Chesapeake Bay Marsh Change under Sea Level Rise

Molly Mitchell
molly@vims.edu
Virginia Institute of Marine Science

CZM Coastal Partners Workshop
Nov 15, 2018, Richmond, VA

Center for Coastal Resources Management
VIMS | William & Mary
Virginia Institute of Marine Science

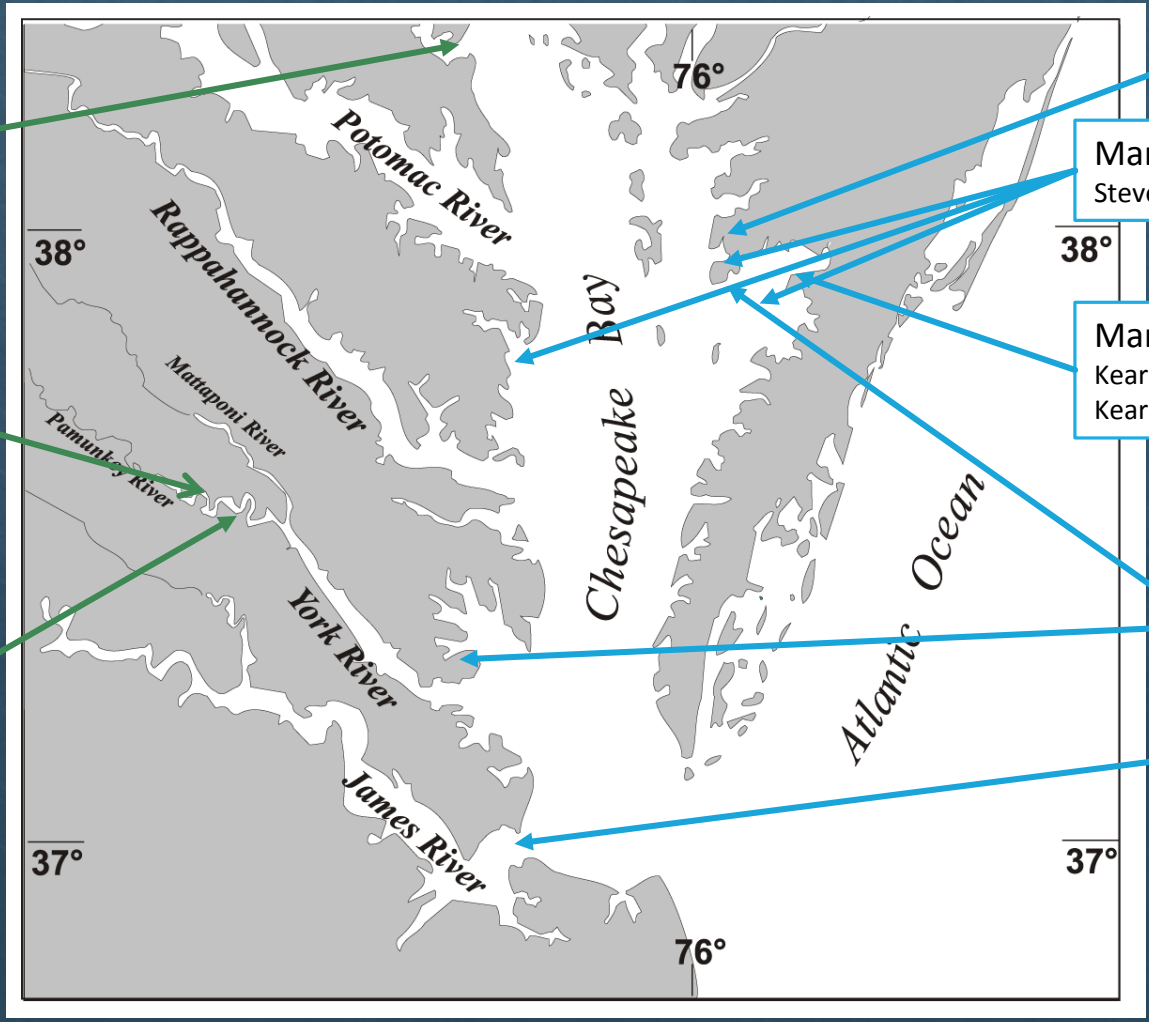
Past research suggests changing communities

