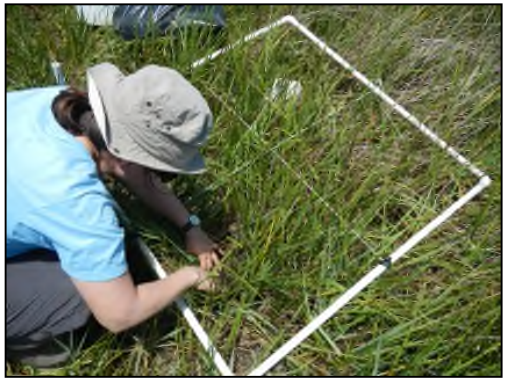
Variable	Temporal Scale	Spatial Scale	Method
Shoreline erosion	Every 2–3 years	6 stations	RTK-GPS, DEM
Marsh surface elevation change	Quarterly and episodic events	16 SETs at 6 stations	SETs
Marsh vegetation and snails	Annually	Permanent 1 m^2 plots, 15–24 plots per site, 6 sites	Stem density, stem height, and percent cover; snail density
Water level, temperature, salinity	Continuous (every 6 minutes)	2 stations	Tide gauges

Shoreline erosion

Marsh surface elevation



Marsh biomass



Water Level

Future Climate-related studies

Coastal Wetlands

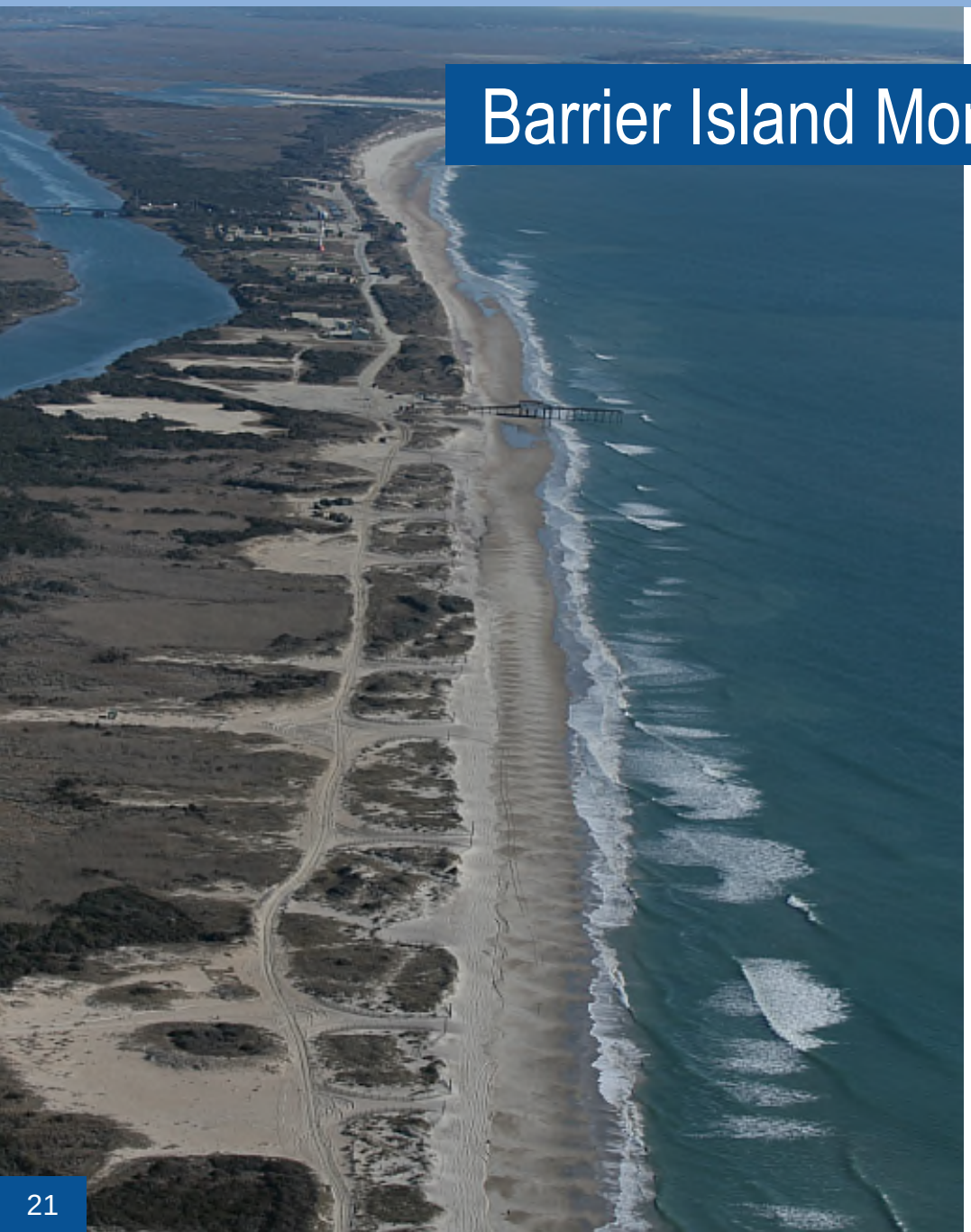
- Assess historic marsh response to SLR over last 100 years using sediment core geochronology
- Assess impacts of SLR on marsh sustainability by developing a Geospatial Marsh Model that incorporates sediment transport processes and influence of marsh vegetation
- Adaptive management pilot study –

