LOSS OF COASTAL MARSHES TO SEA LEVEL RISE

May 2016

Climate Resiliency Workgroup meeting

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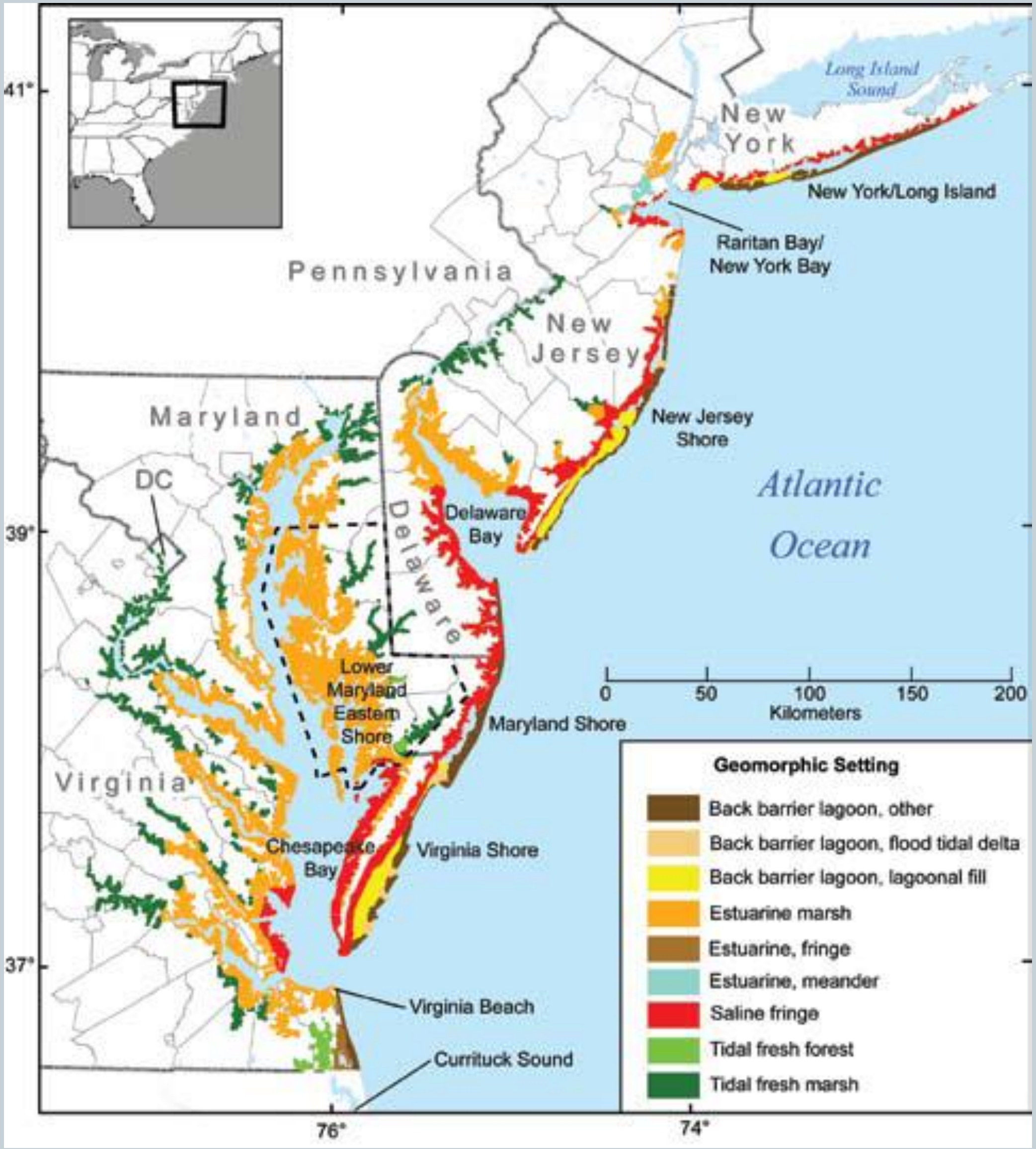
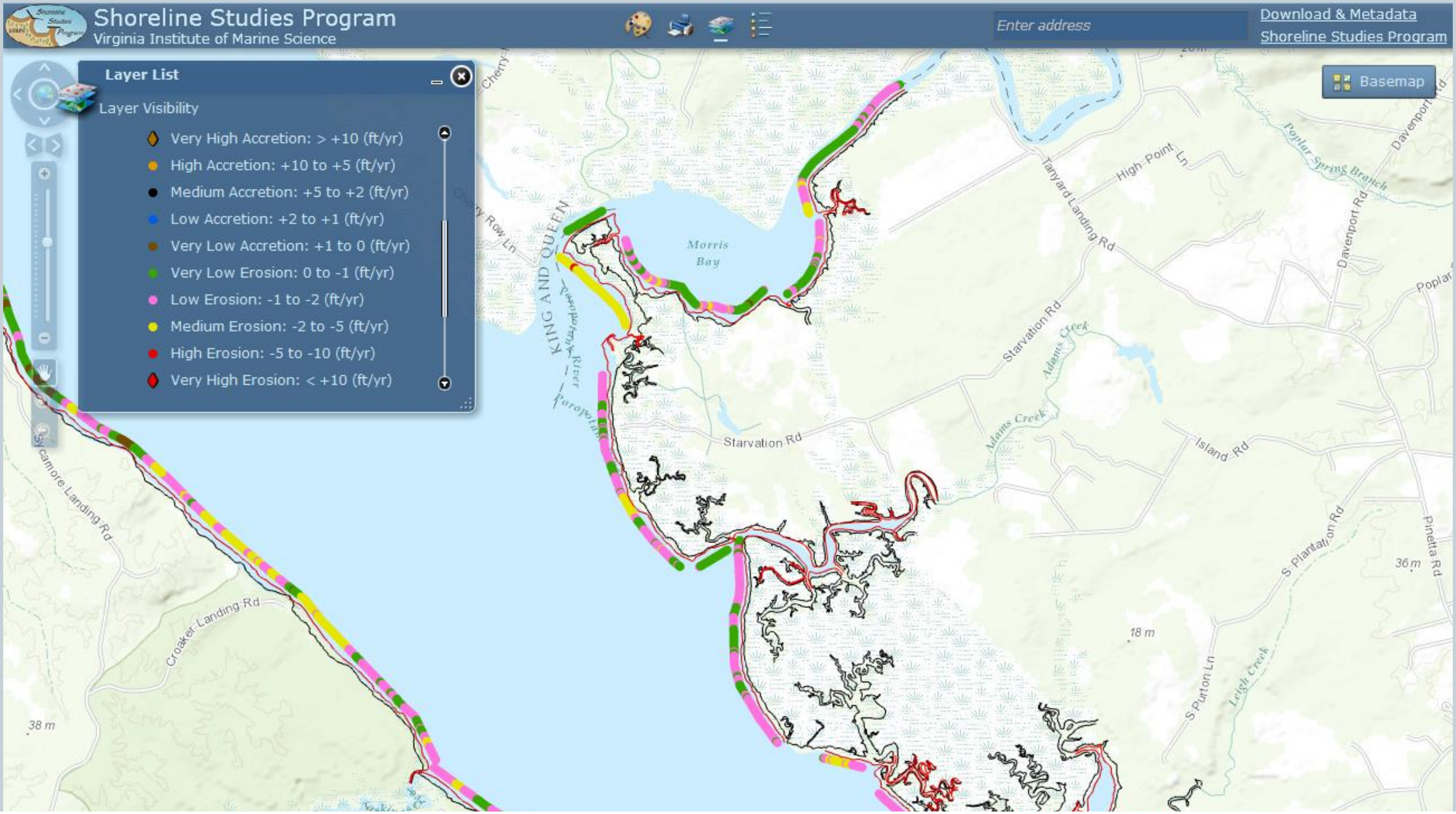
1940-2015 75 Years

