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Understanding the impact of SLR on marshes, coasts, processes, and habitat availability

USGS Chesapeake Bay Studies
Coastal Habitats team (Theme 2)
U.S. Department of the Interior

USGS

Presentation outline

Coastal Response model:
Improving dynamics of landform response to SLR

Coastal habitat modeling:
Connecting SLR, sediment supply, and landscape evolution

Marsh geospatial analysis:
Identifying patterns in vulnerability

Marsh migration, storms, and SLR:
Mapping likelihood and modeling processes

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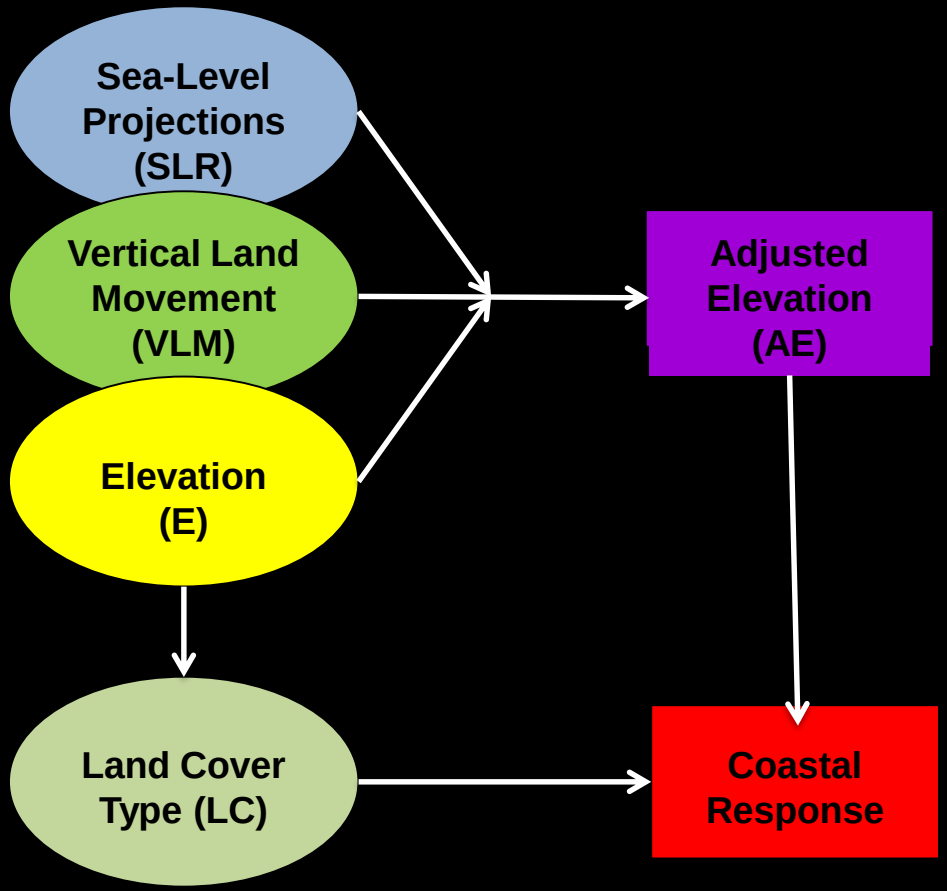
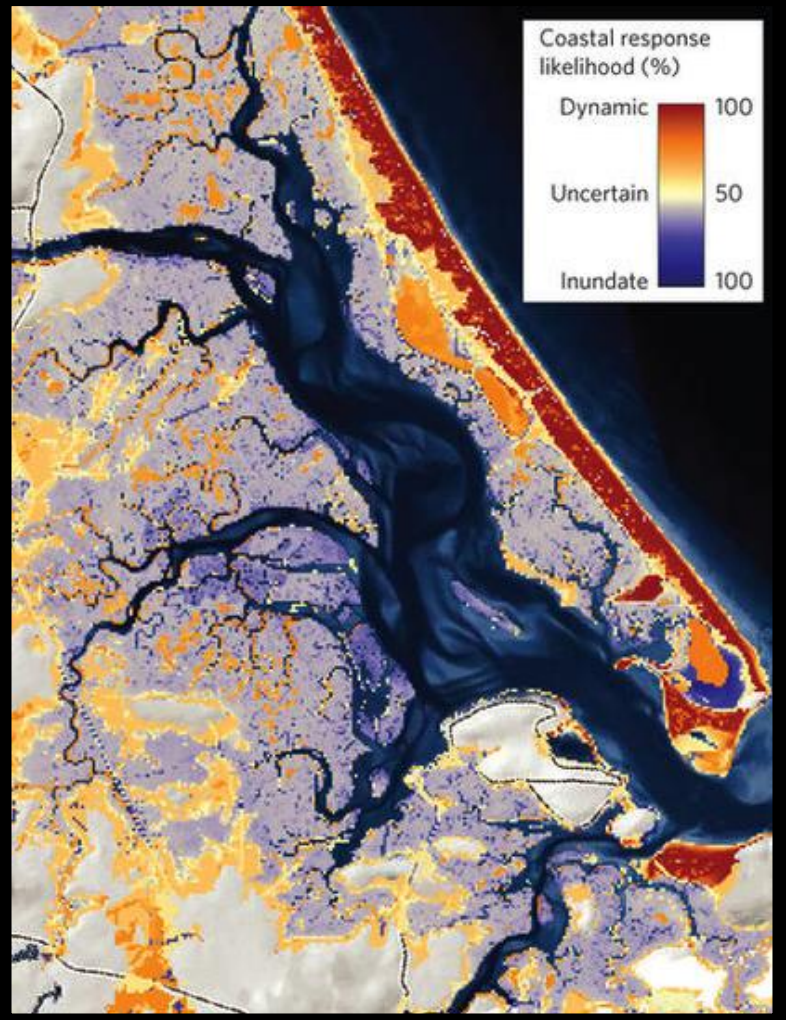
The coastal landscape is variable

Coastal Response model: likelihood of vertical response

Bayesian network of coastal response





Lentz et al. 2016 Nat. Clim. Change

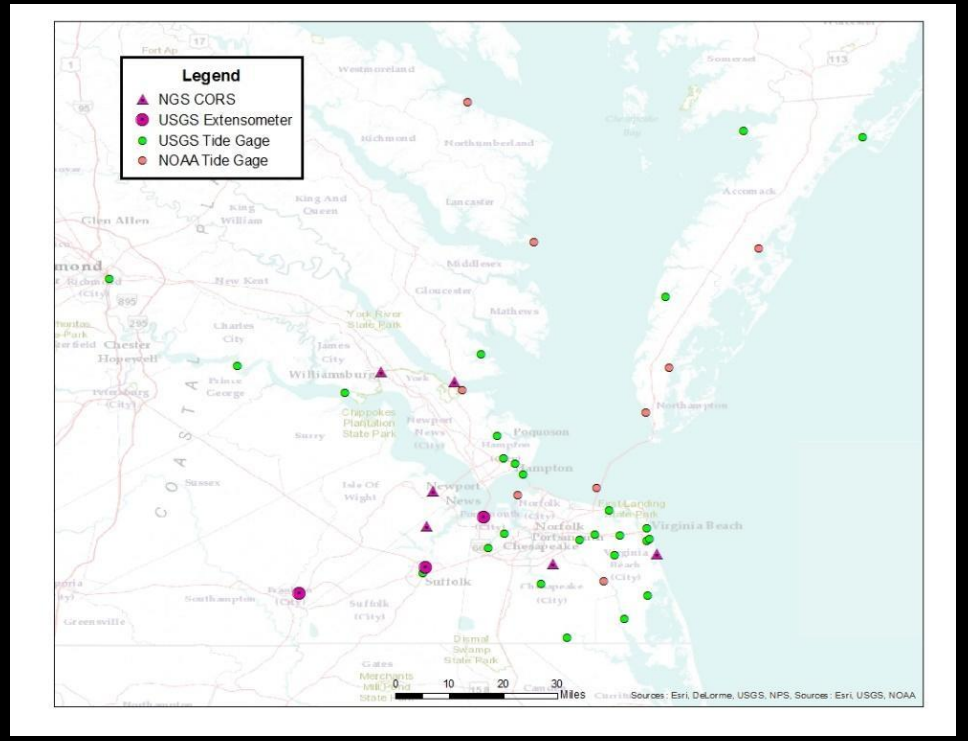
Enhancing the Coastal Response Model

Vertical land movement: expand network of benchmark stations to get updated picture of subsidence

Vertical response of marshes: incorporate representation of tide-dependent processes (biomass→vertical growth)