Center for Coastal Resources Management
Virginia Institute of Marine Science

Δ plant community
Swarth et al 2013

Δ plant community
Bilkovic et al 2012

Δ plant community
Perry & Hershner 1999 &
Davis 2004 &
Sutter 2014



Marsh loss
Wrey et al 1995

Marsh loss/disintegration
Stevenson et al 2002

Marsh loss/disintegration
Kearney et al 1991 &
Kearney et al 1985

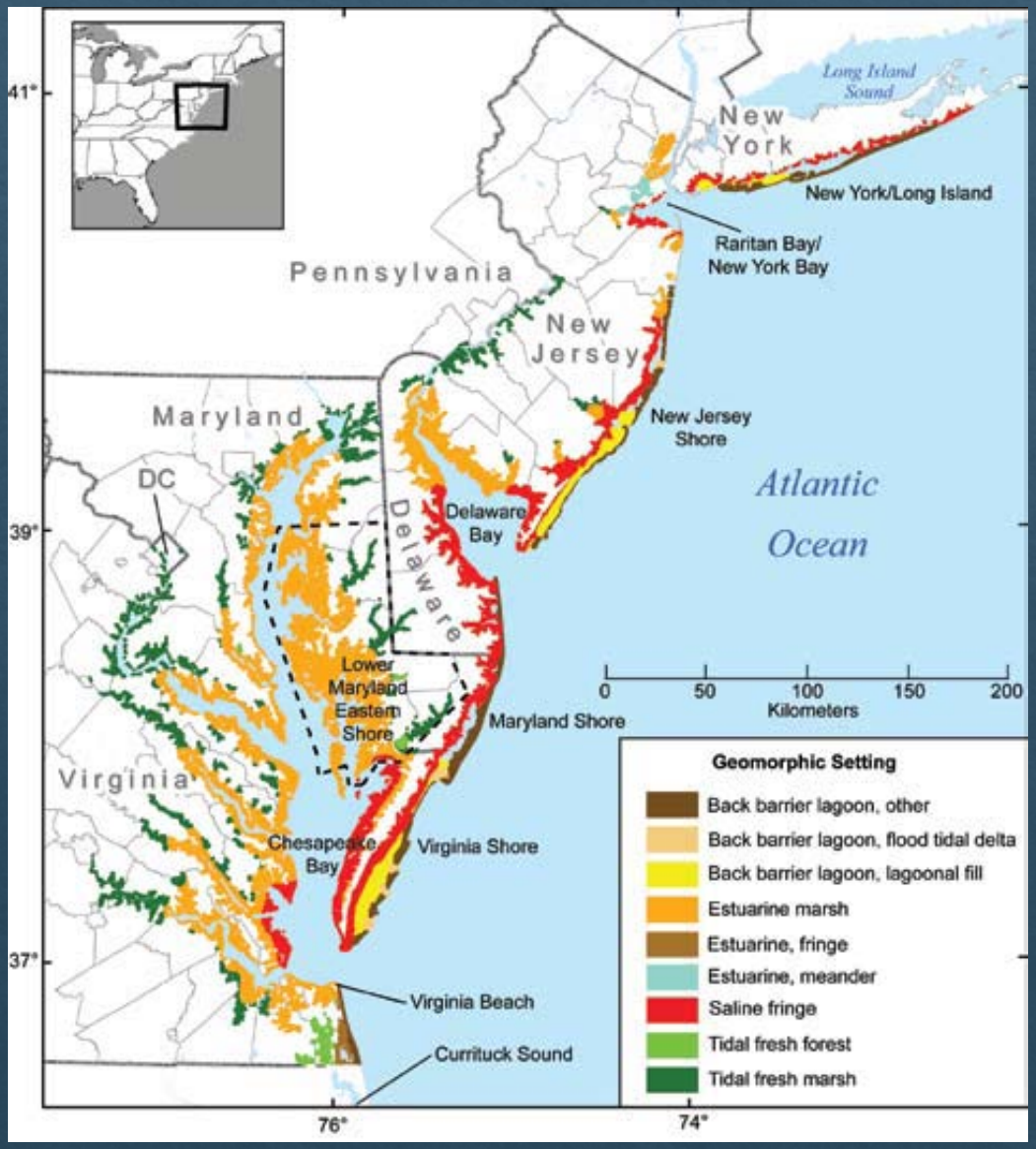
Marsh loss
Kearney et al 2002

Marsh loss
Tiner & Foulis 1994

Questions to consider

- What processes affect marsh persistence?
  - How does climate change alter those processes?
- What climate change impacts do we expect?
- What are the signals of marsh vulnerability?
- Are there any patterns in these signals that we can use to predict vulnerable marshes?

