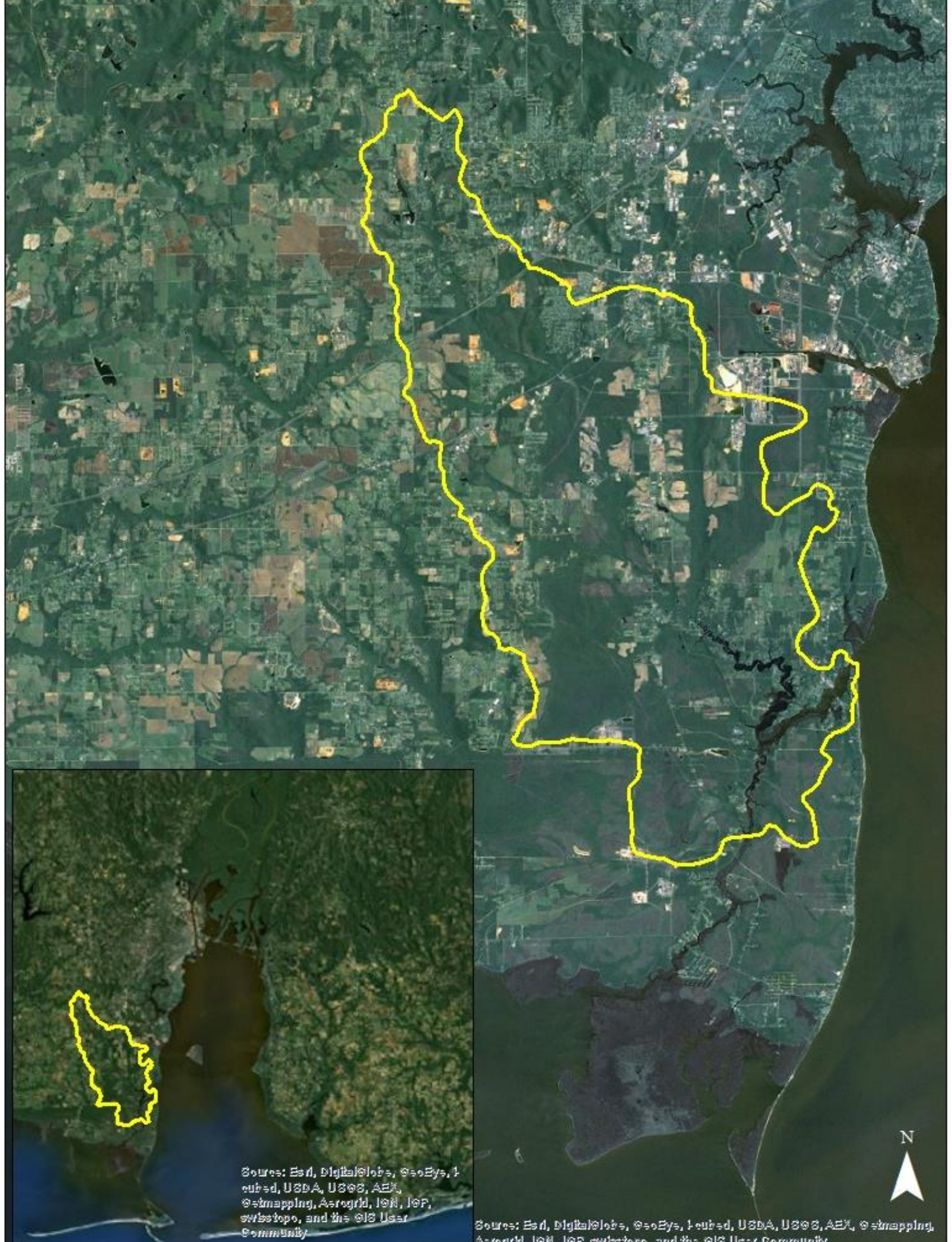
Mobile Bay National Estuary Program SAC Meeting

August 23, 2017



Fowl River Marsh Study

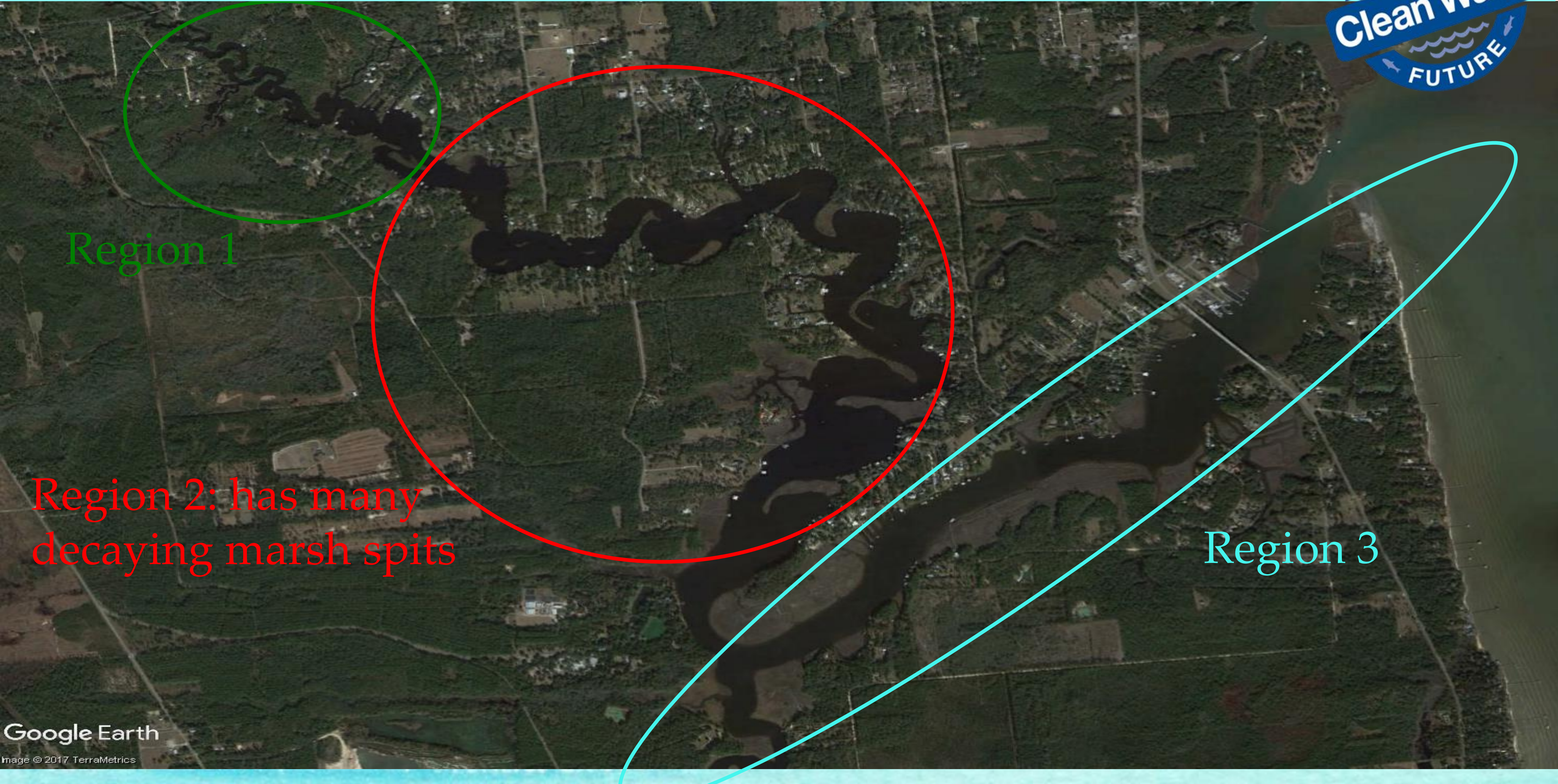
Overarching Purpose (in compliance with the MBNEP Strategic plan): To preserve what people value most about living on the Alabama coast (access, fisheries, heritage, environmental health and resilience, and water quality), while improving the quality of water in Mobile Bay.

Fowl River Marsh Study

Specific goals for the study:

- Characterize the status and health of the wetlands in the River
- Understand the causes of wetland decline observed in many areas of the River
- Inform best-practice engineering designs for wetland restoration and protection

Fowl River Marsh Study



Fowl River Marsh Study

Lost (yellow) Breaching (red) Figure 4.27, pg 145

Changes include narrowing and breaching of spits and point bars; loss of emergent habitat; and fragmentation of marshes.


Photo by S. St. John

Photo by S. St. John

Fowl River Marsh Study

- Study focused on Region 2
- Main goal: Elucidate marsh spit decay (but at the same time also documenting the status and health of marshes in the other Regions)

Fowl River Marsh Study

TABLE 8.2: PRIORITY COASTAL PROJECTS					
Priority (Zone)	Location Name	Length (ft)/ Area (acres)	Est. Cost	Brief Description	Location Diagram
1 (I)	Lightcap	1800 / 1.7	$2.1M	Proposed salt marsh enhancement and protection would include structural stabilization, fill, and appropriate vegetation.	
2 (I)	Tapia	2800 / 4.2	$3.2M	Proposed salt marsh enhancement and protection would include structural stabilization, fill, and appropriate vegetation.	
3 (I)	Strout	1300 / 0.8	$1.5M	Proposed spit and salt marsh enhancement and protection would include structural stabilization, fill, and appropriate vegetation.	
4 (I)	Closing Hole	1700 / 3.2	$2.0M	Proposed spit and salt marsh enhancement and protection would include structural stabilization, fill, and appropriate vegetation.	

Fowl River Marsh Study

- Study focused on Region 2
- Main goal: Elucidate marsh spit decay (but at the same time also documenting the status and health of marshes in the other Regions)
- Three hypothesized mechanisms (acting separately or in conjunction):
  - Sea level rise: Salt intrusion and higher flooding
  - Sediment starvation
  - Boat wakes and wave energy

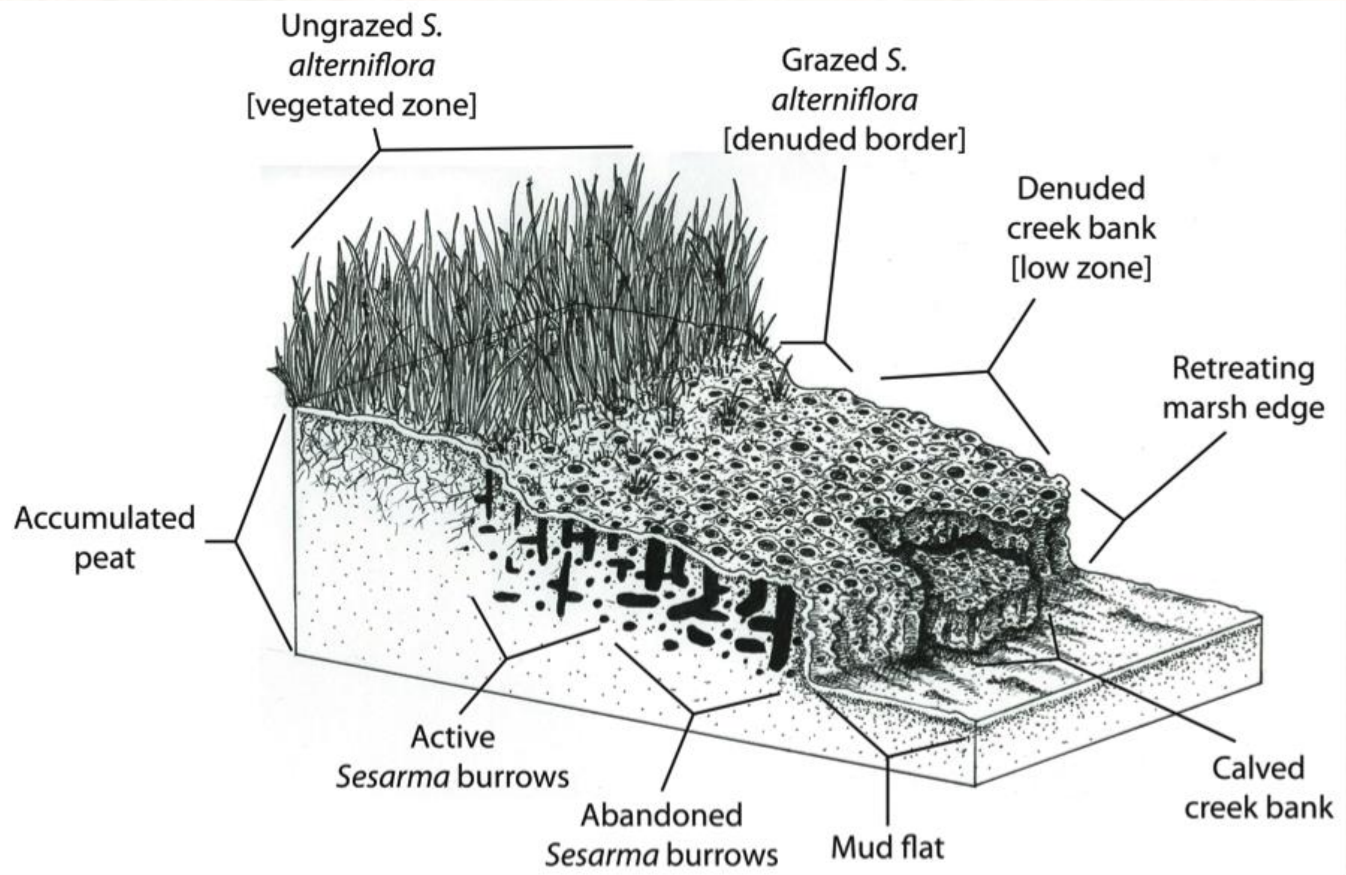
Fowl River Marsh Study

- To look into these mechanisms, the study has three integrated components:
  - Hydrology: salt intrusion, flooding and wave energy
  - Sediments: sediment starvation
  - Vegetation: impacts of these processes on the wetlands