  (1) thin layer disposal of 10-20 cm of dredge material added to marsh surface at two marsh elevations

  (2) shoreline stabilization by planting "living shoreline" of *Spartina*

Sediment Coring

Living Shoreline, NC



Barrier Island Monitoring

- Predict MCBCL coastal morphology under various climate scenarios
  - changes in dune and washover fan morphology
  - Changes in associated ecosystem services

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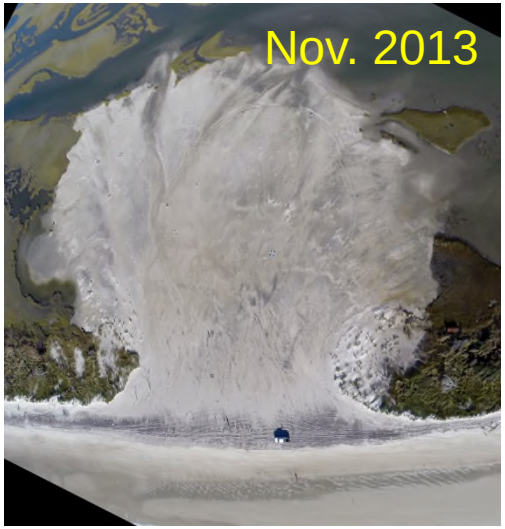
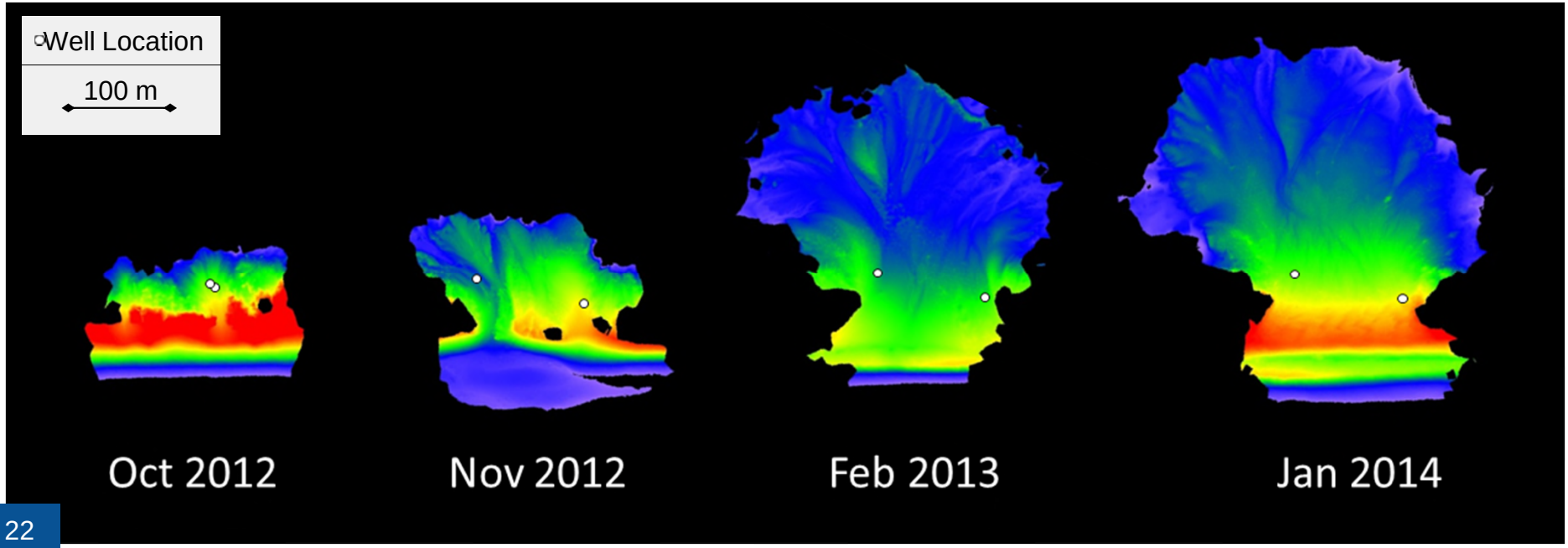
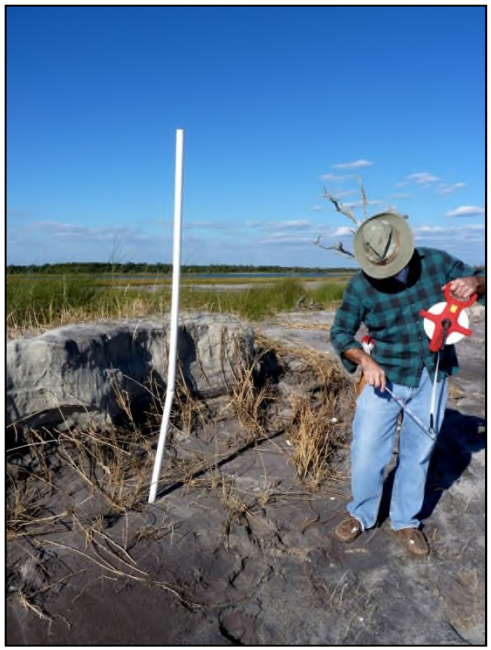
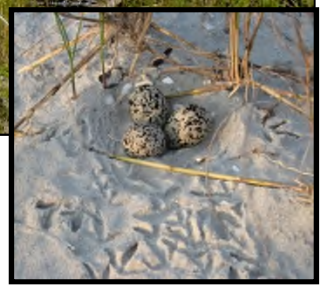
Washover Fan Morphology





