Water Dynamics in the Freshwater Forested Zone of Tidal Creeks

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2013 Tidal Creeks Summit

COLLEGE of CHARLESTON
GRADUATE PROGRAM IN ENVIRONMENTAL STUDIES

Tidal Freshwater Ecosystems

- Broad Extent
  - 200,000 ha tidal freshwater marsh & forest in the Southeast US
  - 40,000 ha in SC
- Integral to the coastal zone
  - Habitat and terrestrial output
    - Waterfowl and migratory birds
    - Mixing zone : water, nutrients, sediments transported to estuary
- Heterogeneous systems
  - River discharge, geomorphology, climate, and tide stage
  - Hummock and hollow topography
    - hydrologic microsites
  - Tides = alternating wet & dry
    - high productivity, nutrient turnover

Vulnerability

- Rising sea level
  - 3-4 mm/yr along the SC coast
  - Vegetation shifts and tree mortality
  - Sediment accretion (1.3-2.2 mm/yr) not keeping pace with sea level rise

- Coastal Development
  - Altered hydrology

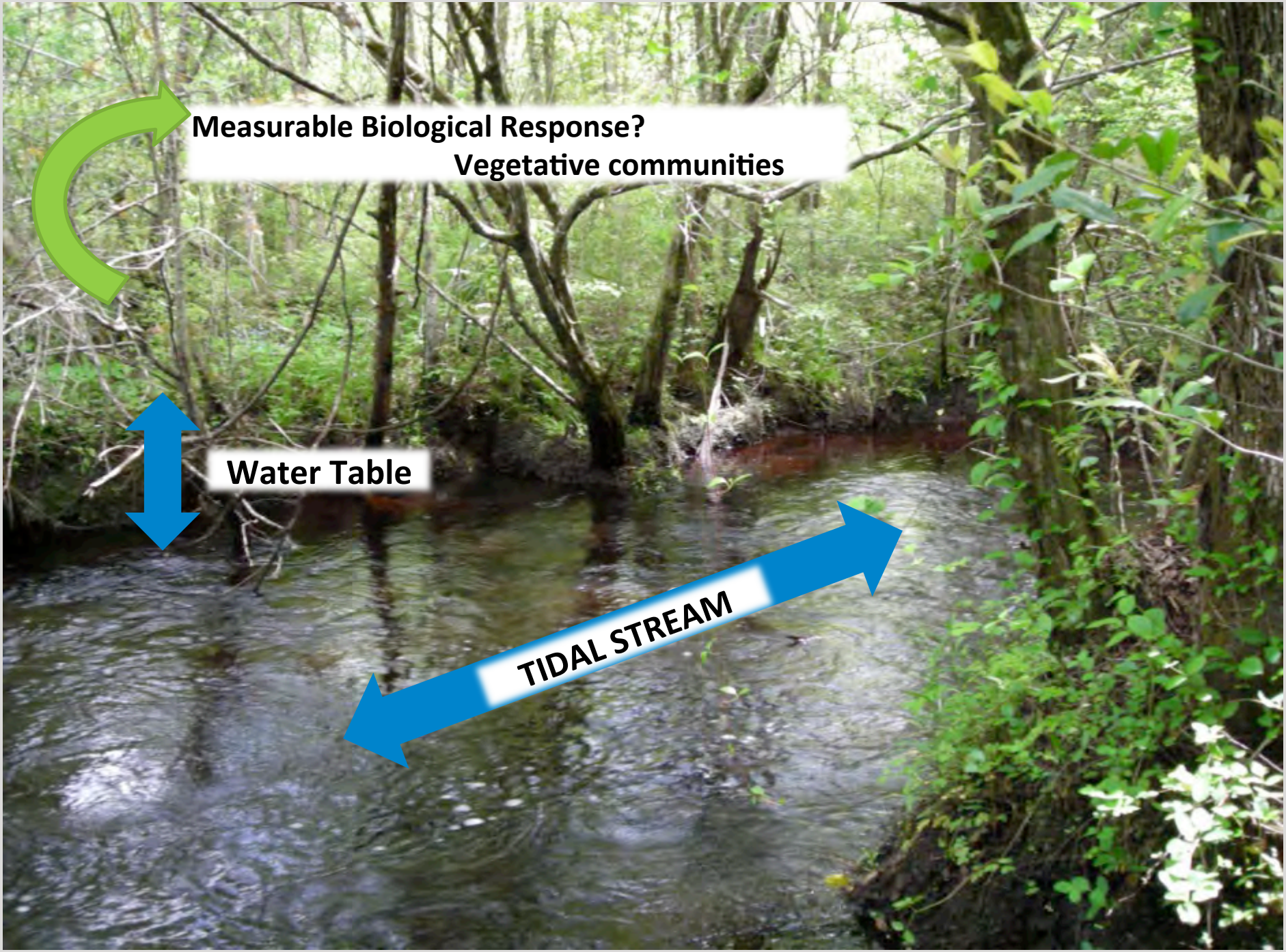
- Inconsistent mapping and terminology
  - Upper boundary obscured by forest cover
  - Lack of a streamlined classification system
  - Reliance on dated/incomplete datasets