Geomorphic settings of mid-Atlantic tidal wetlands



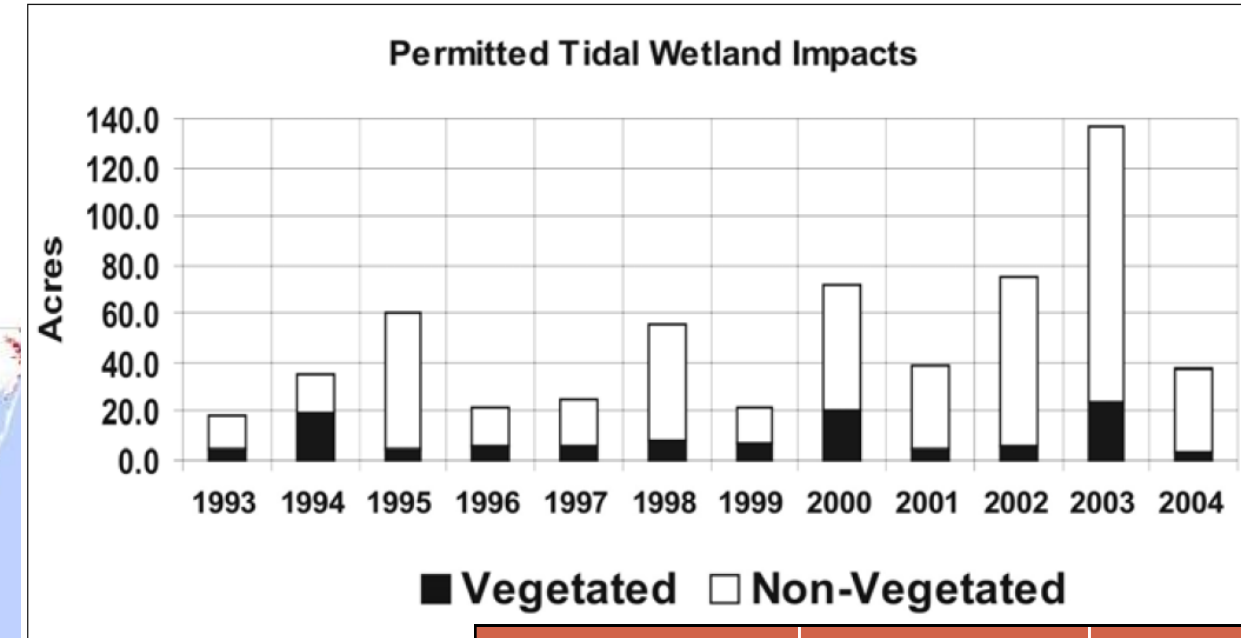
- Geomorphic settings have differing hydrodynamics, sediment sources, & vegetative communities
- Wetland response to climate change is expected to vary with geomorphic setting
- Different climate drivers are important in different settings
  - Precipitation more important for non-tidal, stream and headwater wetlands
  - Sea level rise more important for tidal wetlands

CCSP 2009: Cahoon et al. 2009; data source: Reed et al., 2008; map source: Titus et al., 2008

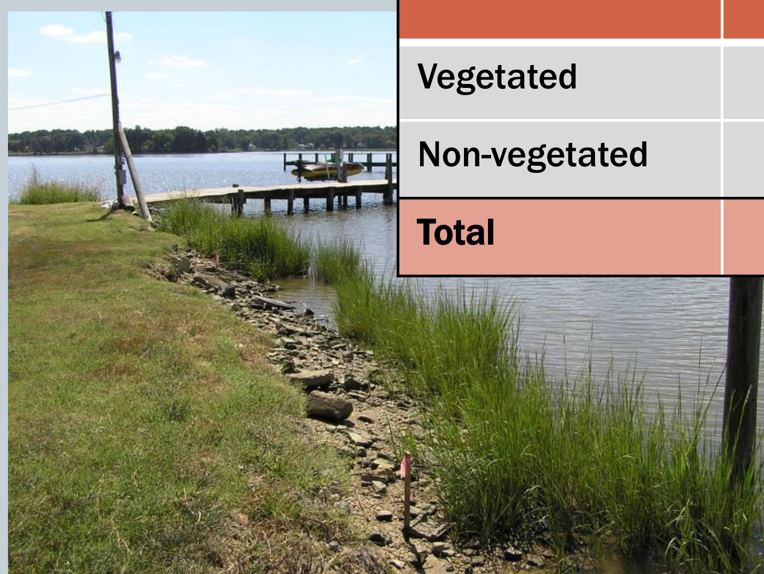


The primary mechanism for marsh loss is <u>erosion</u>

The primary mechanism for marsh gain is <u>retreat</u>



	Total impacted (acres)	Impacted acres/year
Vegetated	186	11
Non-vegetated	545	32
Total	**731**	**43**