Effects on Flora and Fauna





Studies by Dr. Tony Rodriguez and Steve Fegley, UNC

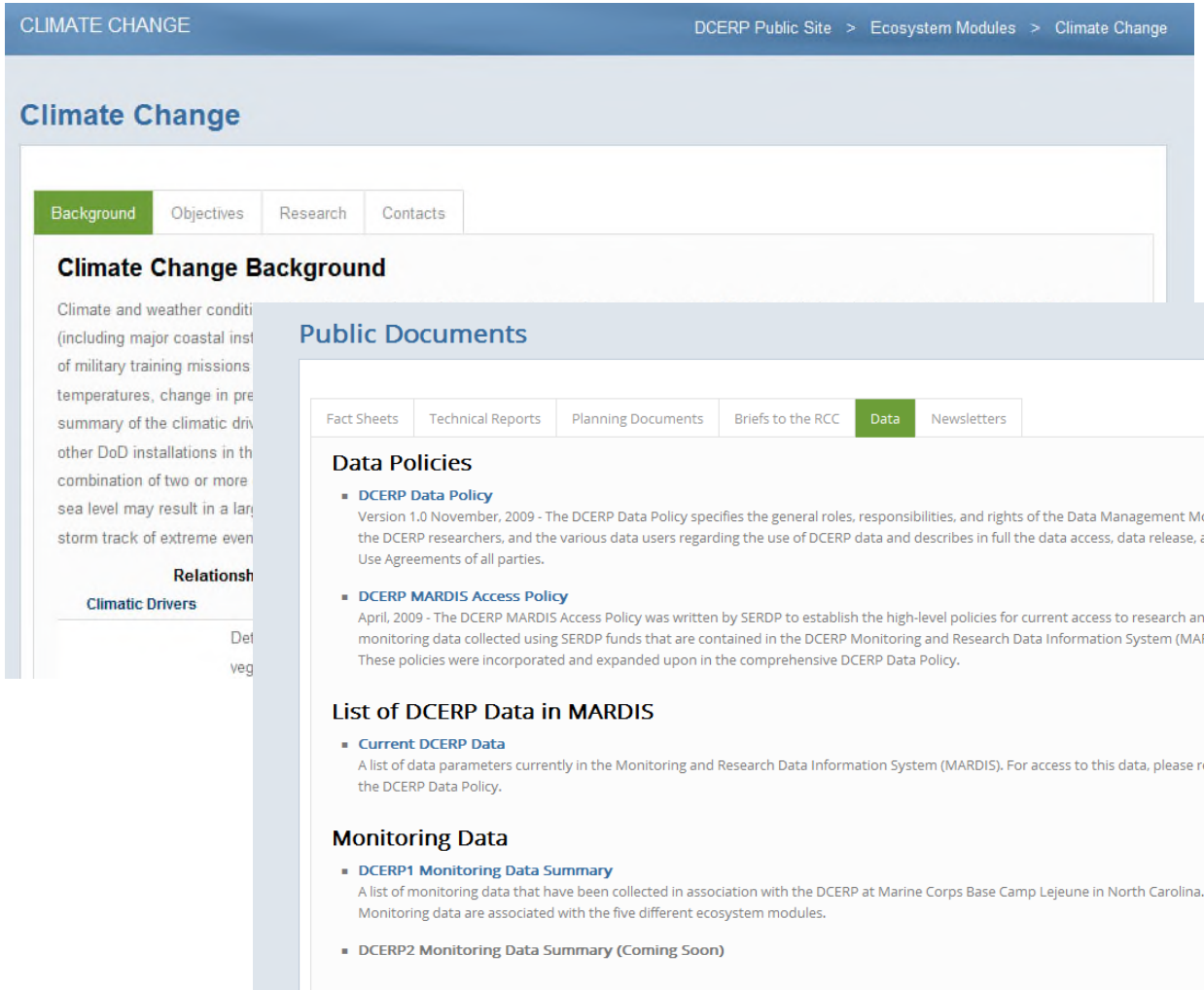
Climate-related Studies

- Predict impacts of SLR and storminess on barrier island shoreline position and coastal landforms (dune, beach and backbarrier)
- Determine how these geomorphic changes may affect carbon flux as well as island flora, nesting sea turtles, and shorebirds.

Aerial photo of washover fans (Hurricane Irene).

More information: dcerp.rti.org

- DCERP1 Final Reports
- DCERP2 Planning Documents
- Data Summary
- Quarterly newsletters
- Publication
- Presentations



Acknowledgements

- DCERP Researchers: Hans Paerl, Mike Piehler, Iris Anderson, Scott Ensign, Jen Stanhope, Nathan Hall, Joey Croswell, Rachel Smith, Carolyn Currin, Tony Rodriquez, Steve Fegley, Rick Luettich, Brent McKee, Craig Tobias
- DCERP On-site Coordinator: Susan Cohen

