USGS Chesapeake Bay wetland and waterbird research

(Image by LorraineHudgins/Shutterstock)

Greg Noe

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Water Mission Area HQ, USGS

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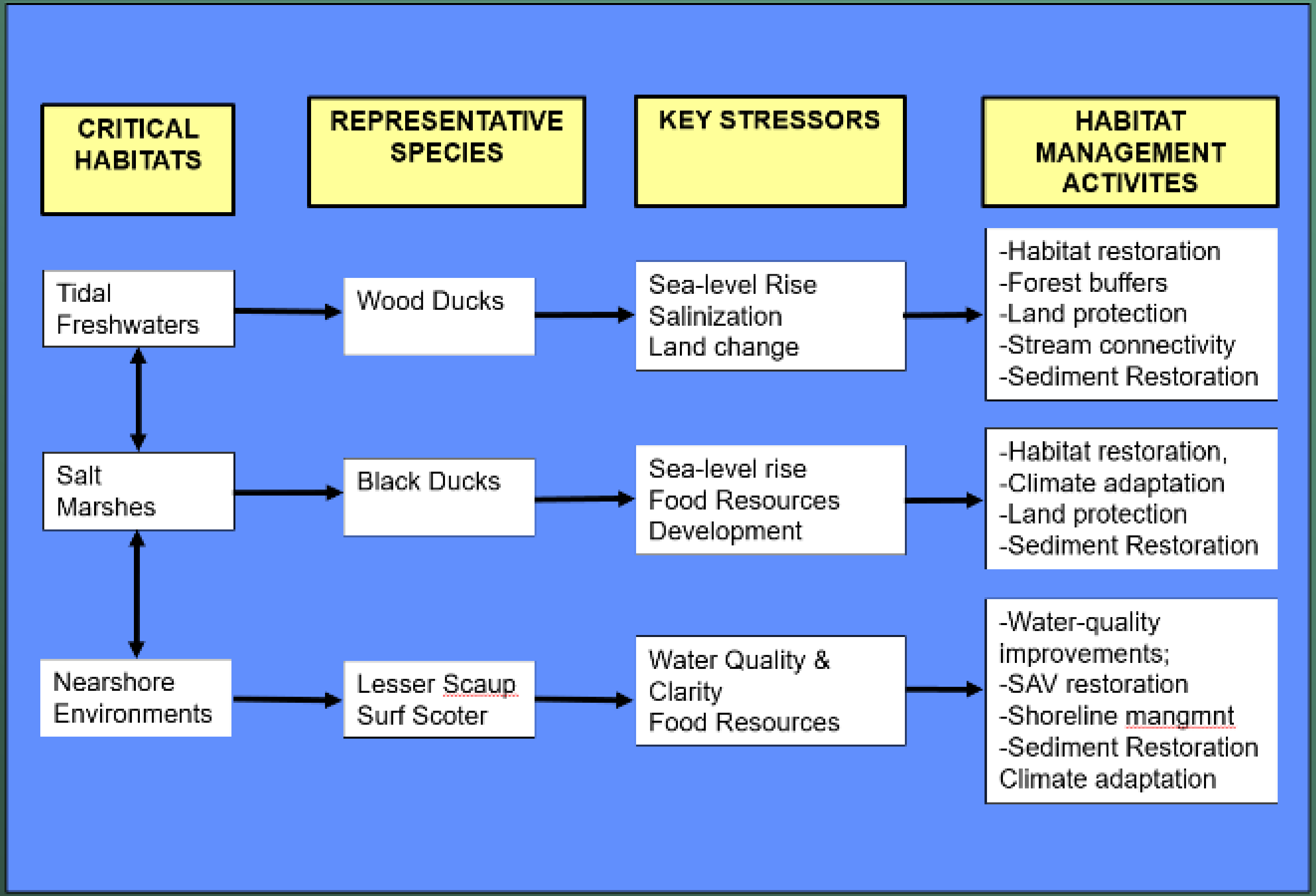
USGS Chesapeake Science Strategy 2018-2025:
Coastal Habitats and Migratory Waterbirds

What are the risks to coastal habitats, DOI lands, and their carrying capacity for waterbirds from regional drivers and environmental stressors, and how are these systems responding to management activities?



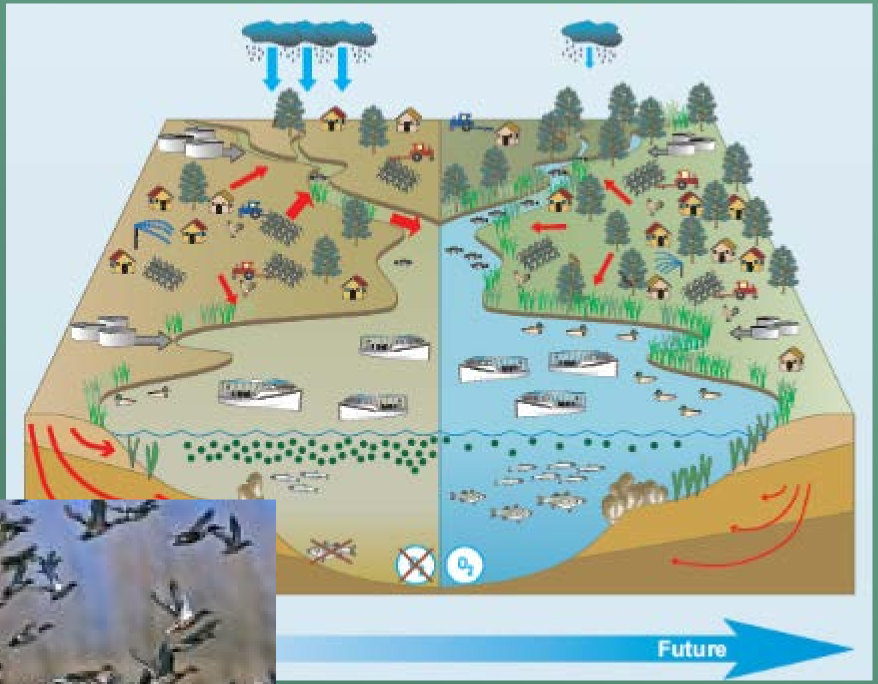
Partners:

1.FWS, NPS
2. State Agencies
3. NGOs
4. GITs (Habitat, Water Quality, Climate)

Coastal Habitats and Migratory Waterbirds

<u>Coastal continuum to support waterbirds</u>

1. Tidal Freshwaters as nexus
2. Salt Marsh Systems
   - Sea-level rise
   - Sediment delivery
   - Development
   - Climate and storms
   - Marsh response
   - Coastal dynamics
   - Habitat for waterbirds
   - Carrying capacity?



<u>Management Implications</u>

- Inform Managers
- Co-benefits

Coastal Habitats and Migratory Waterbirds

Coastal continuum to support waterbirds

3. Nearshore environments
   - Sediment and nutrient delivery
   - Water Clarity
   - SAV
   - Forage fish and food web
   - Habitat for waterbirds
   - Carrying capacity?

Management Implications
- Inform Managers
- Co-benefits

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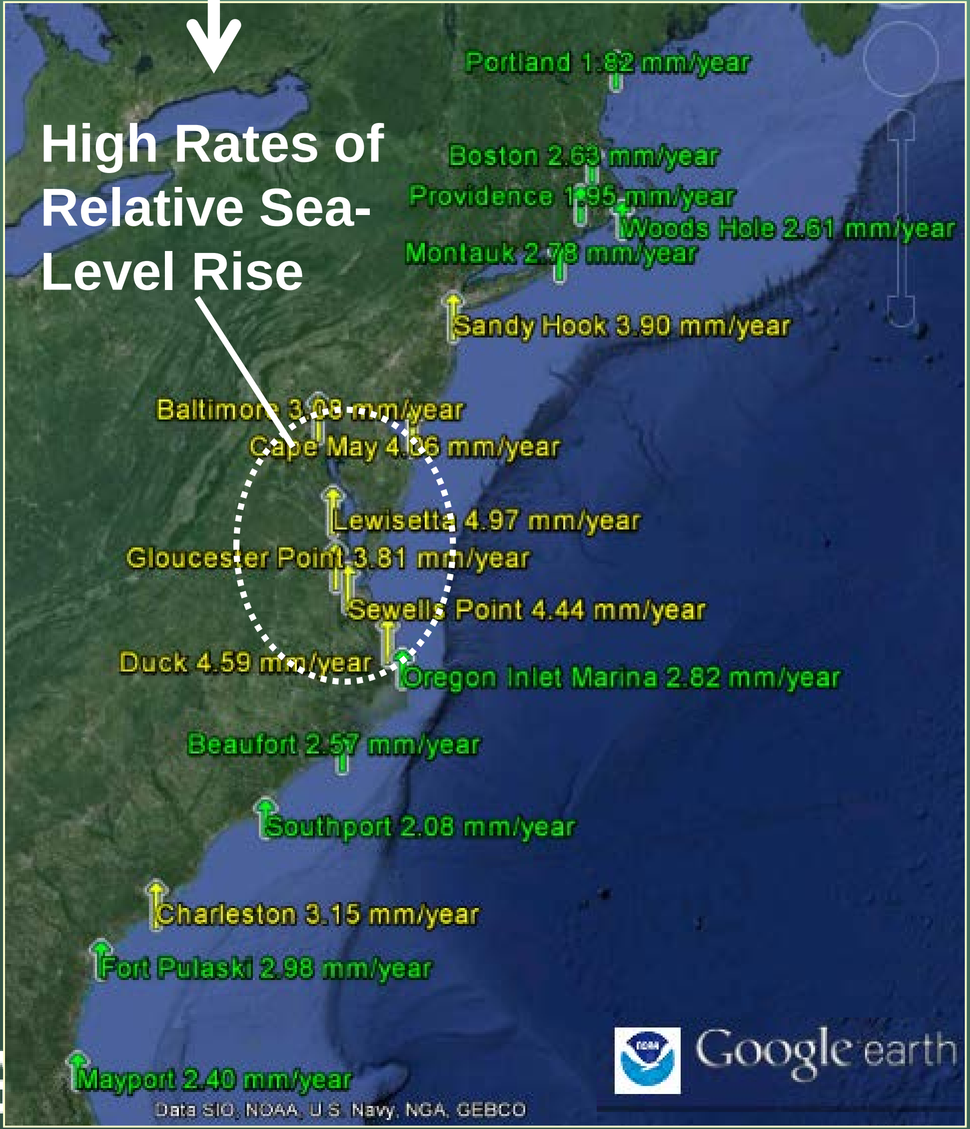
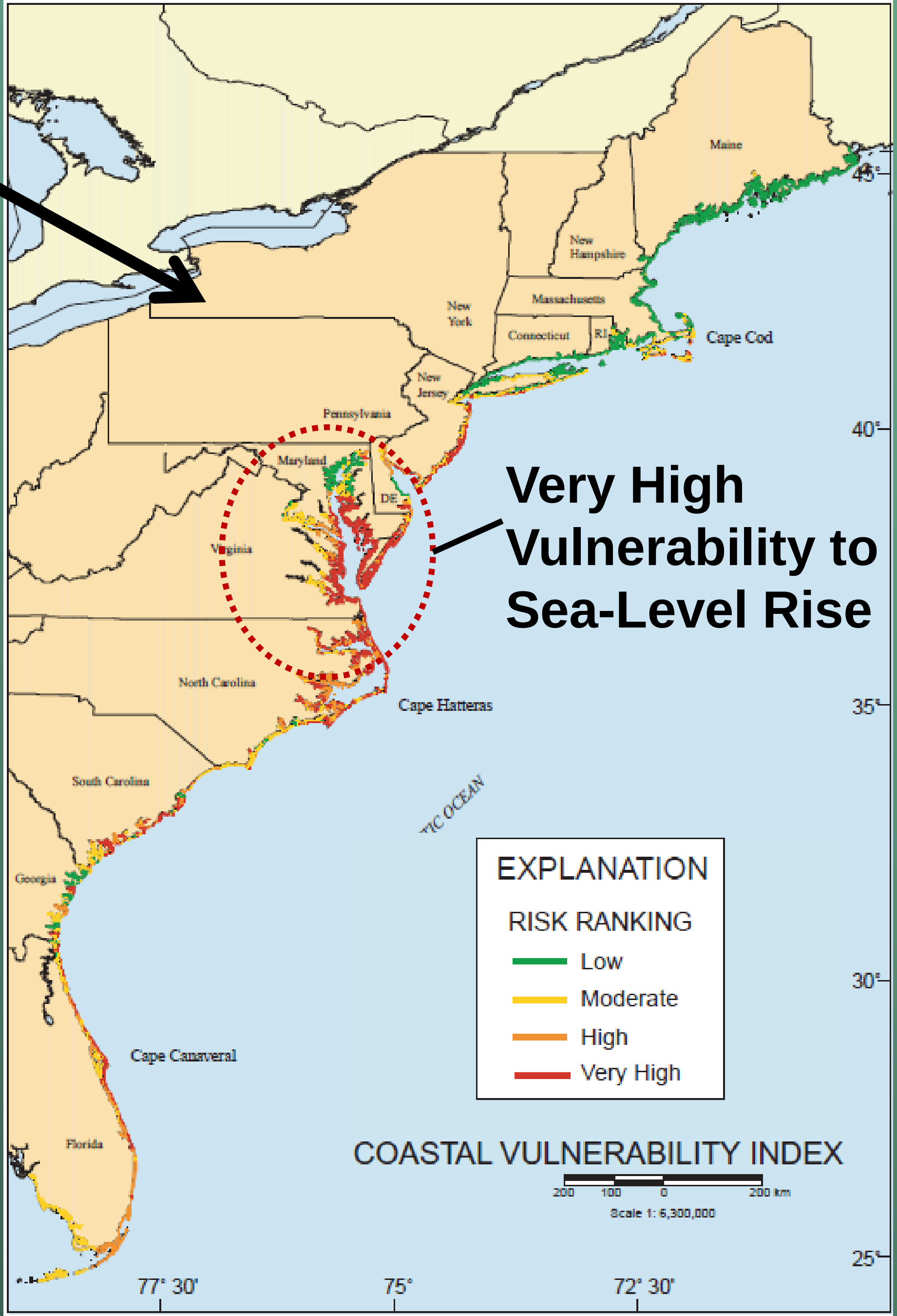
The Problem