<u>Chesapeake Bay</u>

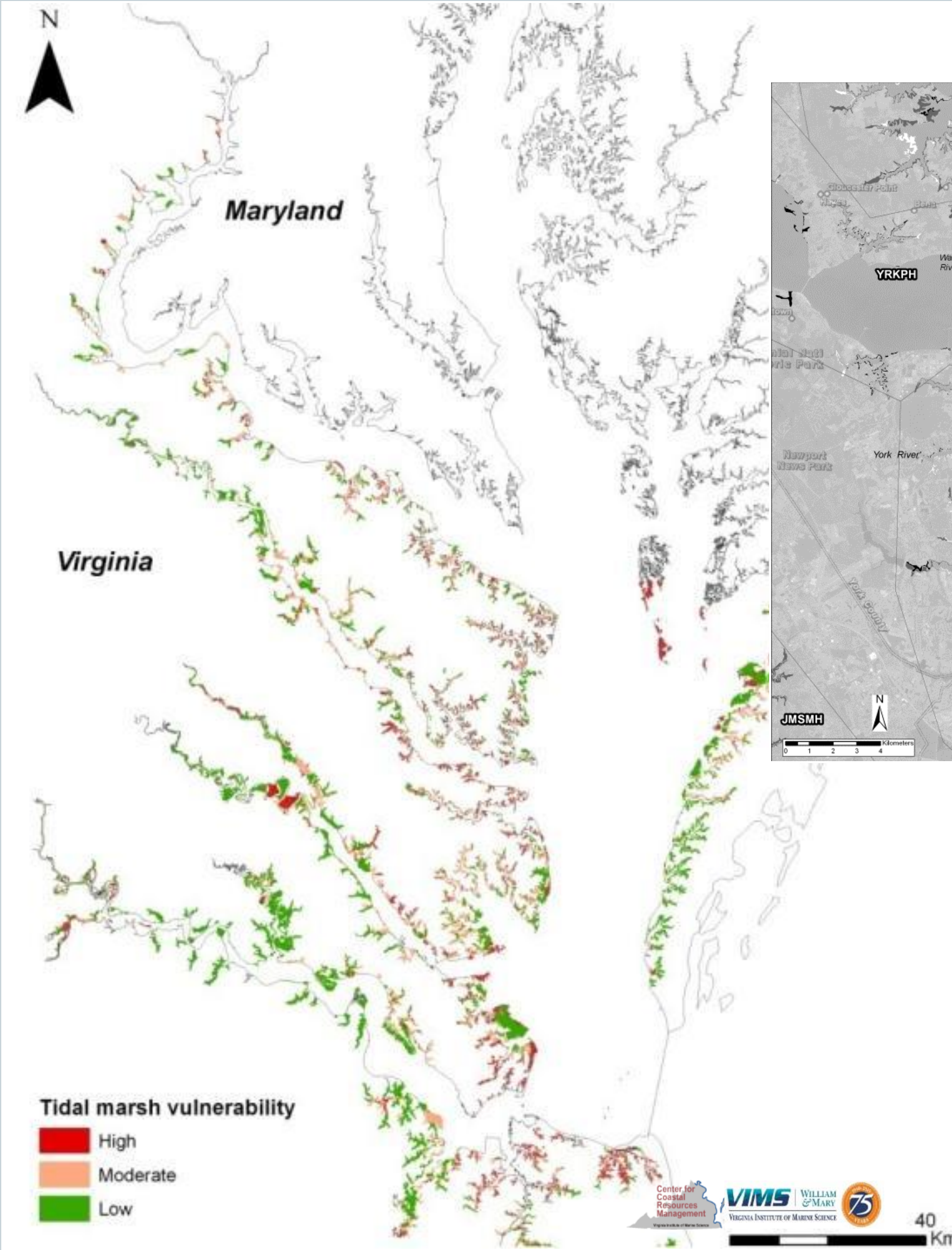
18% of tidal shoreline hardened

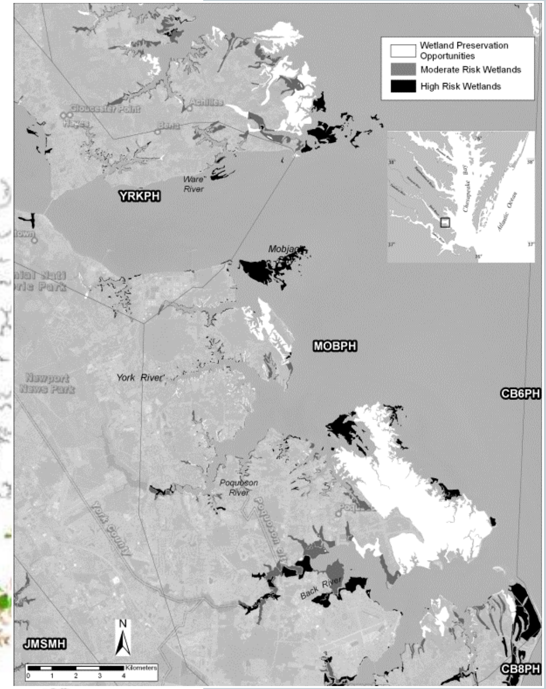
VA: *11%* ***MD***: *28%*

32% riparian land developed

~5 km^2 of artificial substrate introduced (*intertidal impacted*)

Tidal Marshes & barriers to migration





Tidal marshes in the meso-polyhaline reaches at highest risk due to land development & SLR

Tidal Marshes - vulnerability to fragmentation or loss from sea level rise on the basis of landscape setting (*bank height, land use & shoreline structures*). Marshes classified at low risk represent potential wetland preservation opportunities

Nearly 40% of Virginia marshes are vulnerable to SLR due to adjacent development

High Risk Marsh

Low Risk Marsh

Bilkovic et al. 2009 Vulnerability of shallow tidal water habitats in Virginia to climate change. **http://ccrm.vims.edu/research/climate_change/index.html**

Driving Questions

- How has marsh extent changed since 1960s? (erosion & human activities are a big driver of this)
- Aside from marsh loss—how have marsh communities changed?
- Can we see signals of sea level rise in the community shifts?
- What can we learn about the patterns & processes driving marsh change that we can apply to forecasts?