Fowl River Marsh Study - Hydrology

Hypotheses

- Hydrologic variability drives differential sedimentation rates in the marshes of Regions 1, 2, and 3
- Marsh soil properties such as porewater salinity and sediment grain size and organic matter content are linked to hydrologic dynamics in the Fowl River estuary
- Boat wakes are a dominant erosion term on spit/marsh edges

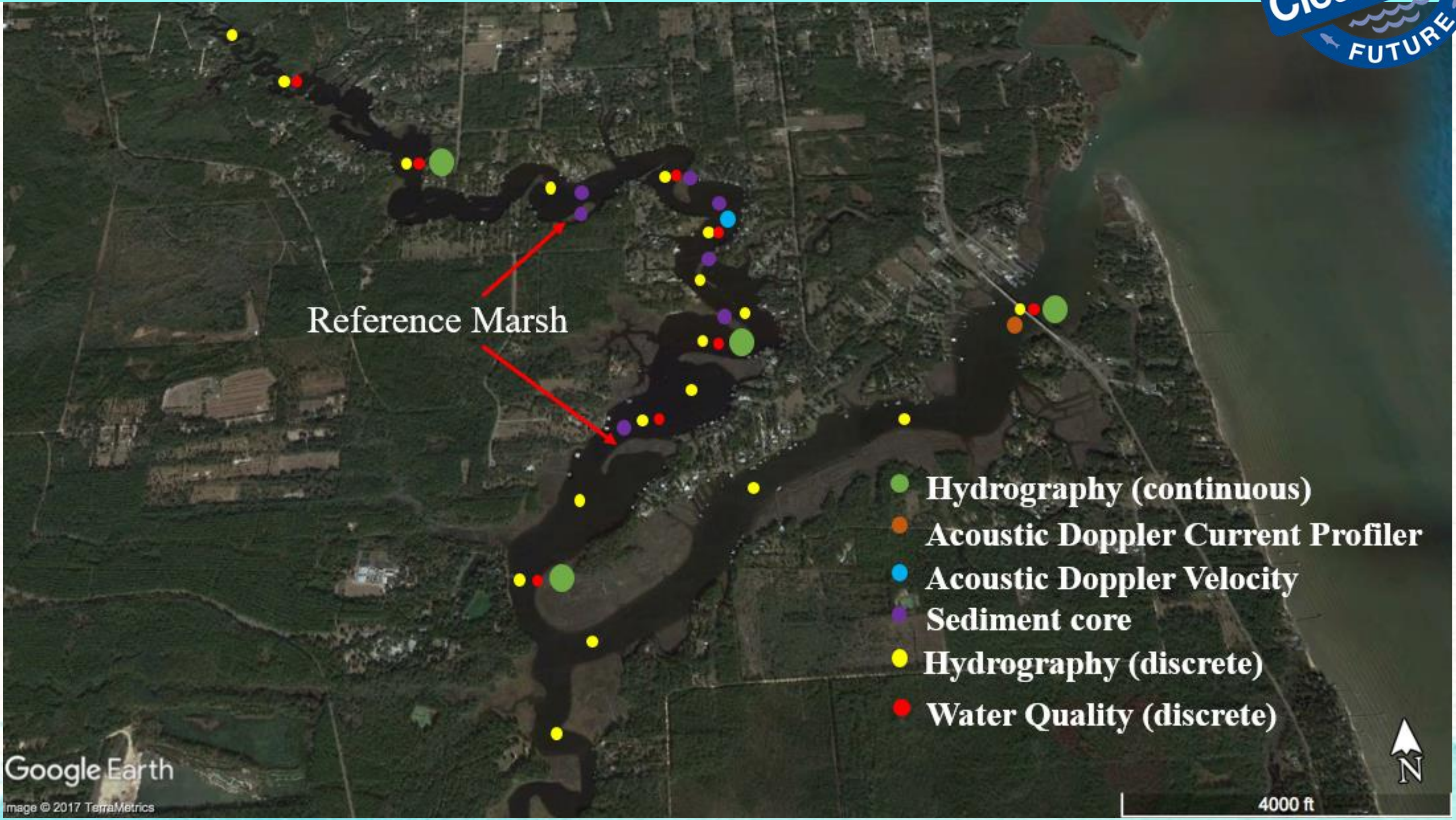


Fowl River Marsh Study - Hydrology

Objectives

- Identify monthly and seasonal cycles in the water and salt budgets for the system
- Characterize the high frequency temporal and spatial variability in the vertical and horizontal salinity structure of the system during summer season when marsh growth is at maximum
- Determine the main drivers controlling the extent and duration of salt intrusions into the system
- Develop quantitative relationships between the river discharge, water level, and wind to estimate hydrologic variables at specific restoration sites.
- Determine the relationship between salinity dynamics and transport of nutrients, organic matter, O_2, and suspended sediments in the system
- Assess the magnitude and frequency of boat wakes that impinge upon the marsh edge

Fowl River Marsh Study - Hydrology



Fowl River Marsh Study - Hydrology

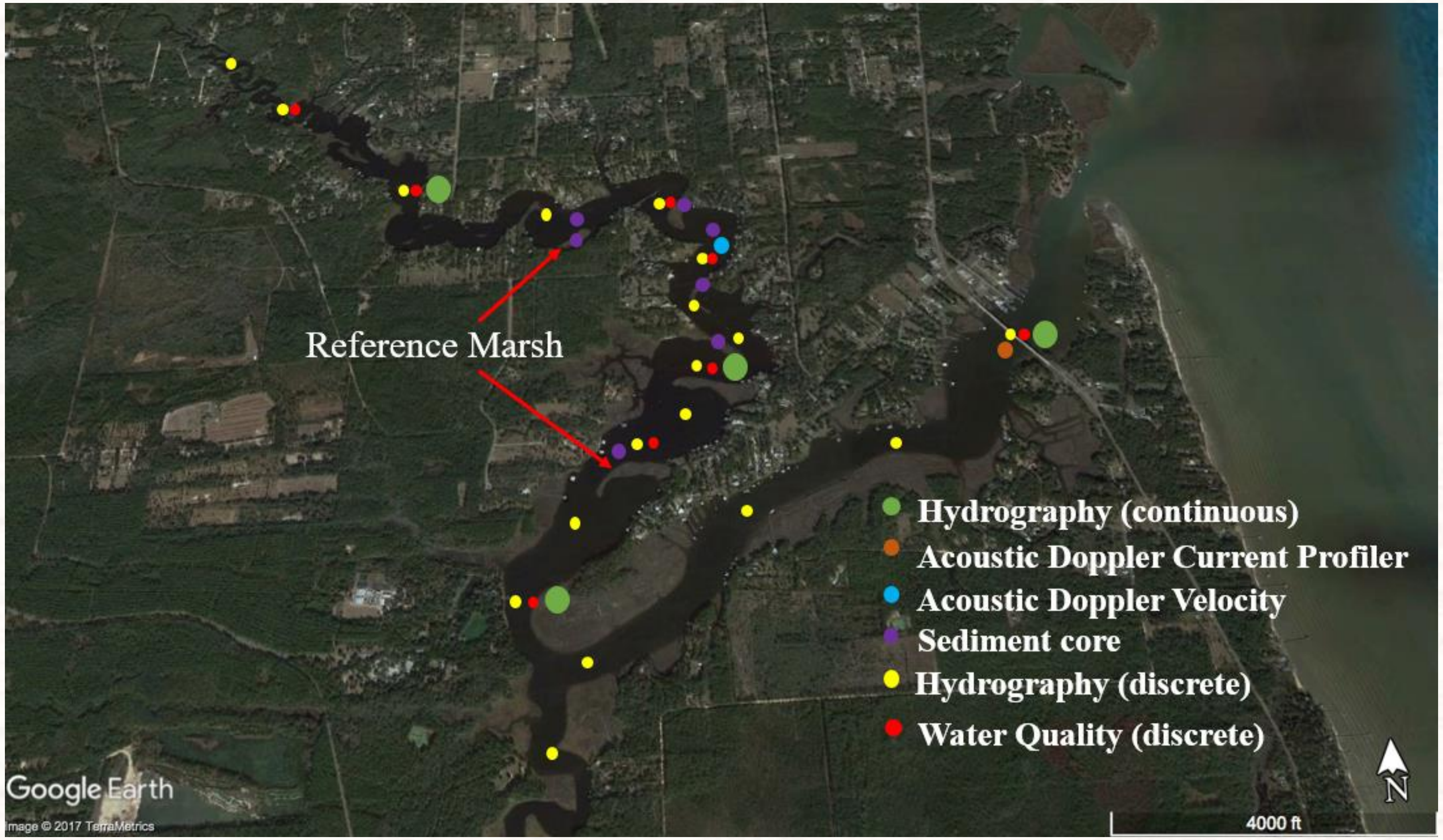
Continuous Measurements

- One eight week deployment
- YSIs for temperature, salinity, O_2
- Currents
  - Surface, Acoustic Doppler Velocity
  - 3D, Acoustic Doppler Current Profiler
- Wave gages
- Existing measurements
  - Discharge and stage at Fowl River gauge (USGS)
  - Water Surface Elevation (WSE)at the Fowl River bridge (NOAA)
  - WSE, T, S, O_2 from mymobilebay.com

Fowl River Marsh Study - Hydrology

Discrete Sampling - monthly

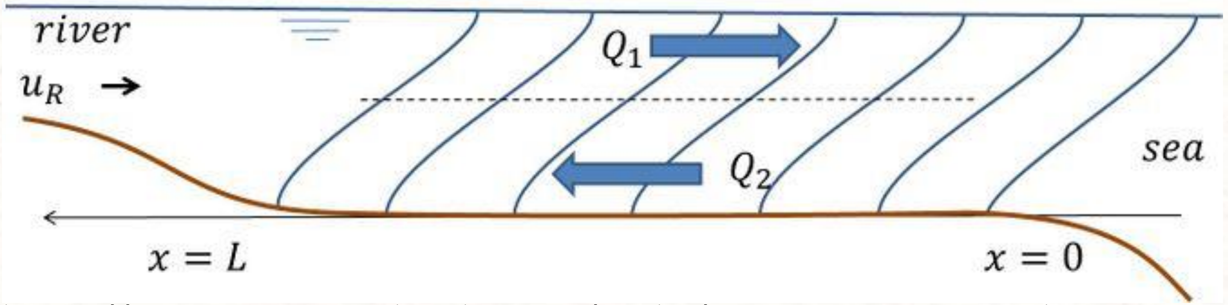
- Hydrography
  - 18 stations
  - Conductivity, temp, depth, salinity, O_2
  - vertical profiles
- TSS, nutrients, organic matter, Chla
  - 8 stations
  - Surface and bottom