Why it is Important



NOAA Sea-Level Trend Data (Zervas, 2009)



Thieler and Hammar-Klose, 1999, USGS , OFR 99-593

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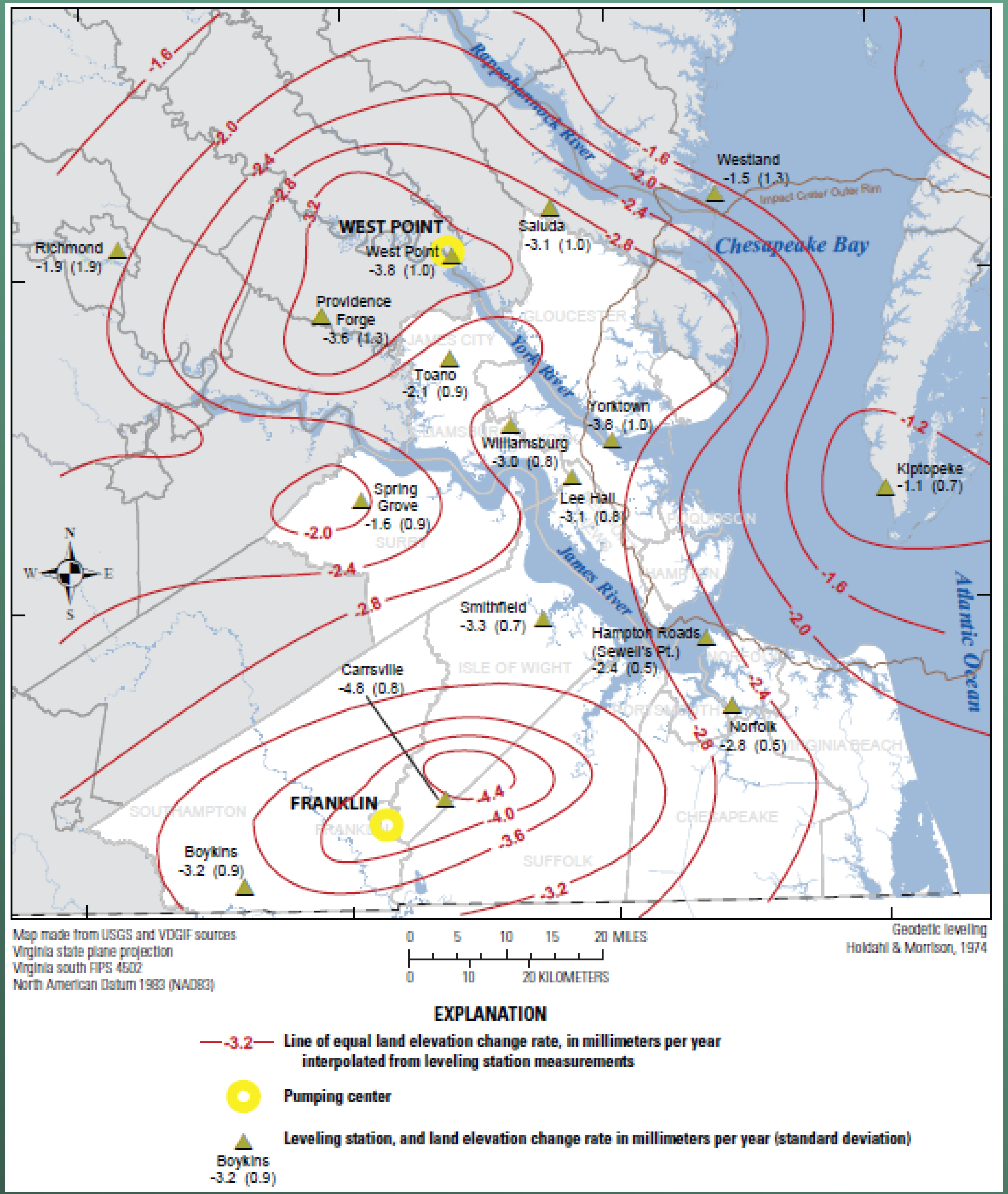
Land Subsidence 1940-1970 (mm/yr)

Published by
National Geodetic Survey

Holdahl and Morrison, 1974, Tectonophysics, 23(4), p. 373–390



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USGS science for a changing world

Long-term Assessment of Chesapeake Bay Hazards

EASTERN GEOLOGY AND PALEOCLIMATE SCIENCE CENTER

Objectives: Extend instrumental observations of floods, hurricane landfalls and sea-level rise in the Chesapeake Bay region.

Projects: (1) Extreme floods on the Susquehanna. (2) Hurricane overwash deposits in Pocomoke Sound. (3) Sea level rise in Potomac salt marshes.

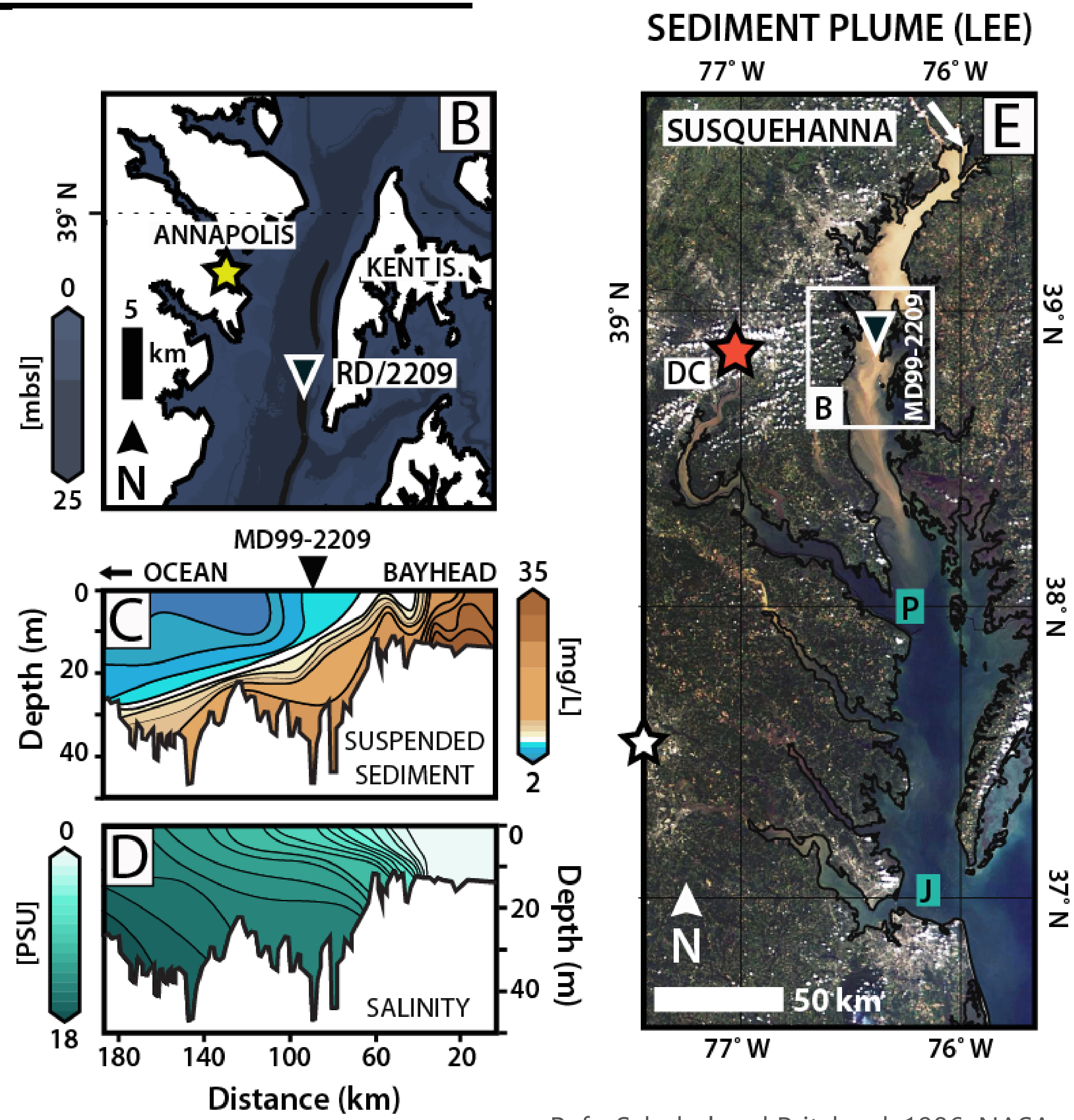
Extreme Floods on the Susquehanna River

Objective: Identify deposits from large floods on the Susquehanna River over the past 2000 years (Toomey et al., 2018—in prep).

Key Findings: Increased flooding and sediment delivery from: (1) 1800-1550, 1300-1100 and 400-0 AD.

(2) Concurrent with negative North Atlantic Oscillation (NAO) conditions and stronger hurricane activity.

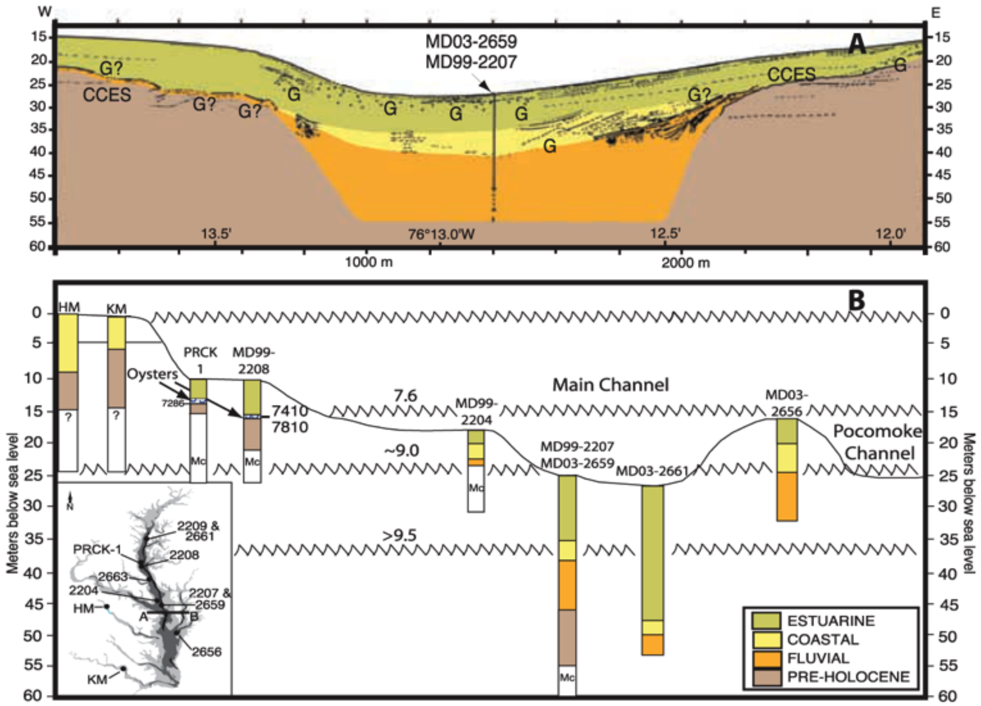
Future Work: Collect new cores from Pocomoke Sound (Fall 2018) to identify hurricane overwash deposits.