Geomorphic settings of mid-Atlantic tidal wetlands

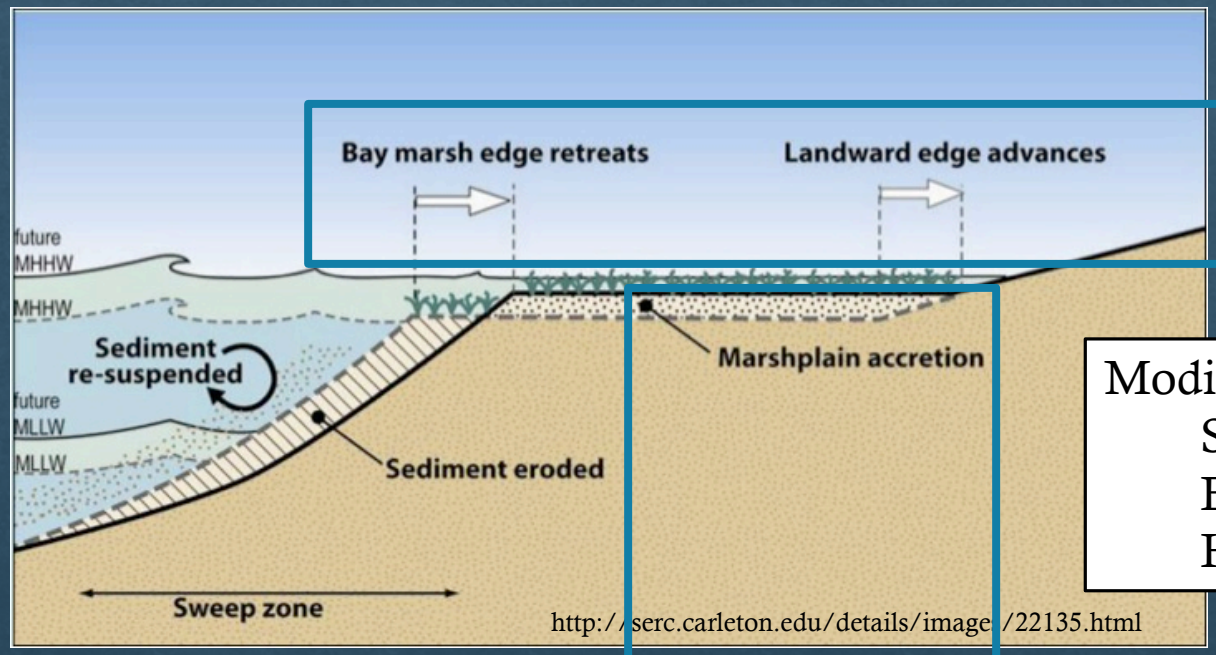


Titus et al., 2008

- 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

Climate Interactions with Marsh Processes

To keep pace with sea level: 1) Marshes migrate
2) Marshes accrete



Δ Water Levels

Controlled by:
- SLR
- Land elevation

Modified by:
- Shoreline alterations
- Erosion rates
- Human Activity

Δ CO_2

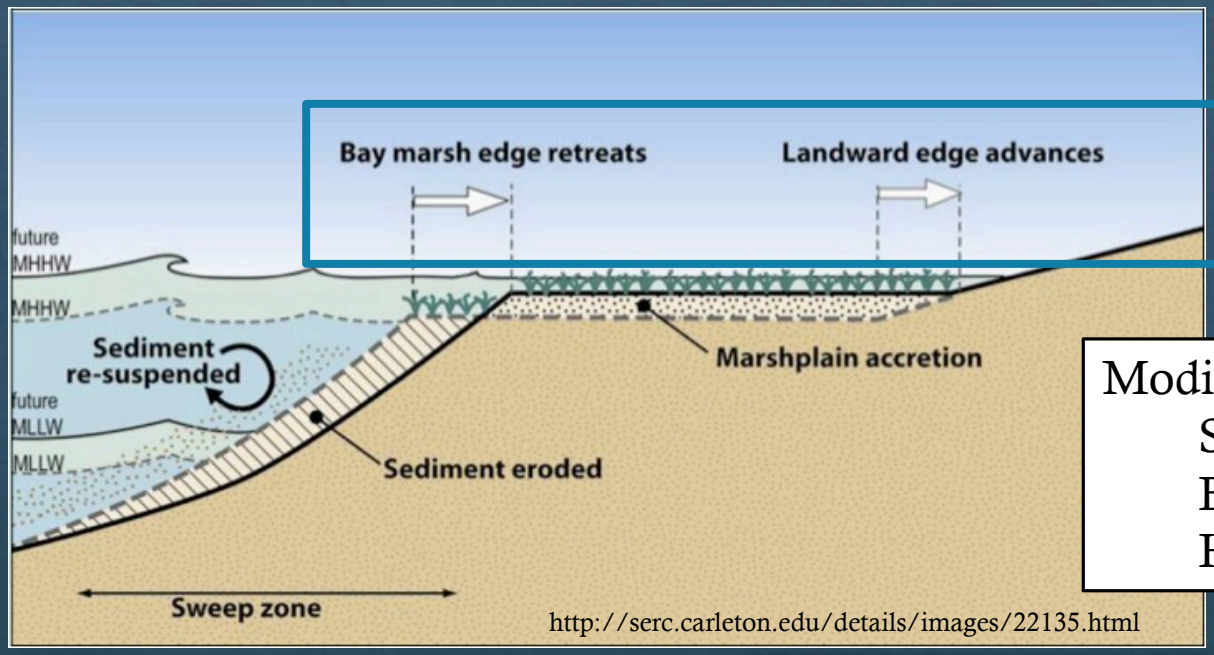
Δ Water Levels

Δ Temperature

Controlled by:
- Plant production
- Sediment availability
- Sediment respiration

Climate Interactions with Marsh Processes

To keep pace with sea level: **1) Marshes migrate (erosion & migration)**
2) Marshes accrete



http://serc.carleton.edu/details/images/22135.html

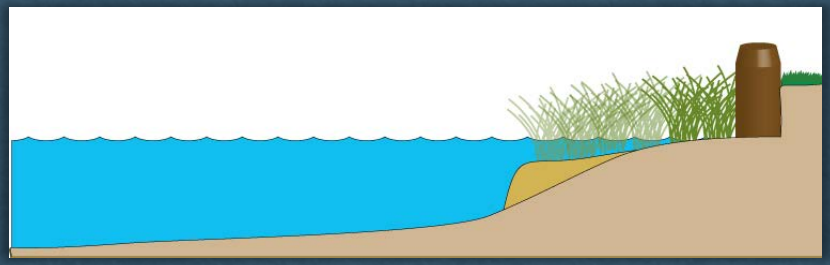
Δ Water Levels

Controlled by:
- SLR
- Land elevation

Modified by:
- Shoreline alterations
- Erosion rates
- Human Activity

+

What processes interrupt marsh migration?