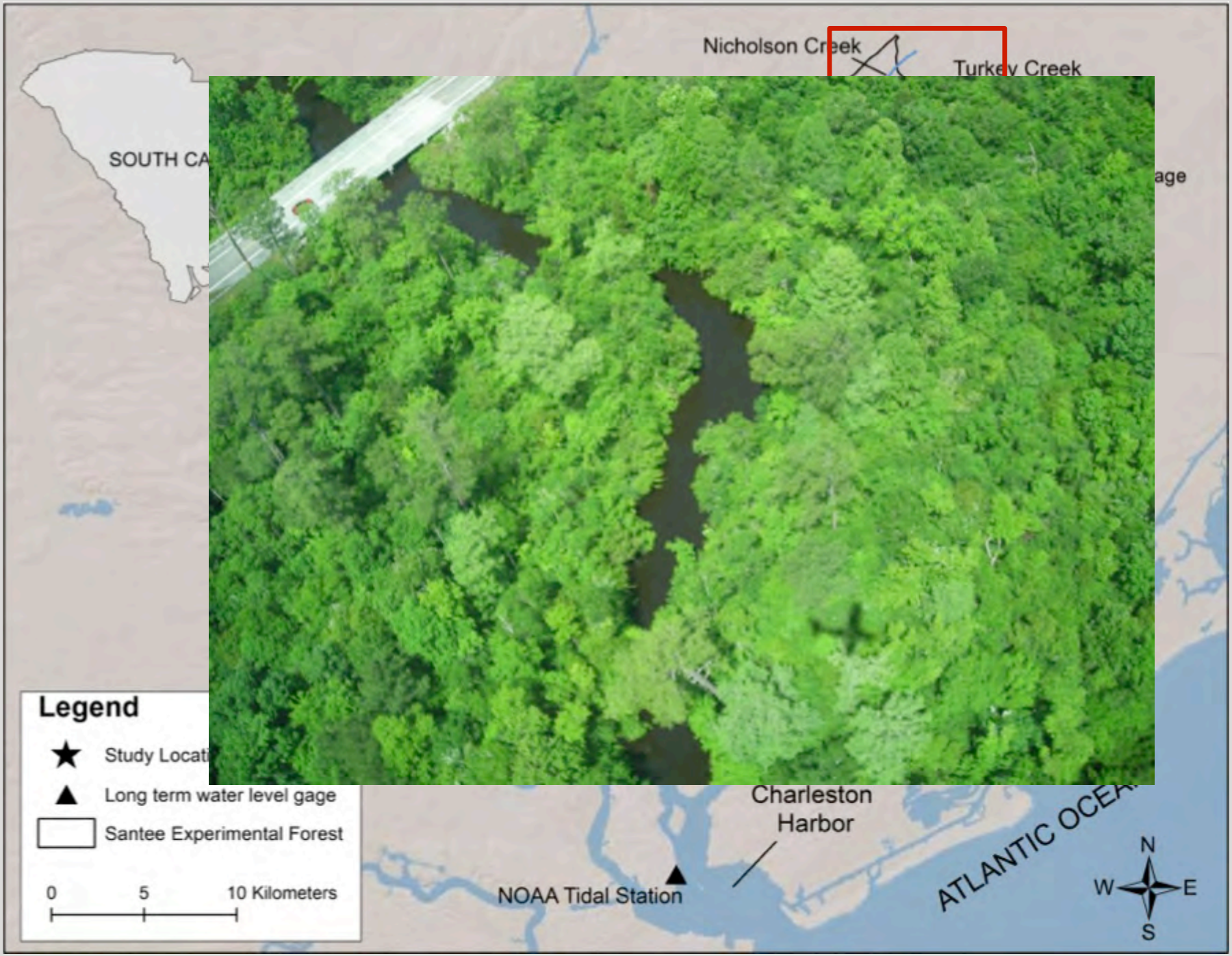
freshwater forest → oligohaline marsh

Photo Credit: http://capefearstudentsummit.blogspot.com/2010/12/fieldtrip-number-1.html