Refs: Schubel and Pritchard, 1986; NASA

Chesapeake Bay Sea-Level Rise (SLR):

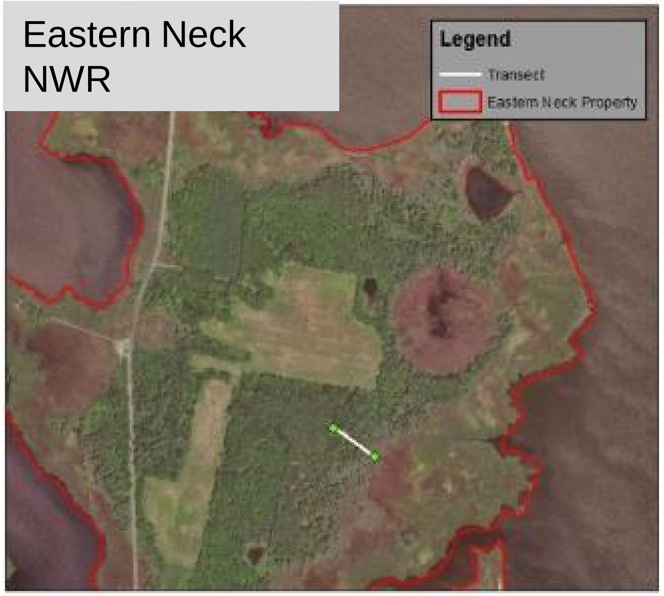
Objectives: Extend observational records from tide gauge stations in order to identify the drivers of rapid sea-level rise in Chesapeake Bay.

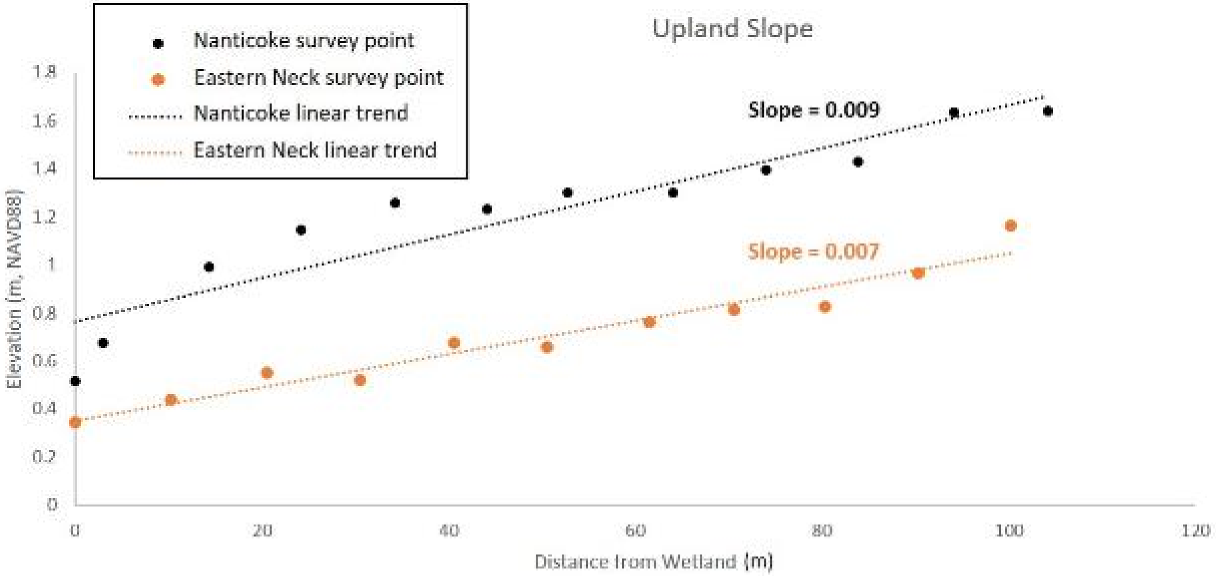


Approach: Collect and date salt marsh peat accumulations along the Potomac River (Cronin et al., 2018—in prep).

Key Findings: (1) Long-term glacio-isostatic adjustment (GIA) rate ~1-2 mm/yr over the late Holocene. (2) Possible deceleration of sea-level rise from GIA since the early Holocene (e.g. Cronin et al., 2007, GRL, figure above)

Topographic surveys to inform marsh transgression model development





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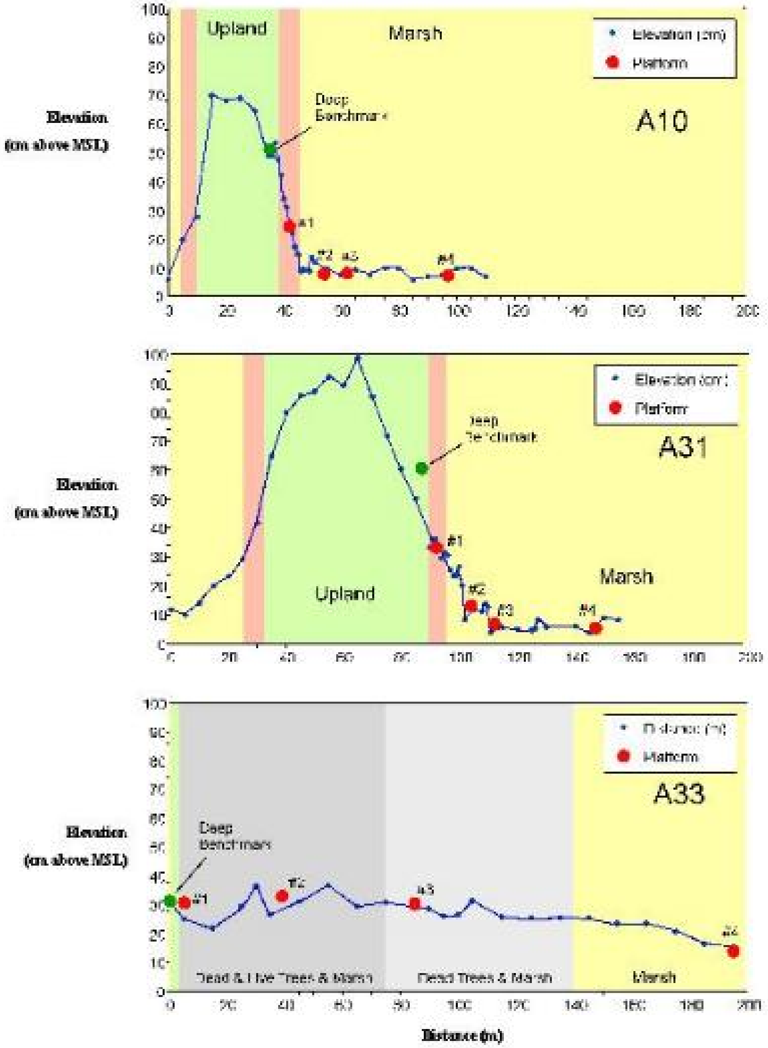
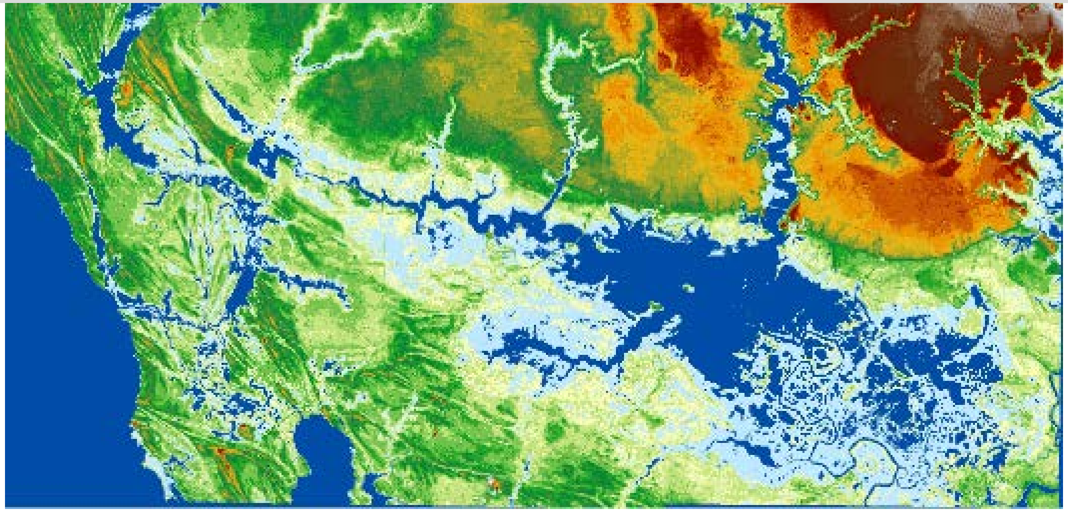
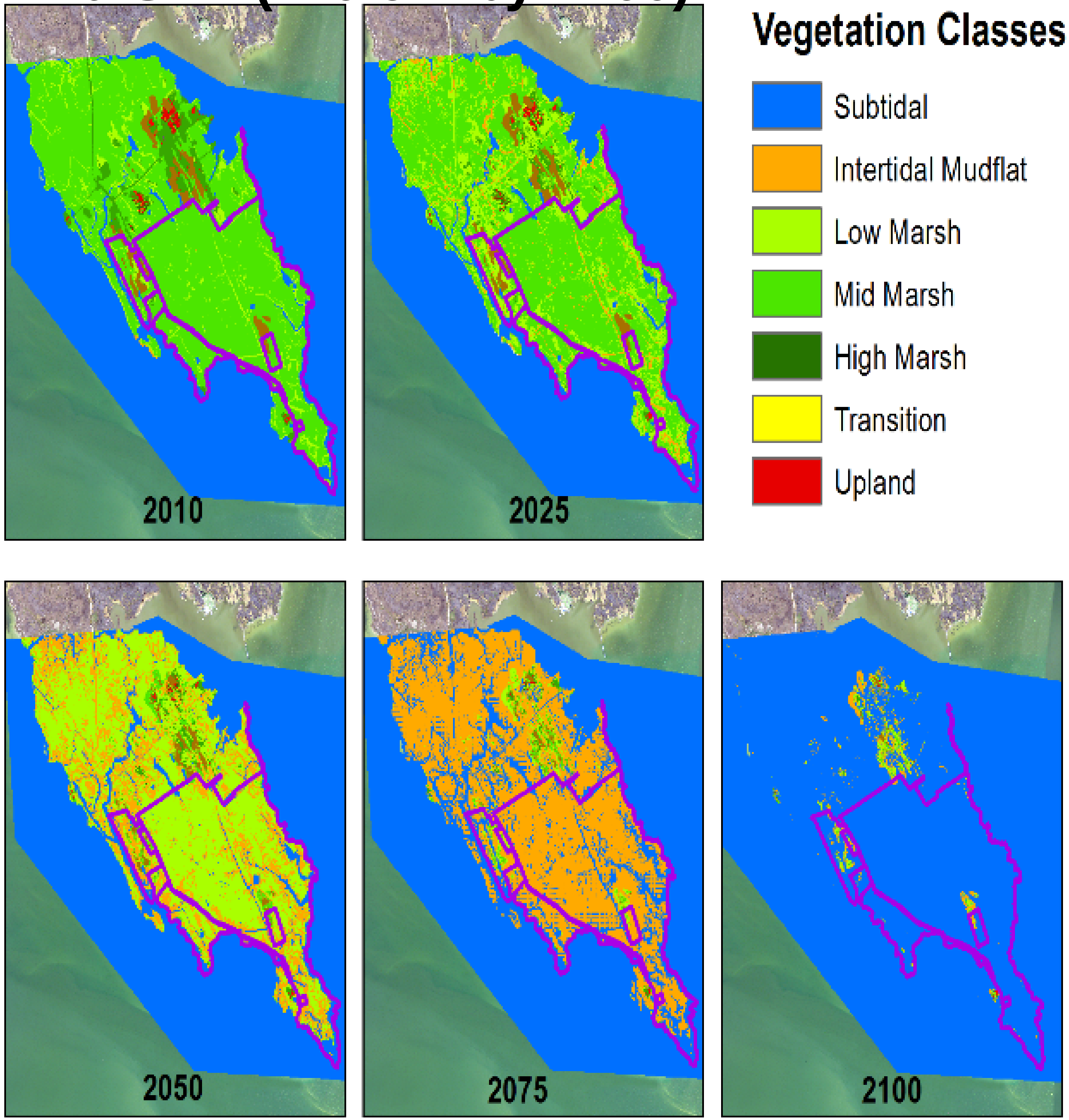
Gradient of slopes at Blackwater NWR