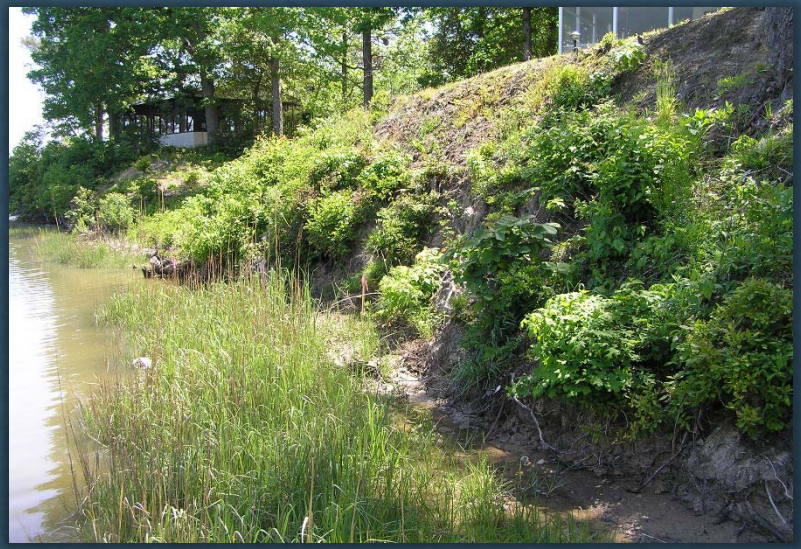
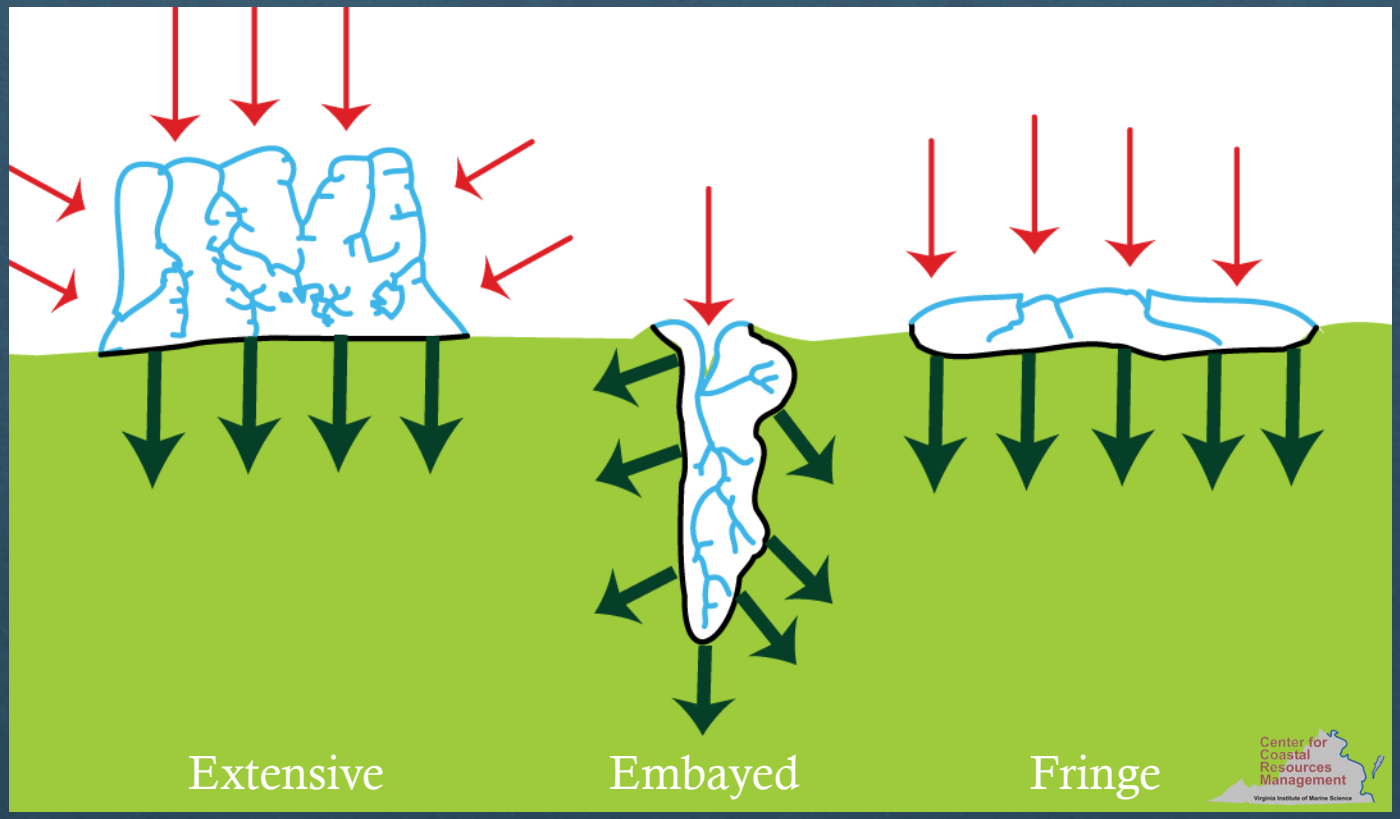


