The Currituck Sound Array:

Introducing a new estuarine field site and test bed for Corps' research

COASTAL & HYDRAULICS LABORATORY

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Outline

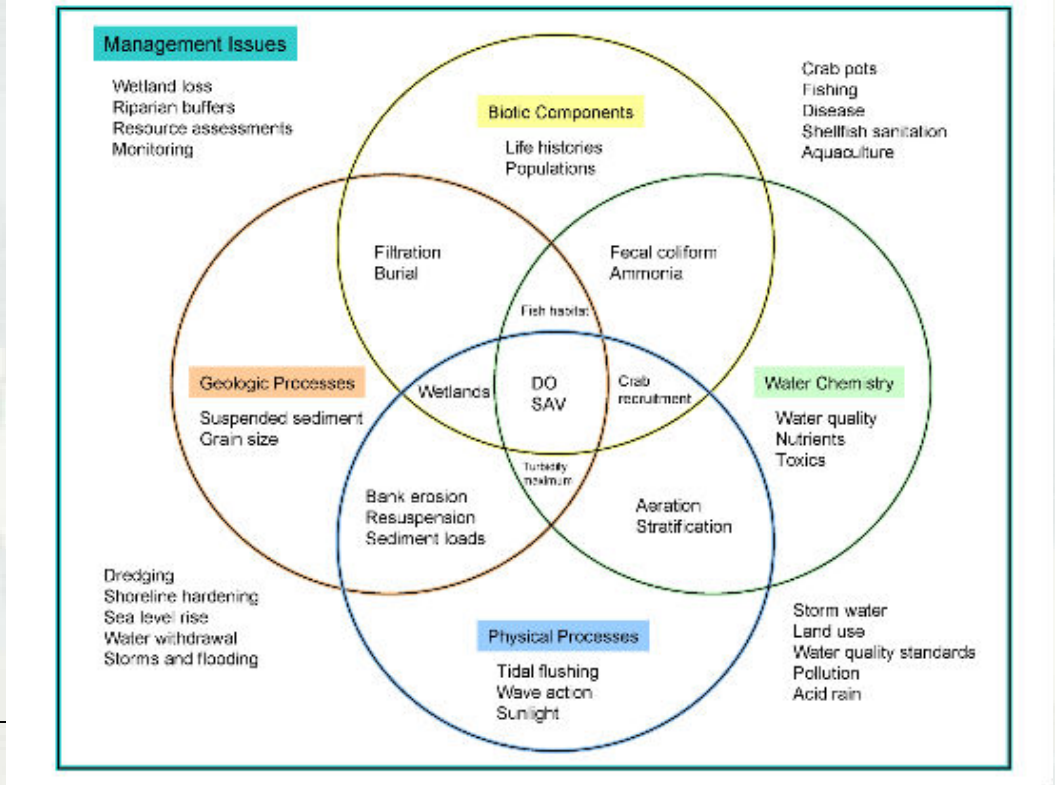
- Review recent (FY14, 15, 16) SoNs
  - RSM-oriented
  - Field component
- Currituck Sound and the FRF
  - Overview of Albemarle-Pamlico Estuarine System (APES)
  - Field Research Facility – Capabilities
  - Currituck Sound Array
- Addressing SoNs with the Array
- Further research ideas to benefit RSM

Recent, RSM-Oriented SoNs:

Water Quality and Sediment Transport SoNs:

1. Incorporating vegetation and sediment parameters in nearshore models
2. Accretion rate of coastal wetlands experiencing relative sea level rise
3. Developing tools useful in testing preventative management strategies of HAB in surface waters.
4. Remote sensing for water quality monitoring.

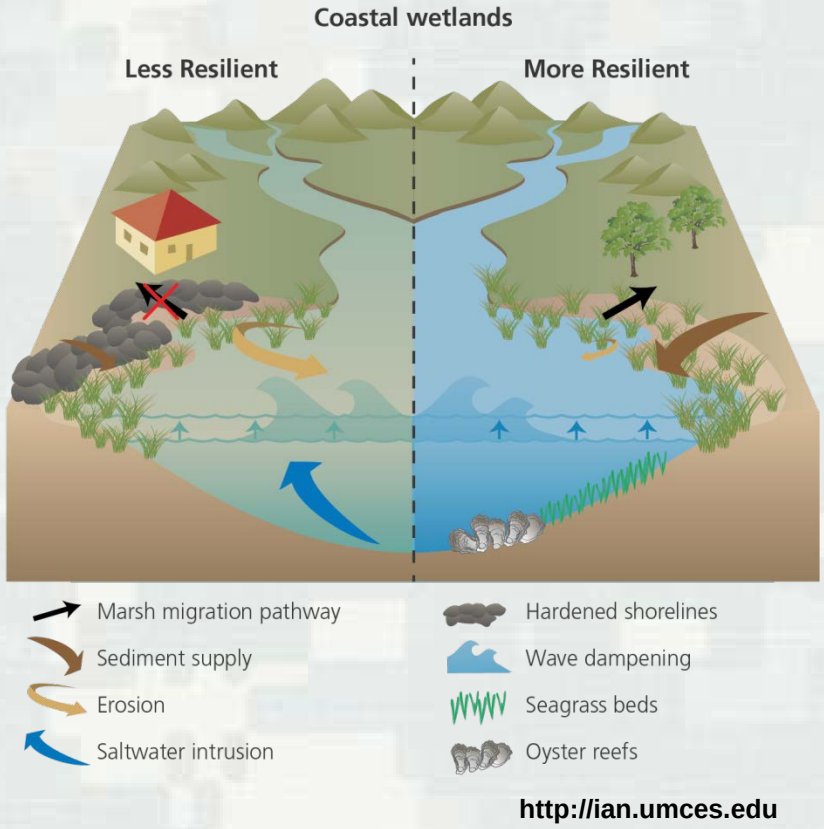
www.ccrm.vims.edu



Recent, RSM-Oriented SoNs:

Sea Level Rise and Coastal Resiliency SoN's:

1. Identifying and addressing potential sea level change impacts to navigation projects.
2. Synthesis of data-related wetland performance and sustainability against relative sea level rise
3. Living shoreline design guidance
4. Guidance and tools for calculating integrated coastal resilience



http://ian.umces.edu

Recent, RSM-Oriented SoNs:

Regional Dredging Impacts SoNs:

1. Environmental assessment of dredged disposal areas
2. Potential for mitigation of dredging impacts on benthic communities
3. Shallow-water transport and fate of dredged material

www.dredgingtoday.com

www.nola.com

How are these all related?