Need for Study

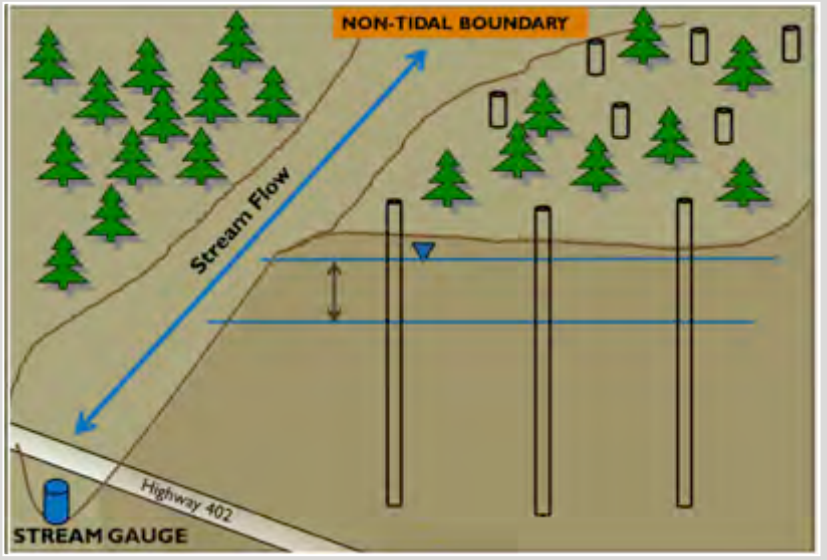
- Hydrologic dynamics are poorly understood in tidal freshwater forests especially near the tidal/non-tidal convergence zone
  - Shift from tidal to fluvial dominated hydrodynamics
- Few studies exist on small headwater tidal systems connected to mesotidal estuaries
- There is uncertainty related to how non-tidal bottomland hardwood stands will respond to persistent freshwater tides from sea level rise