Photo by Karen Duhring

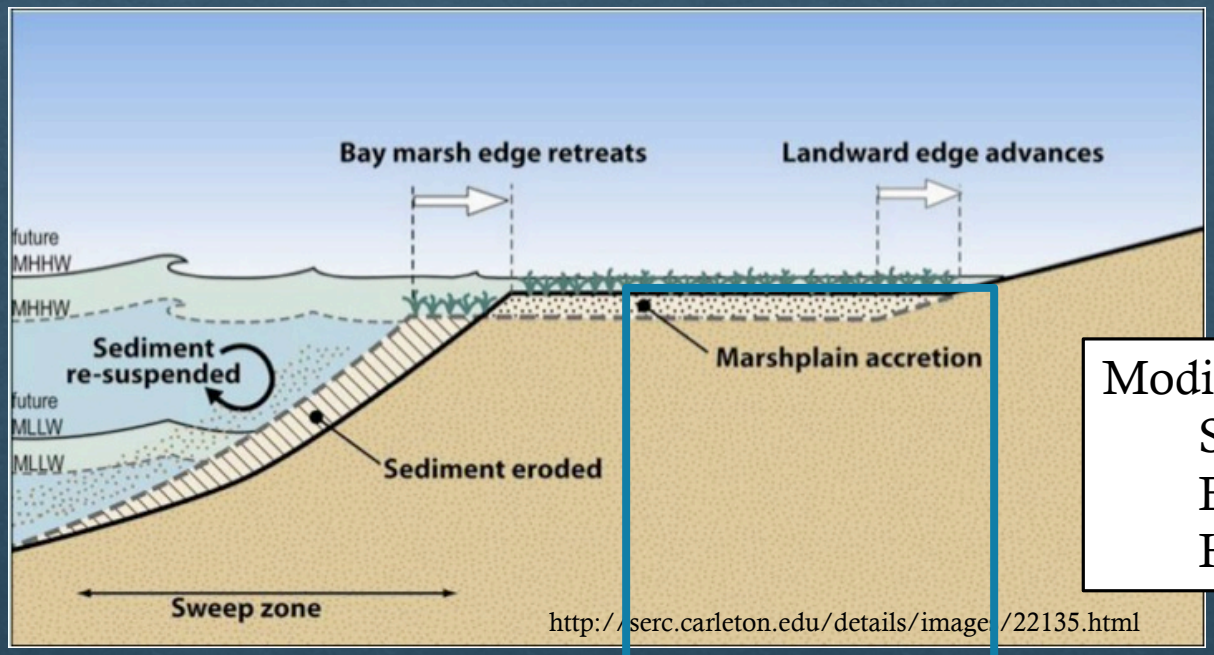
Photo by Skip Stiles

Are some marsh forms more vulnerable than others?



Climate Interactions with Marsh Processes

To keep pace with sea level: 1) Marshes migrate
2) Marshes accrete



Modified by:
- Shoreline alterations
- Erosion rates
- Human Activity

Δ CO_2

Δ Water Levels

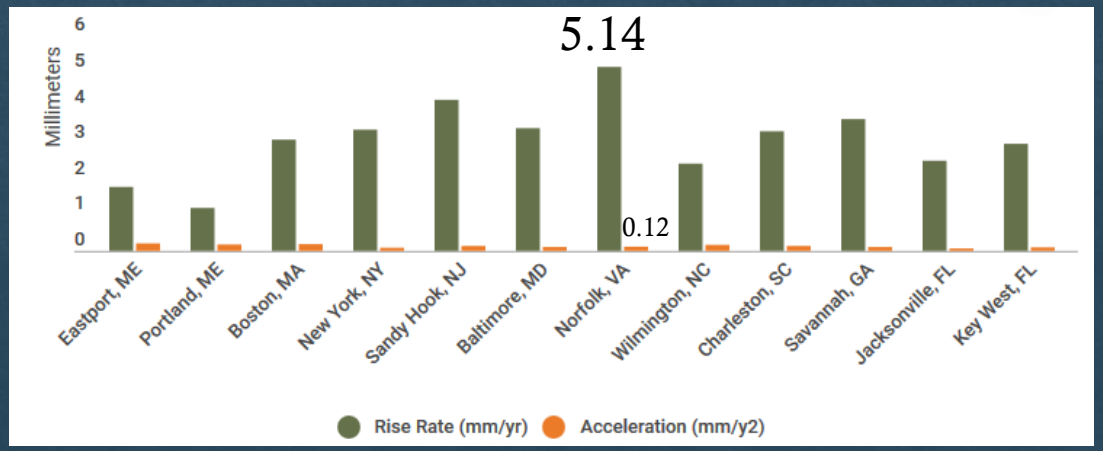
Δ Temperature

Controlled by:
- Plant production
- Sediment availability
- Sediment respiration

Organic marsh accretion affected by:

1. Change in plant type affects **production rates** or **root:shoot ratio** and **decomposition rate**
2. Changes in inundation affect **production rates of roots and shoots** (species specific response)
3. Changes in sediment decomposition rates due to changes in temperature

Theoretical maximum ~ 5mm/yr
(Morris et al. 2016)

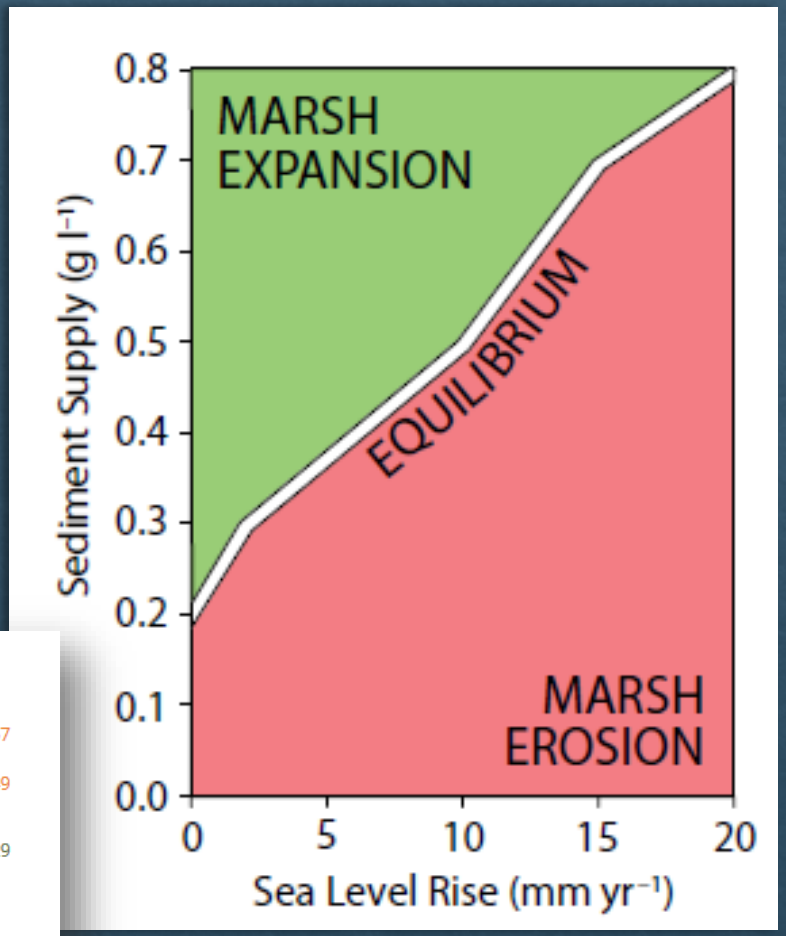


http://www.vims.edu/research/products/slrc/compare/east_coast/index.php

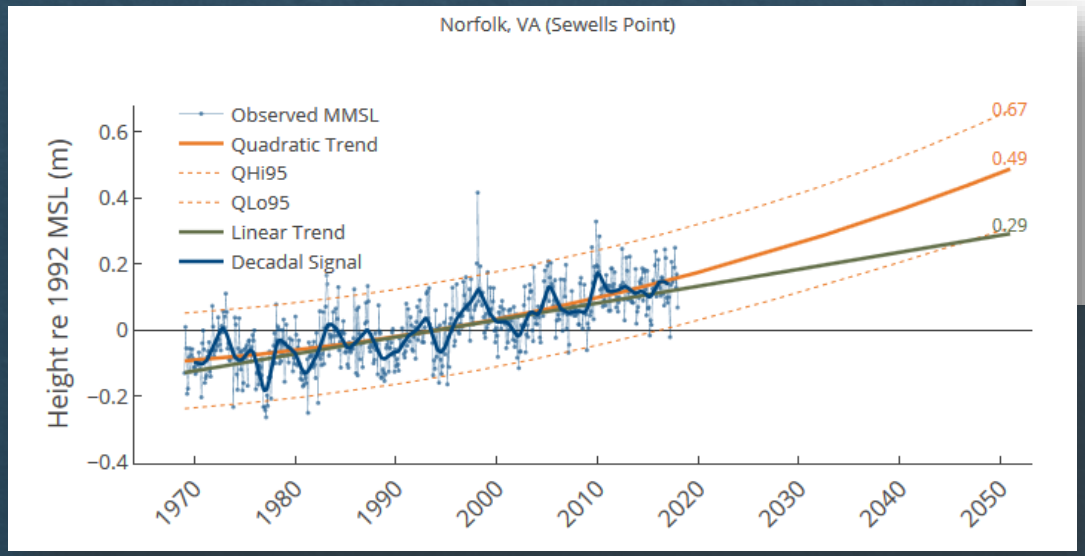
Center for Coastal Resources Management
Virginia Institute of Marine Science