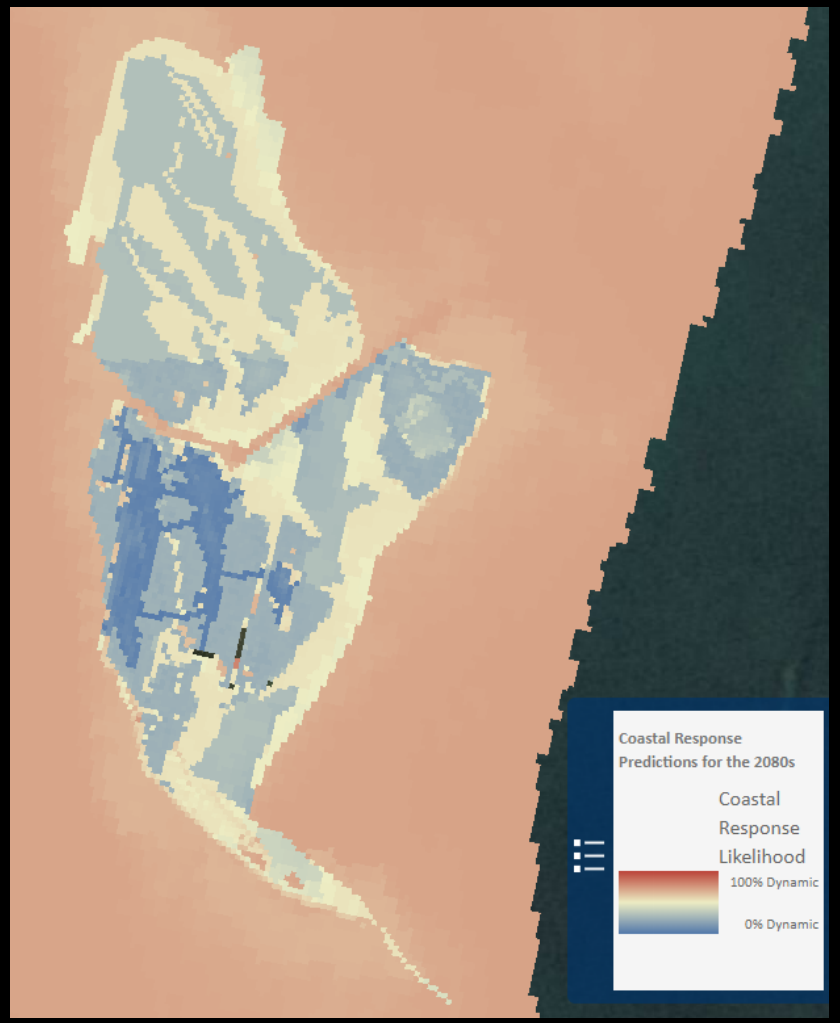
Lateral response of coasts: incorporate probabilistic wave climate into sandy and marsh coastlines

Internal response of marshes: use remote-sensing metrics to estimate likelihood of internal deterioration (UVVR)