HOW ARE MARSHES RESPONDING TO SEA LEVEL RISE?

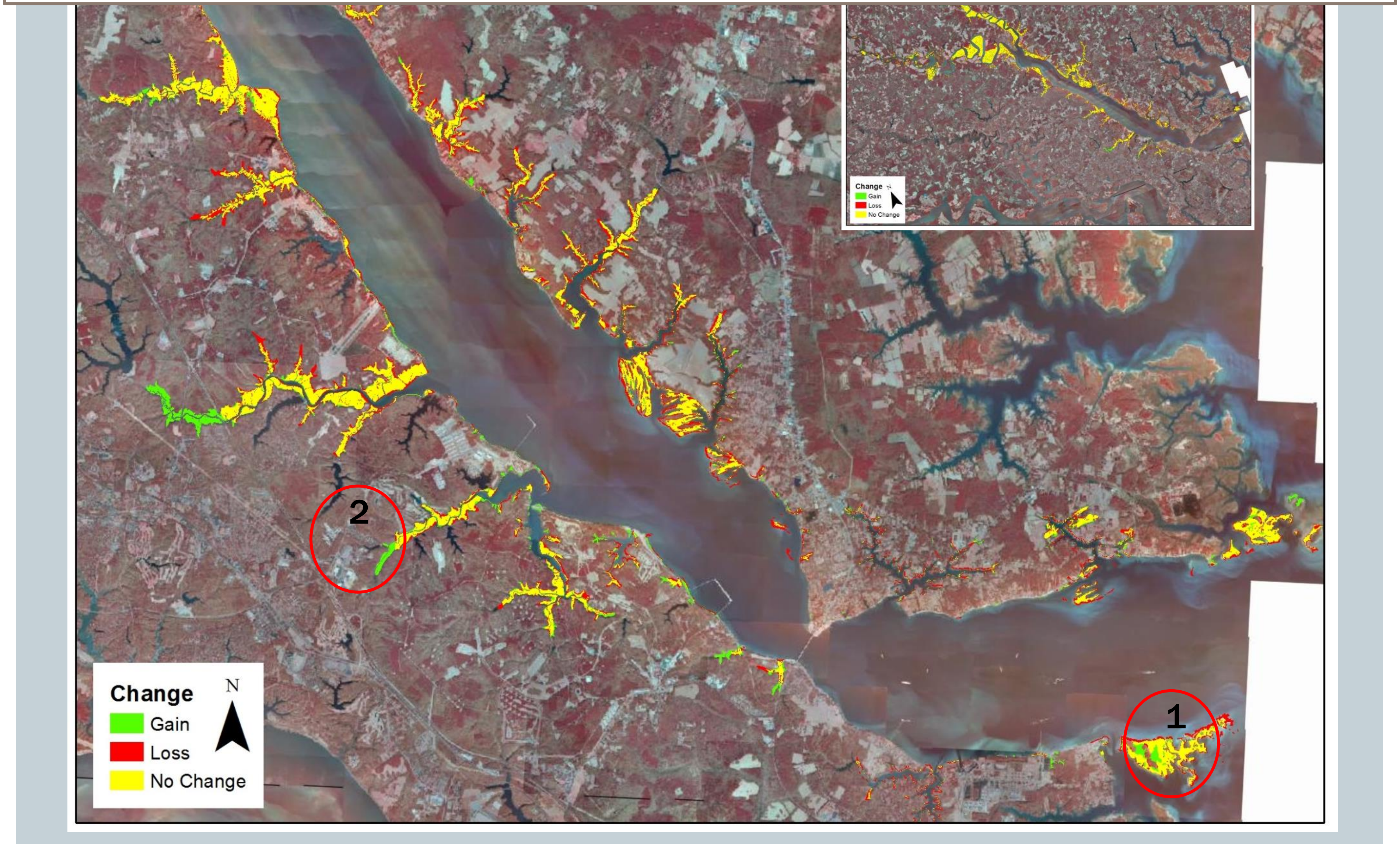
- Compare the extent and composition of communities from the previous surveys with the existing marshes