DEM Blackwater NWR



Mid SLR (110 cm by 2100)



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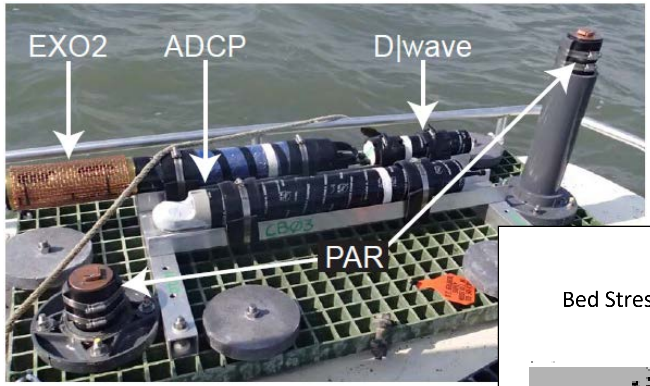
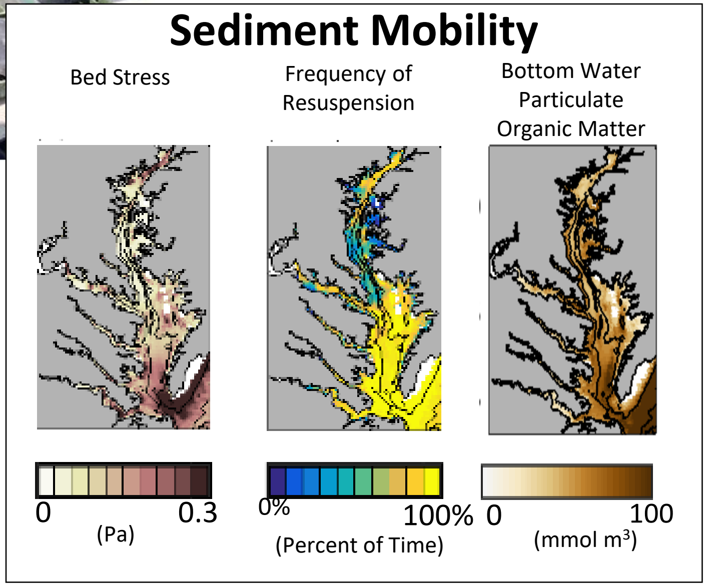
USGS Coastal and Marine Geology Program

Ready to Make Another Splash in Chesapeake Bay

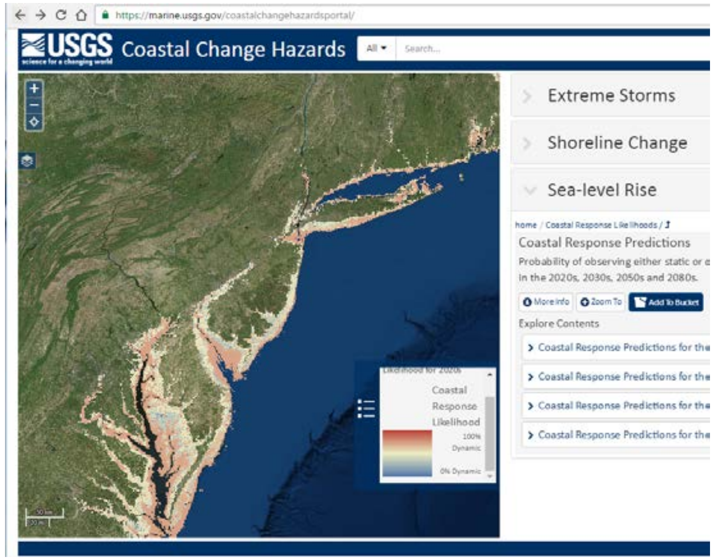
Observations



Modeling



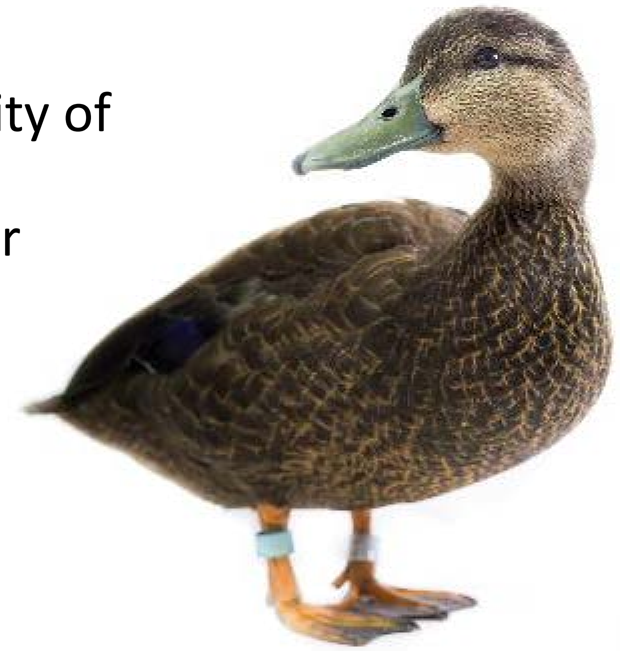
Forecasting



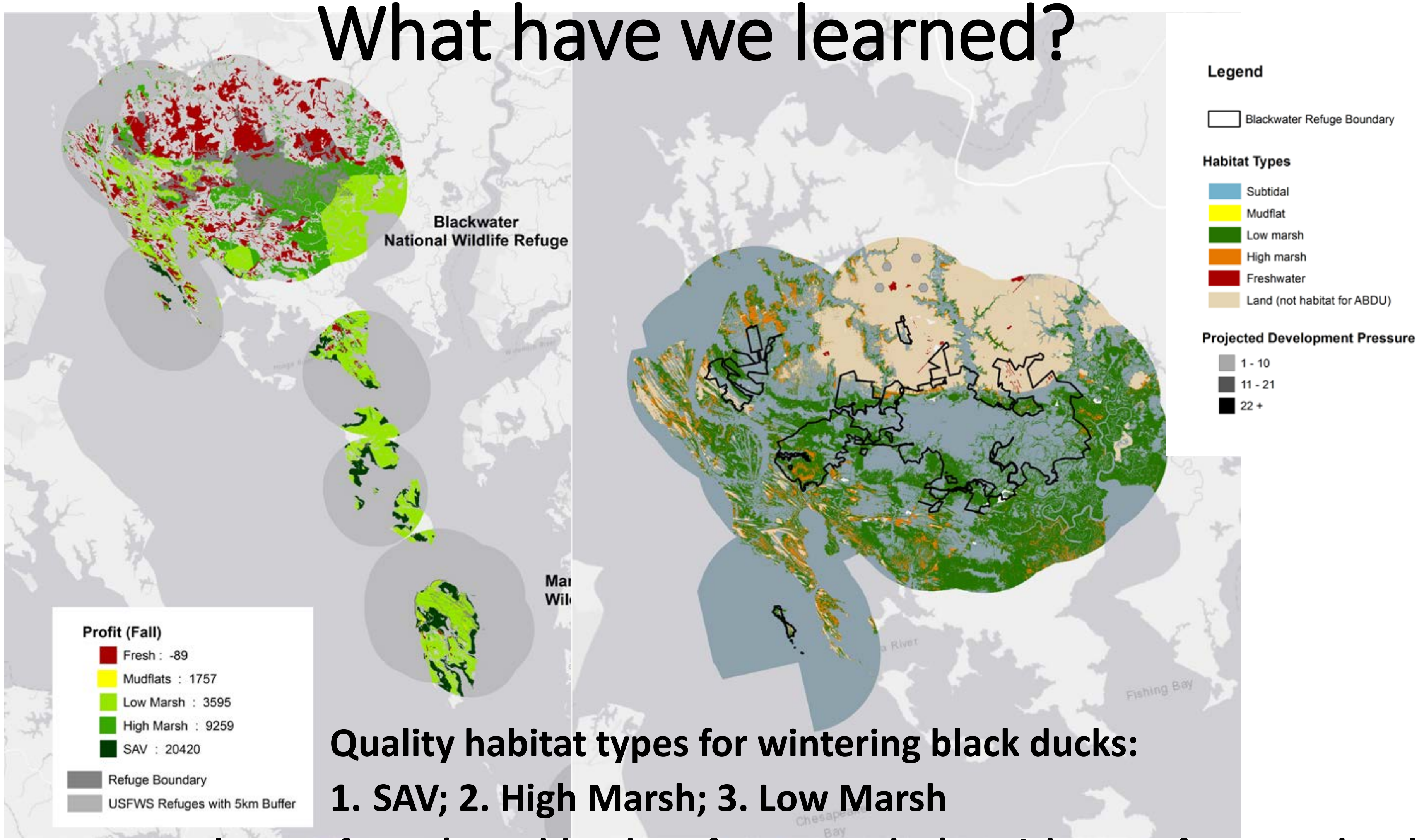
The future evolution of coastal systems will be driven significantly by **storms, sea-level change, sediment transport, and geomorphic change**: Chesapeake Bay is a logical place to expand.

Migratory waterbird science questions:

- What is the present food availability, density, and dispersion for wintering black ducks in high marsh, low marsh, mudflat, SAV, and freshwater habitats within the refuges?
- How much energy is obtained by wintering black ducks as the top prey items (killifish, saltmarsh snail, horned pondweed, widgeongrass) vary in densities?
- What is the present energetic carrying capacity of high marsh, low marsh, mudflat, SAV, and freshwater habitats on the wildlife refuges for wintering black ducks?
- How are coastal wetlands and their carrying capacity for waterbirds affected by changing climate and land use?



What have we learned?

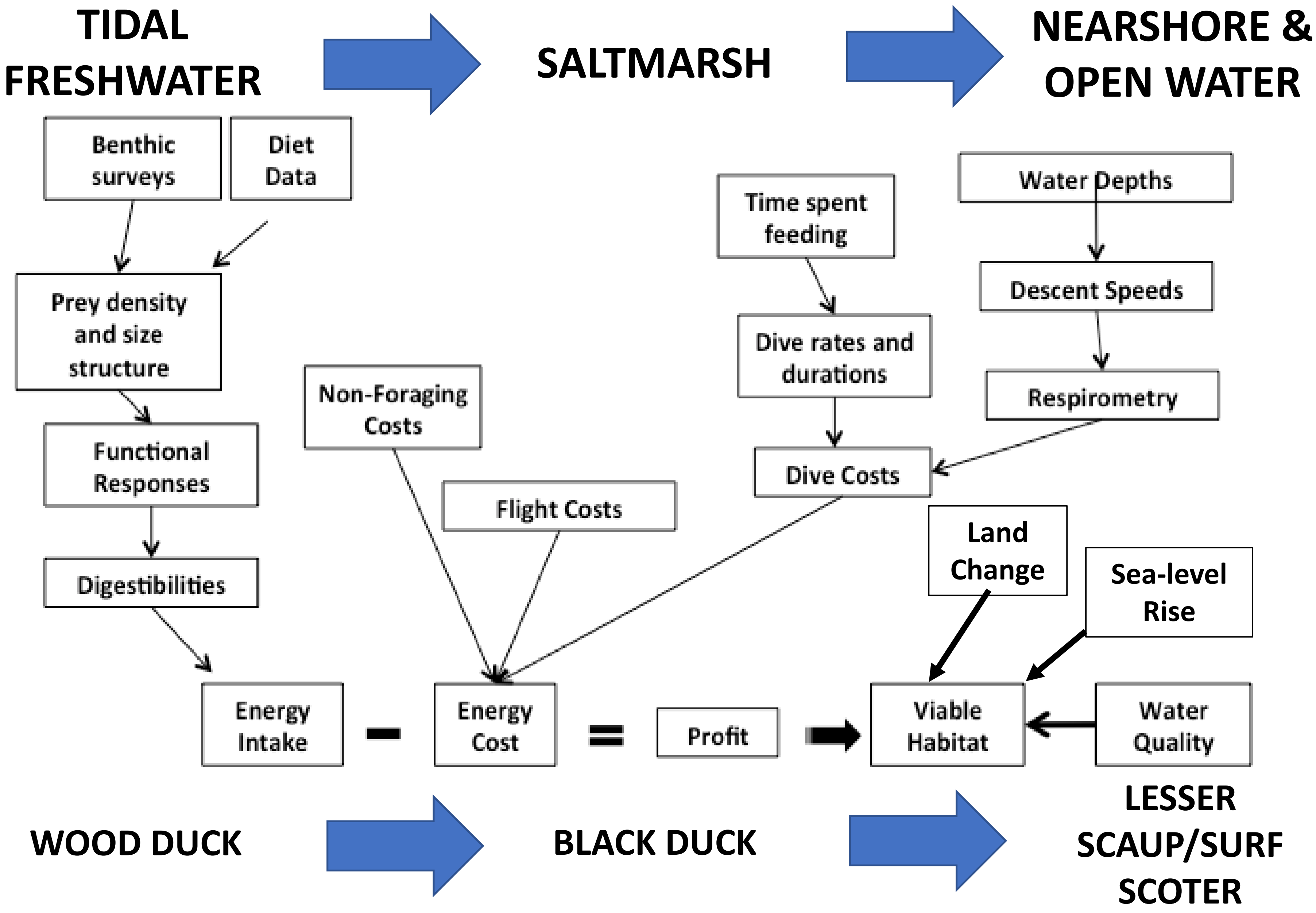


Quality habitat types for wintering black ducks:

1. SAV; 2. High Marsh; 3. Low Marsh

- **Eastern shore refuges (Marshlands Refuge Complex) at risk more from sea-level rise than development pressure.**
- **Western shore refuges (Virginia Rivers Refuge Complex) at risk from both sea-level rise and development pressures.**
- **Shoreline hardening lowers breeding waterbird diversity.**

Where are we going?