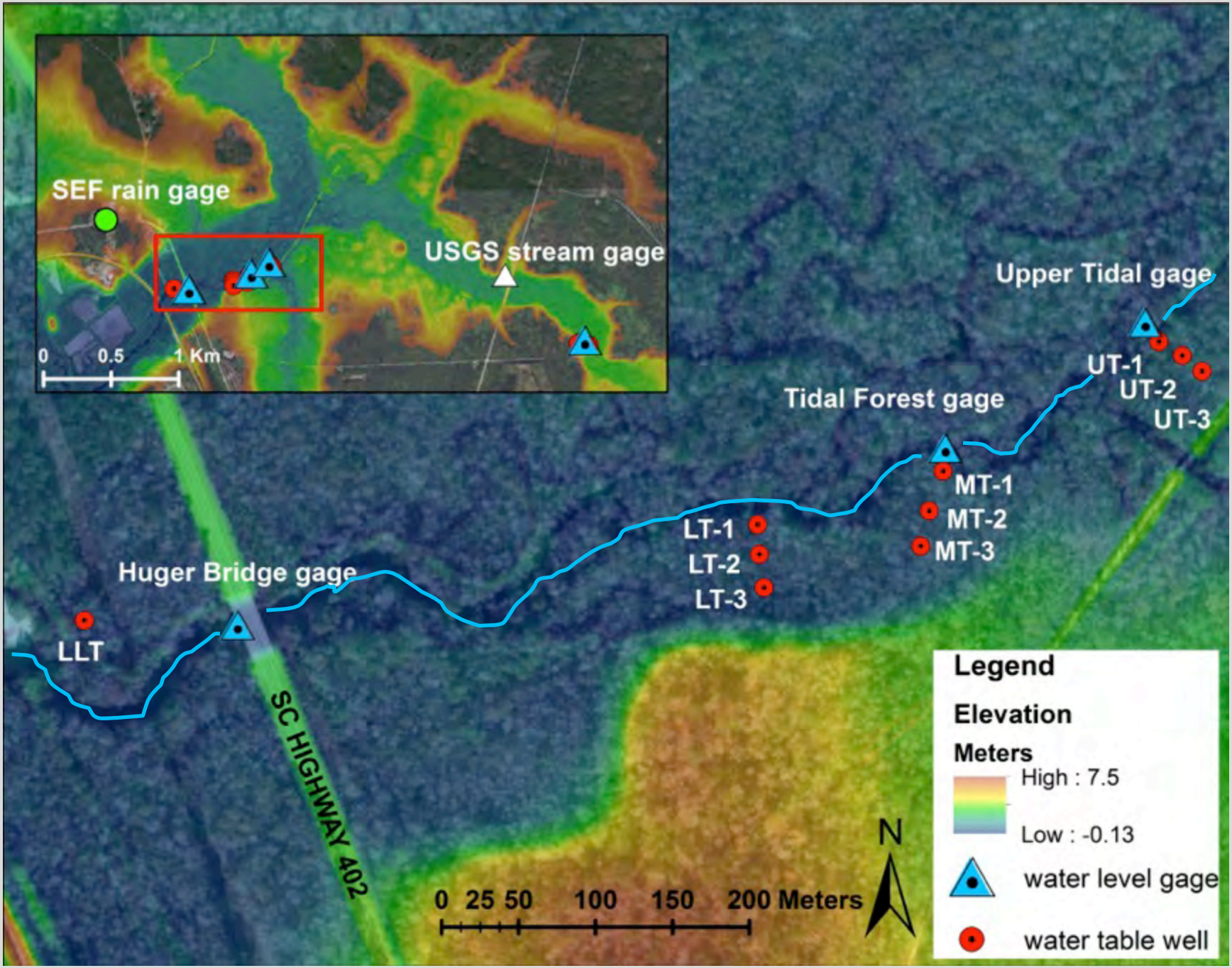

Measurable Biological Response?
Vegetative communities
Water Table
TIDAL STREAM


Nicholson Creek
Turkey Creek
SOUTH CA
age
Legend
Study Locati
Long term water level gage
Santee Experimental Forest
0
5
10 Kilometers
Charleston
Harbor
NOAA Tidal Station
ATLANTIC OCEA
N
W
E
S

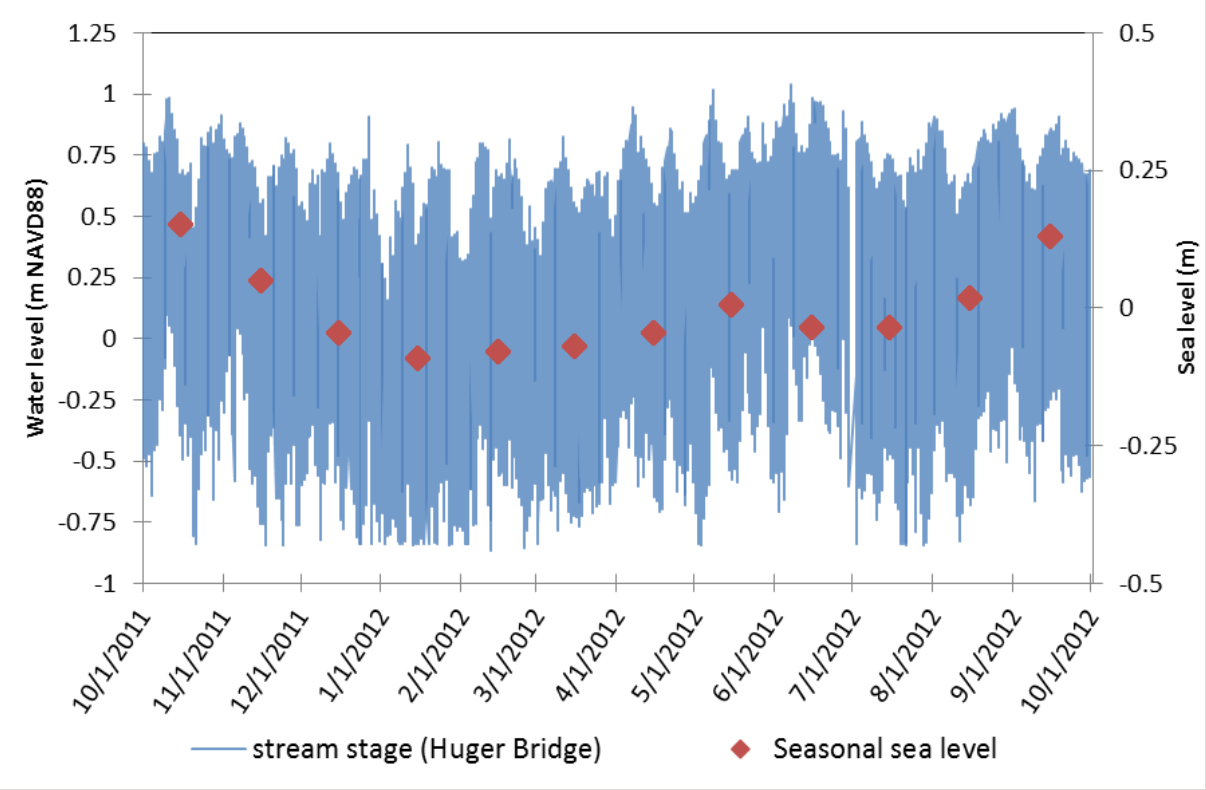
Methodology

- Hydrologic Infrastructure
  - In-channel stream gages
    - stilling wells and water level loggers
  - Water table well transects in riparian zone
    - Automatic water level loggers and manual wells
- Vegetative Communities
  - 0.1 ha plots
    - Overstory (DBH)
    - Understory (% cover)
  - Flooding tolerance & Wetland Indicator Status