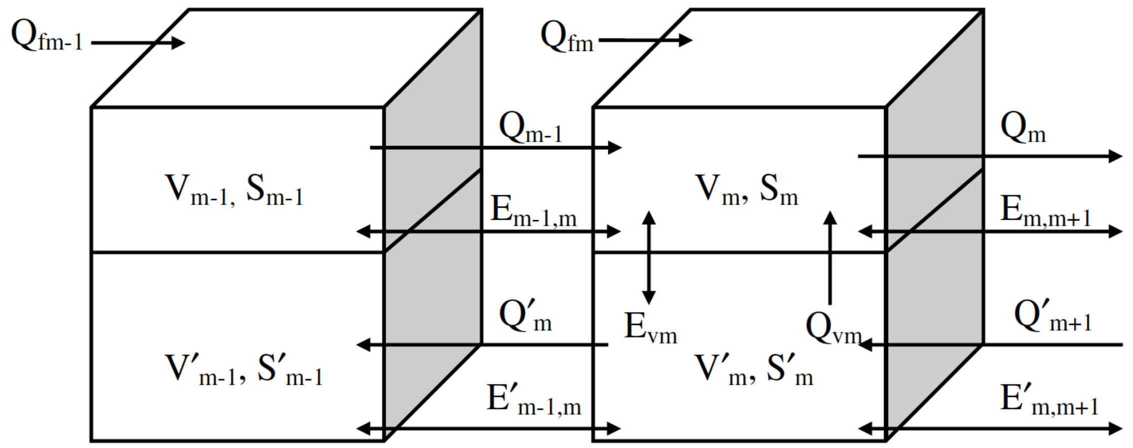
Fowl River Marsh Study - Hydrology

Outputs

- Characterization of regional means and variability in hydrologic variables
- Cause-effect relationships between physical forcing and hydrologic variables
- Budgets of water, salt, TSS, nutrients, and organic matter



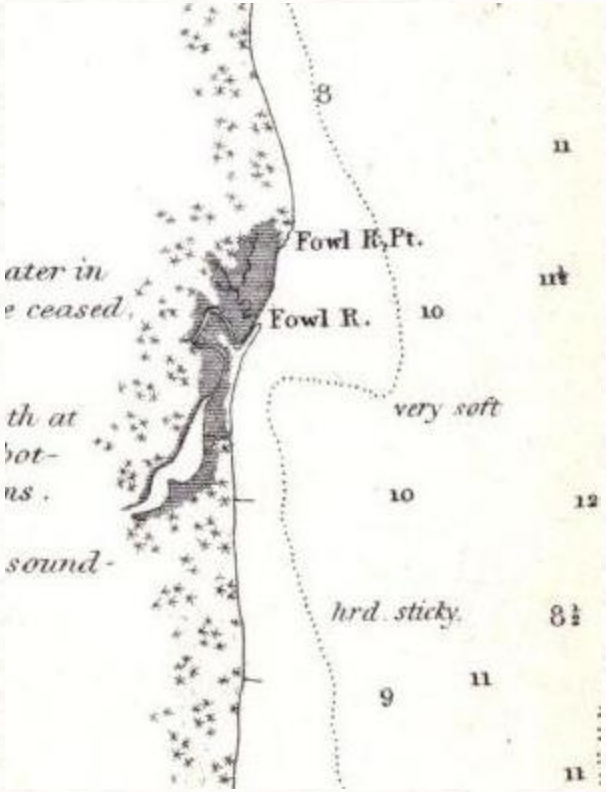
http://www.coastalwiki.org/wiki/Estuarine_circulation



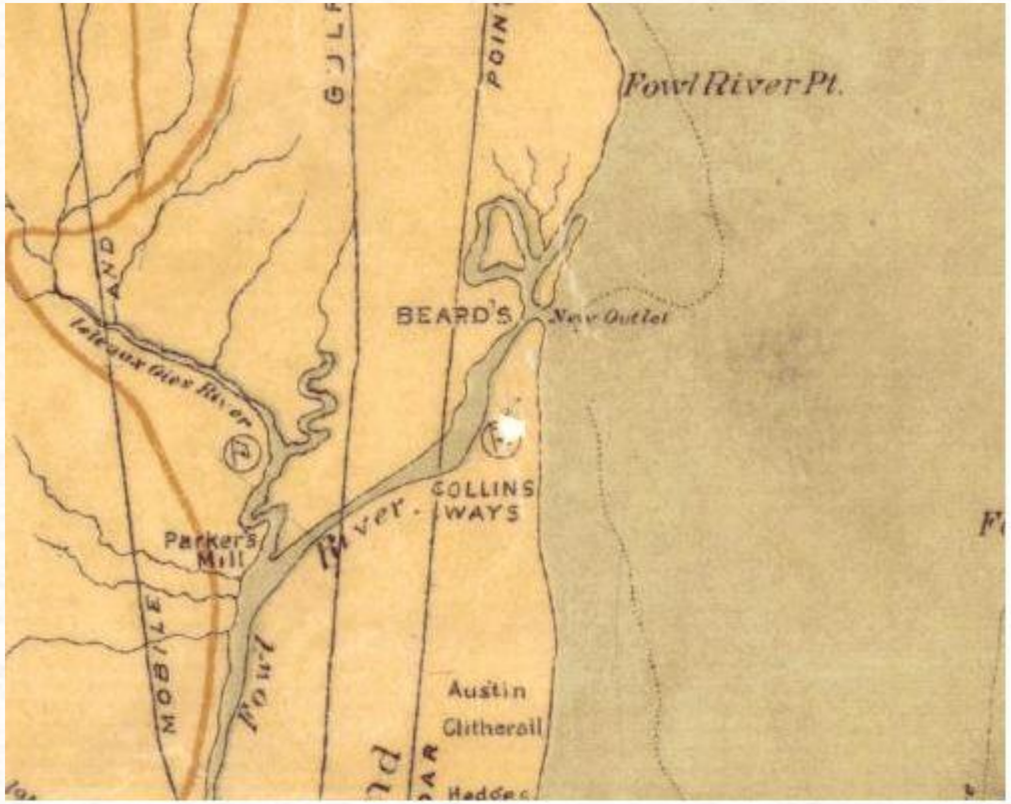
Conceptual model for salt and water budgets (Lehrter 2008)