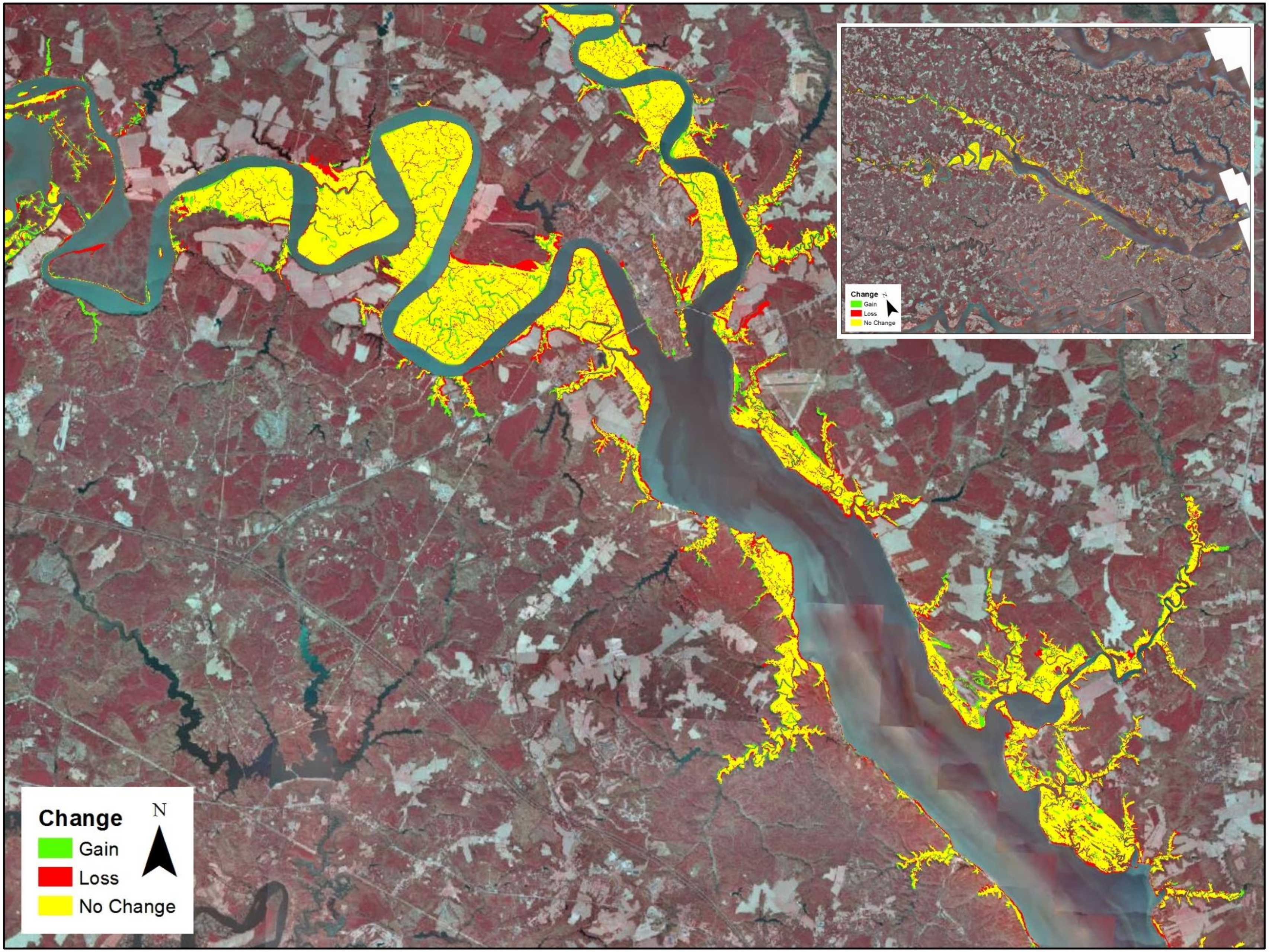
  - Begin to establish trends of either marsh loss or gain
    - No net loss of wetlands is a management goal

  - Changes in community composition (indicative of estuarine processes)
    - Each community supports unique food webs and chemical processes

Used coverages of mapped wetlands for two time periods

- Both coverages were clipped to the same study boundaries to insure a direct comparison
- Used superposition techniques in ArcMap to analysis of change in coverage




Change
Gain
Loss
No Change
N

Preliminary tidal wetland area changes between the 2 surveys

Marsh Class	1973 TMI	2009 TMI	Change
Embayed	5,462.279	4,872.708	-589.571
Extensive	13,934.873	13,077.216	-857.657
Fringe	999.927	714.400	-285.527
Marsh Island	798.140	736.492	-61.648
Total	21,195.219	19,400.816	-1,794.403

Marsh Class	Unchanged (ac)	Loss (ac)	Gain (ac)
Embayed	3,570.313	1,892.015	1,312.850
Extensive	11,872.249	2,062.629	1,222.298
Fringe	310.659	689.270	384.962
Marsh Island	566.777	231.363	160.708

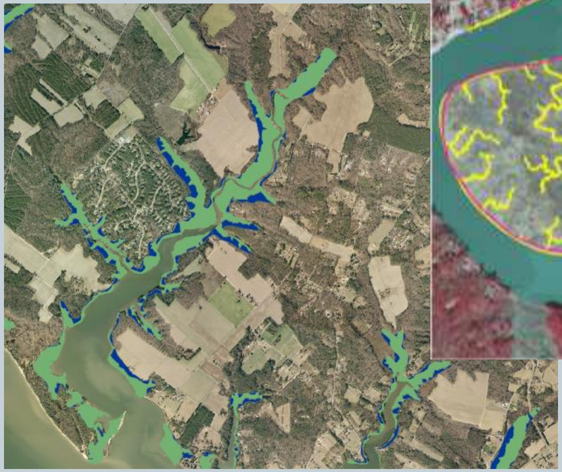
Fringe marshes = 69% of the original marshes lost

***but this depends on location**

Embayed marshes (34%); extensive marshes (15%), and marsh islands (29%).

What is our confidence in these results?

- We know there are some overestimations of marsh loss
  - Mostly due to differences in scale and increased precision in digitizing
- We are working on techniques to minimize known errors