SEF rain gage
USGS stream gage
0 0.5 1 Km
Upper Tidal gage
UT-1
UT-2
UT-3
Tidal Forest gage
MT-1
MT-2
MT-3
LT-1
LT-2
LT-3
Huger Bridge gage
LLT
SC HIGHWAY 402
0 25 50 100 150 200 Meters
N
Legend
Elevation
Meters
High : 7.5
Low : -0.13
water level gage
water table well

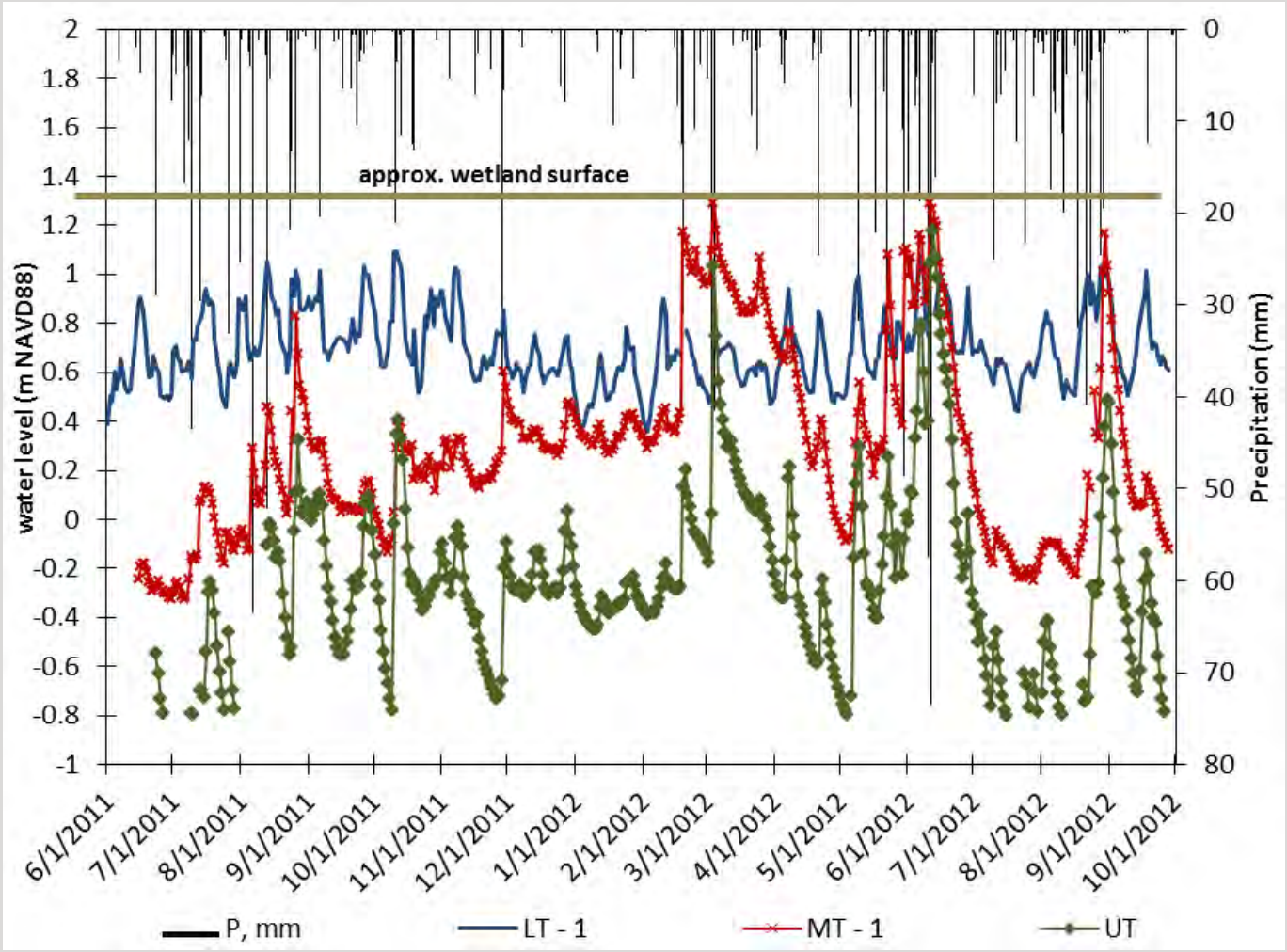