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More Information

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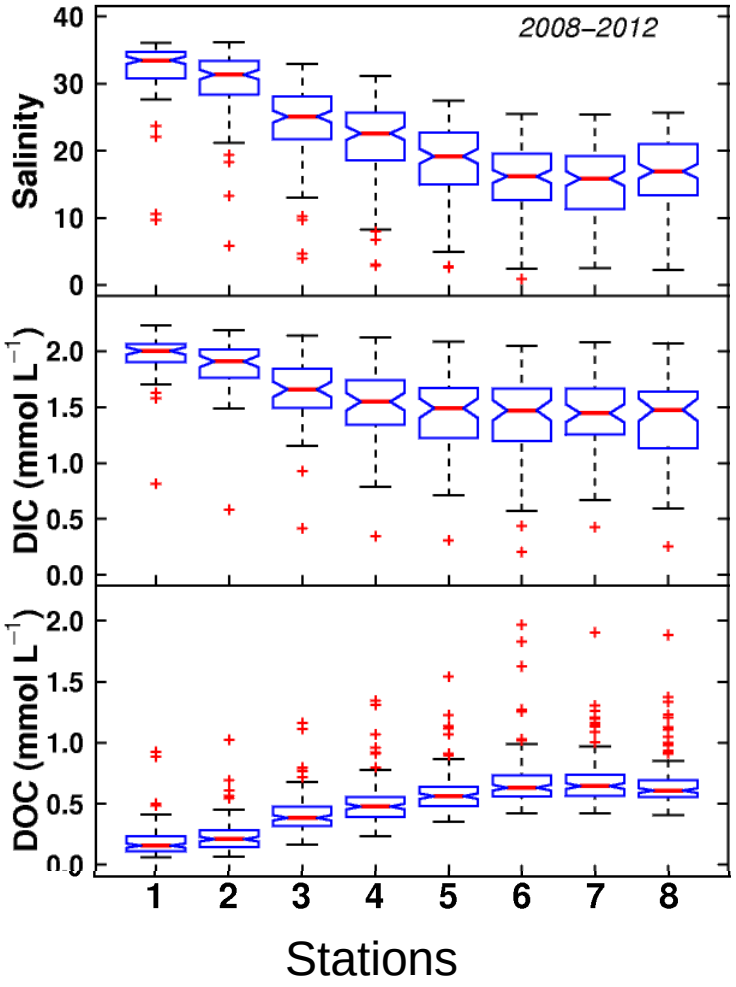
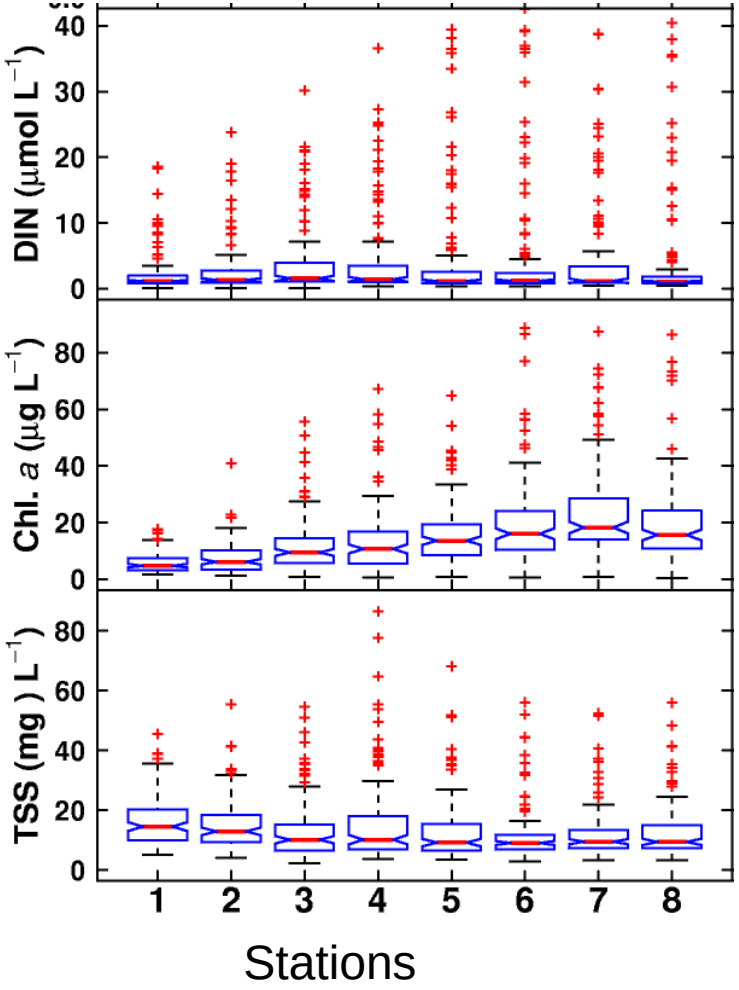
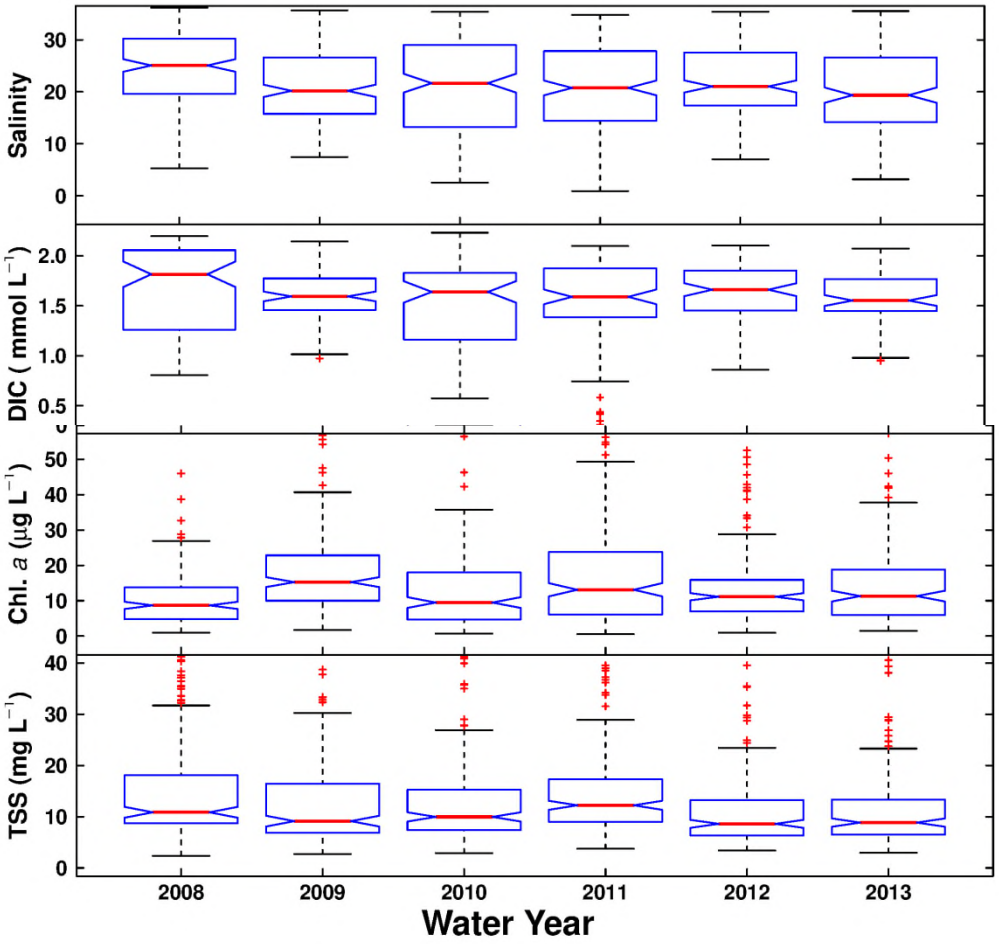
Spatial Trends