Fowl River Marsh Study - Sediment

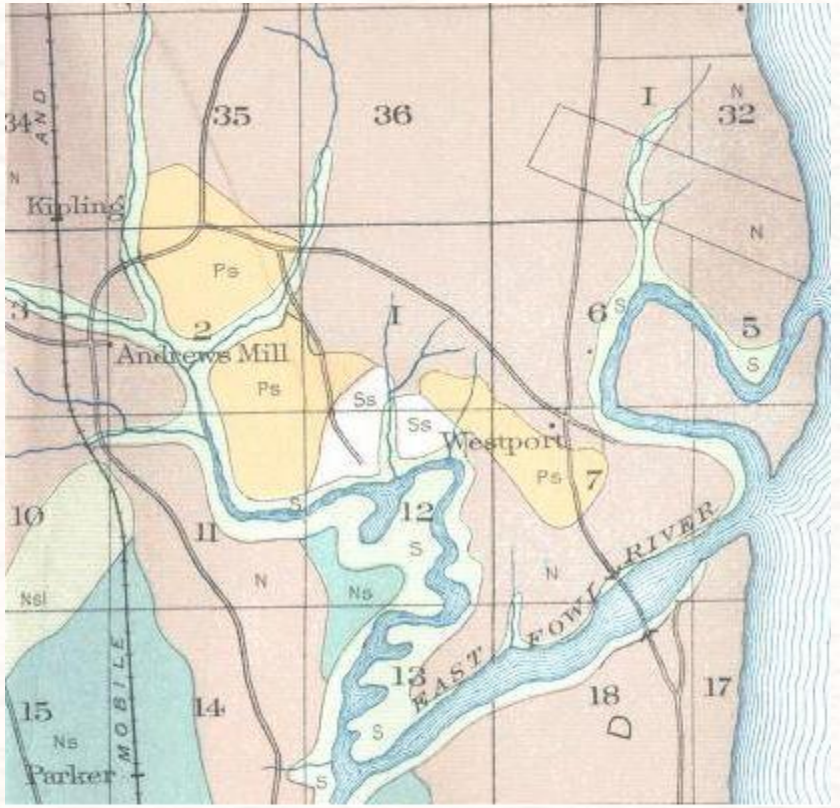
Geomorphic Variability in Fowl River



1852



1889

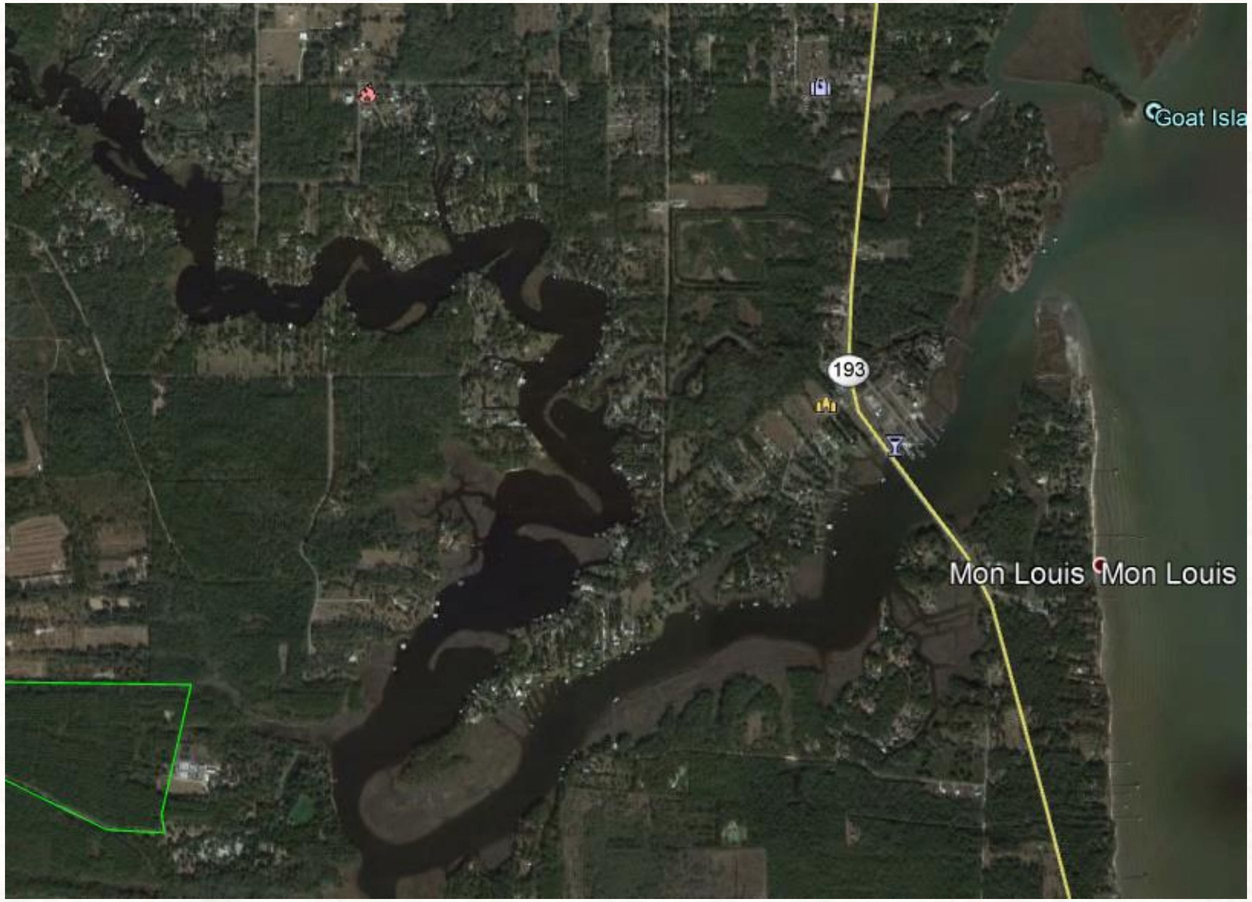


1911

Fowl River Marsh Study - Sediment

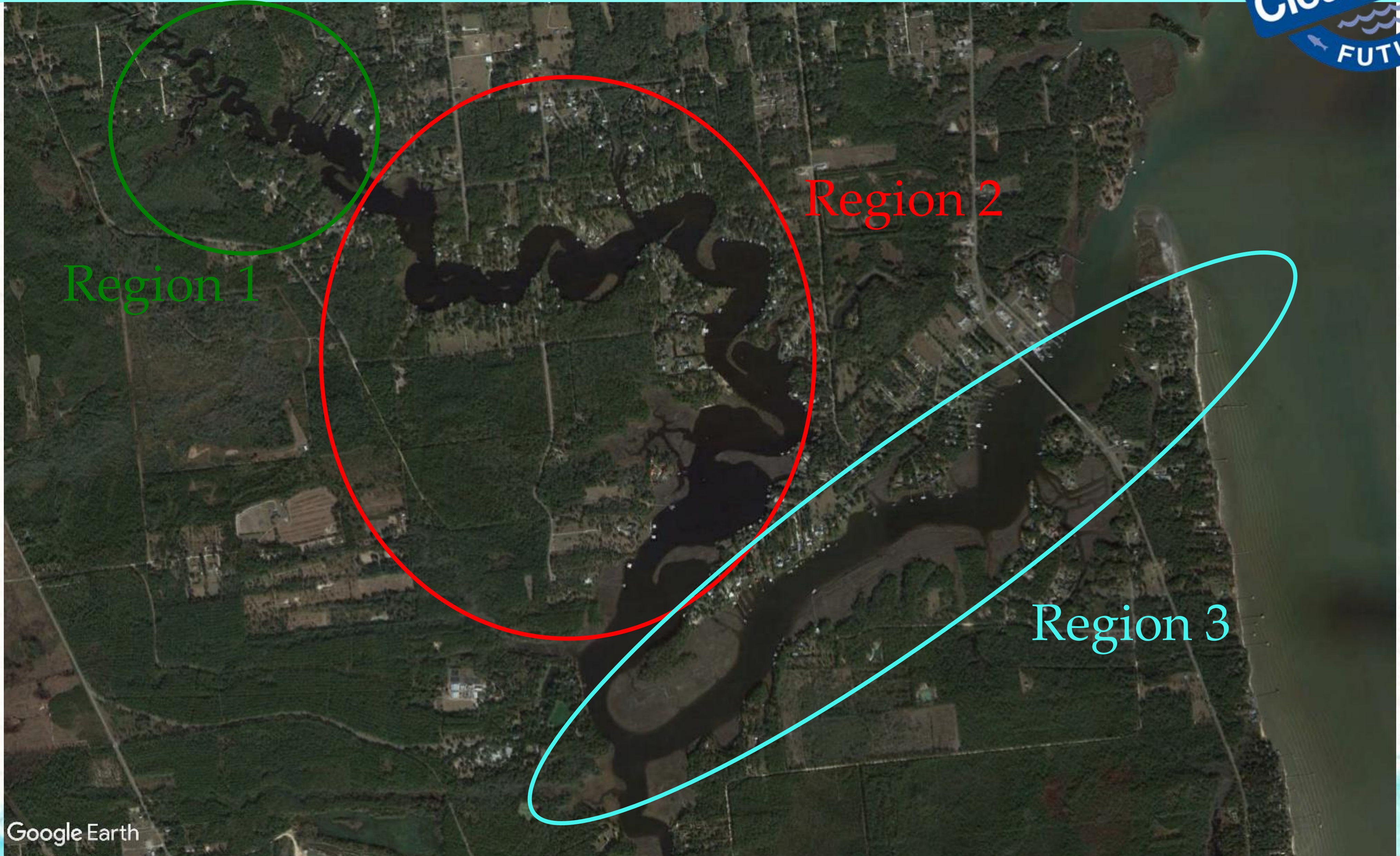
Geomorphic Variability in Fowl River

1938



2016

Fowl River Marsh Study - Sediment



Fowl River Marsh Study - Sediment

Questions:

1. What is the current sediment supply, fate, and transport in Fowl river?

2. What is the current sediment accretion/erosion rate in the marshes?

3. How do the current sediment conditions compare to the past?

Fowl River Marsh Study - Sediment

Questions:

1. What is the current sediment supply, fate, and transport in Fowl river?

   Dynamic Sediment Transport and Water-Quality Assessment

2. What is the current sediment accretion/erosion rate in the marshes?

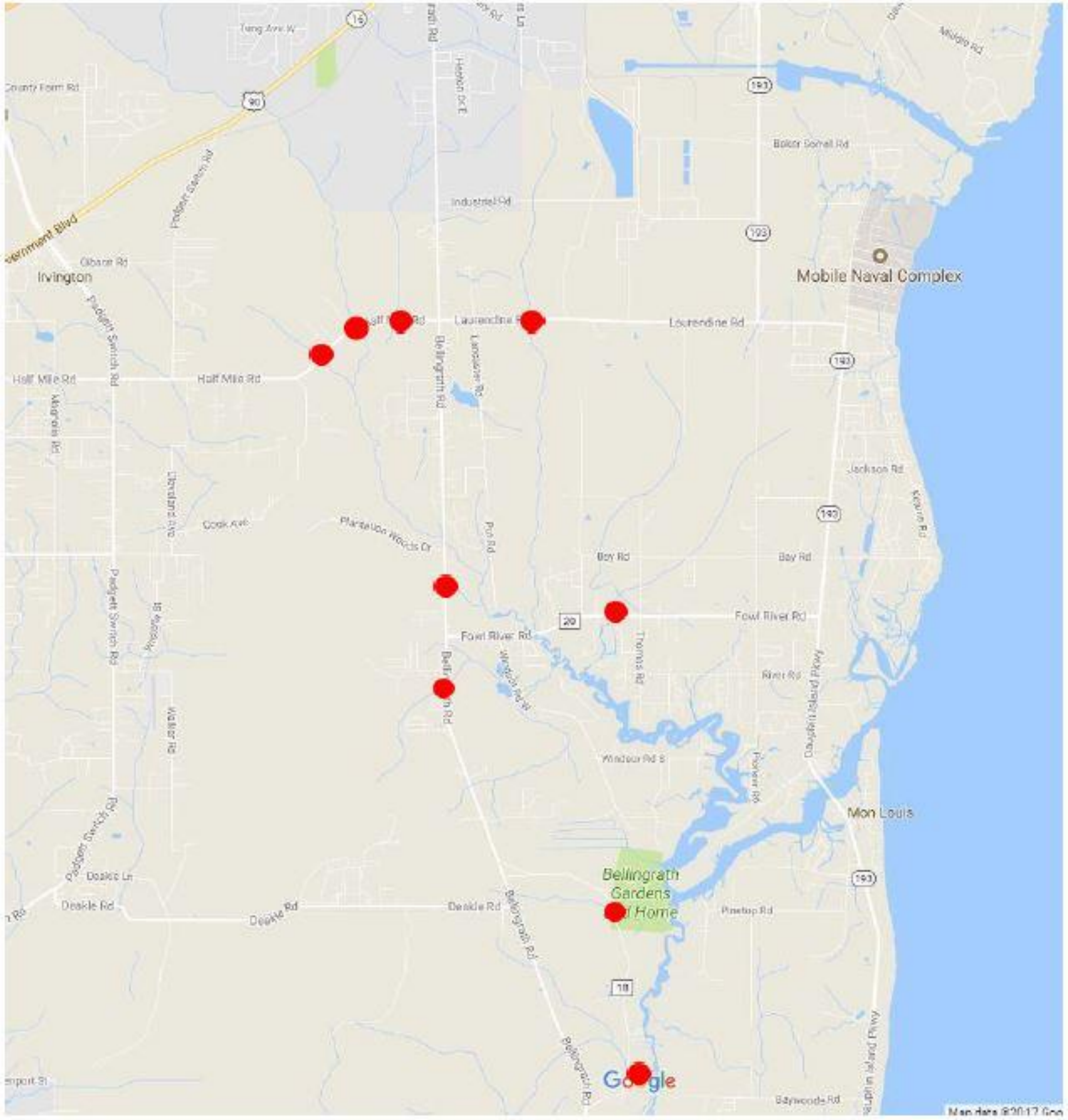
   Marsh feldspar horizon and sediment marking pins (vegetation)