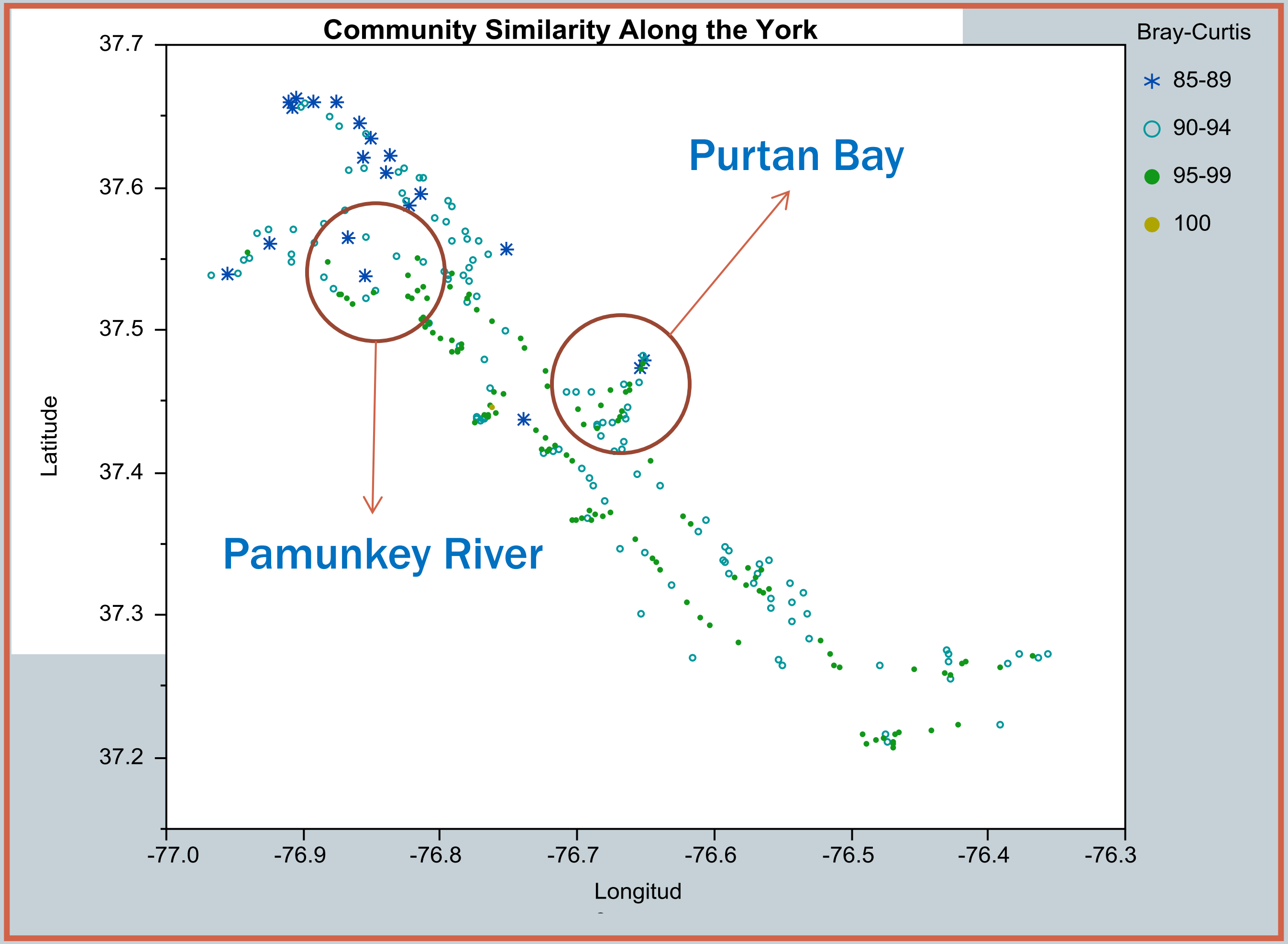


We have verified apparent erosion against other work.

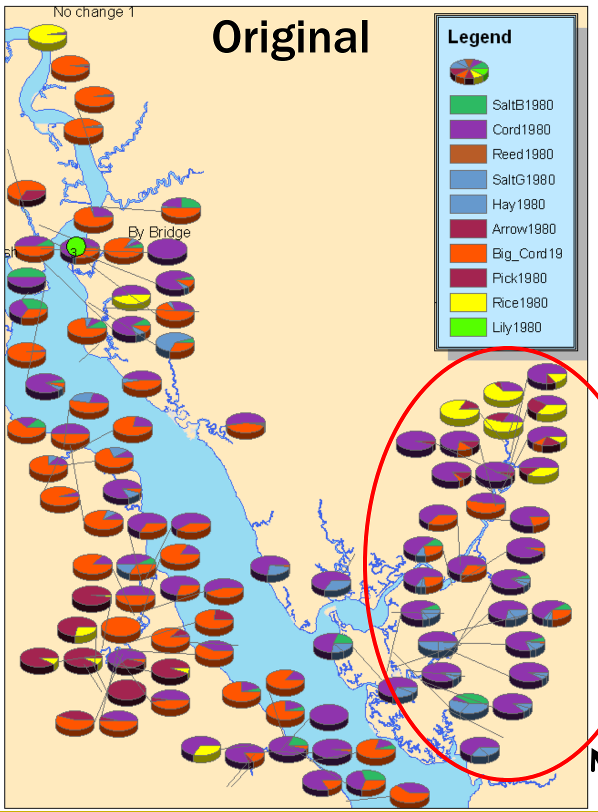
- Marsh lost ~ 44 acres between 1979 and 2009
- Predominantly due to shoreline erosion
- Milligan *et al*. (2010) found up to1.5 meters of erosion/year here

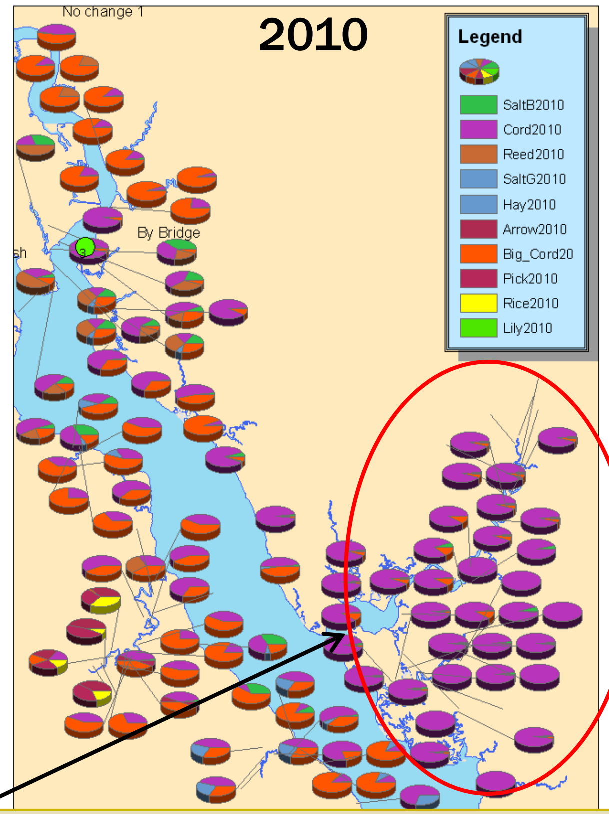
- Marsh lost ~ 134 acres between 1979 and 2009
- Predominantly due to shoreline erosion
- Milligan *et al*. (2010) found continuous recession here
- Some inland migration