Surface water and tides



Tide Range = 1.28 m

- Semi diurnal, ocean driven tides
- 12.5 hour cycle, 4.5 hours behind coast

Tidal Riparian Zone



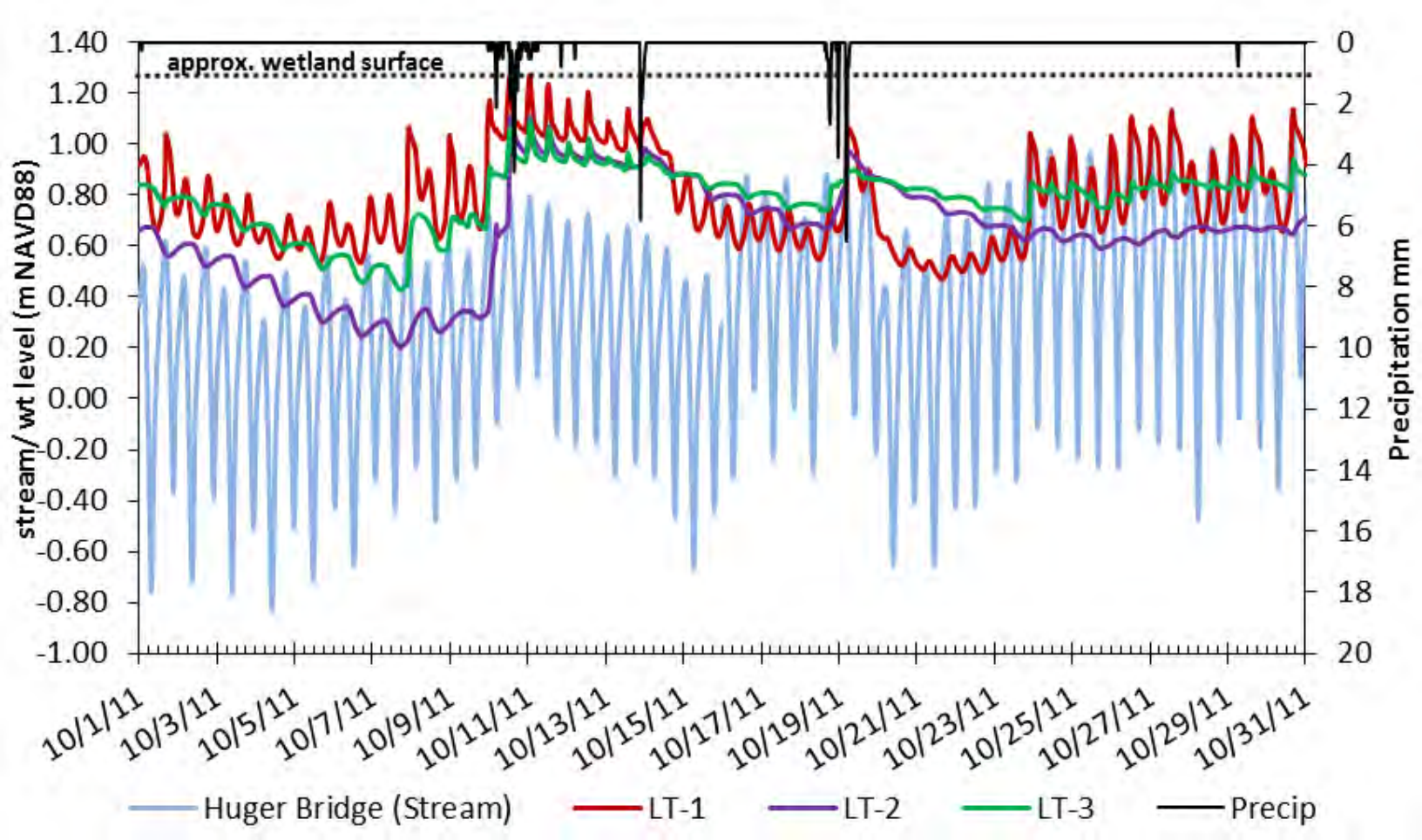
LT-1 – tidally dominated

- dynamic short-term, stable long-term
- muted climate response
- follows sea level