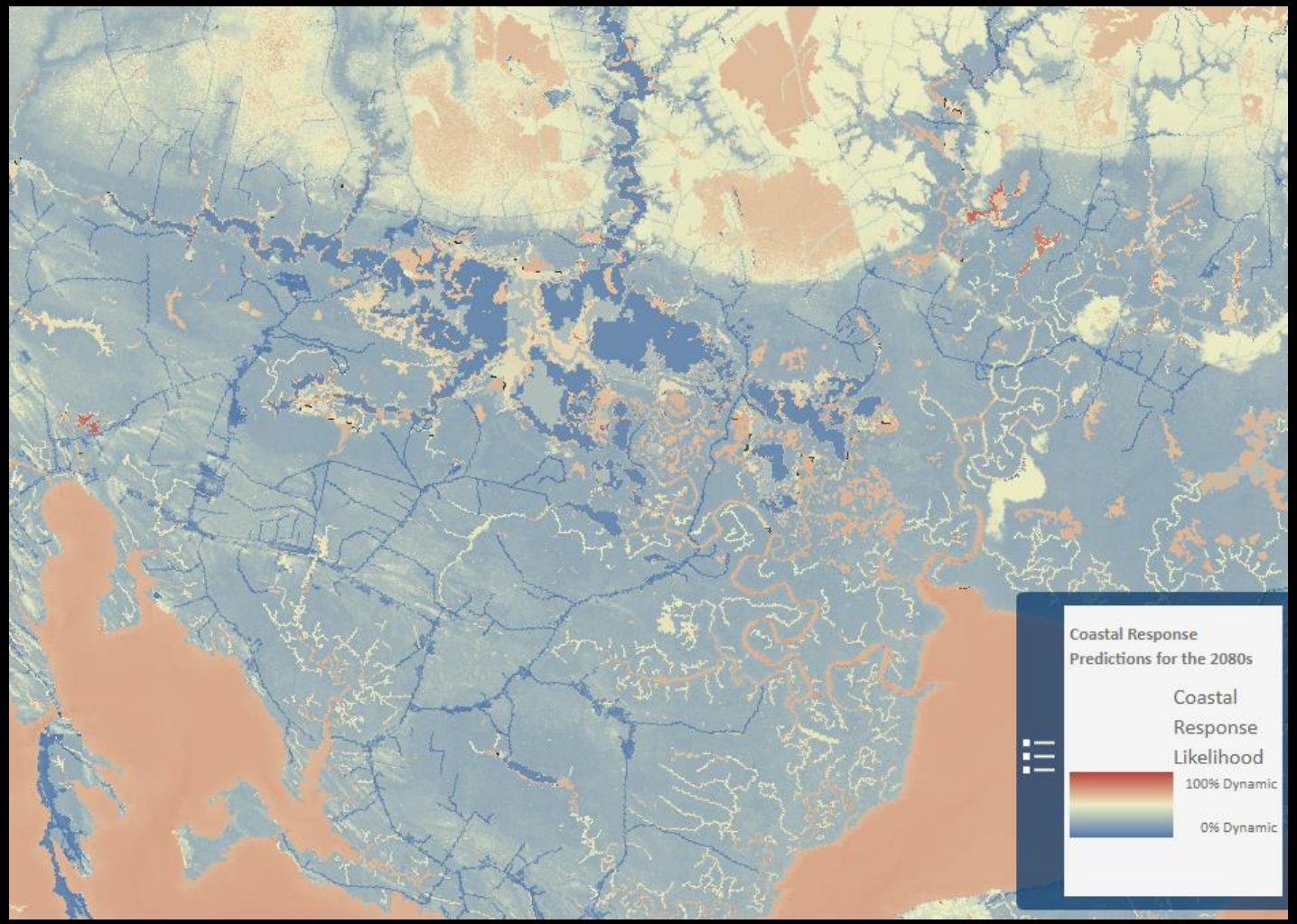


Testing the enhanced model: expected results FY 21-22

Tangier Island: mixed land use classes, edge erosion, marsh vertical response



Blackwater NWR: internal deterioration, landward marsh migration



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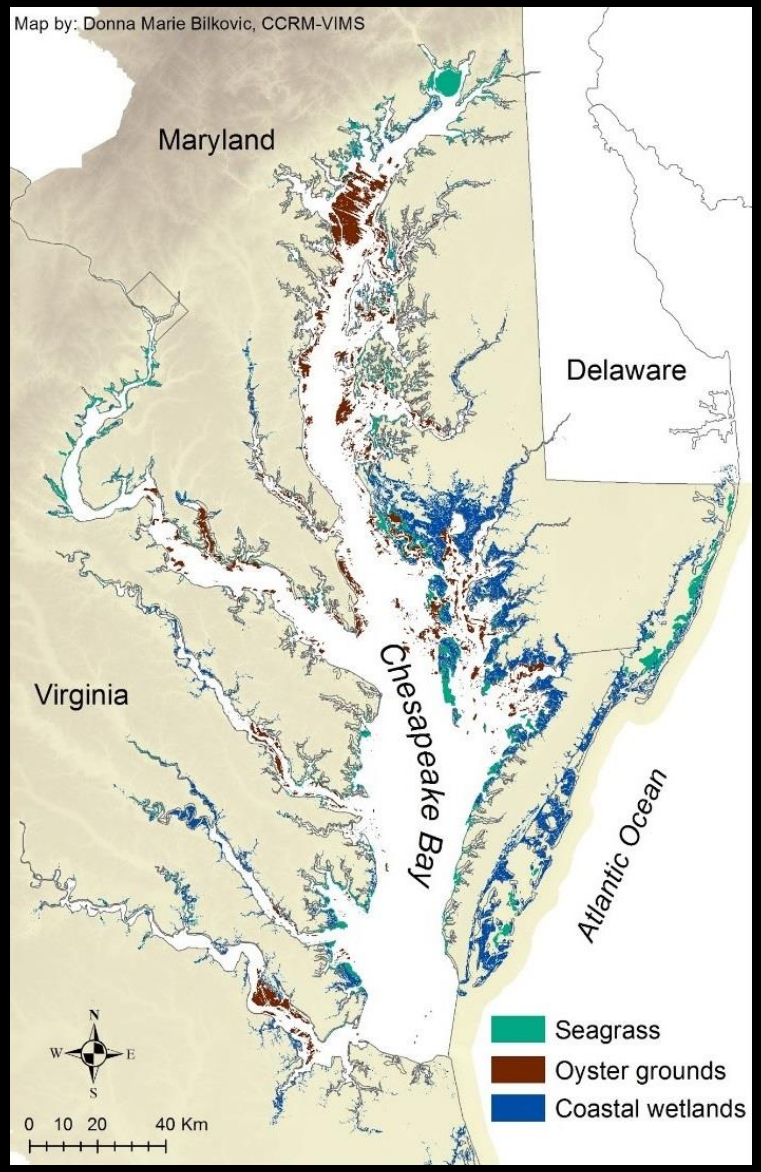
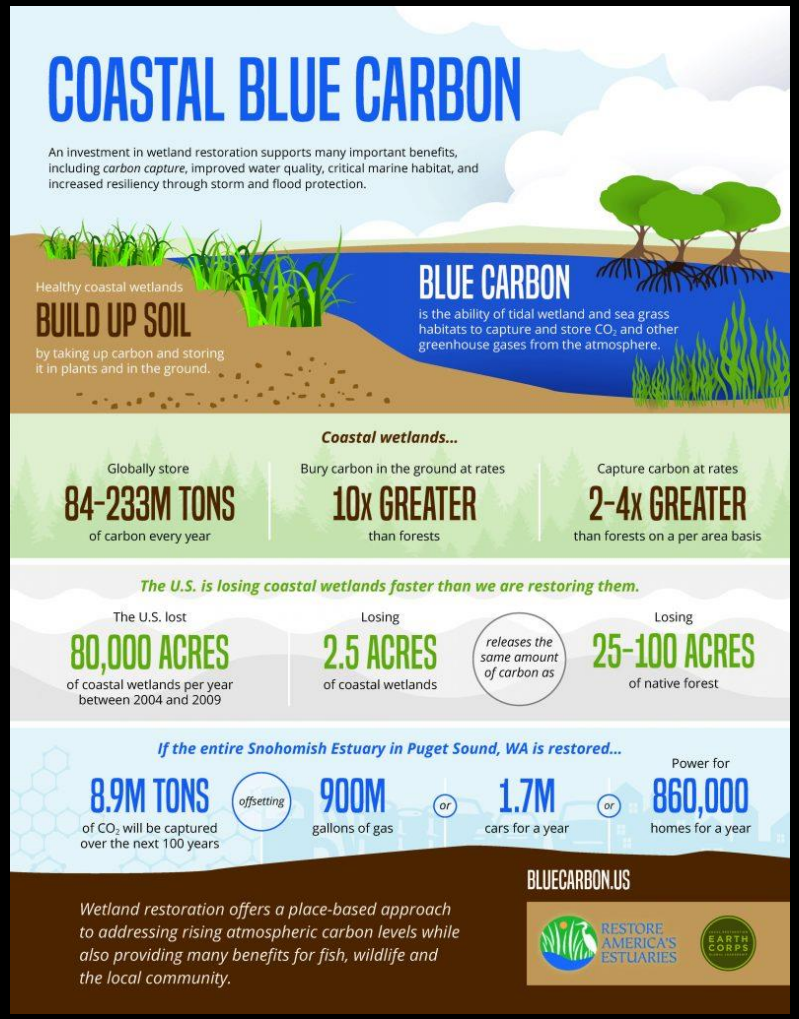
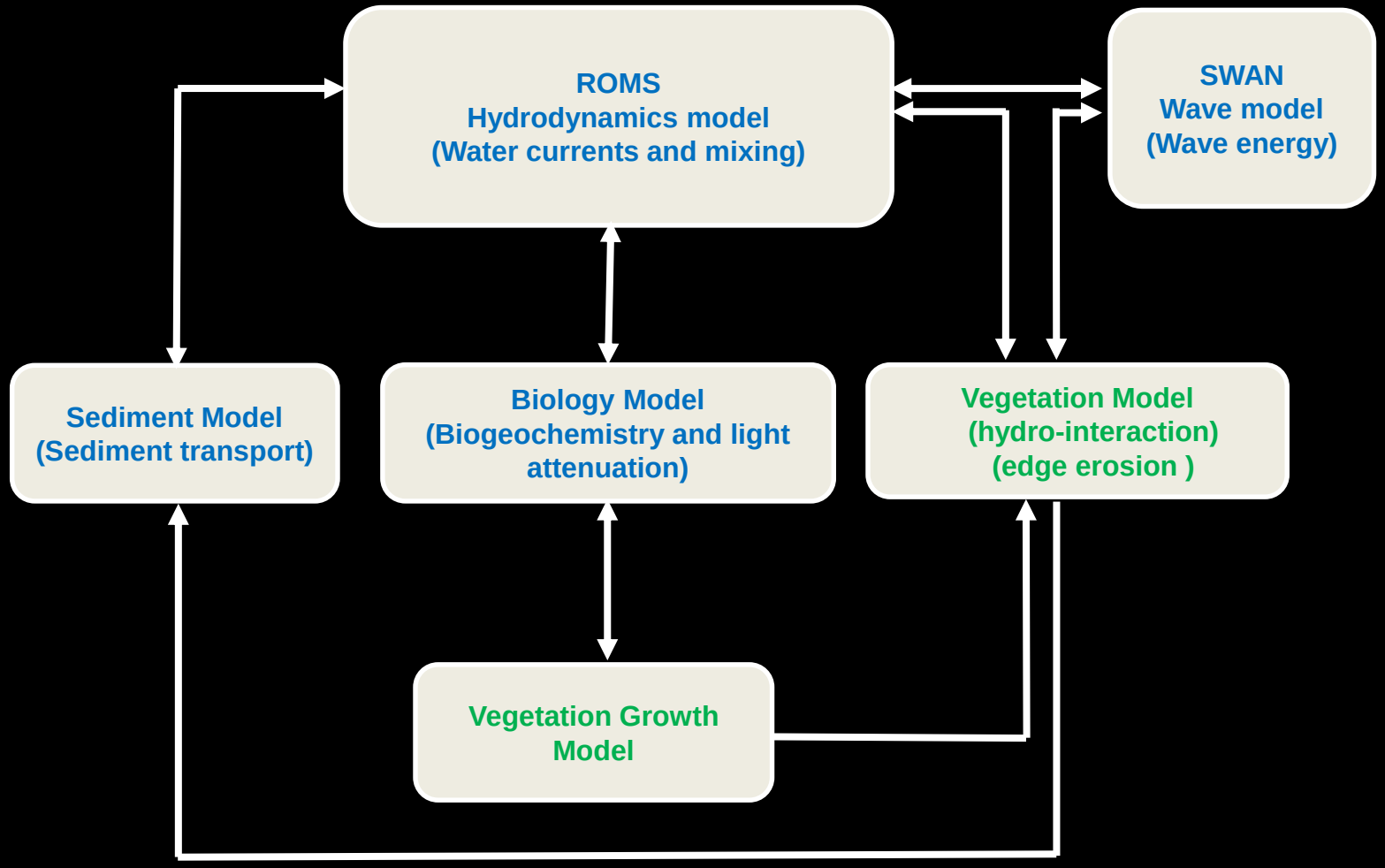
Coastal habitat modeling: how does SLR, wave attack, and sediment supply shift distributions of marsh and SAV?