Changes in sediment availability along upper estuaries create a sediment shadow: consequences for tidal freshwater wetland dynamics

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STROUD WATER RESEARCH CENTER

GEORGE MASON UNIVERSITY

How do watersheds and estuaries control TFW ecosystems? and their ecogeomorphic responses to SLR?

Watershed

Estuary

Nontidal

...al

Fr...

Oligohaline +

Floodpla...

Channel

Tidal river

2,850 km along U.S. Atlantic Coast, median length = 20 km among 127 rivers

(Ensign and Noe 2018)

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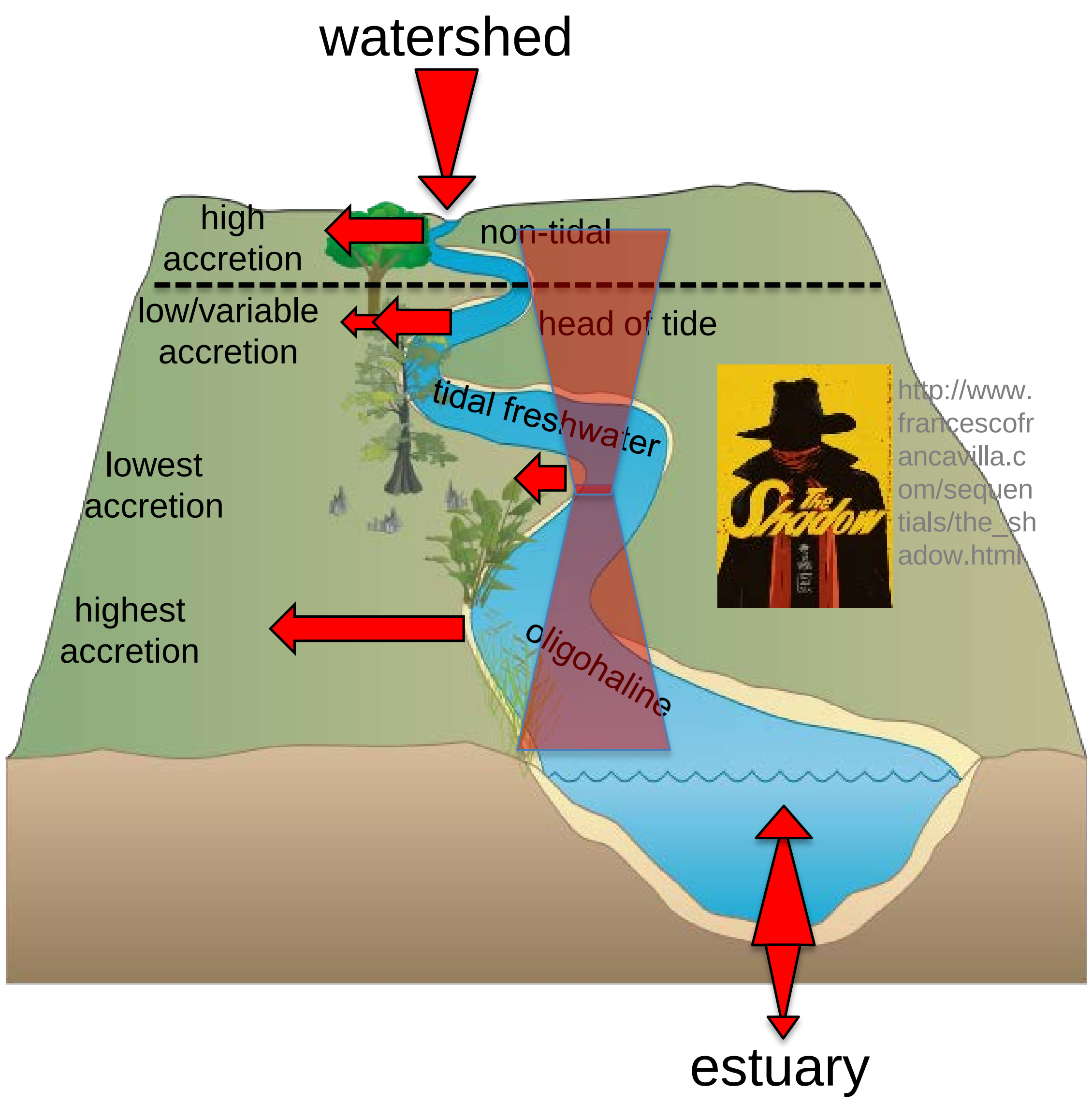
What is the Sediment Shadow?

Minimal sediment availability in lower tidal freshwater rivers and wetlands,

either in-channel suspended sediment concentration or tidal wetland sedimentation



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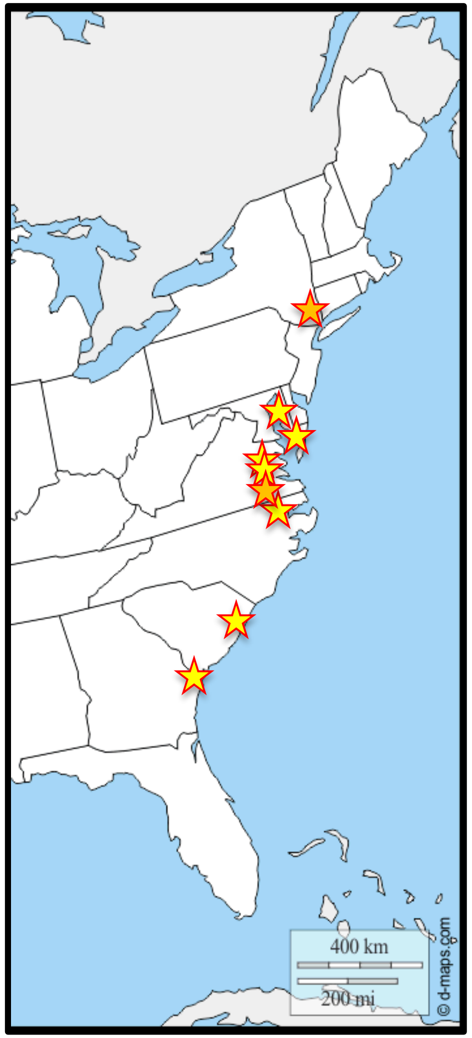
How widespread is the Sediment Shadow?

- We have measured the Sediment Shadow in 7 of 7 U.S. Atlantic Coast tidal freshwater rivers, with either channel SSC/turbidity or wetland sedimentation:
  - Choptank (Ensign et al. 2014, Ensign et al. 2015)
  - Pocomoke (Ensign et al. 2014, Ensign et al. 2015)
  - Mattaponi (Noe et al. unpublished, also Darke and Megonigal 2003)
  - Pamunkey (Noe et al. unpublished)
  - Roanoke (Hupp et al. 2015)
  - Waccamaw/Winyah (Noe et al. 2016)
  - Savannah (Noe et al. 2016)

  - also James (Bukaveckas and Isenberg 2013)
  - also Hudson (Ralston and Geyer 2017)

- "Less than 5% of the sediment from rivers of the Atlantic drainage ever reaches the continental shelf or the deep sea (Meade 1982)



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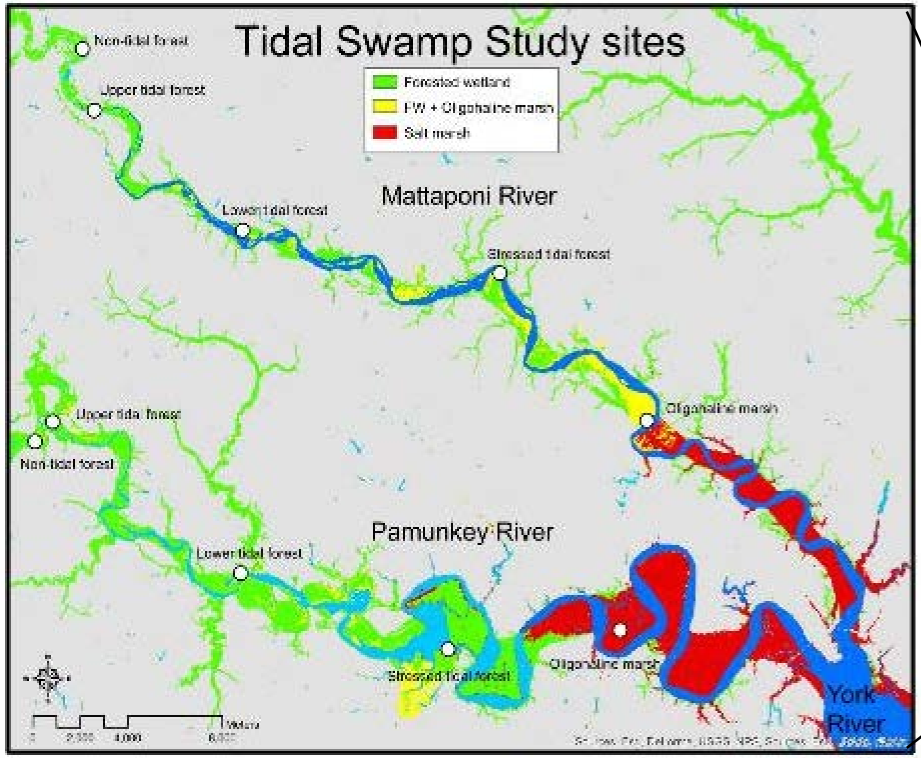
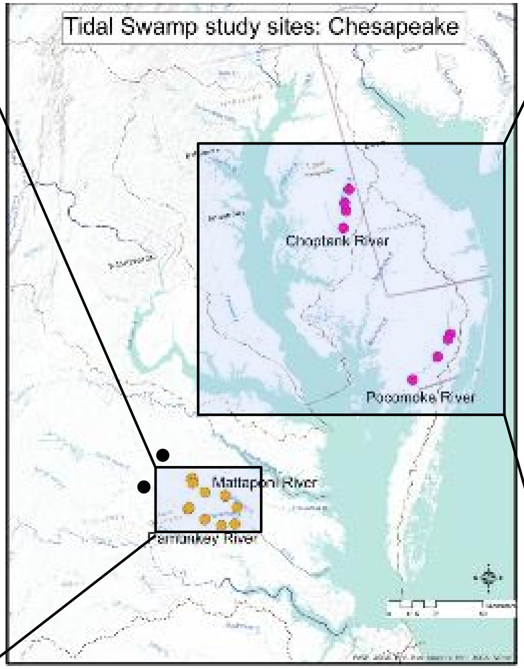
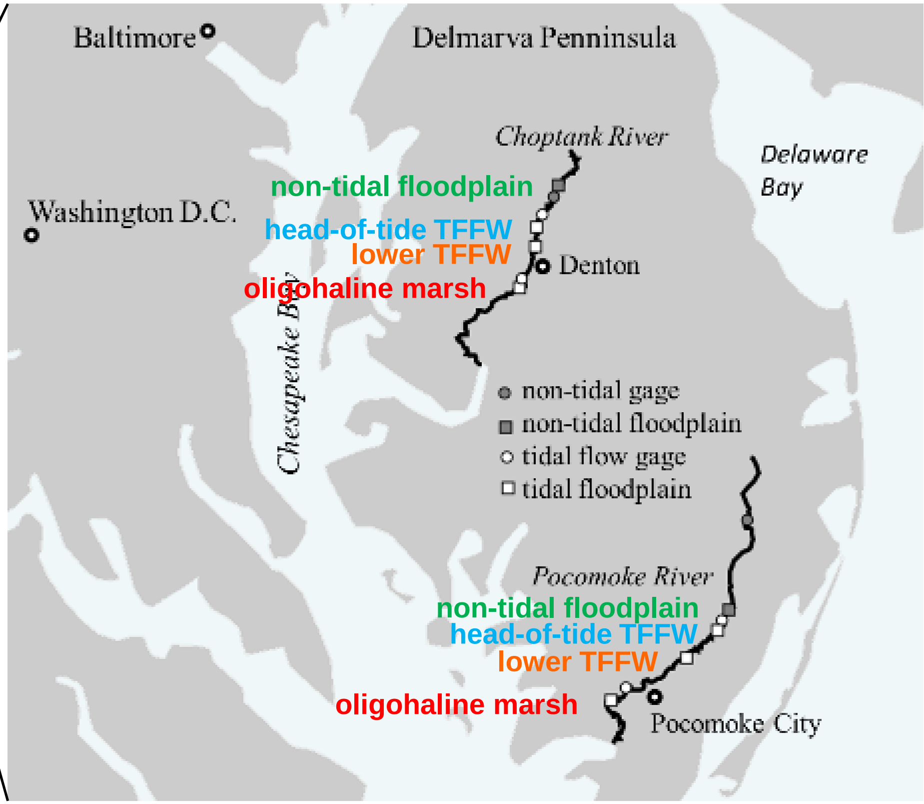
What happens once river loads hit tide?
and does it influence wetland resilience to sea level rise?