Impact a wide range of coastal environments, especially estuaries.

Require a system-wide understanding of interrelated physical, biological, and chemical processes.

Example: "Developing tools useful in testing preventative management strategies of HAB in surface waters" needs:

1. Understanding of what physical & environmental factors drive populations of HAB.
2. Develop the ability to accurately and economically monitor HAB populations in systems – both *in-situ* and remotely (which requires knowledge of what all is in suspension/coloring the water – sediment, organic matter, tannins etc.).
3. Translate these tools to other regions.

How are these all related?

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Require a system-wide understanding of interrelated physical, biological, and chemical processes.

Example: "Living shoreline design guidance" needs:

1. Opportunities to deploy differing designs under similar conditions where all physical parameters are already being measured.
2. Compare shoreline erosion rates and ecosystem function between differing designs and adjacent, "natural" shorelines.

Example: "Environmental assessment of dredged disposal areas" needs:

1. Improved understanding of heterogeneous (mud & sand) sediment dynamics…how it is eroded, transported, and deposited within regions.
2. Implications of sediment input to environmental processes and natural resources.
3. Opportunities to test different disposal geometries, methods.

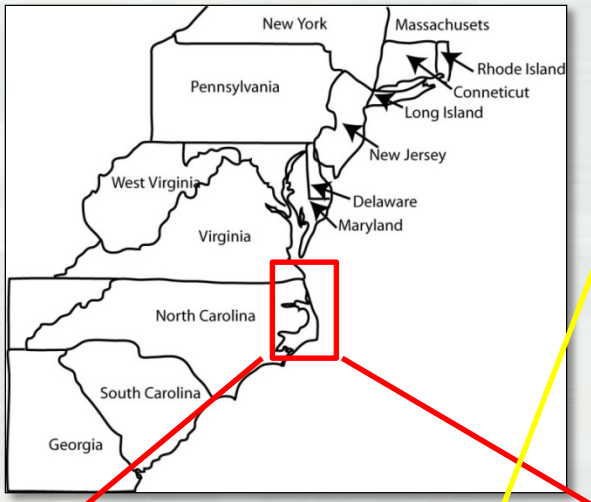
How are these all related?

Impact a wide range of coastal environments, especially estuaries.

Require a system-wide understanding of interrelated physical, biological, and chemical processes.

All would benefit from an state-of-the-art estuarine testbed…

Albemarle-Pamlico Estuarine System (APES):

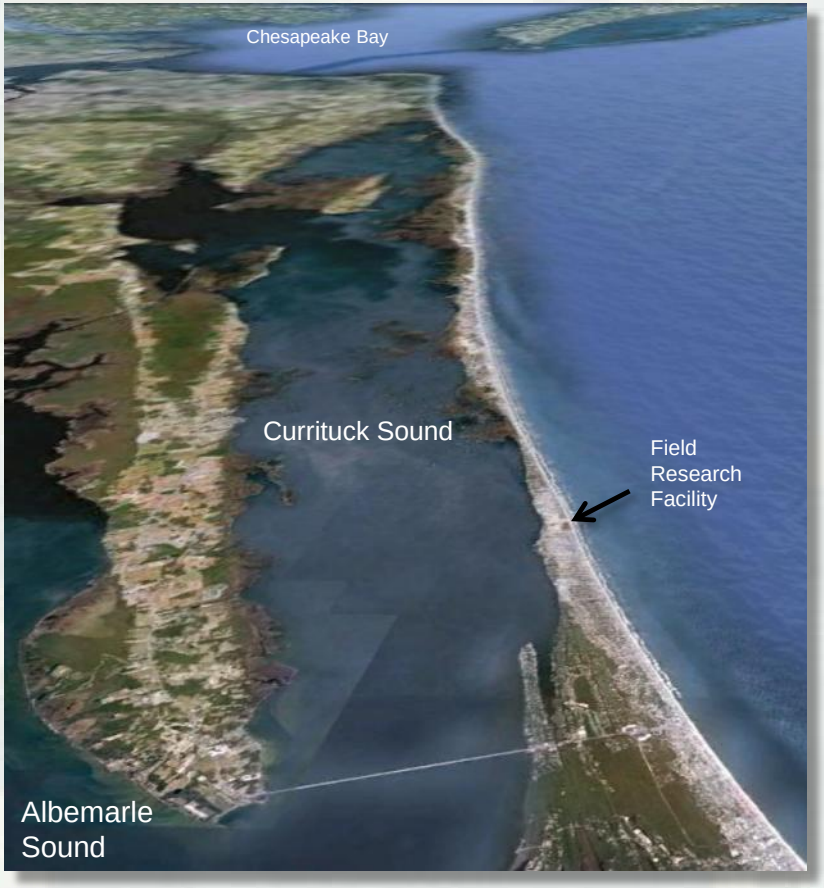


Largest coastal lagoon system in the lower 48 states.