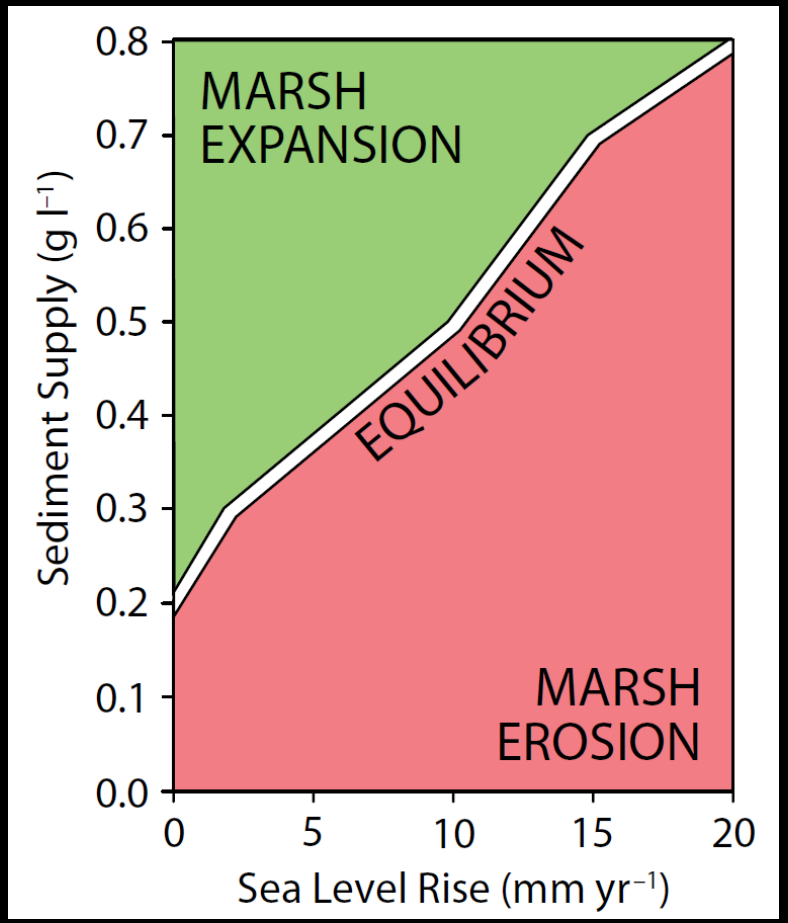




COAWST: coupling of biophysical processes



Can we reproduce fundamental system behavior for marshes and SAV beds? (Fagherazzi et al. 2013)



Focal sites for coupled modeling: hotspots of avian density

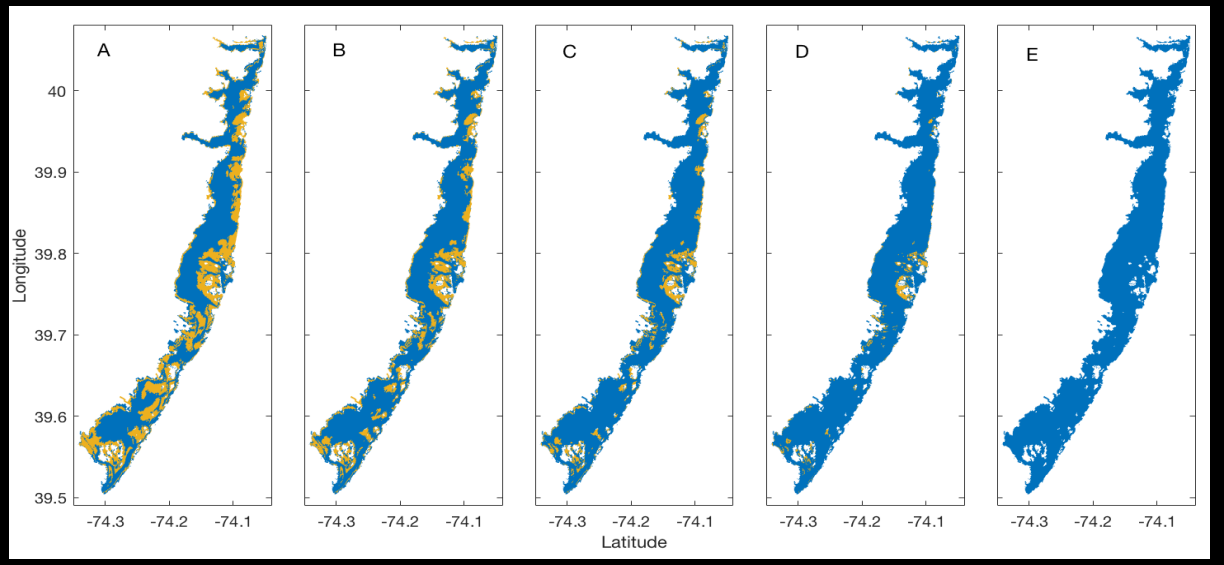
Sites must have:

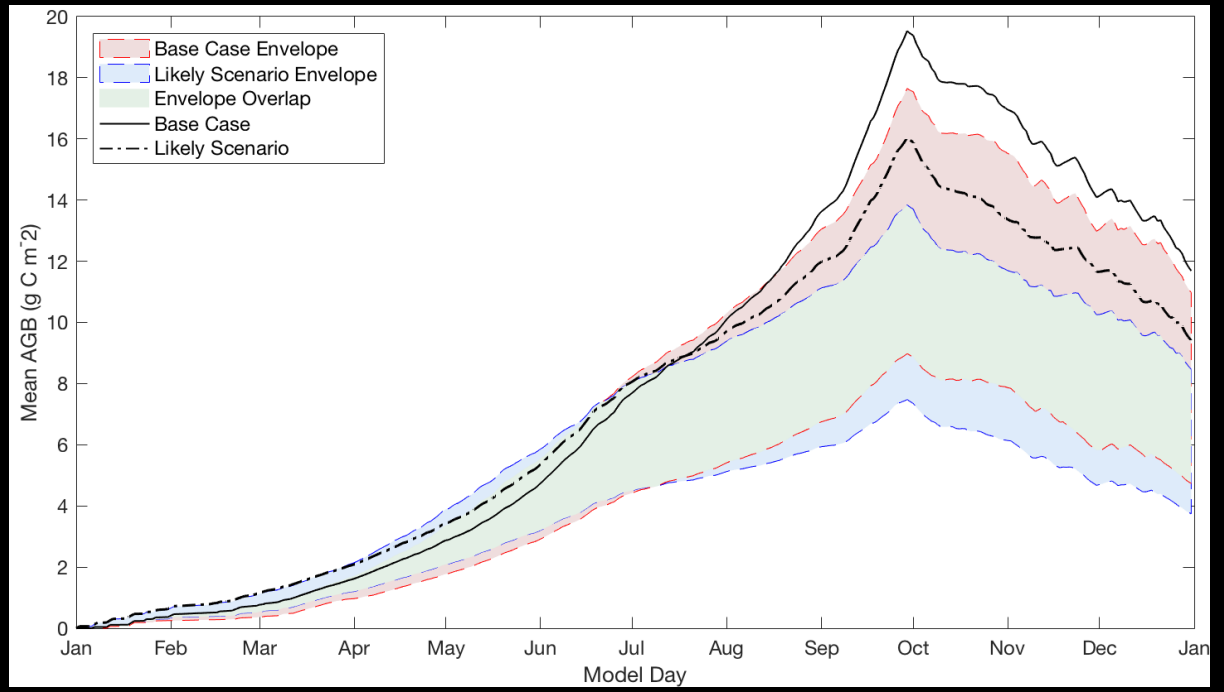
- a continuum of estuarine channel, SAV beds, intertidal flat, marsh scarp, marsh plain (and potentially forest)
- Utilization by waterfowl
- Relatively small footprint, to enable high-resolution modeling (< 25 km^2)
- Robust data for SAV and marsh density
- Early candidates: Fishing Bay, Eastern Neck NWR

Goal: scenarios of habitat coverage under SLR, sediment scenarios: FY 21

End-user applications:

- How does SAV and marsh areal coverage change with SLR?
- How do these changes impact waterfowl?
- How do total ecosystem services (carbon storage, wave attenuation) change with SLR?
- How does sediment load negatively (SAV) and positively (marsh) affect coverage?
- Can we extrapolate results using proxies to estimate future bay-wide coverage?