3. How do the current sediment conditions compare to the past?

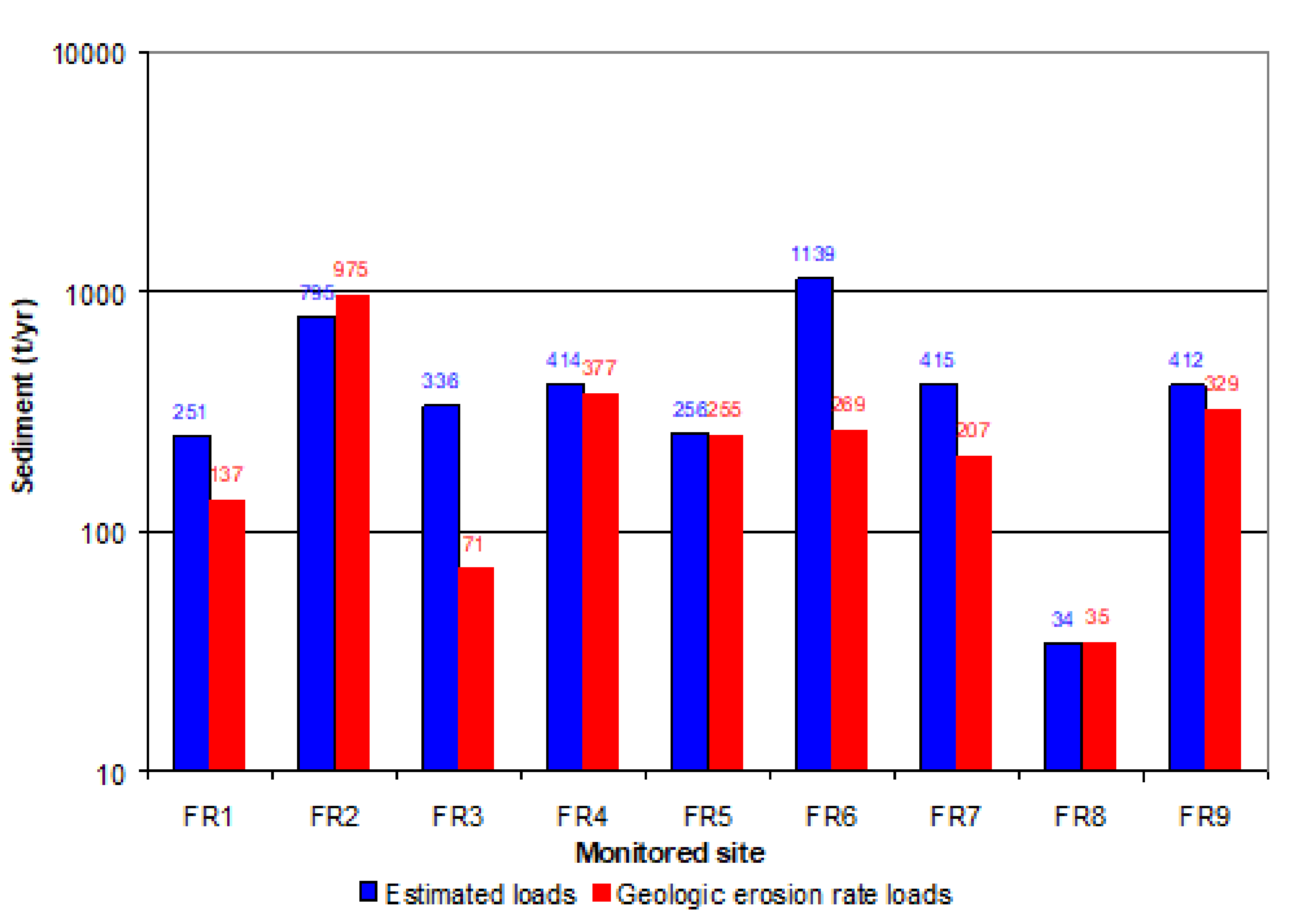
   Deep sediment core analysis

Fowl River Marsh Study - Sediment

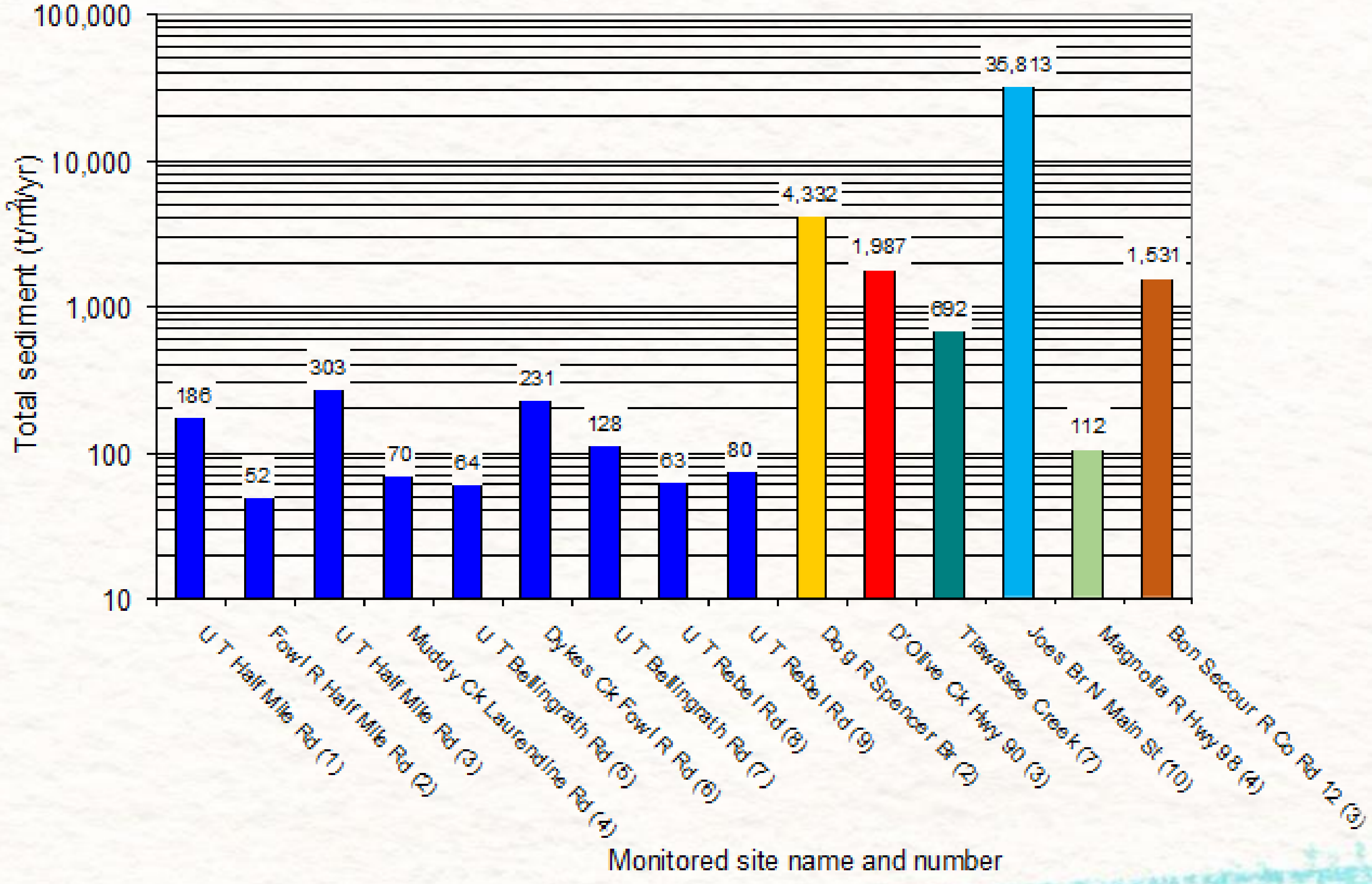
Previous
Fowl River
Water-Quality
and Sedimentation
Assessment
2015



Fowl River Marsh Study - Sediment



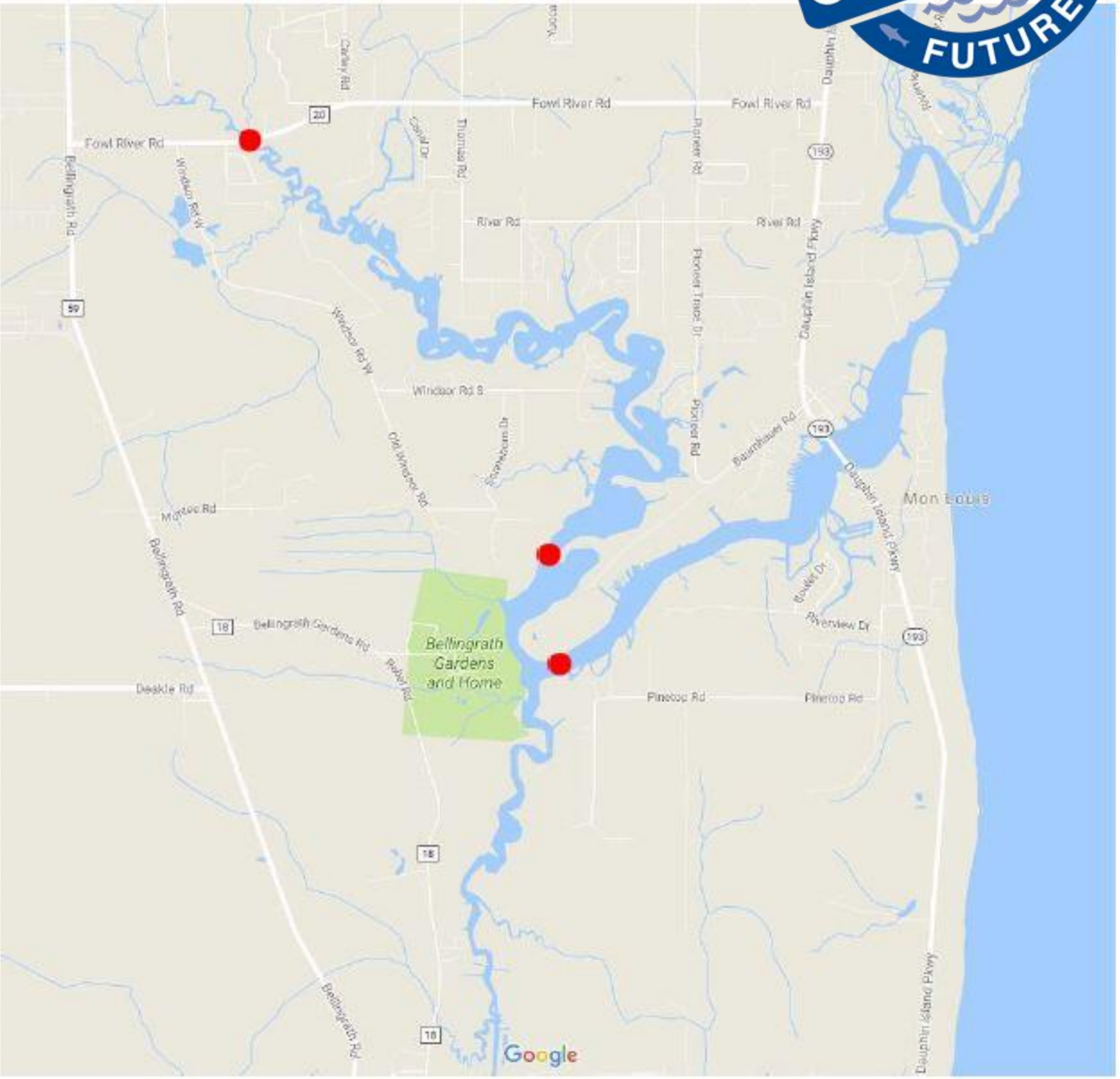
Fowl River Marsh Study - Sediment



Fowl River Marsh Study - Sediment

Dynamic sediment transport – eight events

- Continuance of 2015 sedimentation and water quality assessment
  - TSS, pH, DO, turbidity, salinity, conductivity, temp, erosion/accretion
  - Bed sediment, channel profile, flow and regression establishment



Fowl River Marsh Study - Sediment

Sediment Transport:

- Measure or estimate stream discharge over a range from low to high flow at 3 monitoring sites in the lower reach of Fowl River (minimum 8 monitored events per site).
- Collect field parameters at 3 monitoring sites for each monitored discharge event, including pH, specific conductance, turbidity, temperature, dissolved oxygen, salinity, total dissolved solids, and oxidation/reduction potential.
- Collect bed sediment samples at 3 sites. Bed sediment will be visually described, dried, weighed, and sieved.
- Collect water samples at 3 monitoring sites for each monitored discharge event (minimum of 8 monitored events per site) and submit samples to a certified geochemical laboratory for analysis of TSS concentrations.
- TSS concentrations and stream discharge will be used with the Regression with Centering digital model to estimate suspended sediment loads at each monitored site. Water samples will be collected to establish vertical and horizontal profiles to evaluate variations in sediment content, salinity, and field parameters related to depth and channel position.
- Establish regressions for sediment loading and selected field parameters at each monitoring site.

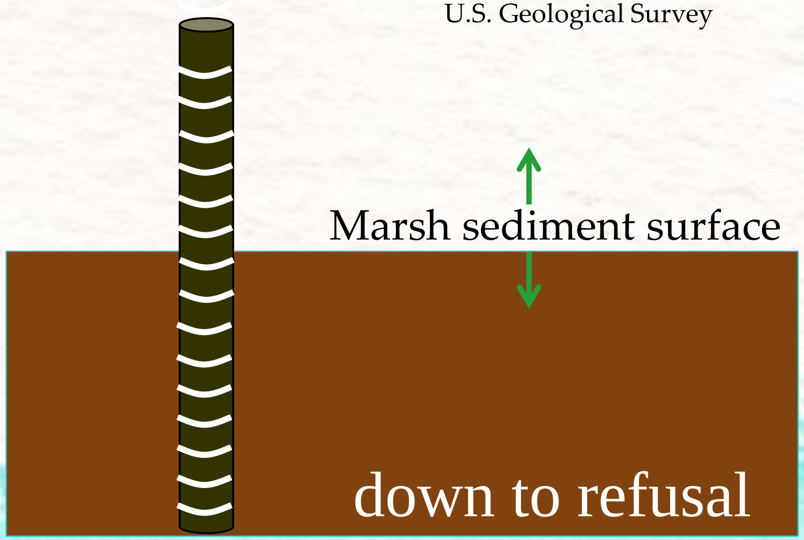
Fowl River Marsh Study - Sediment

MARSH SEDIMENT ACCRUAL/EROSION

Horizon markers: feldspar

U.S. Geological Survey

Sedimentation pins



Fowl River Marsh Study - Sediment

Deep piston cores (<3m) from marshes and channel

Discretized measurements from each core:

- Grain size distribution
- Grain shape
- Mineral content
- Carbon content
- Radiometric dating (^{14}C, ^{137}Cs, ^{210}Pb)
- Isotope analysis

Fowl River Marsh Study - Sediment

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- Isotope analysis

How has lithology changed over time?

How has deposition changed over time?

Fowl River Marsh Study - Sediment

Sampling locations

- Zone II
  - Eight cores in spits
  - Two channel cores
  - One dynamic sediment transport site
- Zone I & III
  - Four channel cores
  - Two cores reference marsh
  - Dynamic sediment transport
    - One at Fowl River Rd.
    - One downstream of E. Fowl River confluence.
    - Historic sites