Microtidal, full salinity range, primarily wind forcing

Minimal ocean exchange via inlets (Oregon, Hatteras, Ocracoke, Drum, and Irene (New Inlet))

Over 4000 km of ecologically diverse shoreline



Currituck Sound

~20 km length, ~5 km wide, 2.5 m depth

Brackish (typically ~3-5ppt)

Insignificant tides

No major rivers or modern coastal inlets; Albemarle Sound and Back Bay, NC/VA are traditional boundaries

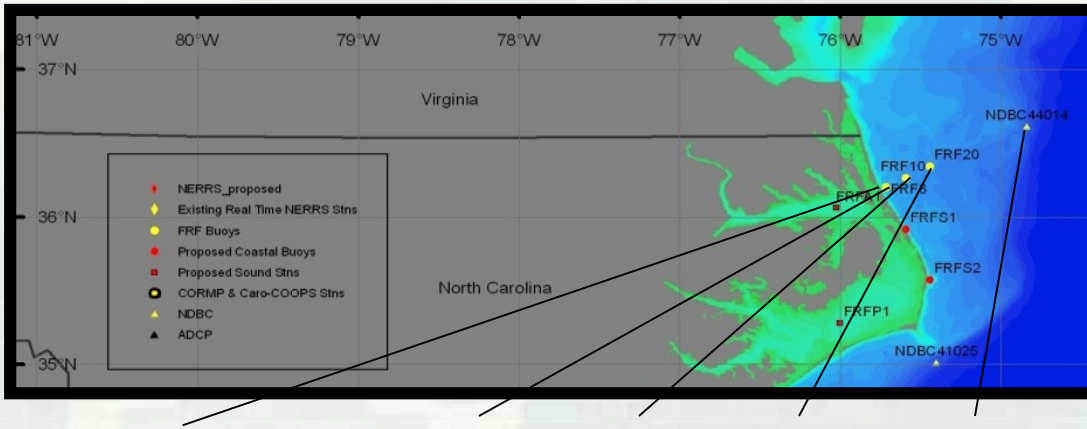
Energetic (Nor'easters, hurricanes)

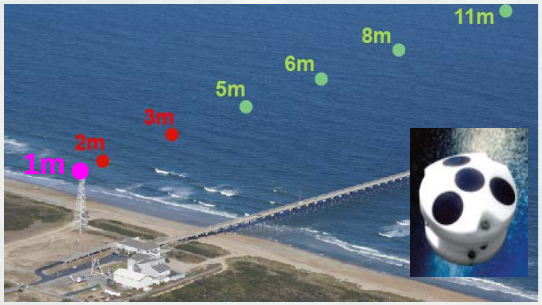
Heterogeneous geology

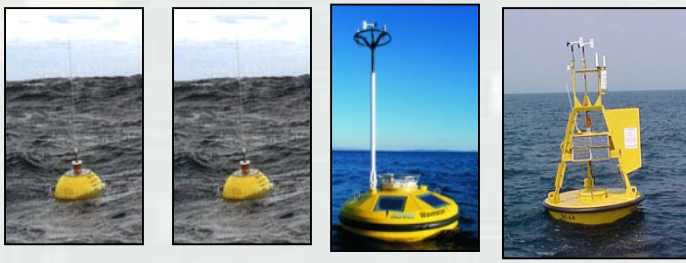
Most eutrophic region of the Albemarle Sound System *(Moorman et al., 2014)*

USACE Field Research Facility

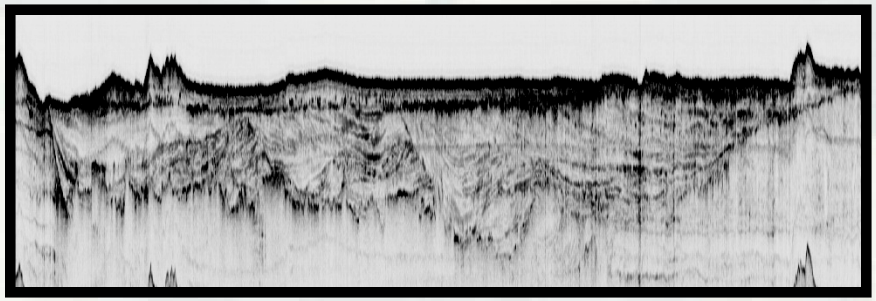
The USACE Coastal and Hydraulics Laboratory's Field Research Facility (FRF) has a 35-yr history of long-term monitoring on the coastal ocean, including ~20 years of water level data in Currituck Sound.



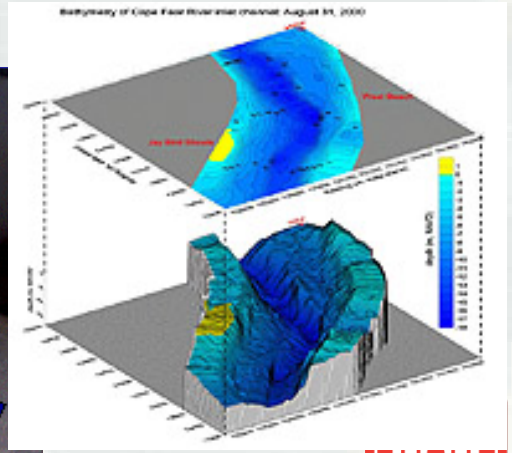




Cross-shelf (1.5 m – 48 m) Wave and Current Array



CHIRP – Sub-bottom profiling system with co-registered sidescan sonar



Interferometric Bathymetry

USACE Field Research Facility

LARC- amphibious craft (4)