Watershed sediment load:
Pamunkey 6X > Mattaponi
average 1985-2014







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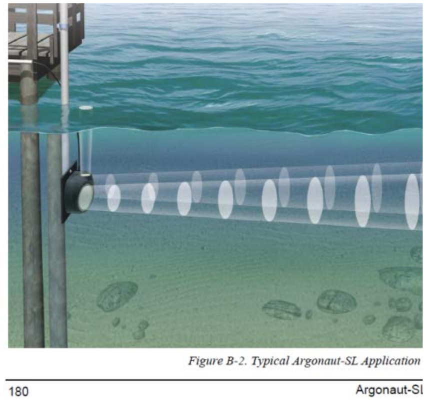
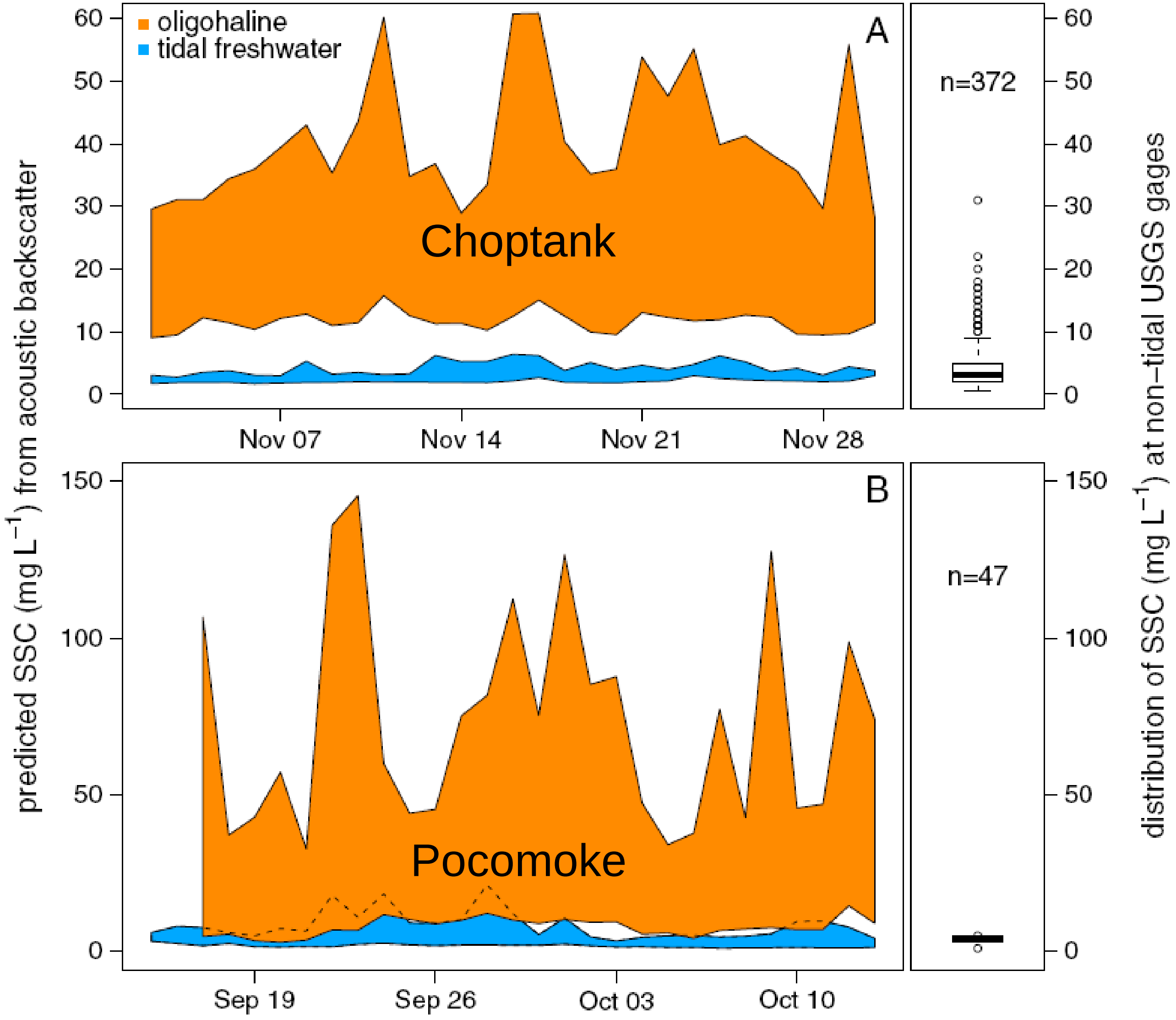
What is influence on nutrient and sediment retention?
Channel suspended sediment





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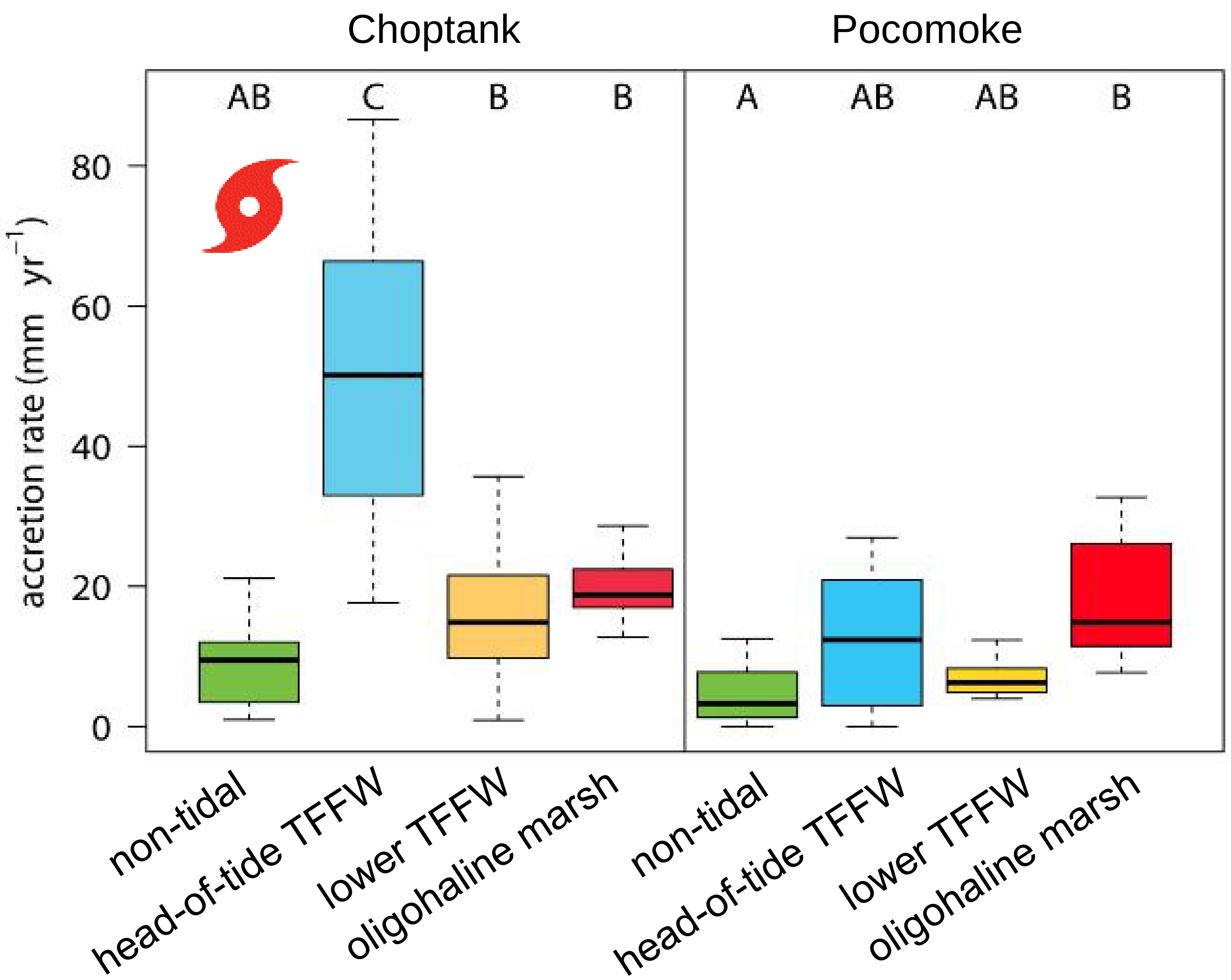
Ensign et al. 2014, *JGR-ES*

What is influence on nutrient and sediment retention?
Wetland sedimentation



Watershed → Estuary

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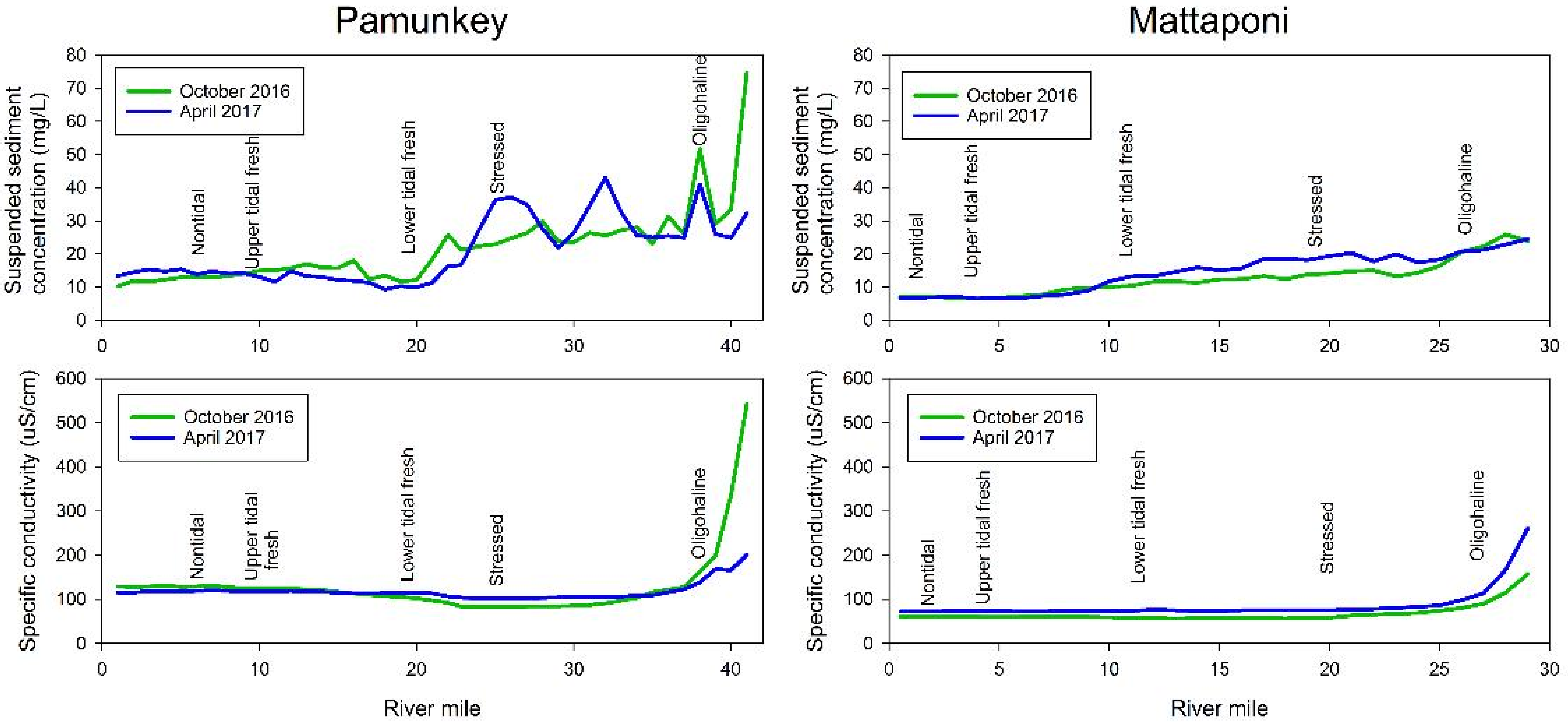
Ensign et al. 2014, *JGR-ES*

What is influence on nutrient and sediment retention?