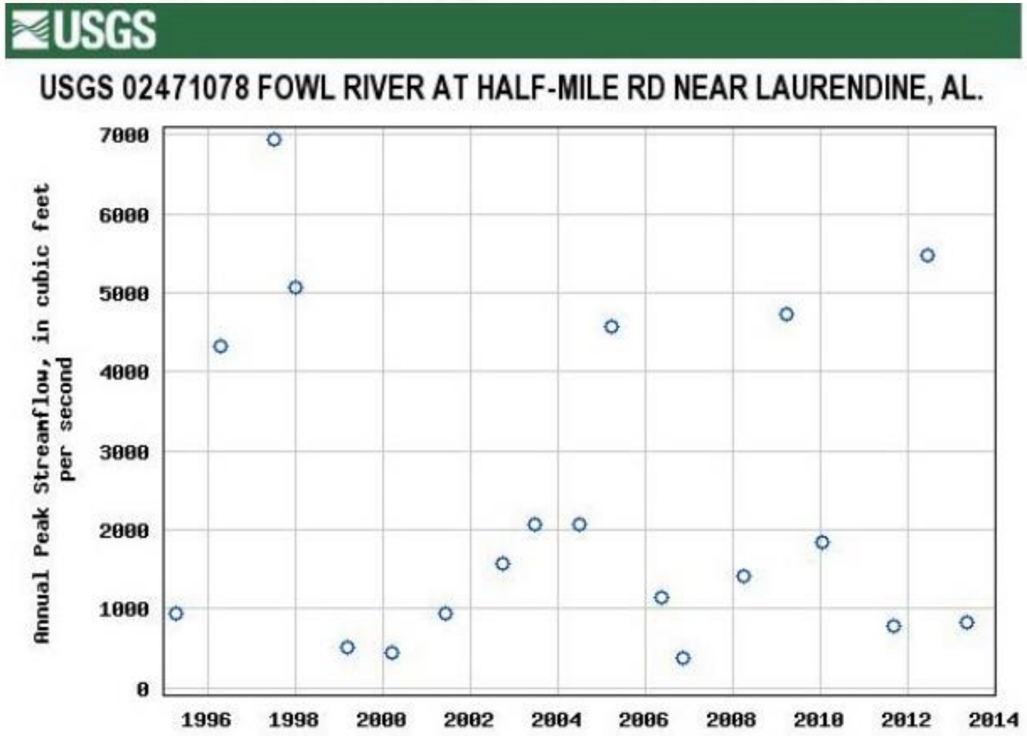
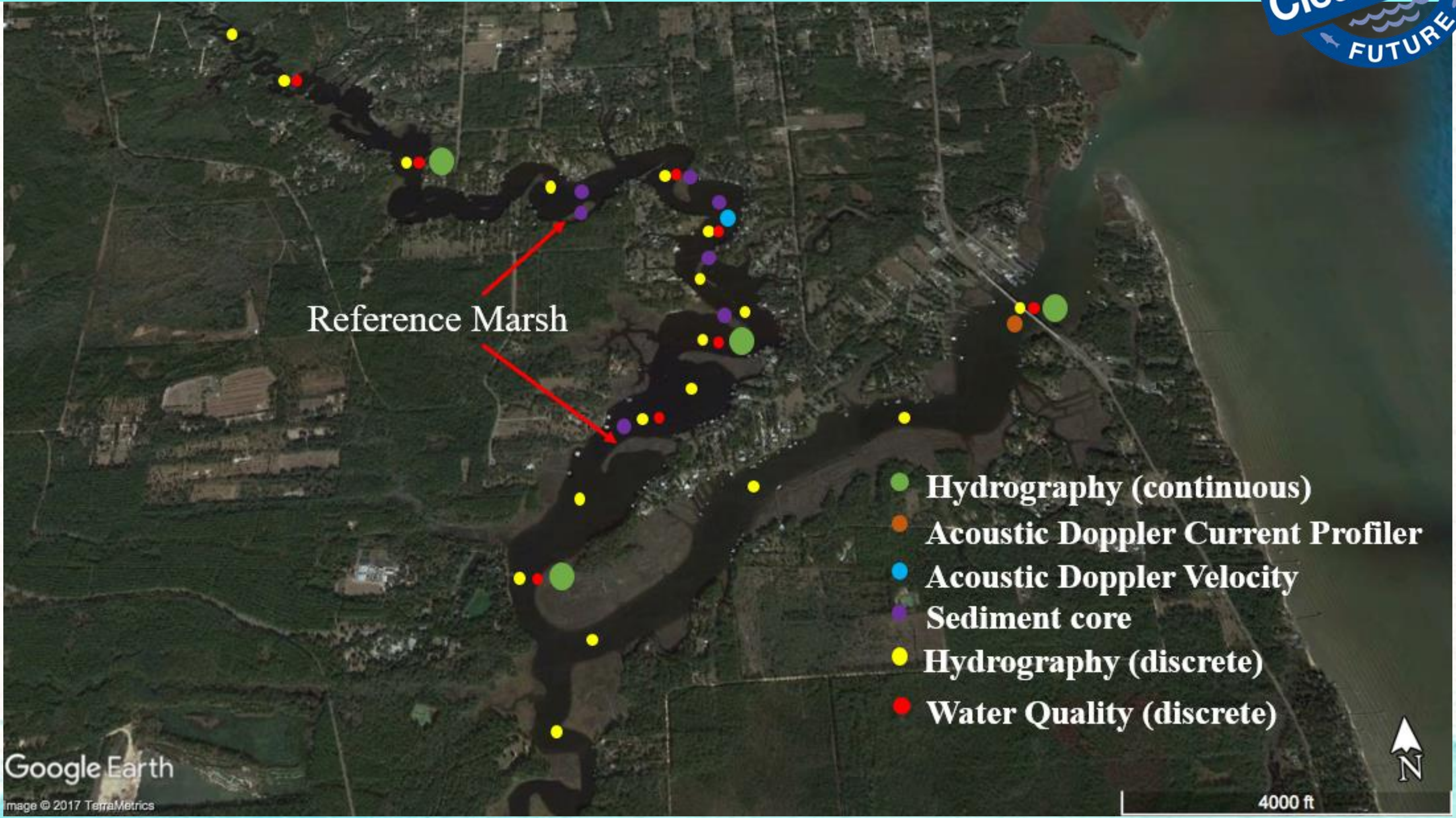


Figure 4.36: Record of annual peak streamflow (cfs) on Fowl River for the period 1995 to 2015

Fowl River 1938, credit Kane Family

Fowl River Marsh Study - Sediment



Fowl River Marsh Study - Vegetation

Measurements:

1) Plant species diversity, % cover, distribution
2) Plant community zonation
3) Habitat quality indices – HGM and FQI

Measured in Summer

4) Plant morphology and productivity
5) Marsh elevation
6) Sediment erosion/accrual on the marsh

Measured in Spring and Fall

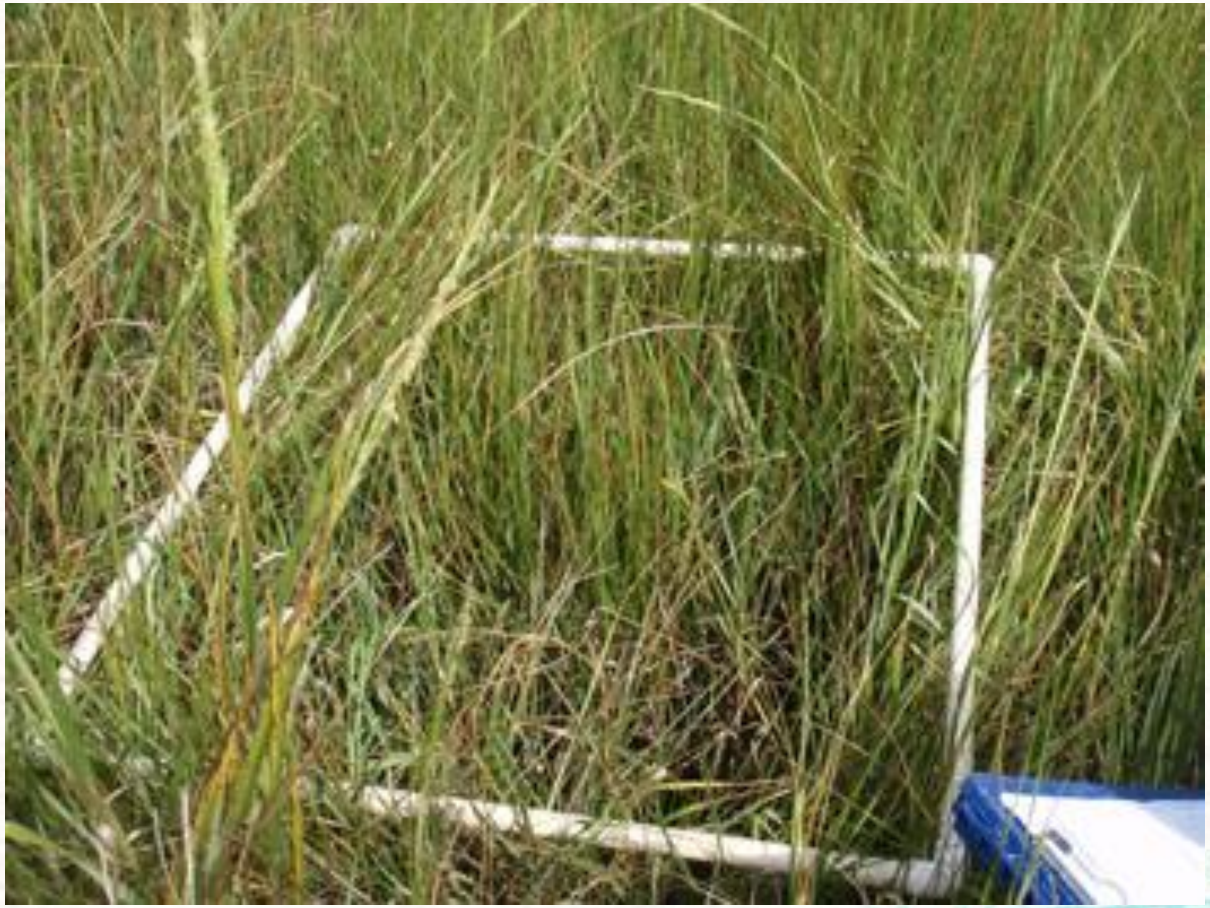
7) Marsh porewater measurements:
   - Monthly measurements of salinity, oxygen and sulfide
   - Continuous records of salinity and water level

Fowl River Marsh Study - Vegetation

PLANT SPECIES DIVERSITY, % COVER, AND DISTRIBUTION

Percent coverage will be measured within 1-m^2 quadrats placed along the study transects, and also haphazardly to account for site heterogeneity.

All plant species will be identified.



Fowl River Marsh Study - Vegetation

PLANT COMMUNITY ZONATION

Plant community zones, including SAV bed boundaries, will be delineated and mapped with GPS.

Fowl River Marsh Study - Vegetation

TIDAL MARSH HYDROGEOMORPHIC MODEL

Mathematically derived indices assess the capacity of Alabama fringing tidal marshes to perform specific ecosystem functions (Shafer et al. 2007).

Multiple variables are combined using mathematical expressions to estimate major ecosystem functions.

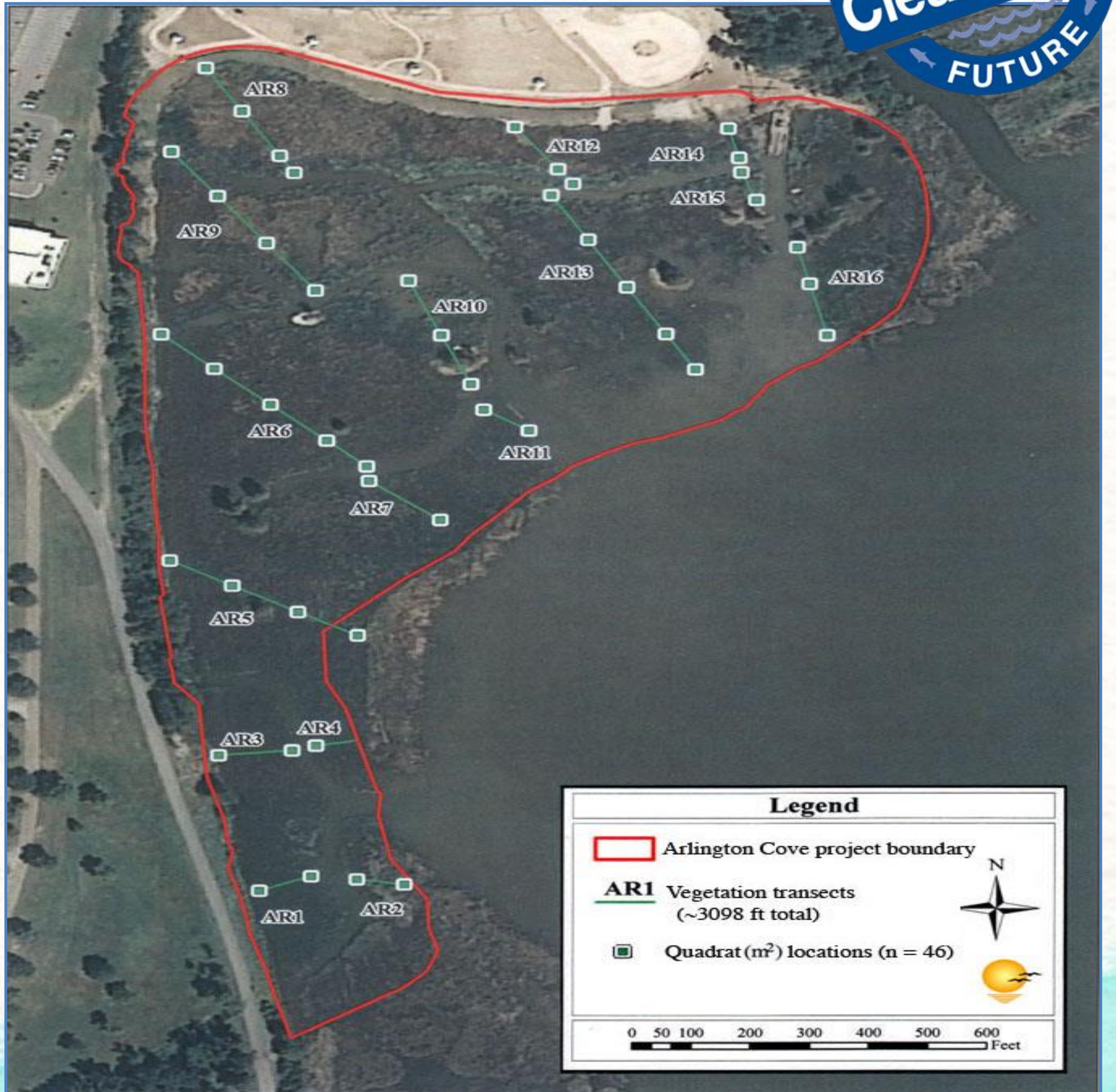
Field variables include:

- Mean % Cover of Marsh Vegetation
- Vegetation Height
- Percent Cover of Invasive or Exotic Species

Landscape-scale variables:

- Marsh Patch Size
- Mean Marsh Width

Functional Capacity Equations	
Wave Energy Attenuation	$FCI = [(3V_{WIDTH} + V_{COVER}) / 4 \times V_{EXPOSE}]^{1/2}$
Biogeochemical Cycling	$FCI = [V_{HYDRO} \times V_{COVER} \times V_{LANDUSE}]^{1/3}$
Nekton Utilization Potential	$FCI = (V_{EDGE} + V_{HYDRO} + V_{NHD}) / 3$
Provide Habitat for Tidal Marsh Dependent Wildlife Species	$FCI = \{V_{SIZE} \times \text{Minimum}(V_{HEIGHT} \text{ or } V_{COVER}) \times ((V_{EDGE} + V_{WHD}) / 2)\}^{1/3}$
Maintain Plant Community Composition and Structure	$FCI = (\text{Minimum}(V_{COVER} \text{ or } V_{EXOTIC} \text{ or } V_{WIS} \text{ or } V_{WOODY})$



Fowl River Marsh Study - Vegetation

FLORISTIC QUALITY INDEX (FQI)

FQI is used to estimate wetland habitat quality based on plant species composition.

A coefficient of conservatism (C value) is scaled from 0 to 10 and is applied to each plant species in a local flora.

C values are based on:

1. Breadth of habitat preference(s)
2. Tolerance to disturbance

C values

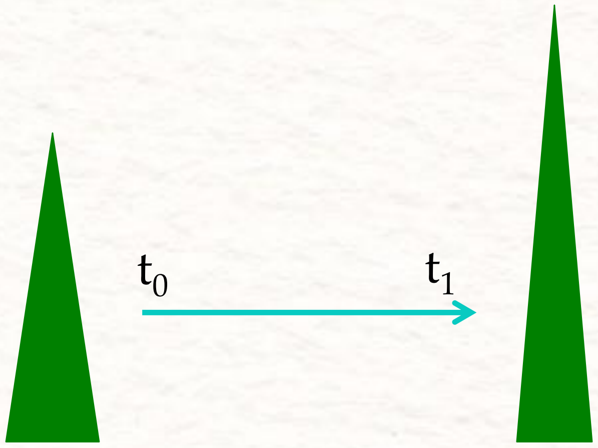
Black needlerush = 8
Sawgrass = 7
Bulltongue arrowhead = 4

Fowl River Marsh Study - Vegetation

PLANT MORPHOLOGY AND PRODUCTIVITY

Stem density, number of leaves per stem, and leaf length and width

Above-ground (leaf) productivity: leaf length increases



Below-ground (roots and rhizomes) productivity

forestry.gov.uk

Fowl River Marsh Study - Vegetation

MARSH ELEVATION

Trimble® Real Time Kinematic (RTK) GPS (TSC-2 controller and Trimble-R8 Model-3 rover): horizontal and vertical accuracy < 5 cm

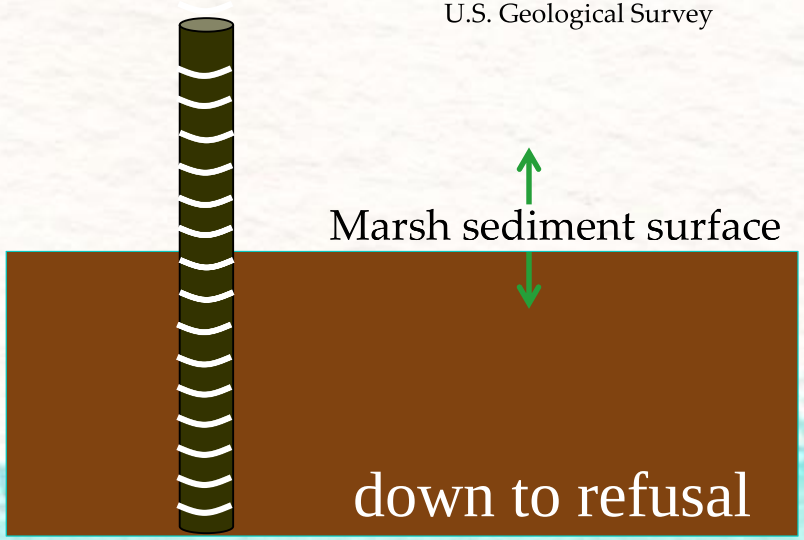
Fowl River Marsh Study - Vegetation

MARSH SEDIMENT ACCRUAL/EROSION

Horizon markers: feldspar

U.S. Geological Survey

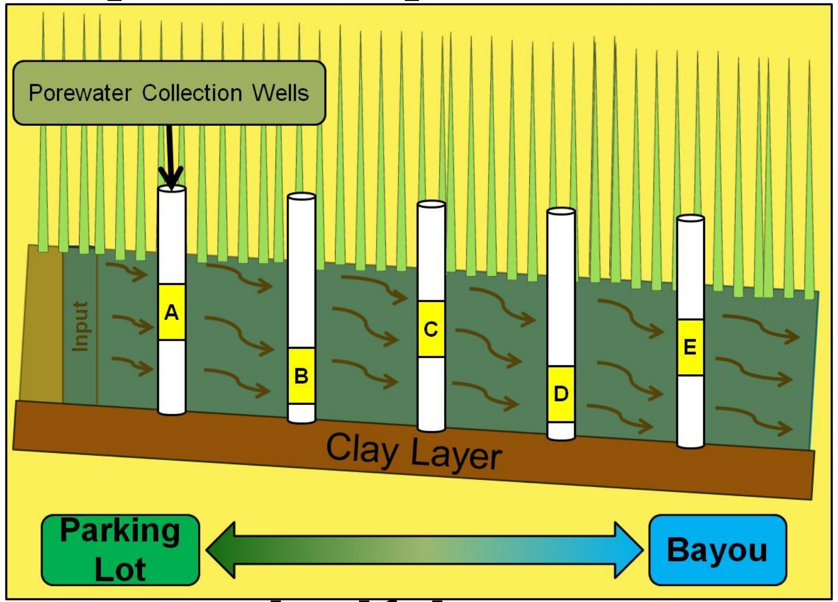
Sedimentation pins



Fowl River Marsh Study - Vegetation

MARSH POREWATER SALINITY, OXYGEN AND SULFIDE

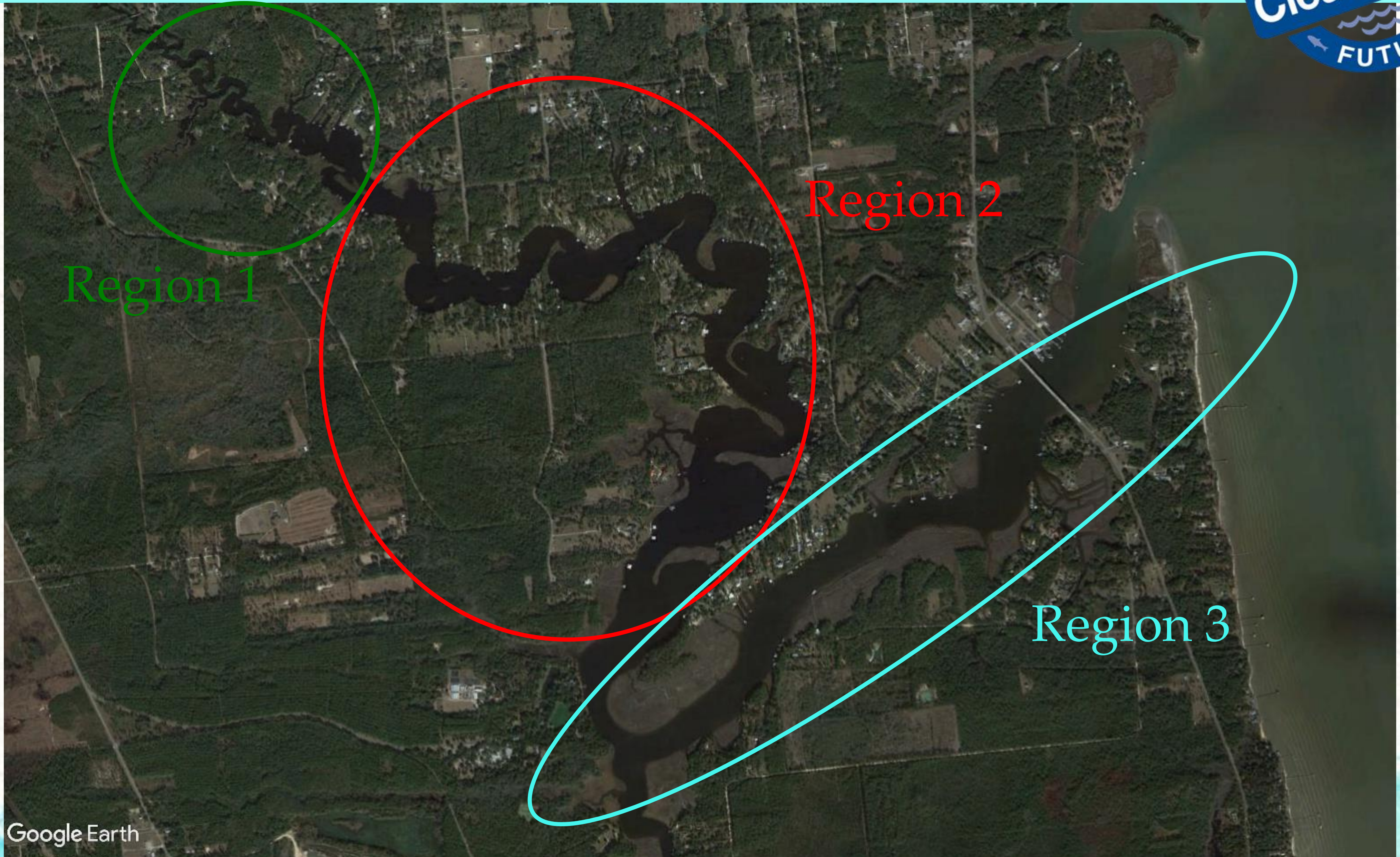
Marsh sediment wells: slotted PVC pipe 10 cm in diameter
and 30 cm deep to encompass the complete rhizosphere



Monthly measurements of porewater salinity, oxygen and sulfide:
pump wells dry and sample the recharged water

Continuous records of water level and porewater salinity:
loggers located in a second set of similar wells

Fowl River Marsh Study - Vegetation



Fowl River Marsh Study - Vegetation

STUDY LOCATIONS

- Focus on Region 2: understanding spit decay
- Additional work done on Regions 1 and 3 to:
  - Better describe the status of wetlands throughout the River
  - Complement the information obtained in Region 2