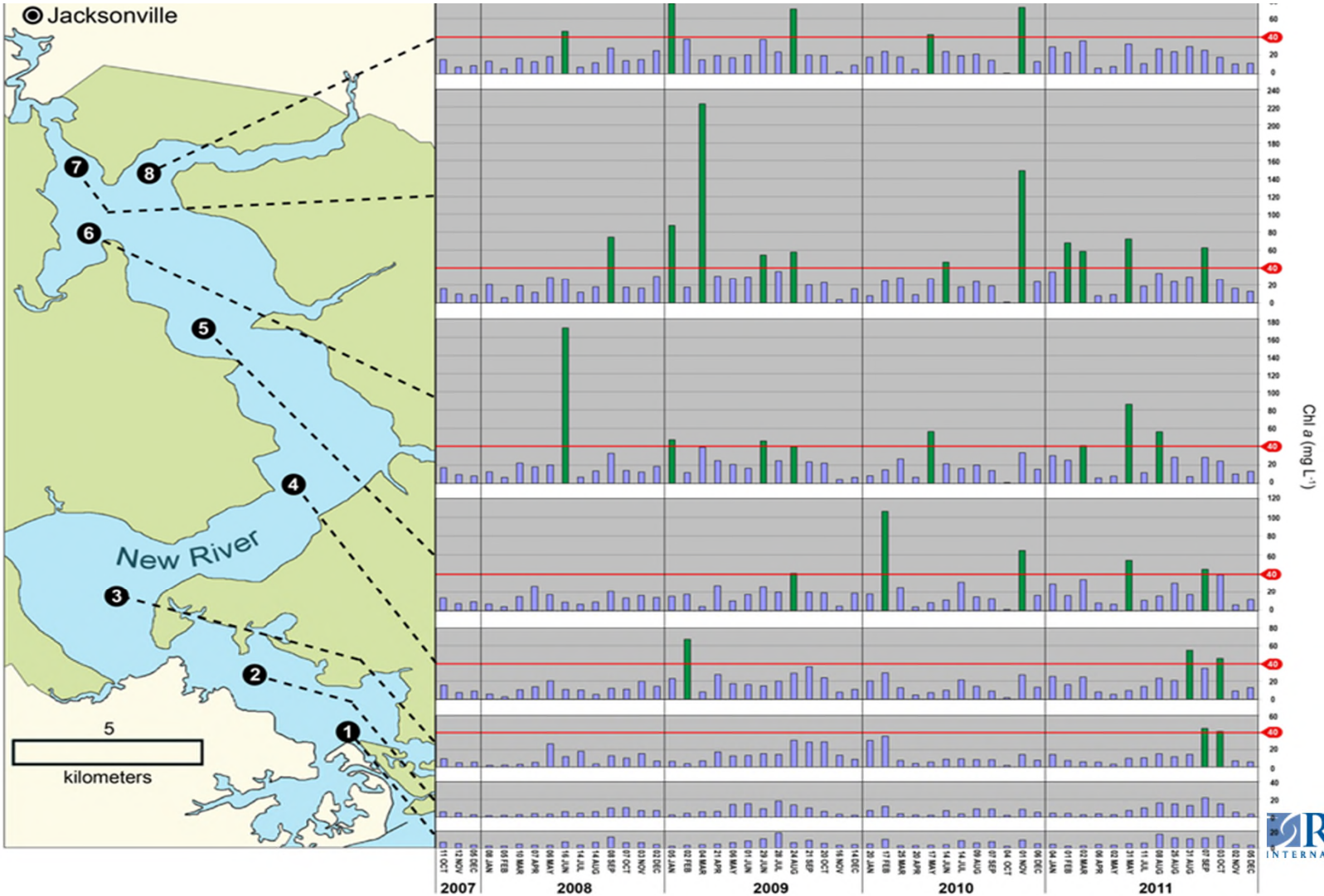


Temporal Trends

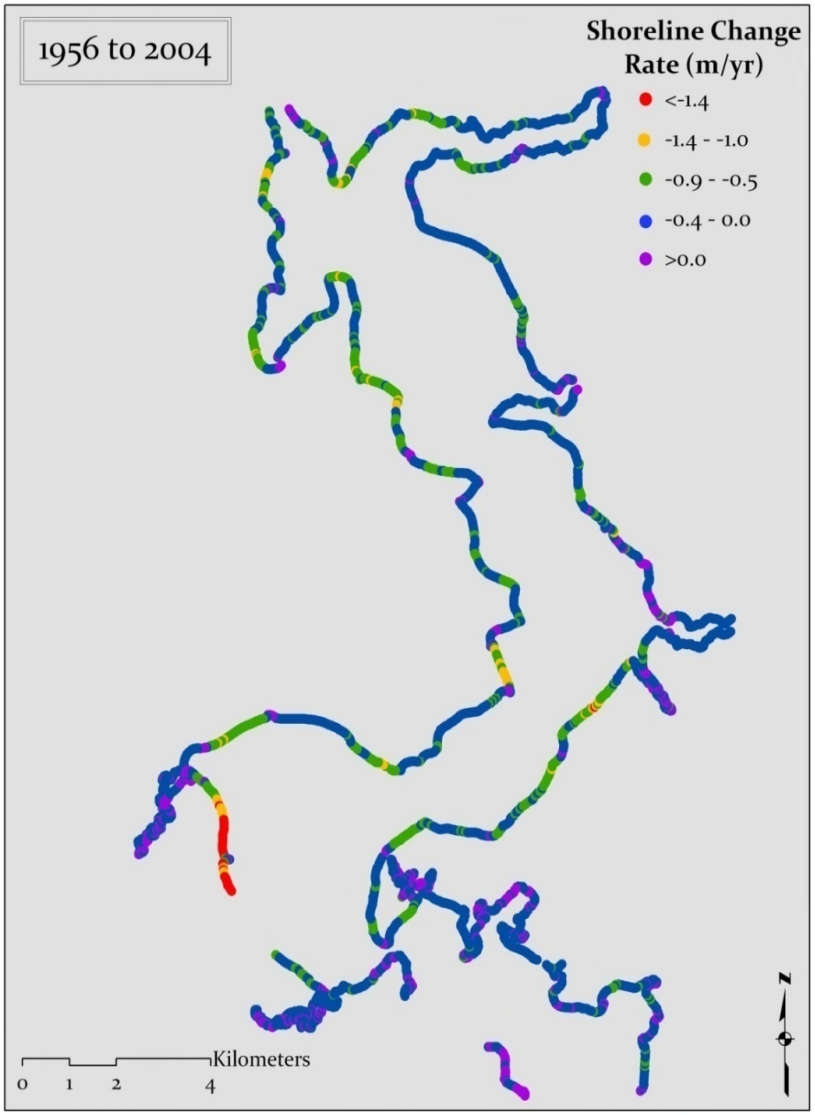


NRE – Chlorophyll a

Chlorophyll *a* exceedances of 40μg L^{-1} : Track FW discharge-driven blooms



Shoreline Erosion Rates – Historic Rates



- Shoreline erosion rates were determined using aerial photography from 1956, 1989, and 2004