R/V Barlowe with crane

Metal fabrication & machine shop

New sound-side landing craft

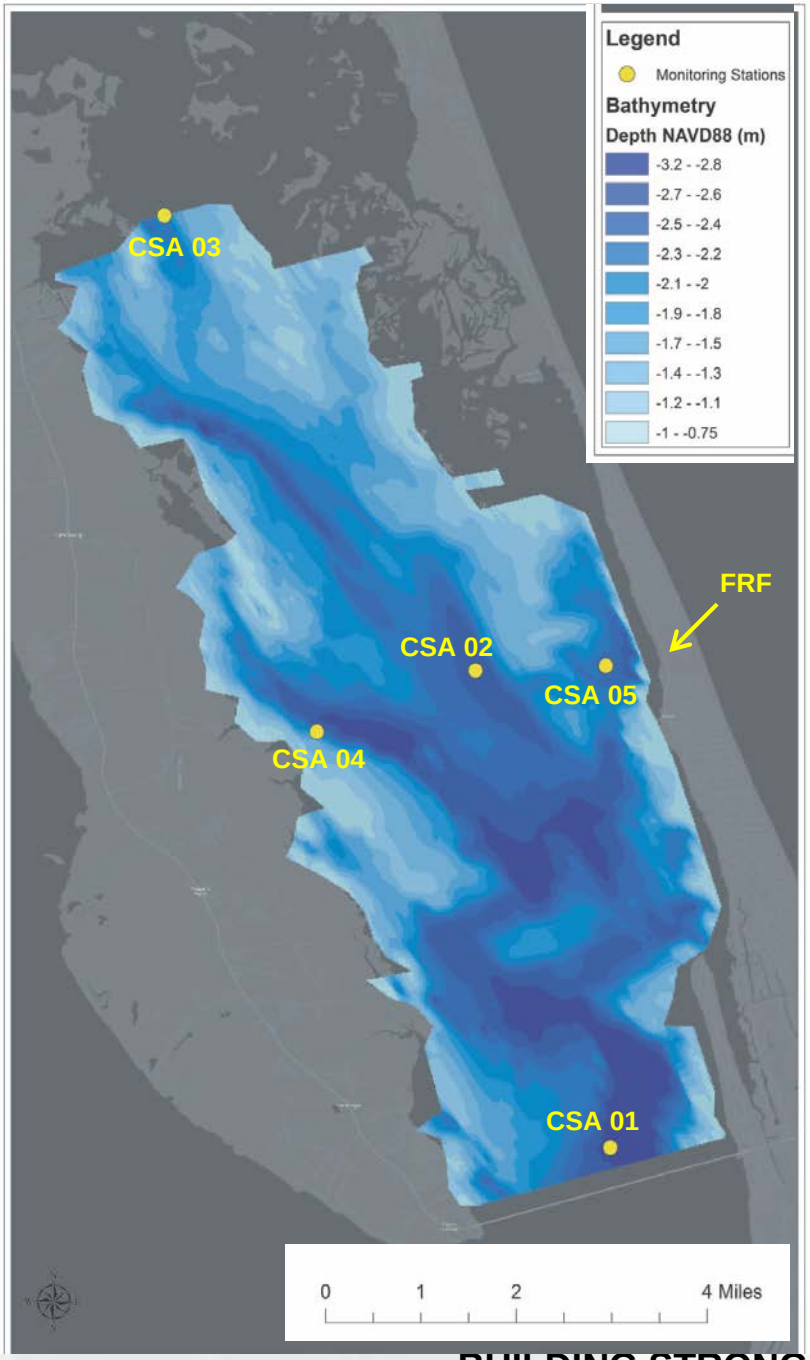
Currituck Sound Monitoring Array

Five monitoring platforms
- Along-estuarine and cross-estuarine arrays

"Channel" and "Shoal" environments

"Shoal" location actually restricted by scope of existing SAV beds

Additional platform in Albemarle Sound (UNC-CSI)



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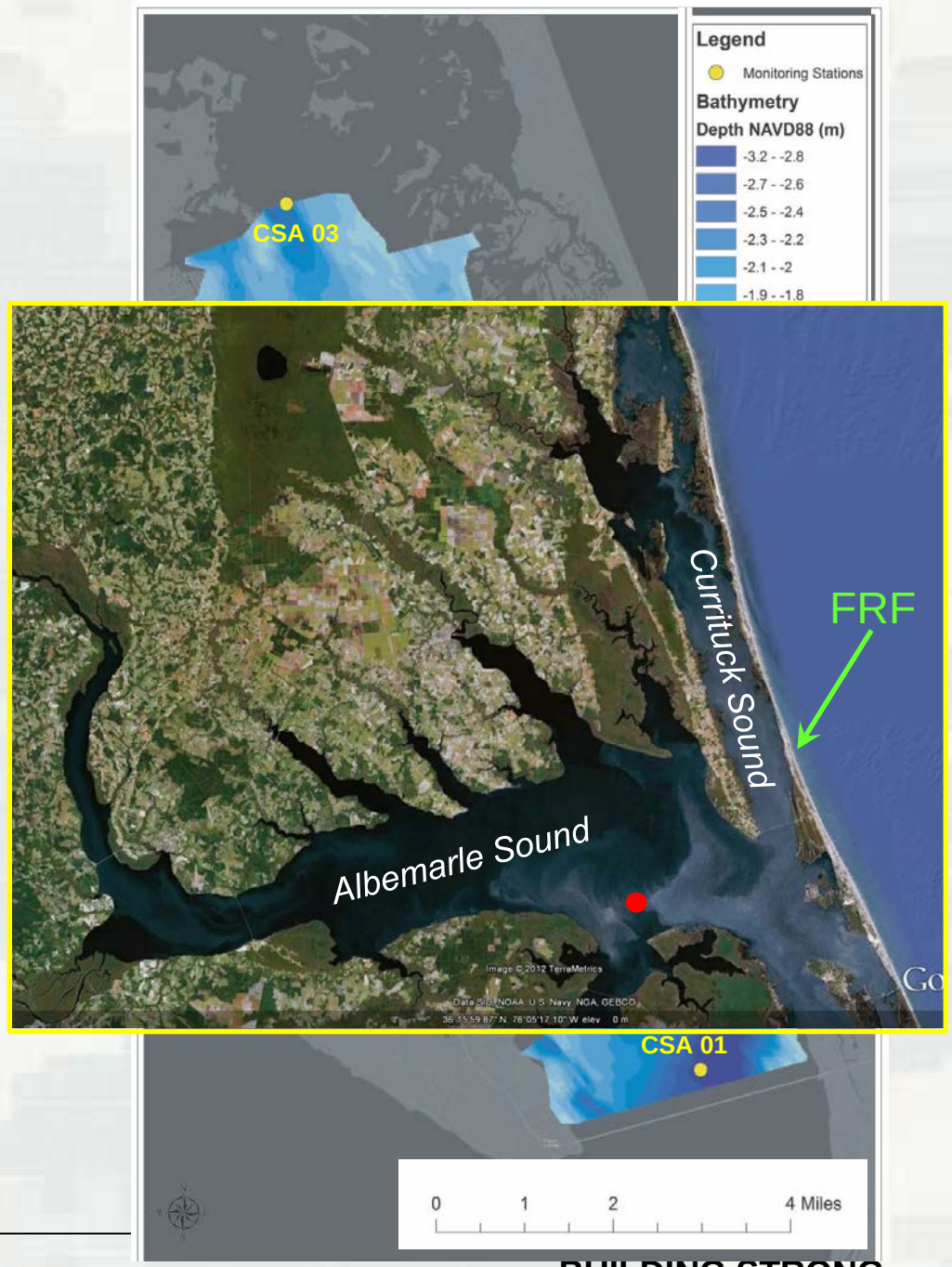