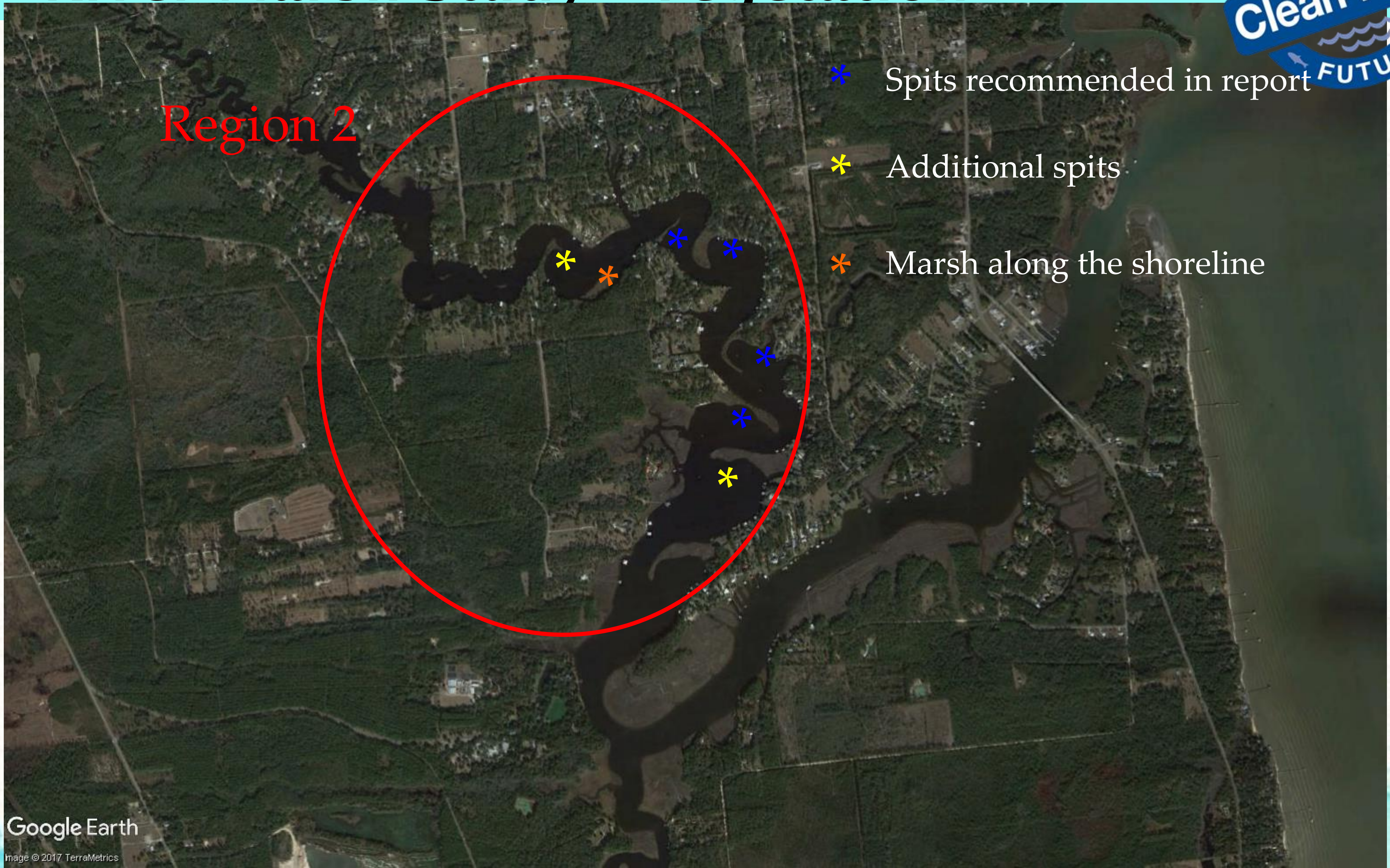
Fowl River Marsh Study - Vegetation

REGION 2

- All measurements

- Sites: 4 spits recommended in the Fowl River Watershed Management Plan; two additional healthy spits; and a healthy marsh along the main channel shoreline

Fowl River Marsh Study - Vegetation



Fowl River Marsh Study - Vegetation

REGION 2

- All measurements

- Sites: 4 spits recommended in the Fowl River Watershed Management Plan; two additional healthy spits; and a healthy marsh along the main channel shoreline

- At each site:

    - Sampling stations on transects from the seaward subtidal end of the marsh to the landward transition with maritime forest

    - Number of transects per site and stations per transect to be determined depending on natural variability (minimum number of transects per site: two longitudinal and two transversal to the shoreline)

Fowl River Marsh Study - Vegetation

Marsh transects from water fringe to upland edge

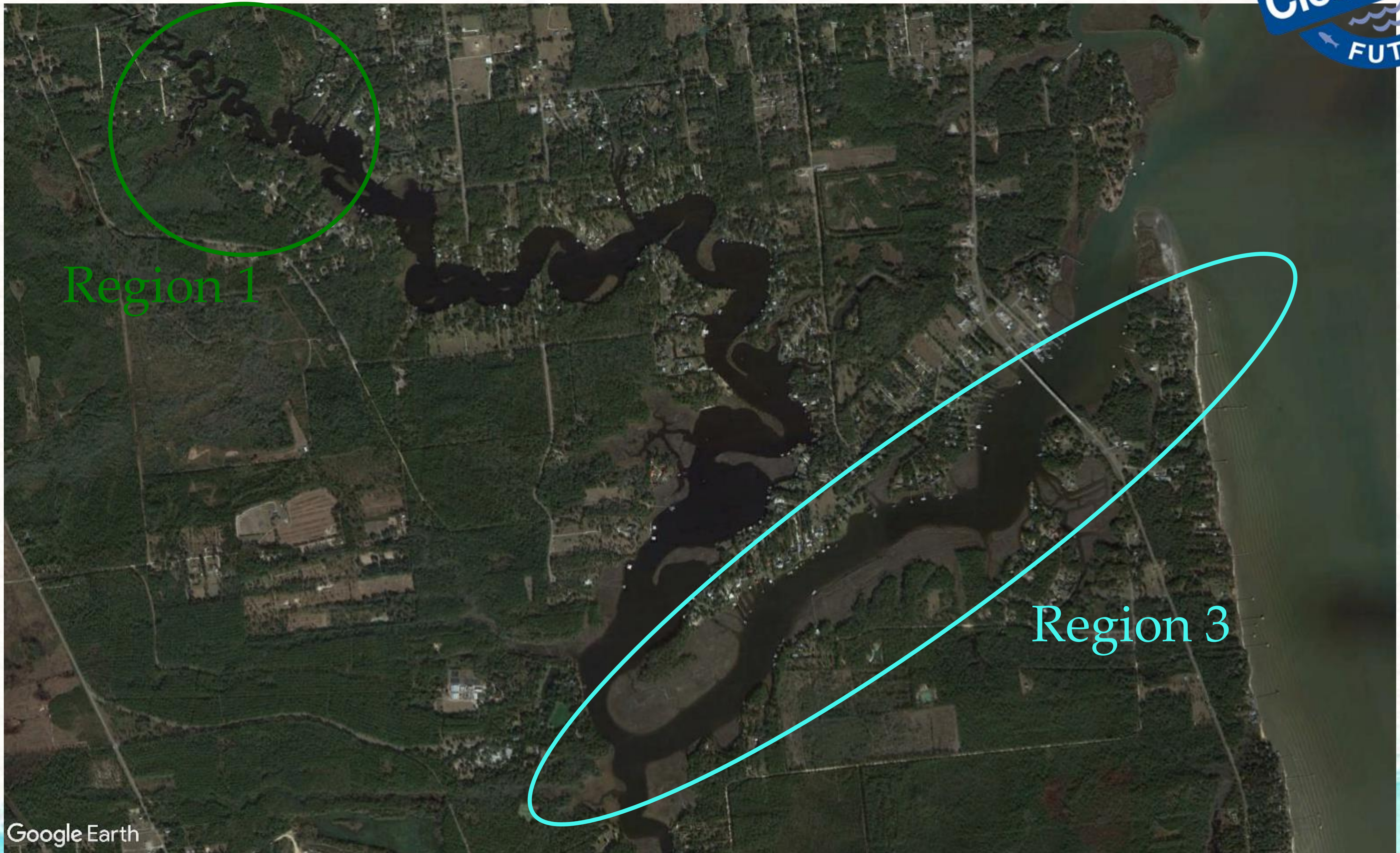
Fowl River Marsh Study - Vegetation

REGIONS 1 and 3

- Subset of measurements: plant community abundance, diversity and zonation; marsh elevation; and marsh porewater (monthly measurements of salinity, oxygen and sulfide; and continuous measurement of water level and salinity).

- Sites: marshes along the main channel shoreline; number of sites per region to be determined depending on natural variability

Fowl River Marsh Study - Vegetation



Fowl River Marsh Study - Vegetation

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Fowl River Marsh Study

SO, ARE WE DOING OUR JOB?

- Main goal: Elucidate marsh spit decay
- Three hypothesized mechanisms (acting separately or in conjunction):
  - Sea level rise: Salt intrusion and higher flooding
  - Sediment starvation
  - Boat wakes and wave energy

Fowl River Marsh Study

How do the three components (Hydrology, Sediment and Vegetation) come together to shed light on these mechanisms?

- Sea level rise: salt intrusion and higher flooding: Hydrology + Vegetation→ Elucidation of water movement and salinity distribution on the River, and resulting salinity and flooding on the marsh

Fowl River Marsh Study

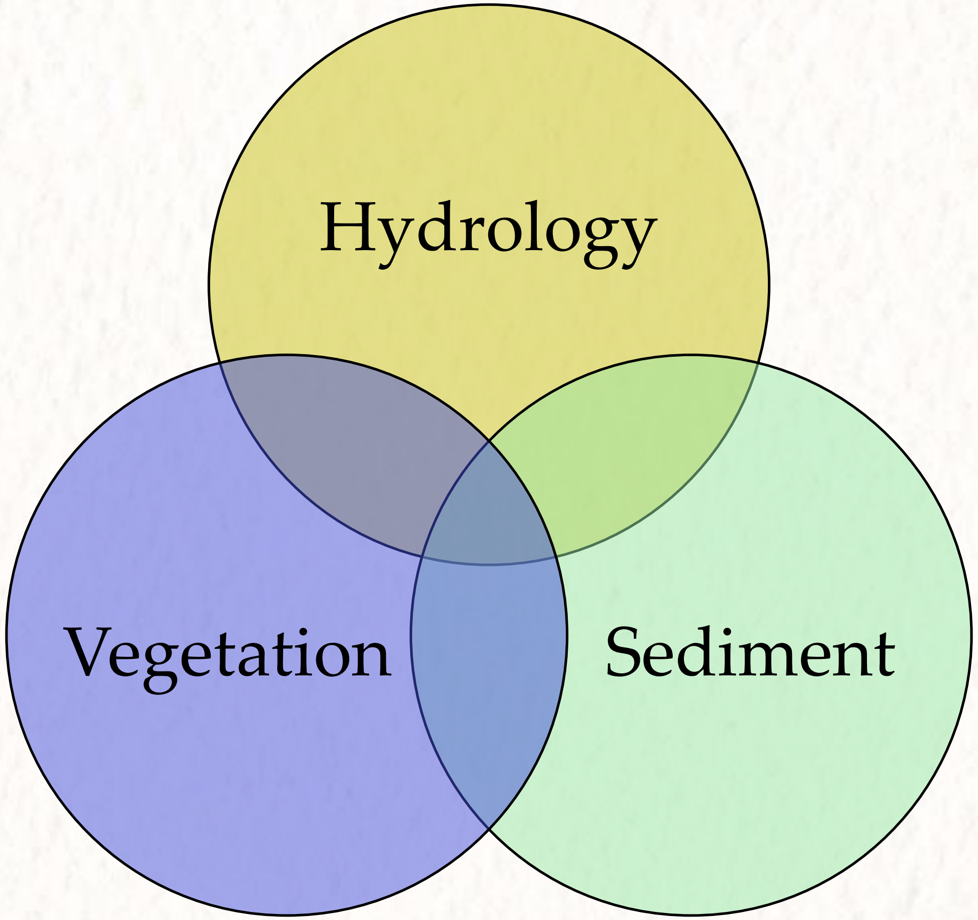
- Sediment Starvation:
  - Historical trends (deep cores): Sediment→ Sediment dynamics over the past decades: Has the system been sediment-starved for a while? (also sources of the sedimentary materials)
  - Contemporary trends (present-day analysis): Hydrology + Sediment + Vegetation→ Current sediment inputs and distribution under varying flow regimes and hydrological conditions, and resulting effects on the marsh

Fowl River Marsh Study

- Boat wakes and wave energy: Hydrology +Sediment + Vegetation → How do boat wakes interact (enhancement or inhibition) with hydrological conditions; and what are the effects on sediment dynamics in the River and wetlands?

Fowl River Marsh Study

SO by combining the study components we will advance our understanding of the causes of wetland decline observed in the River



Fowl River Marsh Study

And also (as additional goals of this study):

- Characterize the status and health of the wetlands in the River
- Inform best-practice engineering designs for wetland restoration and protection

Fowl River Marsh Study

QUESTIONS, DISCUSSION AND FEEDBACK ☺