- Between 1956 and 2004, the New River Estuary shoreline position receded an average of 12.3 meters, or -0.28 m/yr
- Higher rates of erosion for most shoreline types post 1989

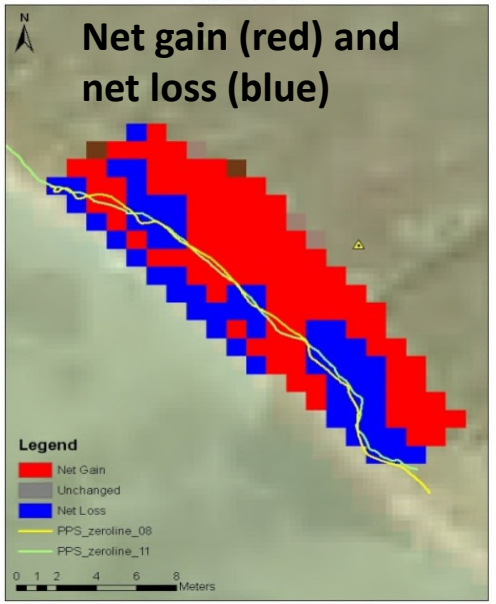
Studies by Dr. Carolyn Currin, NOAA

Shoreline Erosion – Current Rates

Change Analysis of Digital Elevation Models of Shoreline marsh sites (biannually/storm)