MT-1 & UT-1 – mixed tidal and fluvial

- Variable on long term
- Increased response to rainfall and ET

Water table tidal forcing



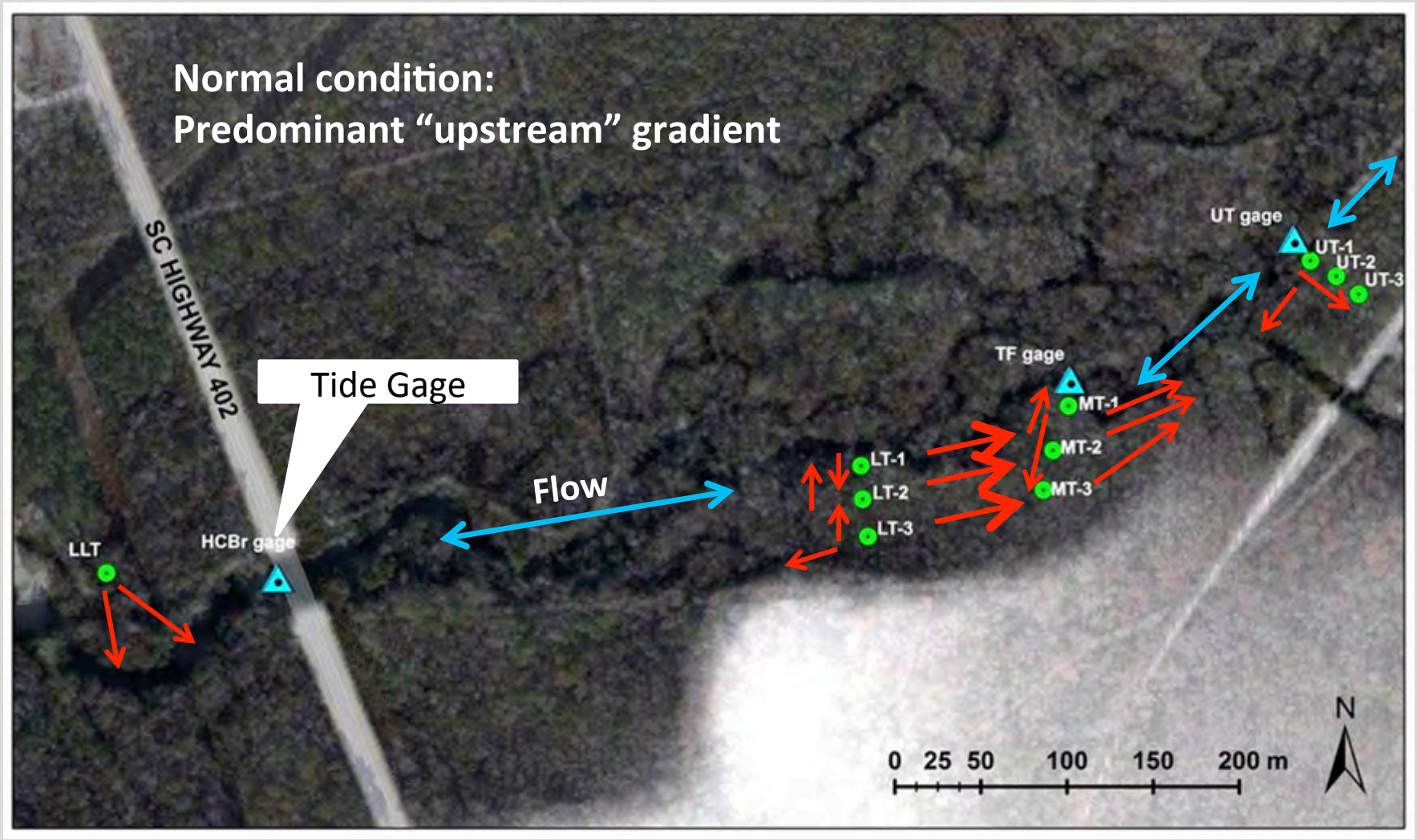
Vegetative Communities

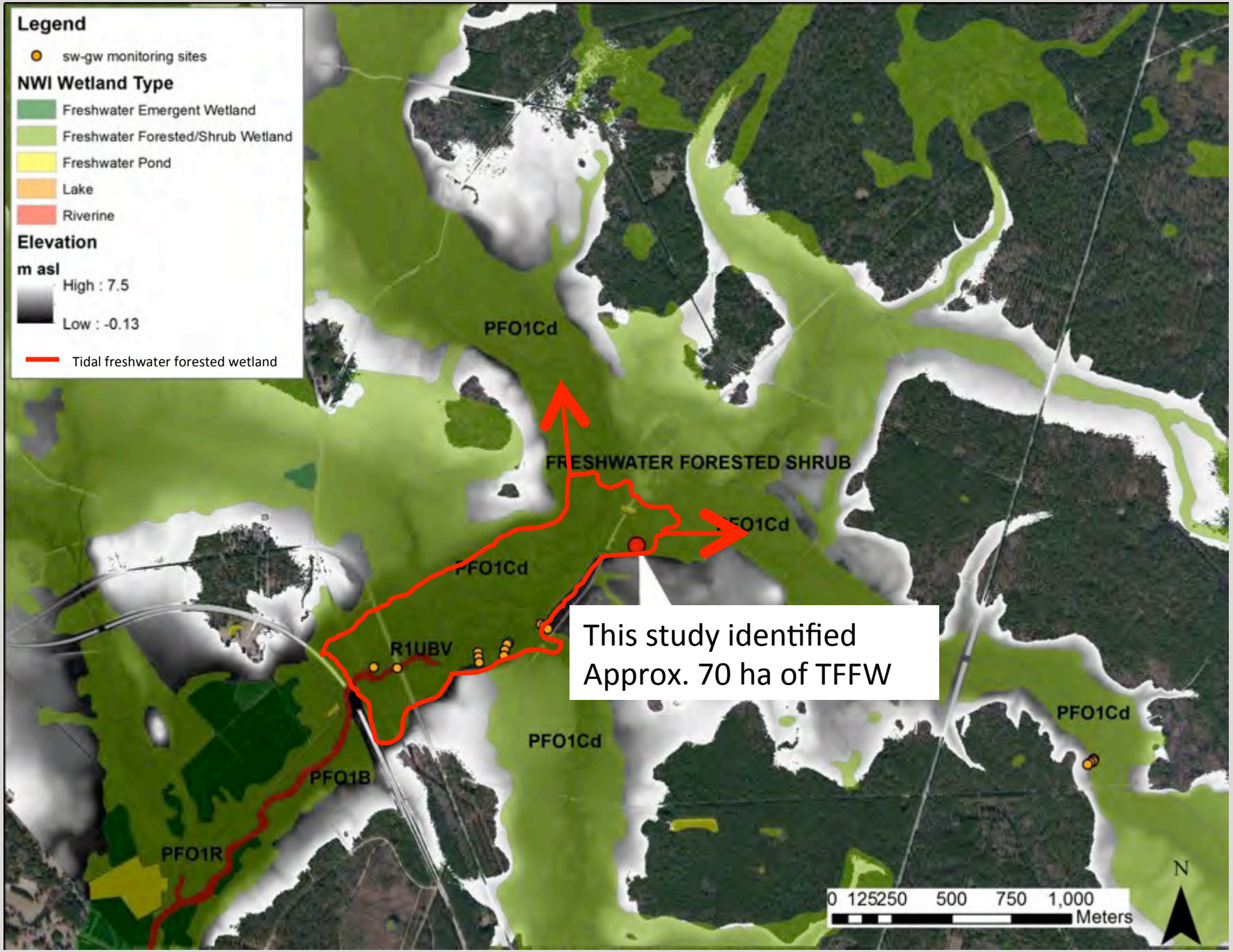
- Insensitive to hydrologic regime
  - Bottomland hardwood community
    - ironwood, laurel oak, sweetgum, green ash, elm, swamp chestnut oak
    - switch cane and dwarf palmetto
    - poison ivy, sedges, grasses

- Tidal reach did not possess more
  - "Most " or "Moderately" flood tolerant trees

    or
  - "OBL" or "FACW" wetland indicator species

Hydrologic Gradient




Legend
sw-gw monitoring sites
NWI Wetland Type
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Riverine
Elevation
m asl
High : 7.5
Low : -0.13
Tidal freshwater forested wetland
PFO1Cd
FRESHWATER FORESTED SHRUB
PFO1Cd
PFO1Cd
R1UBV
This study identified
Approx. 70 ha of TFFW
PFO1Cd
PFO1Cd
PFO1B
PFO1R
N
0 125250 500 750 1,000
Meters

Summary

- Direct relationship between tidal creek and riparian zone hydroperiod
  - Tidal forcing in water table a function of mean surface water stage and residence time
  - Middle tidal transect is a “critical zone” = shift from tidal to fluvial hydrodynamics
- Predominant “upstream” water table gradient
  - Huger Creek functions a freshwater reservoir
- Vegetative community response = scale dependent
  - Broad ecological amplitude of bottomland hardwood forest type, nuances in soil texture, differences in water demand from plants, past land use and disturbance

Future Research Needs

- Develop Huger Creek into a tidal freshwater forest reference site
  - Site in "good" condition

- Intensify and enlarge vegetation plots and include the marsh/forest transition zone
  - Primary production and leaf area index measurements
  - Marsh sites to include salinity gradient (fresh → oligohaline → mesohaline) to evaluate sea level rise impacts

- Water budget for Huger Creek
  - Additional riparian wells in opposite floodplain, piezometers, velocity measurements, rain gages, sap flow measurements

- Mapping the current extent of tidal freshwater forested wetlands
  - Use LiDAR data to refine estimates of tidal freshwater wetlands

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