Channel suspended sediment



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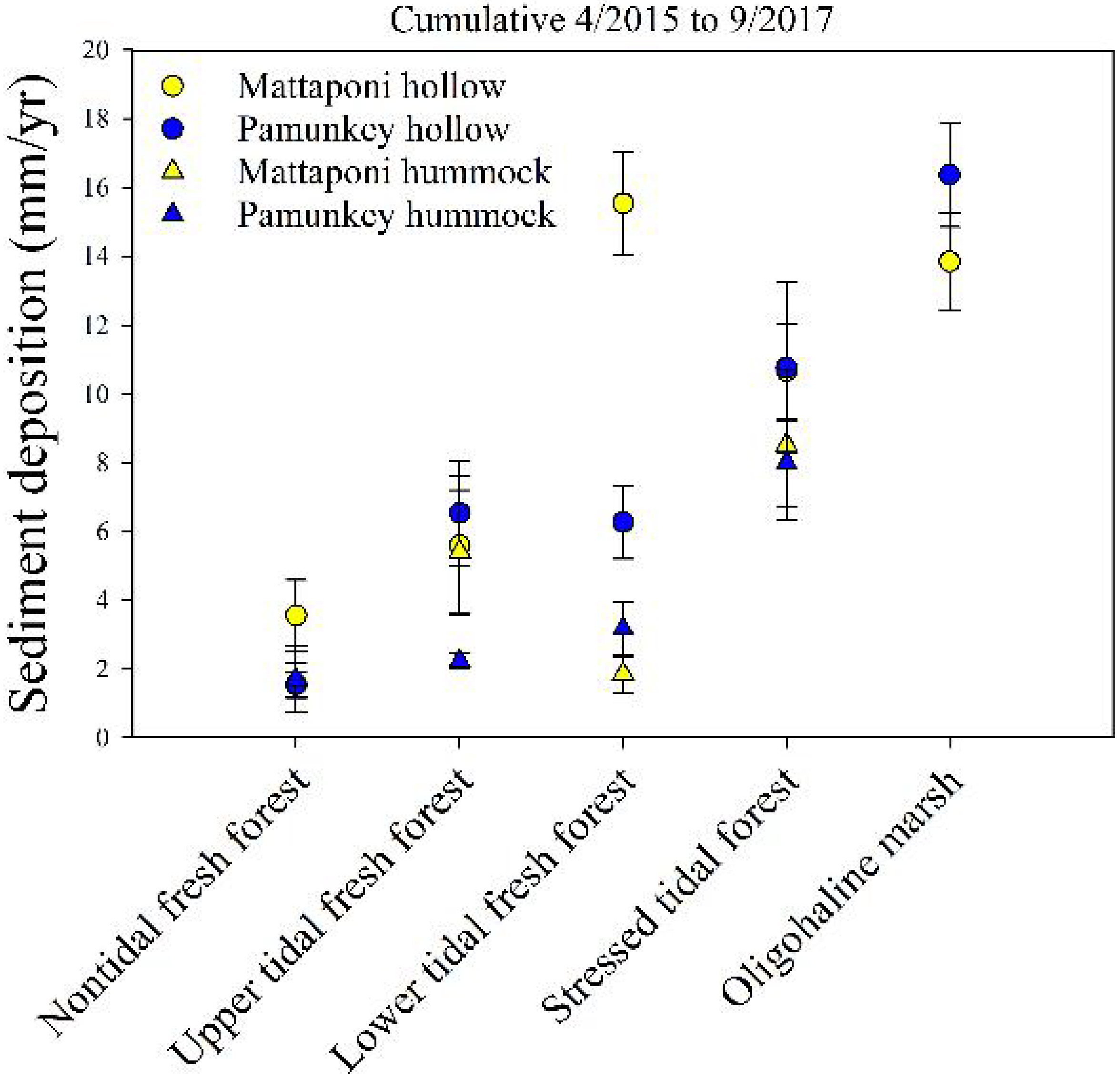
What is influence on nutrient and sediment retention?
Wetland sedimentation

Sediment accretion

April 2015 to April 2016

n= 6 hummock, 6 hollow
marker horizons per site



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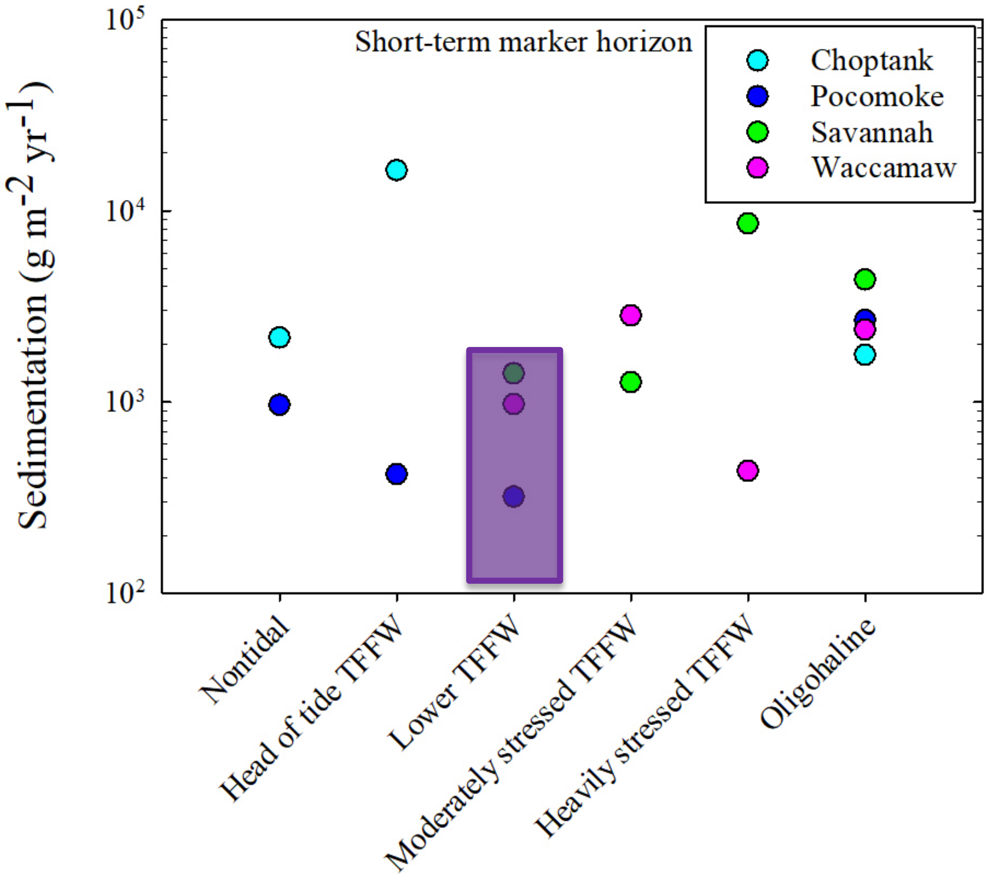
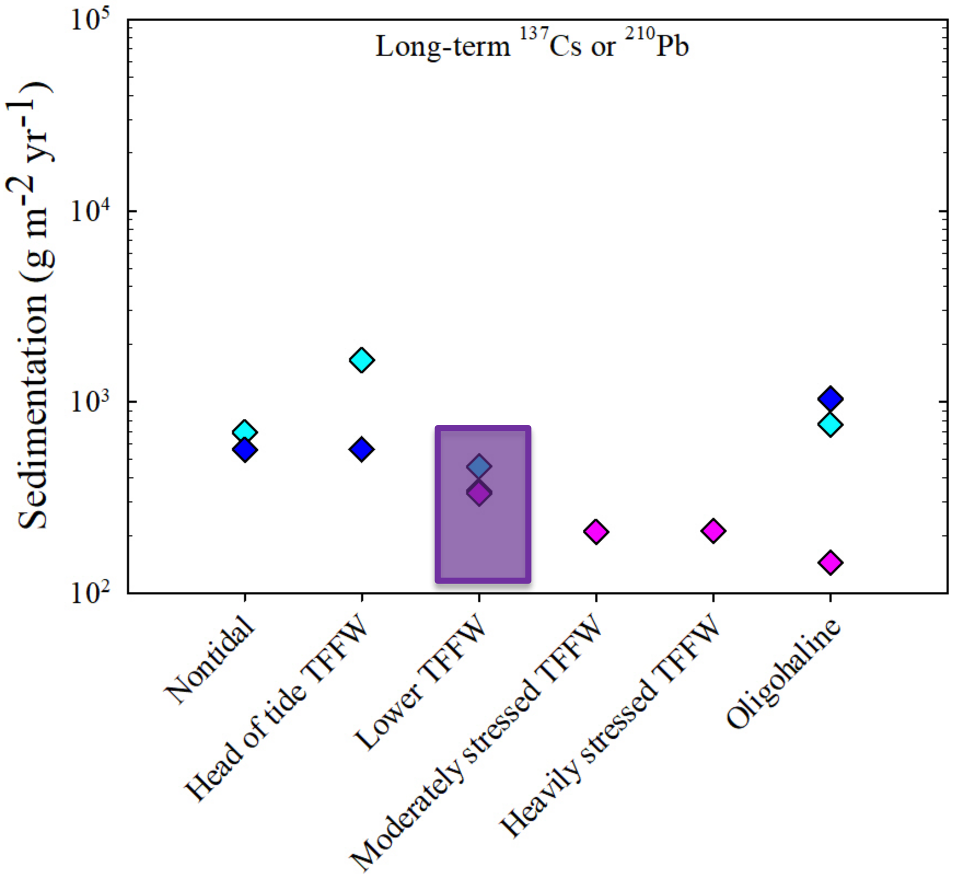
What is influence on nutrient and sediment retention?
Wetland sedimentation