Currituck Sound Monitoring Array: Instrumentation

Measurements – Every Station:

Winds, waves, currents, water level

Temperature and salinity

Near-surface and near bottom turbidity

Measurements – Select Stations:

Light Attenuation *** Most extensive suite of long-term, real-time, estuarine LA measurements in the world ***

Bed elevation change

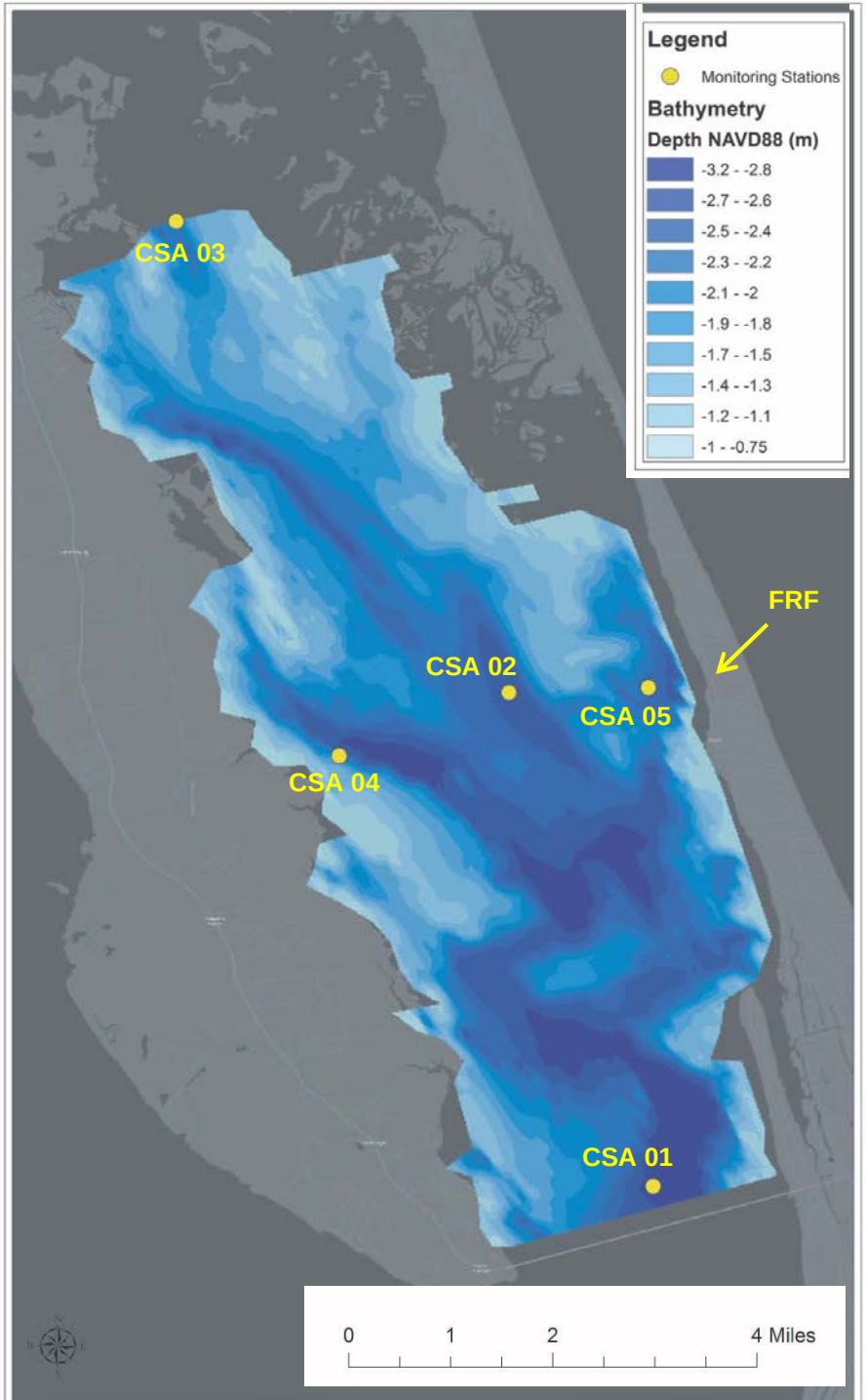
Water quality (*CT, pH, DO, Turb, Algae, FDom)*

Air temperature & humidity

Full 50’ wind profile

Infrastructure – Power & Data Logging/Streaming (CHL Data Portal)

http://navigation.usace.army.mil/CHL_Viewer/FRF/



How does the new Currituck Sound Array help RSM?

Establishes long-term, real-time monitoring of multiple key estuarine processes.
- -- Needed to address SoNs

Provides structure on which to conduct multiple scientific and/or testbed experiments
- -- Allows for controllable field environment

Provides access to CHL's Field Research Facility tools and expertise
- -- Know how to work in the coastal zone
- -- Ability to "manipulate" the natural environment… and measure the result.

Initial Research Questions:

Basic, RSM & SoN-Related Research

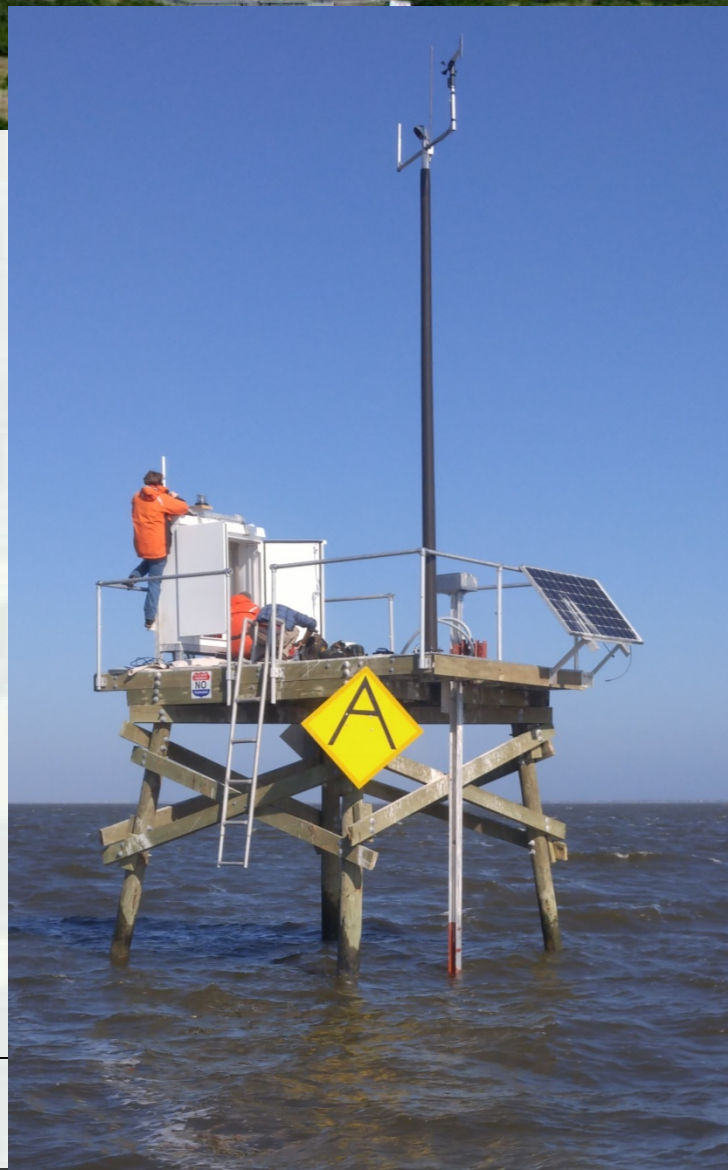
What are the relative roles of wind forcing versus seiching and/or tides on observed water level fluctuations?

How might these change under differing physical conditions (e.g. inlets opening/closing; sea level rise)?

Help Address:

Accretion rate of coastal wetlands experiencing relative sea level rise

Guidance and tools for calculating integrated coastal resilience



Initial Research Questions:

Basic, RSM & SoN-Related Research

What controls light attenuation in shallow estuaries?

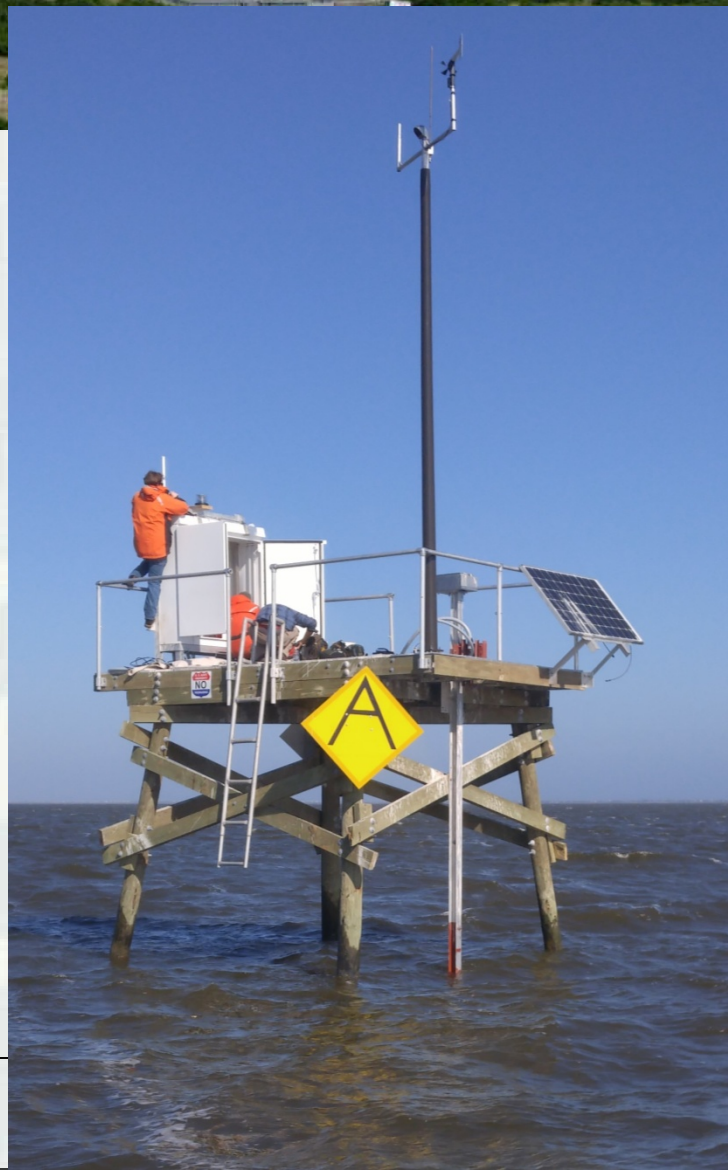
Can we predict periods of high sediment transport versus low, or conditions that support increased productivity?

Can these data be used to improve remote sensing capabilities?

Help Address:

Developing tools useful in testing preventative management strategies of HAB in surface waters.

Remote sensing for water quality monitoring.



Initial Research Questions:

Basic, RSM & SoN-Related Research

What are the relative roles of biology and geology on shoreline stability?

How do the above impact both short-term (storms) and long-term (sea level rise) shoreline change?