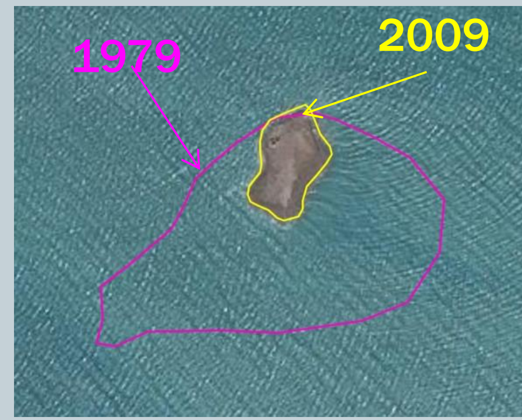
COMMUNITY SHIFTS BETWEEN THE 2 SURVEYS



PURTAN BAY



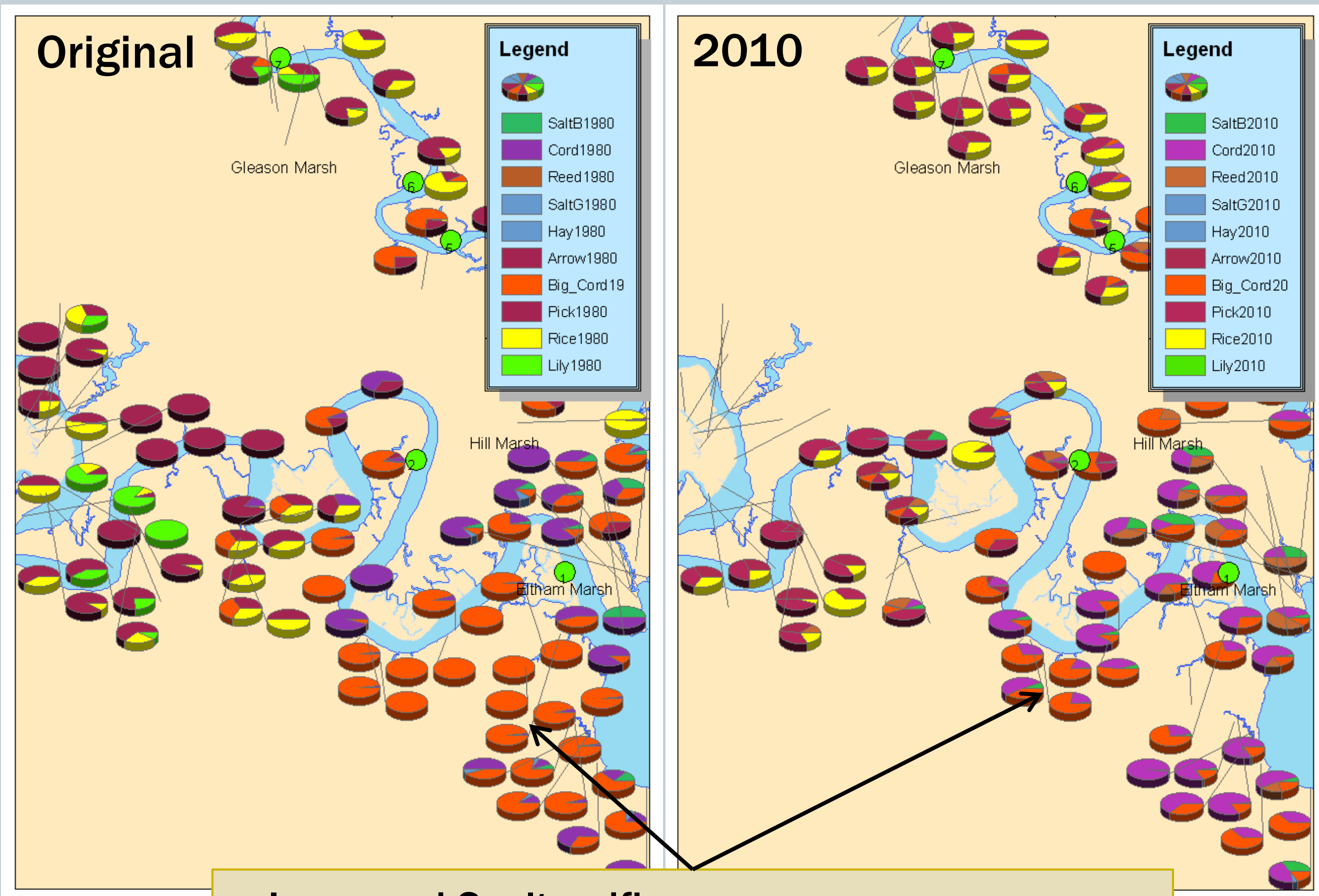


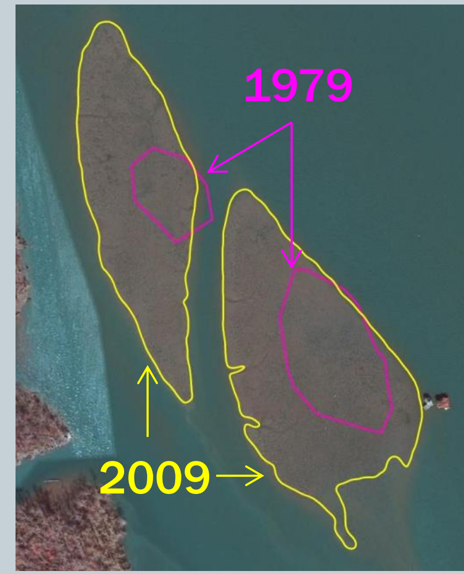


Purtan Creek Marsh Island

- **Shift from fairly diverse marshes to almost monotypic *Spartina alterniflora.***
- **Lost fresh water community at top of creek**