Four rivers (MD, SC, GA) show modern sedimentation minima in lower TFFW

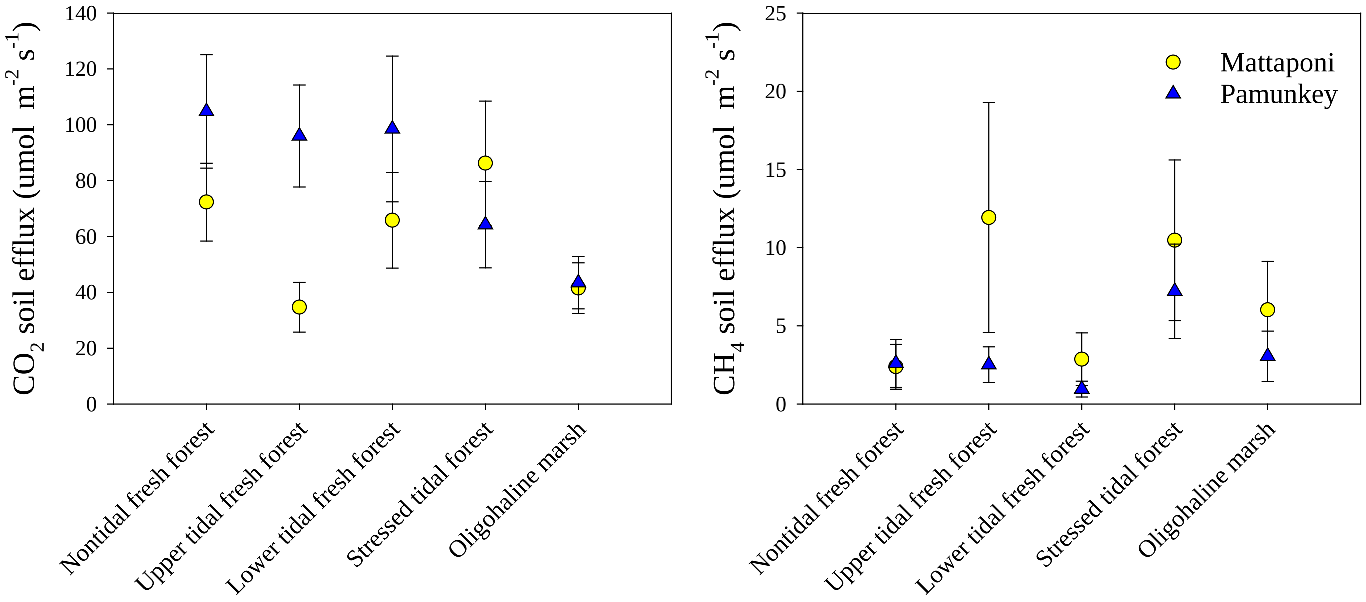




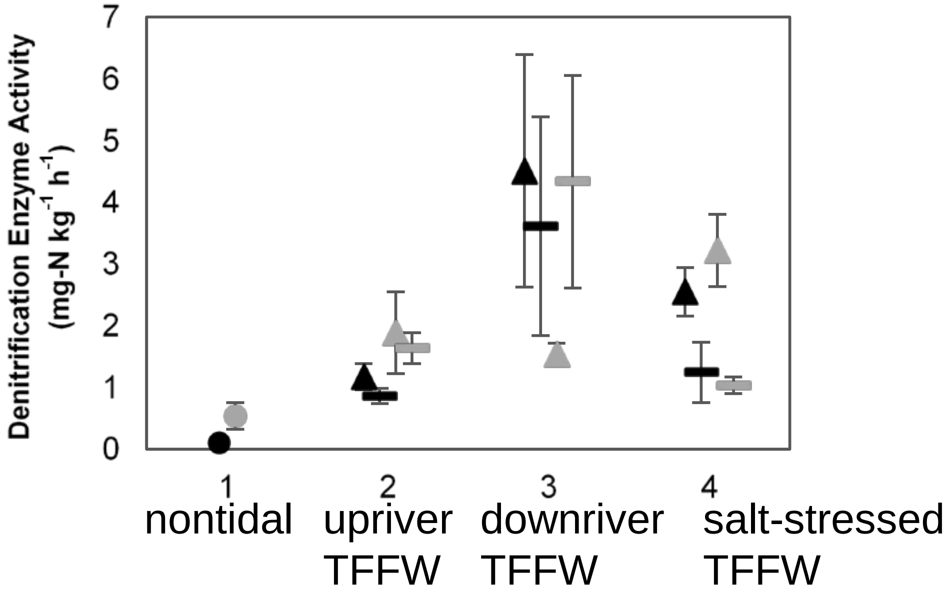
Ensign et al. 2014, *JGR-ES*
Ensign et al. 2015, *GRL*
Noe et al . 2016, *Estuaries & Coasts*

What are biogeochemical functions?

Soil GHG flux



Soil denitrification potential



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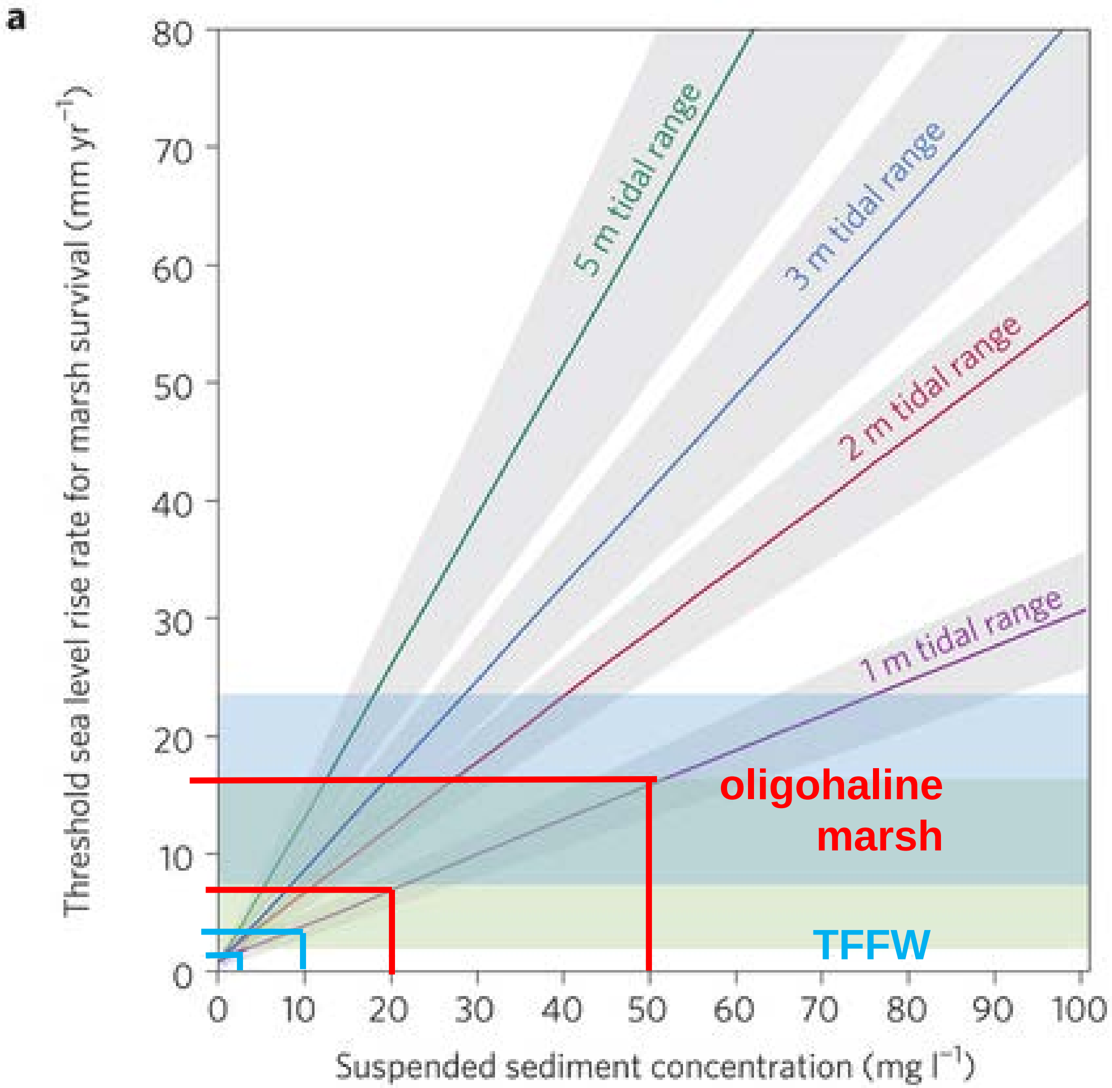
Are there consequences for resilience to sea level rise?

Mineral sediment
is responsible for
38% of tidal freshwater marsh accretion

Neubauer 2008, *Estuarine, Coastal and Shelf Science*



Kirwan et al. 2016, *Nature Climate Change*

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Consequences of Sediment Shadow?
Soil surface elevation change

Tidal Freshwater Wetlands

SET:	**mm/yr**	
Cadol et al. 2014:	+3.5	marsh
Beckett et al. 2016:	+4.5	marsh
Stagg et al. 2016:	+2.4 or +4.5	forest

Coring (^{210}Pb or ^{137}Cs):		
Neubauer 2008:	+7.6 (median)	marsh
Craft 2012:	+1.3 or +2.2	forest
Noe et al. 2016:	+3.5	forest

Coring (millenia):		
Khan and Brush 1994:	+0.5	marsh
Pasternack et al. 2001:	+0.8	marsh
Neubauer et al. 2002:	+1.6	marsh
Jones et al. 2017:	+0.5	forest

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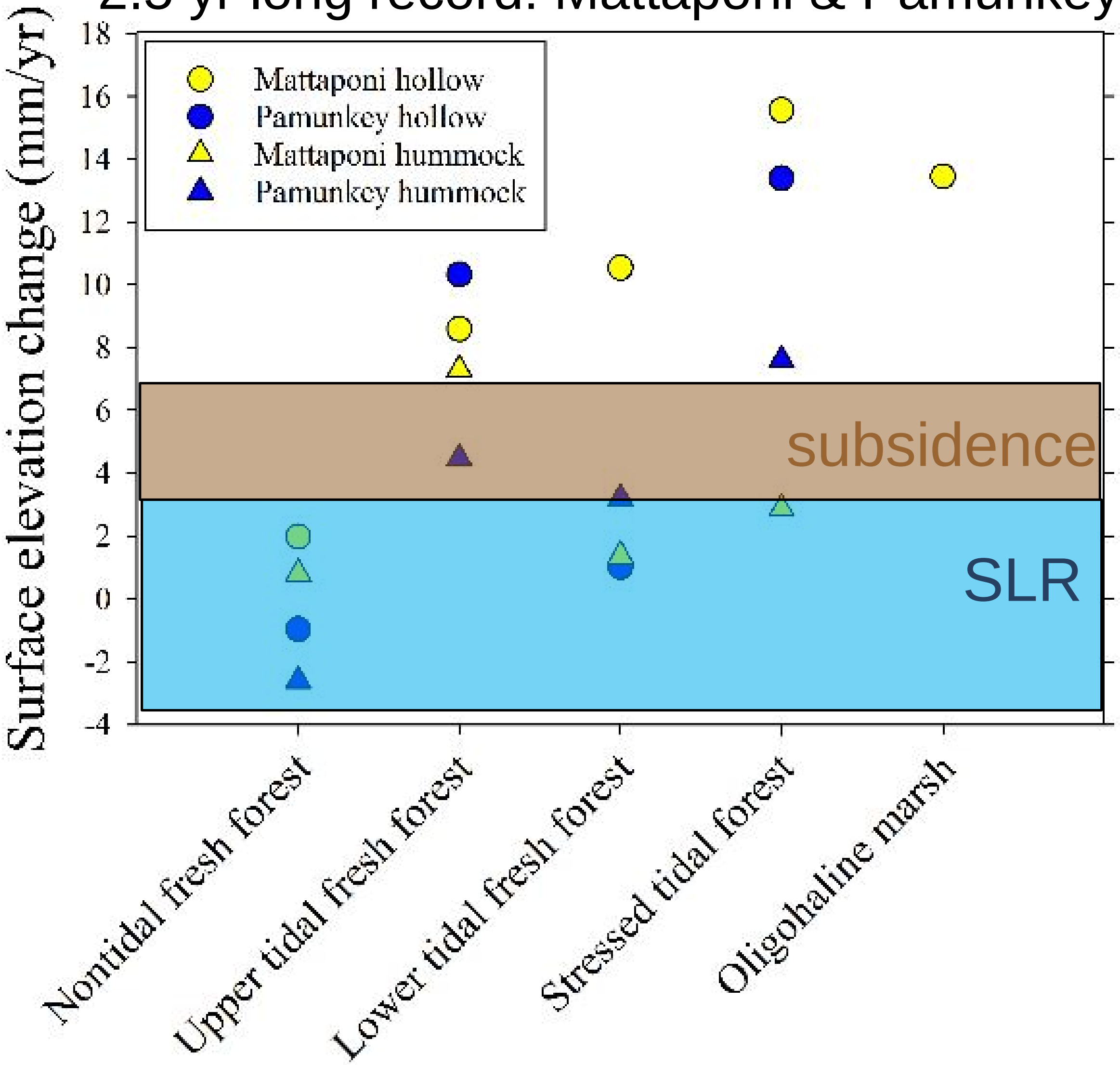
2.5 yr long record: Mattaponi & Pamunkey



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The impacts of the Sediment Shadow phenomenon on the dynamics of tidal freshwater wetlands

1) How widespread is the Sediment Shadow?

   Very common along U.S. Atlantic Coast

2) Are sediment loads to coastal rivers changing over time?

   Conflicting evidence in modern river suspended sediment record, clear decrease from Colonial era

3) What is influence on nutrient and sediment retention?

   Tidal freshwater wetlands trap much of watershed sediment and assoc. P loads, with important consequences for estuarine WQ

4) What are associated changes in TFW biogeochemical cycling?

   Increased soil N and P mineralization, increased productivity, perhaps increased CH_4 efflux

5) Are there consequences for resilience to sea level rise?

   At some level of rSLR, will result in conversion and loss of tidal freshwater wetlands (esp. forest)