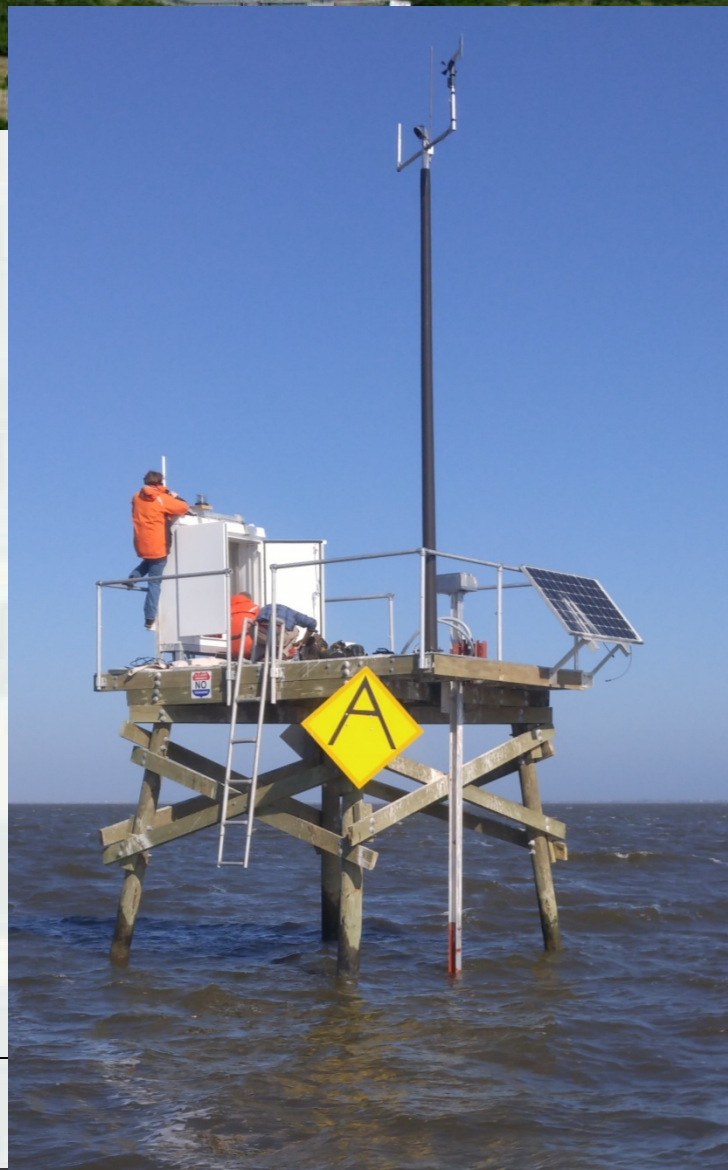
Help Address:

Incorporating vegetation and sediment parameters in nearshore models

Accretion rate of coastal wetlands experiencing relative sea level rise

Living shoreline design guidance

Guidance and tools for calculating integrated coastal resilience



Initial Research Questions:

Basic, RSM & SoN-Related Testbed

Data can be used to improve existing models: hydrodynamic, sediment transport, water quality, morphology…

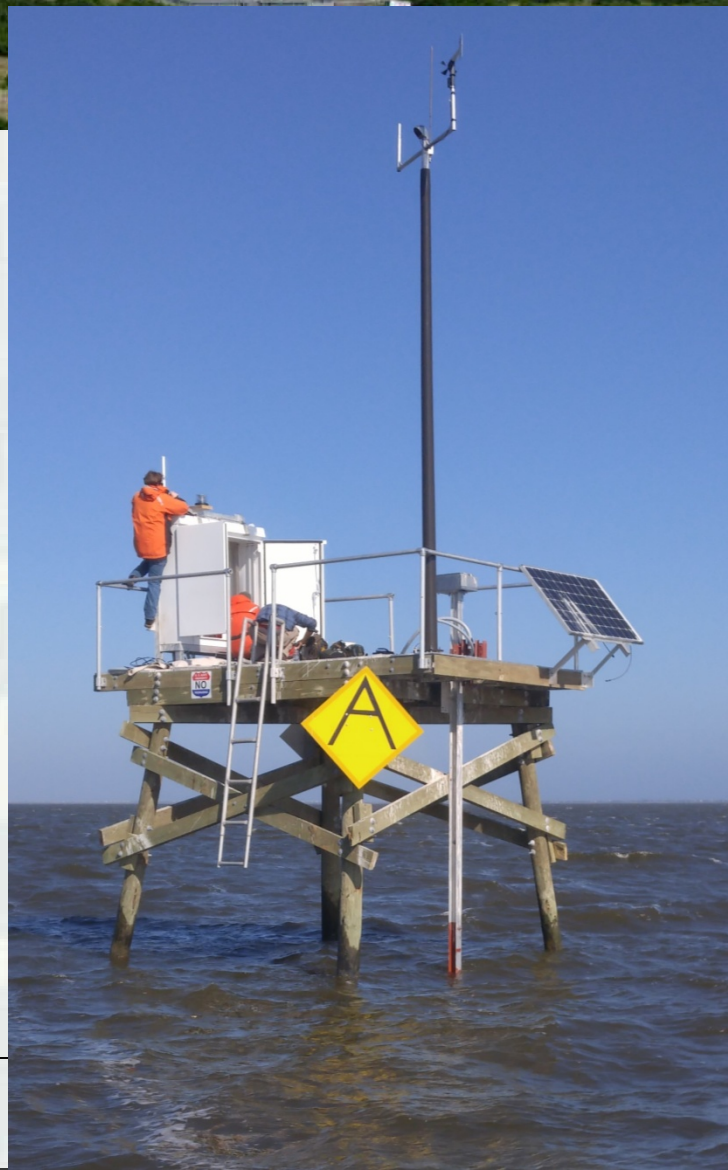
Experiments can be conducted to test novel dredge disposal techniques (such as the efficiency of GAC) and/or locations (such as thin-layer placement on wetlands).

Help Address:

Environmental assessment of dredged disposal areas

Potential for mitigation of dredging impacts on benthic communities

Shallow-water transport and fate of dredged material

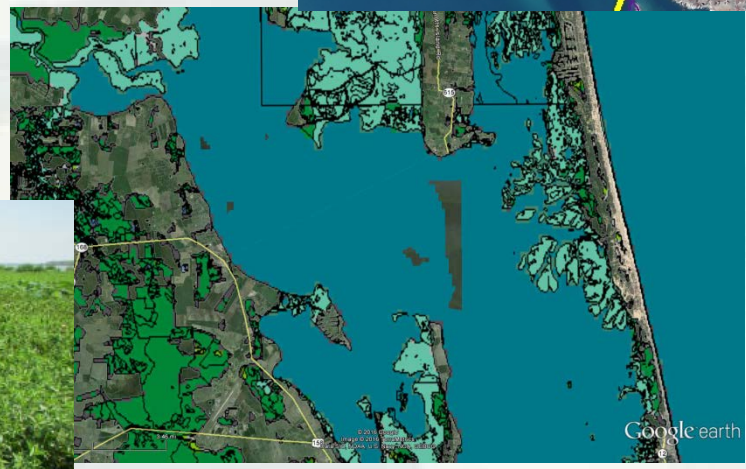


Future research ideas to benefit RSM:

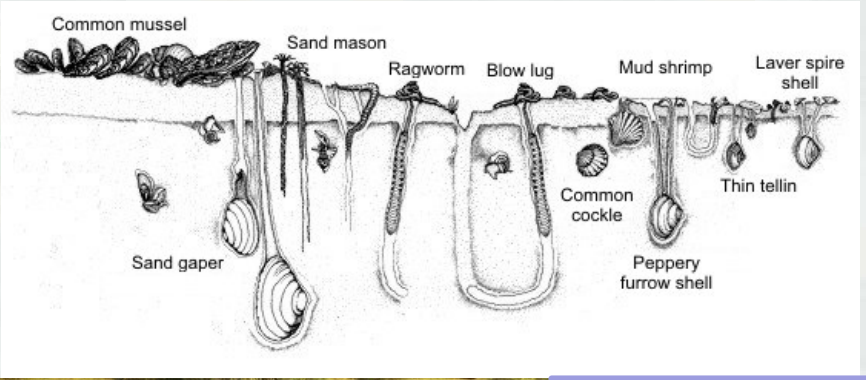
Expanding the implications of the monitoring array to address ecological resource questions

Building long-term datasets of ecological resources

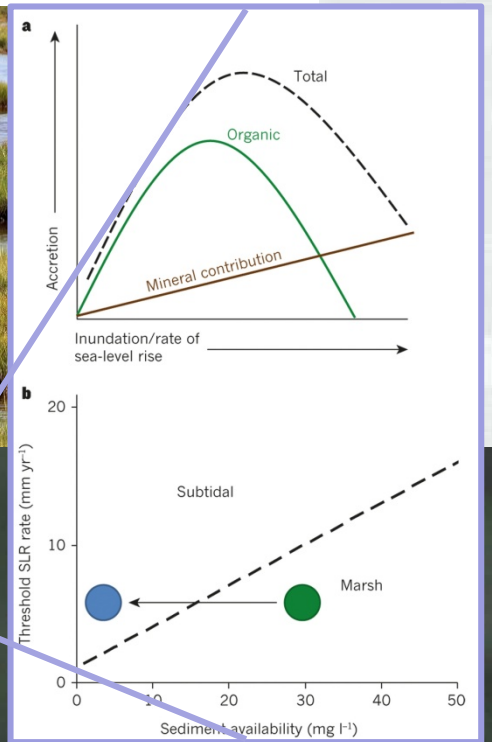
- Establish long term datasets for wetland and SAV habitat distribution and response to disturbances
- Link water quality with wetland distribution, function, and reaction to impacts



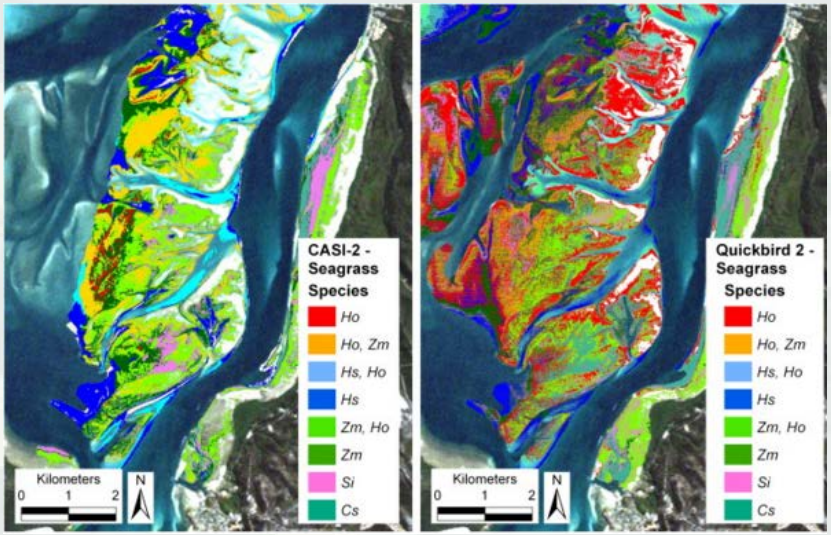
Sediment dynamics and ecological processes



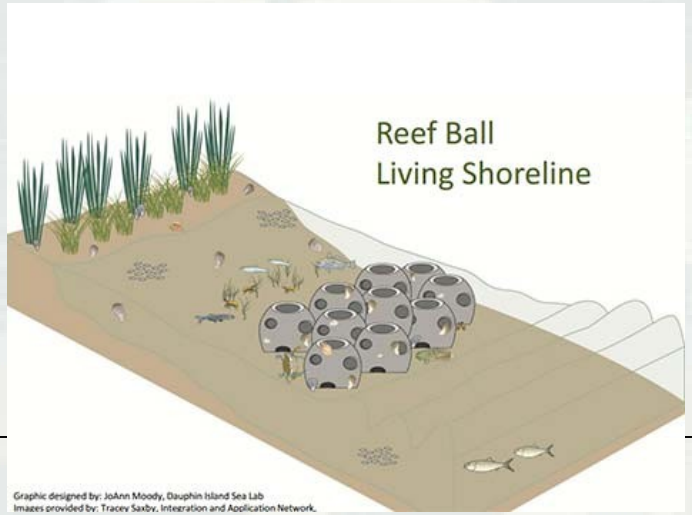
- Examine distribution of benthic communities and recruitment dynamics within different communities
- Isolate the role of episodic sediment inputs in a low tidal environment



Testing monitoring methodologies and novel approaches



Phinn et.al., 2008



- Explore relationships between water quality and remote sensing
- Novel analytical and monitoring technique test bed
- Natural and nature-based feature test bed

Questions and contact information

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CHL Data Portal

http://navigation.usace.army.mil/CHL_Viewer/FRF/