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Geospatial synthesis of wetland vulnerability

Marsh unit delineation using lidar and water-drop analysis

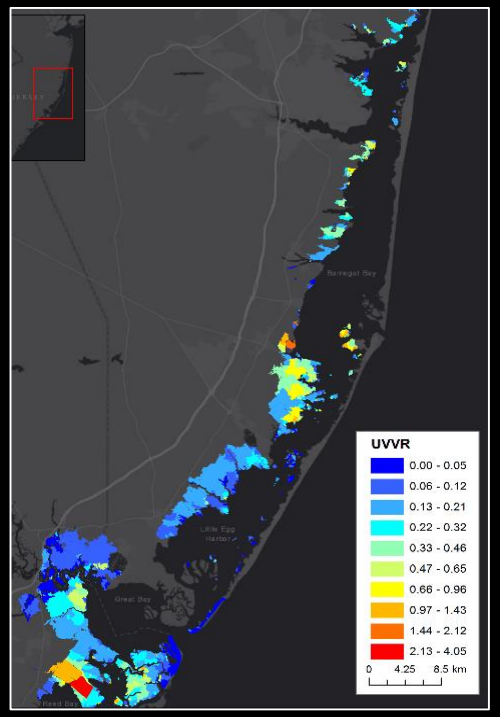
Mapping remote-sensing data and model results on to marsh units for comparison

Synthesis of data layers to identify vulnerable parcels

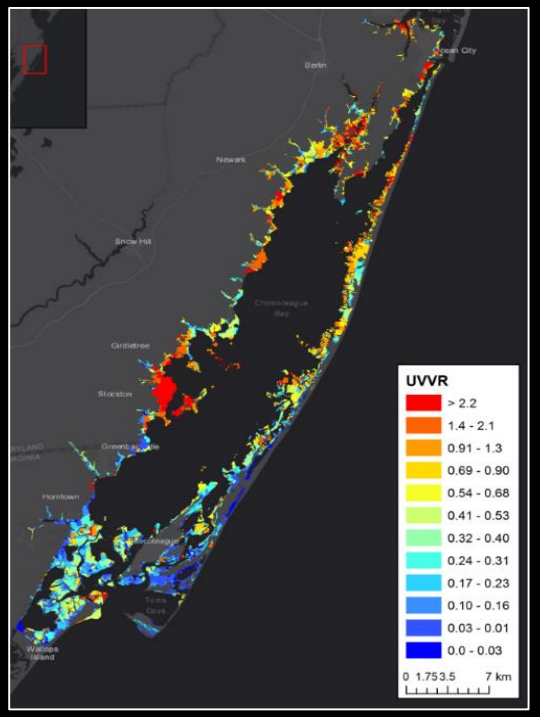
Delivery through ScienceBase and mapping services

Primary product: unvegetated-vegetated marsh ratio (UVVR)