- 2 cm vertical accuracy
- Estimate sediment and C flux via erosion/accretion
- Spring 2014 & 2016

Estimate volume change and edge erosion



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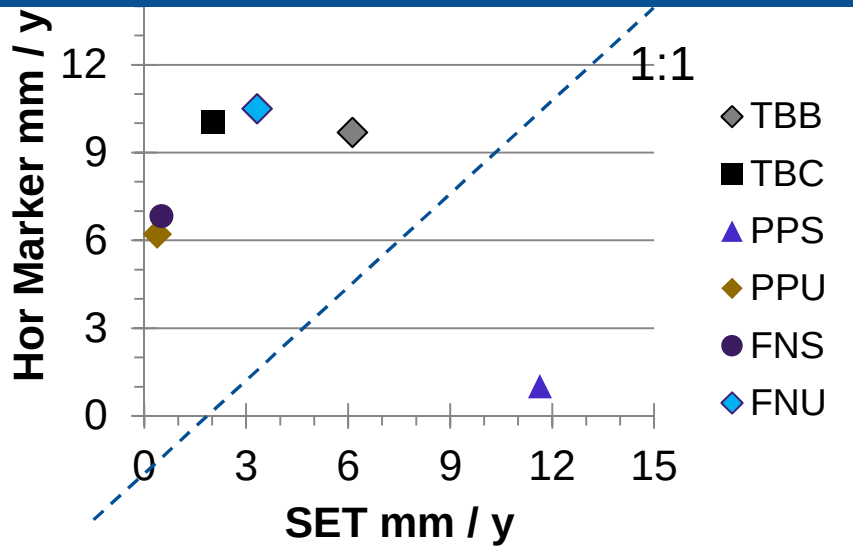
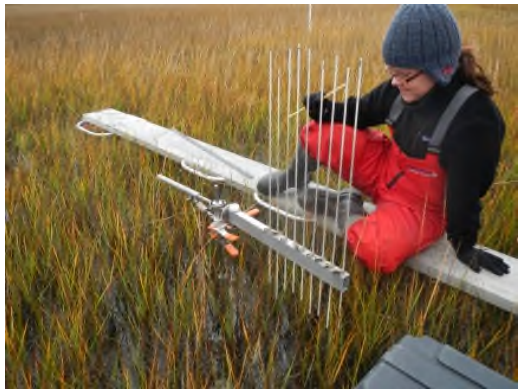
Marsh Surface Elevation

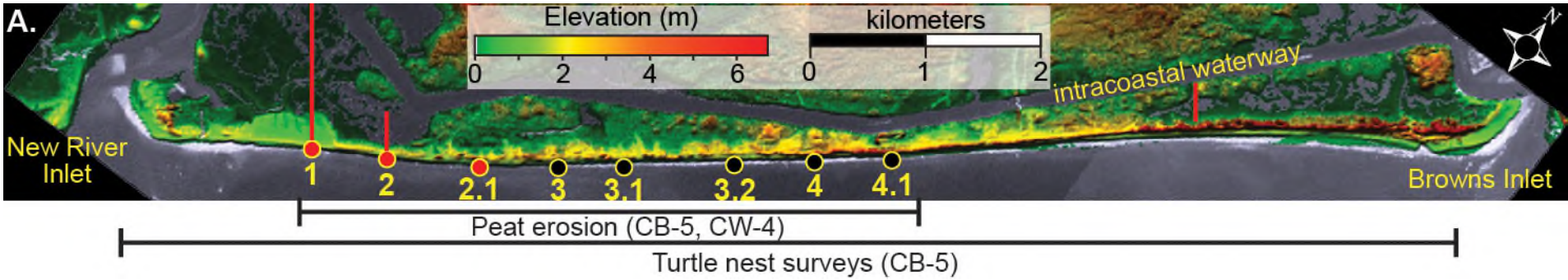
- SETs
  - 6 sites (NRE)
  - 10 sites (ICW)
- Marker Horizon
  - sediment accretion



➢Sediment accretion 1.5 - 6 x greater than elevation change



Barrier Island Station Locations



-laser scanning, washover fan evolution, vegetation surveys and nesting shorebirds (CB-5)

-laser scanning (CB-5)

-core transect (CB-5, CW-4)

-vegetation plot (CB-5)

Studies by Dr. Tony Rodriguez, UNC