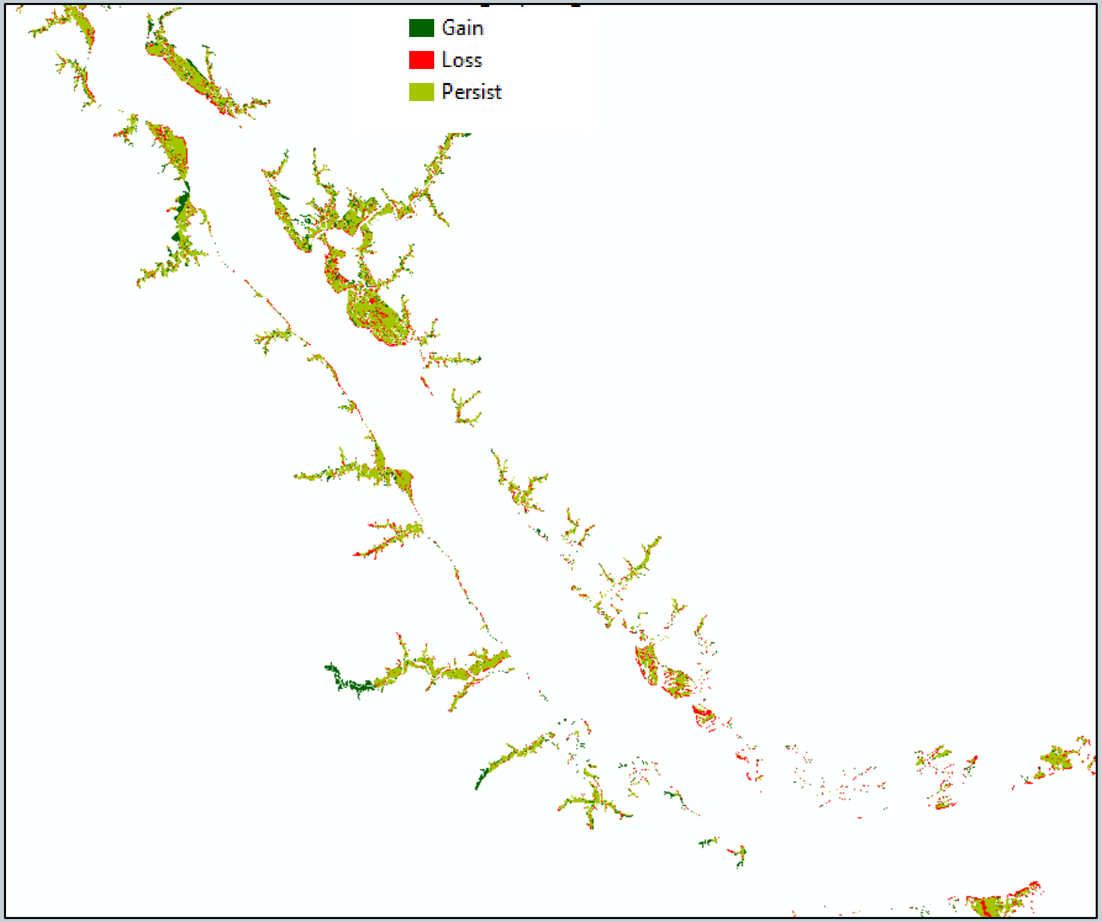
PAMUNKEY RIVER



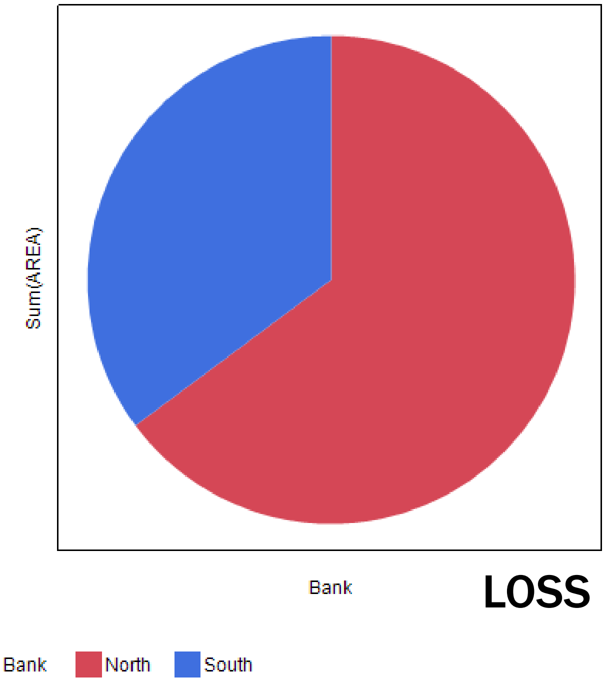


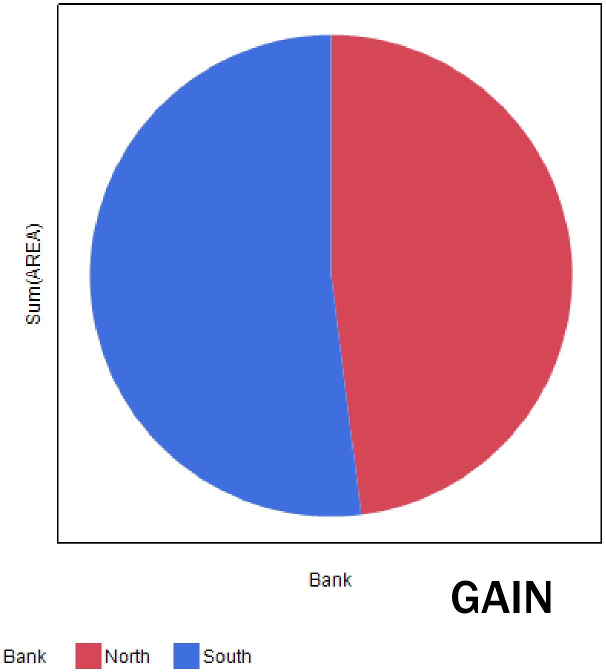
Accretion of Pamunkey marsh islands

- Increased S. alterniflora presence
- Shift in dominant species
  - = shift in salinity, innundation, or both?



Marsh changes also seem to vary between river banks





NORTH BANK

SOUTH BANK

SUMMARY

- Marsh extent and plant composition have changed over the past 30 years, concurrent with sea level rise

- Loss of extent:
  - Fringe marshes (throughout)
  - High salinity/high energy marsh islands
  - Marshes in front of shoreline structures

- Change in community:
  - Freshwater-headwater wetlands
  - Extensive riverine marshes

SUMMARY

- There are site specific drivers of change (such as local sediment supply) that complicate the overall patterns of change

- Human shoreline use will be a key determinant of future marsh distribution