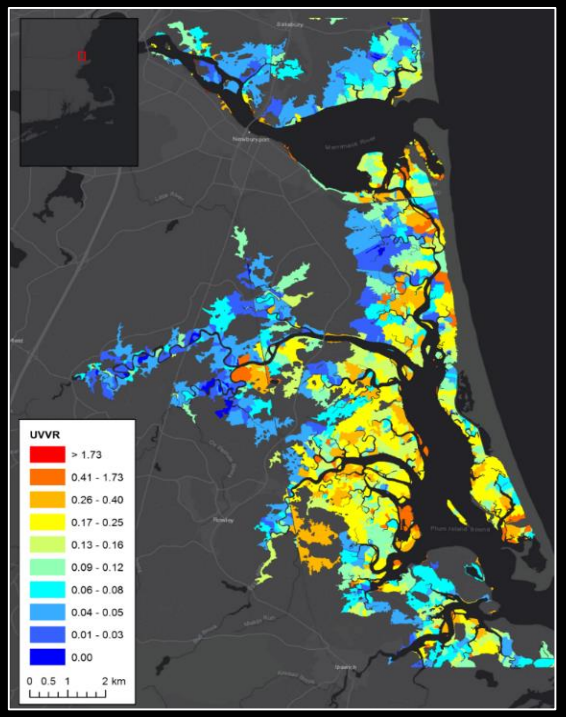
Forsythe NWR



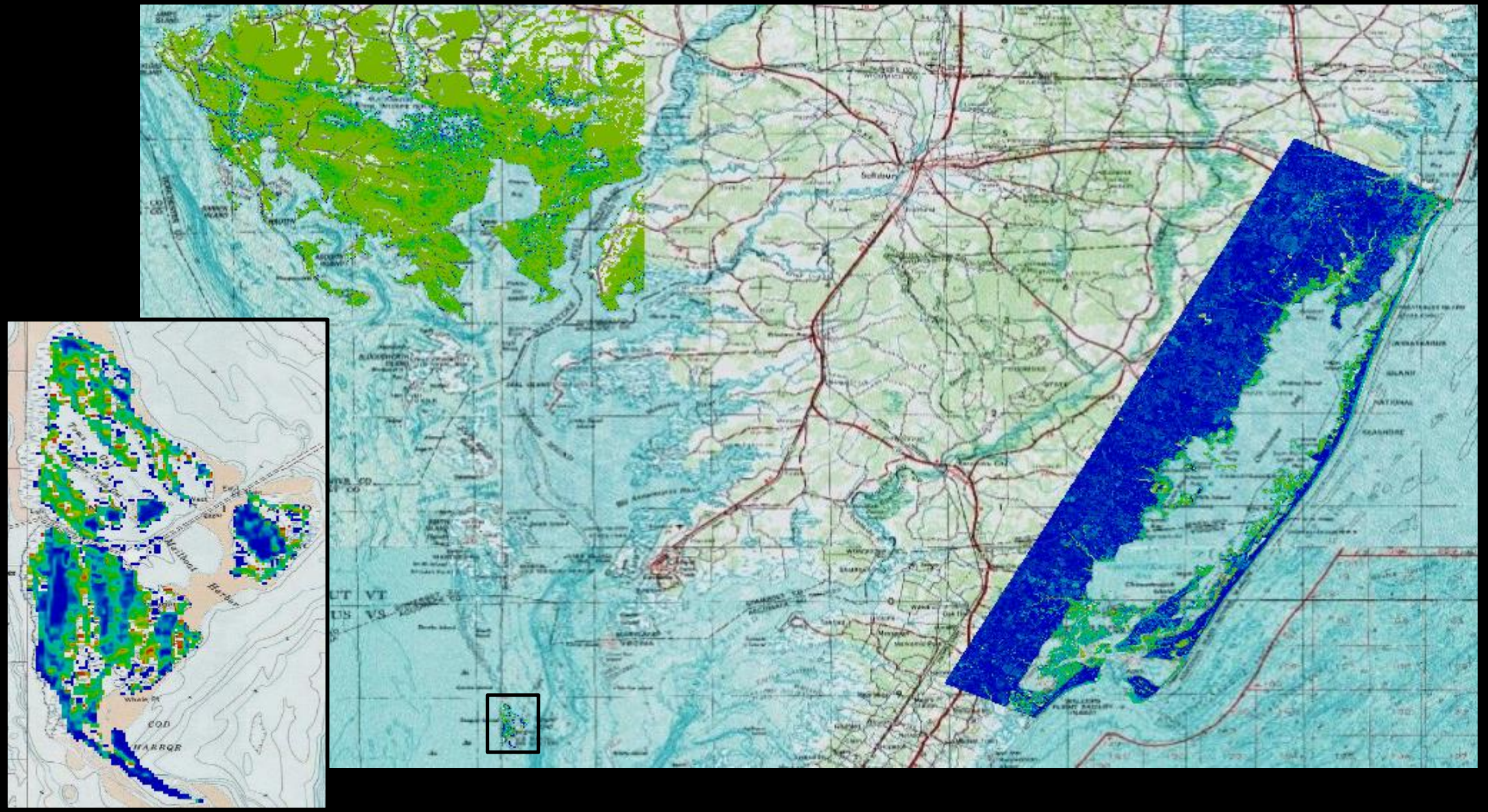
Assateague NS
Chincoteague NWR



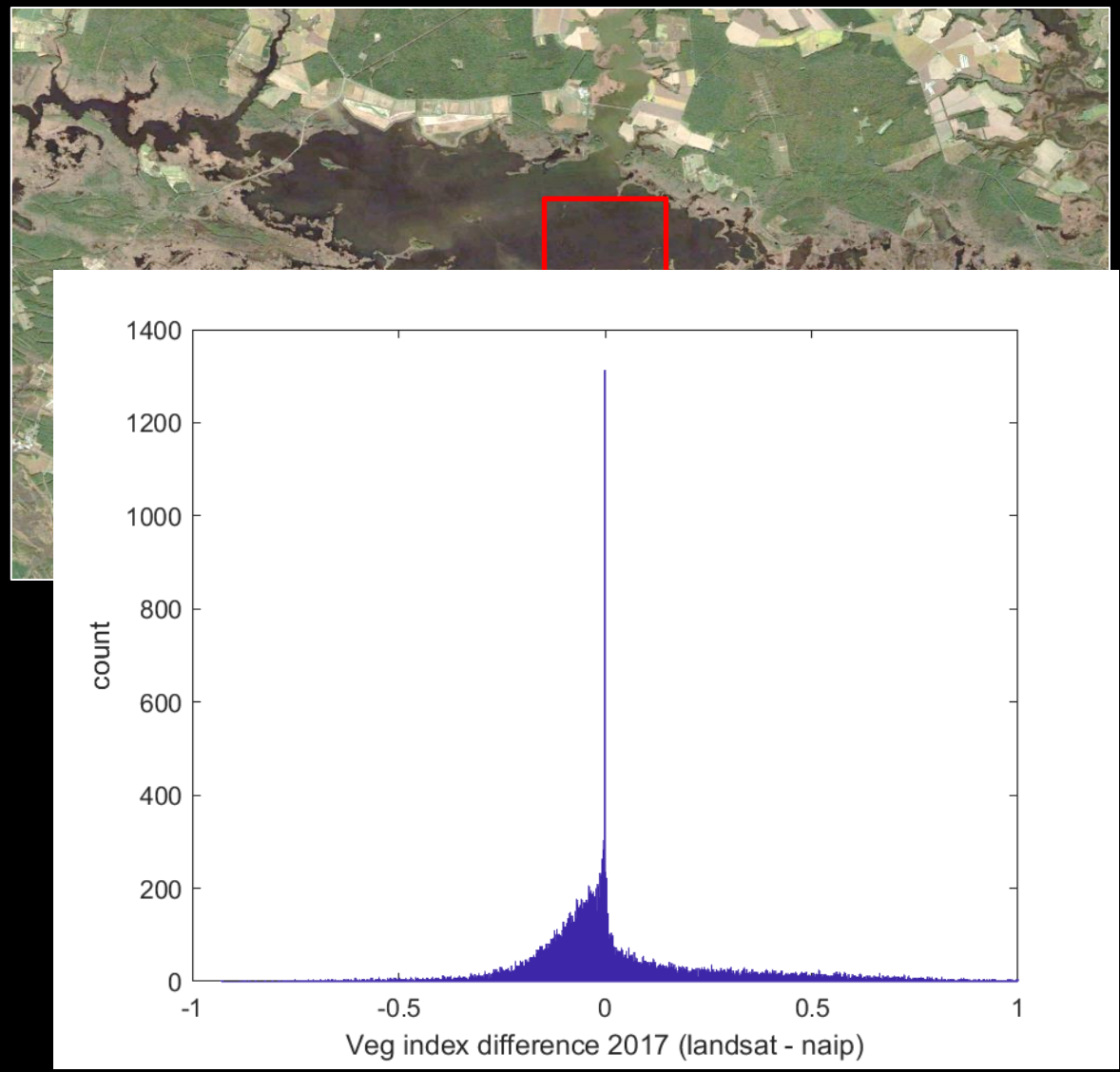
Parker River NWR
Plum Island LTER

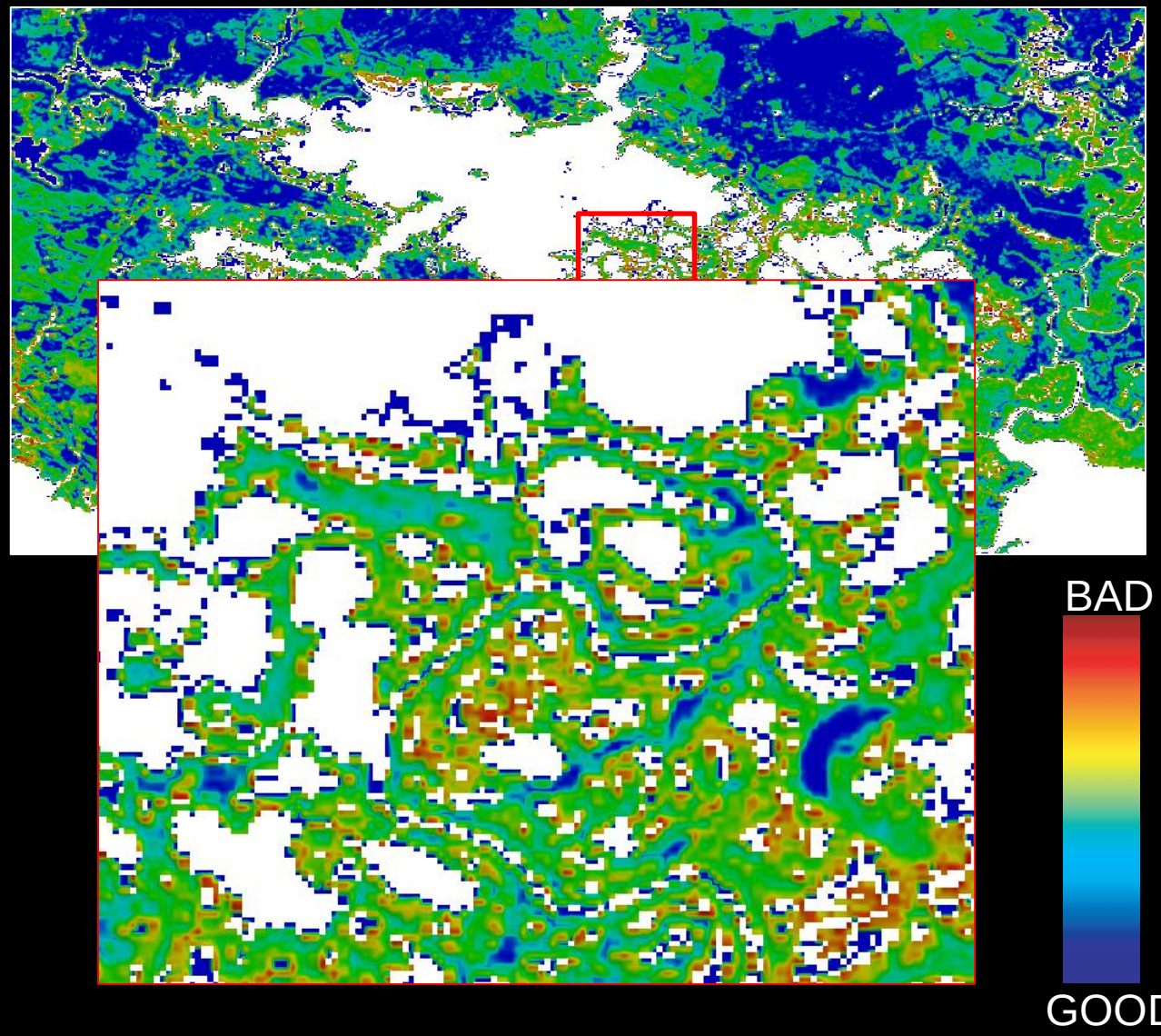


Landsat-based UVVR for entire Bay: final QA/QC underway

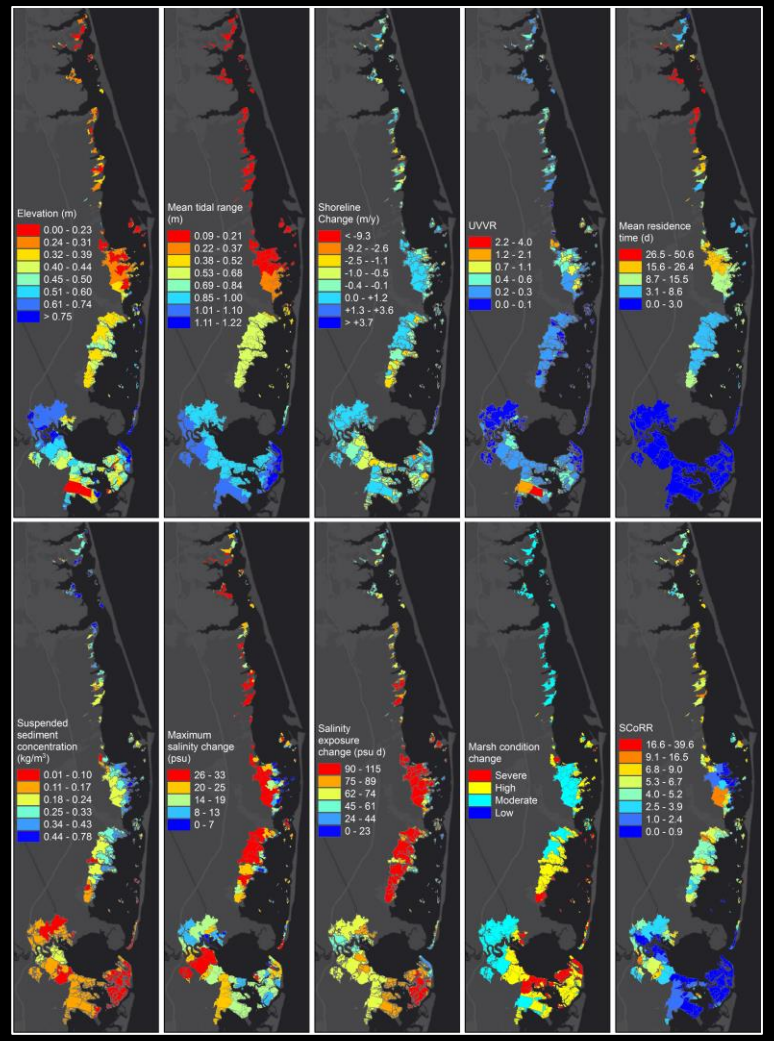


Landsat-based UVVR for entire Bay: groundtruth at Blackwater





Metrics to guide restoration investments: FY22

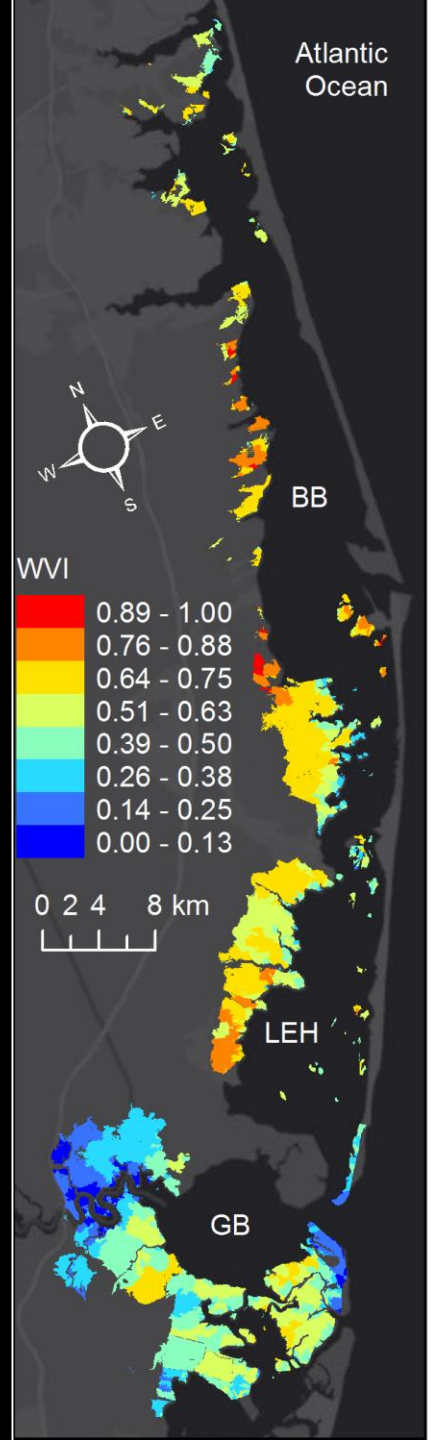


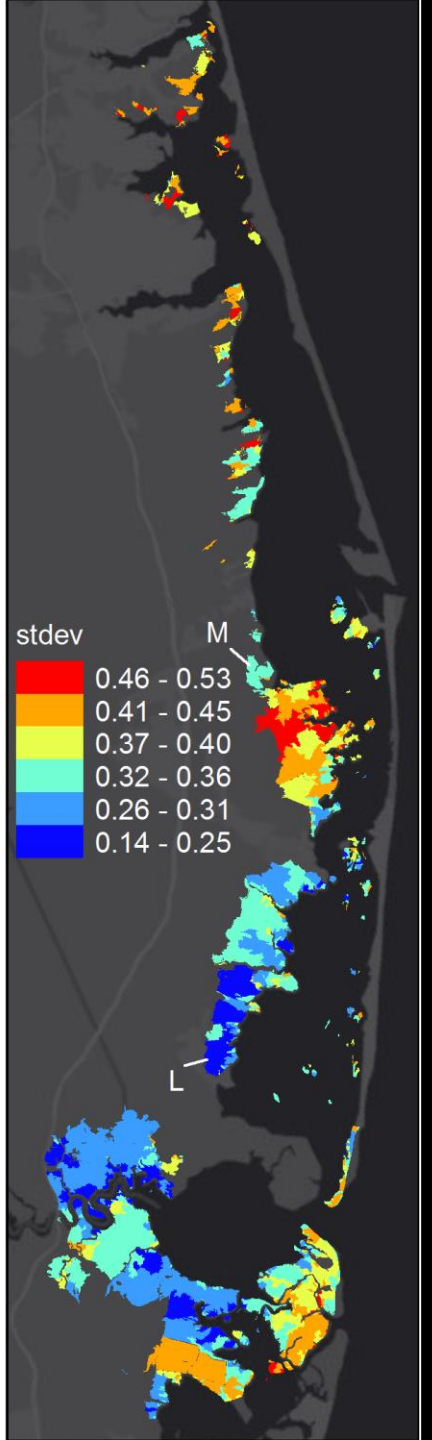
Combine multiple data layers into wetland vulnerability index

Deliver WVI through portals

Map can be explored unit-by-unit to identify parameters causing most vulnerability

Products can be updated regularly to get time-series of vulnerability





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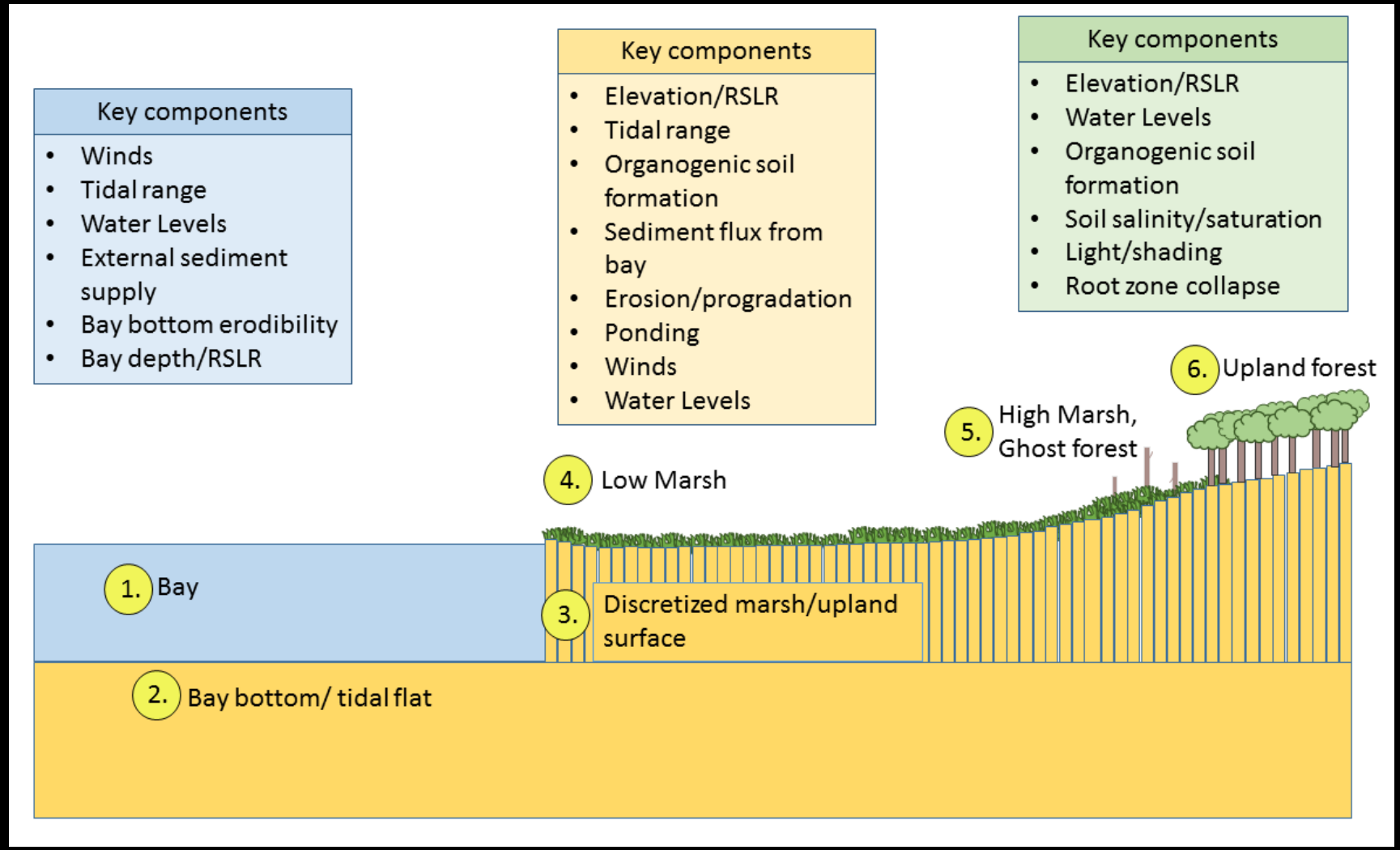
What processes and timescales control marsh upland migration?



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Idealized model can identify key rates and parameters, and nonlinear behavior within migration processes

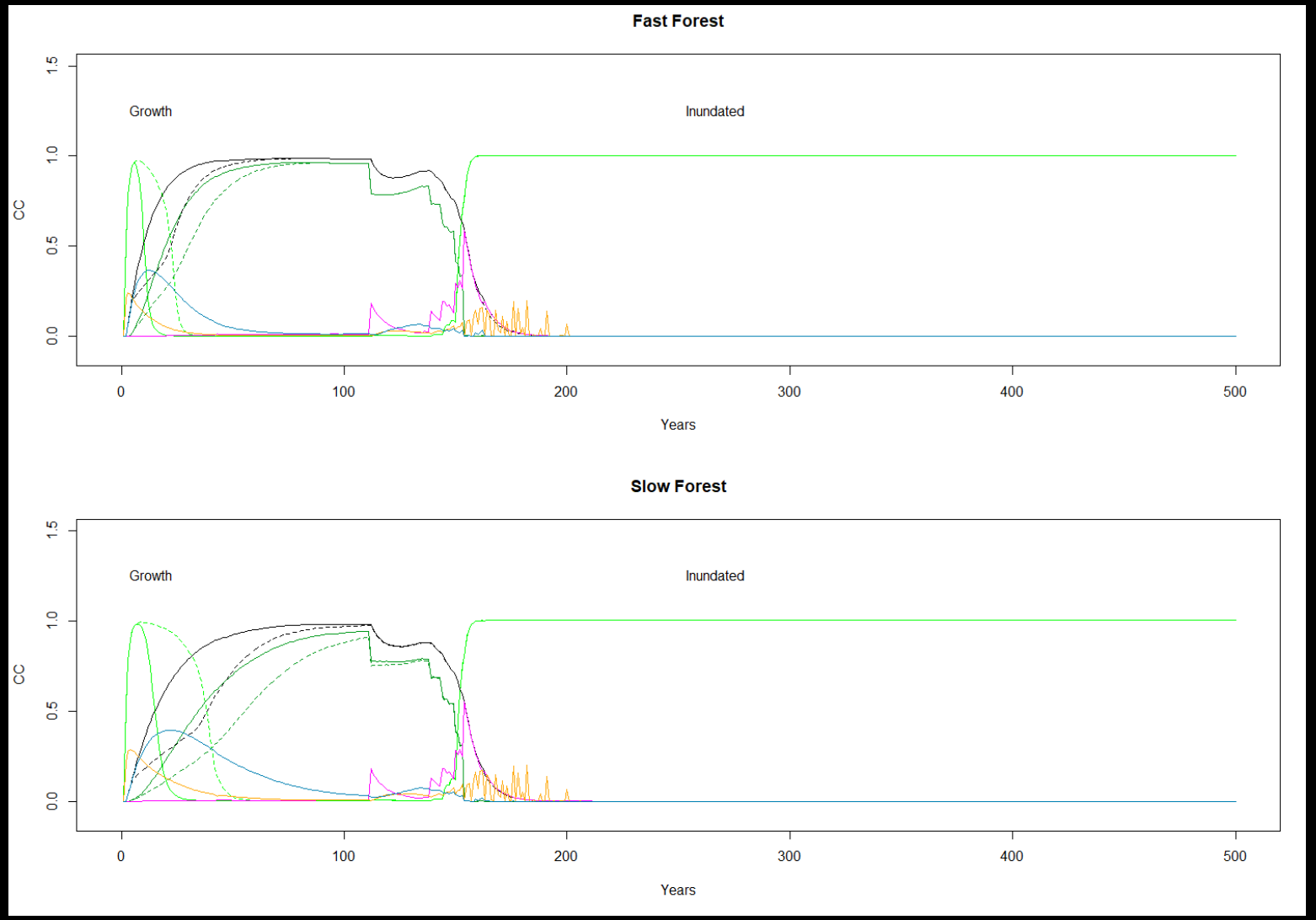
Bare ground at 1m above MHW grows a forest

Expected inundation from bathtub style model with 4mm/yr RSLR to occur at year: 250 for MHW, 225 for MHHW

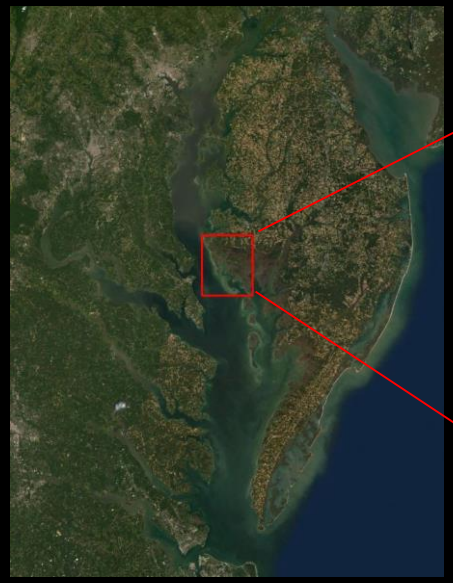
But stochastic events (i.e. storms) transition forest to marsh~50-75 years earlier.

Overall long term migration rates still tend toward slope RSLR dominated process

CC is carrying capacity
Light green is grass
Dark green adult trees
Orange is seedings
Blue is saplings
Black is saplings+adult trees
Maroon is dead standing

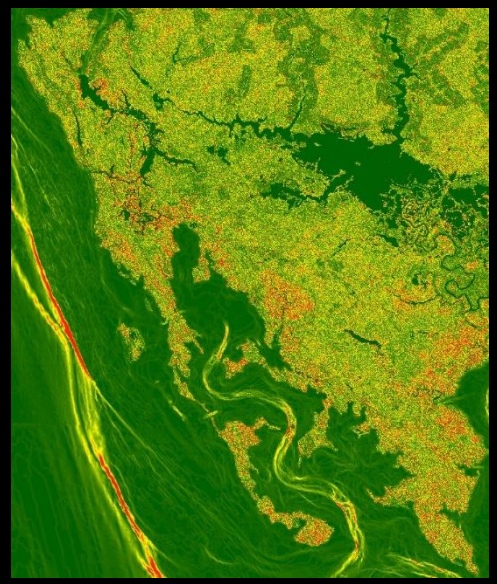


Mapping likelihood of migration: FY20

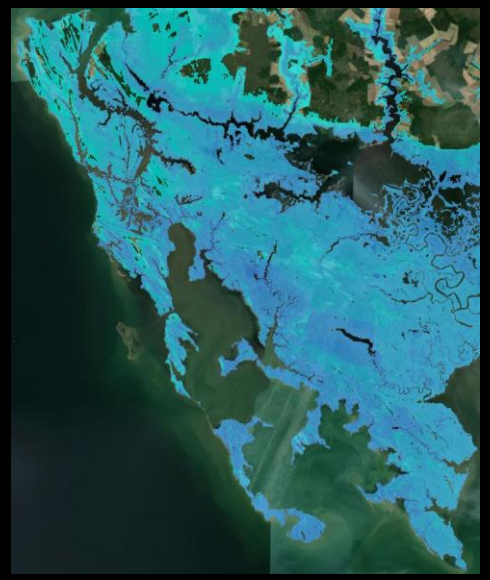


Example: Dorchester County

1) Coastal forest (red) adjacent to tidal wetland



2) Slope (green-low, red-high)



3) Max inundation from Cat1 hurricane

1) Isolate coastal forests adjacent to tidal wetlands using land cover/land use datasets

2) Determine geomorphic slope at the marsh-forest boundary

3) Use hydrodynamic models of real and synthetic storms to determine maximum extent of saltwater

4) Overlay these data and compare with observed migration areas

End-user applications

Can we:

- Identify critical system parameters that determine rates of migration?
- Extract these parameters from remote sensing/model output in ChesBay?
- Deliver maps of migration likelihood?
- Use those maps to guide management, acquisition, and restoration?

Theme 2 team

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Results are preliminary and subject to revision…
Please do not distribute without consulting team