Inorganic marsh accretion affected by:

- Sediment supply coming from
  - Watershed
  - Adjacent lands (via runoff or tidal waters)
  - Marsh front edge erosion
- <u>Current management goals are to restrict sediment in waters</u>



Fagherazzi et al. 2013. *Oceanography*, *26*(3): 70-77.



Center for Coastal Resources Management
Virginia Institute of Marine Science

Tidal marsh inventories

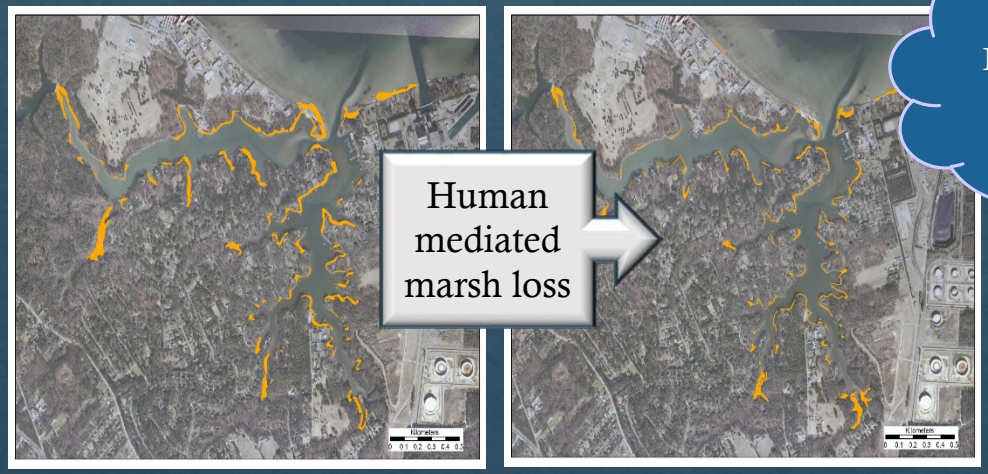
- Survey info:
  - Historic TMIs were surveyed from 1973-1991
  - current TMIs were surveyed from 2010-2018
  - average time between surveys was 32 years
- Plant community comparison:
  - York River = **263** marsh plant species matrices
  - Chesapeake Bay = **17,658** marsh plant communities

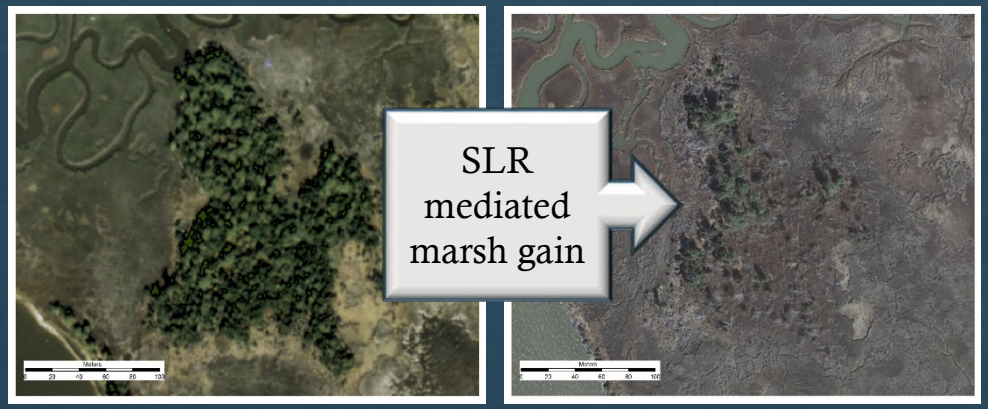
Marsh response varies by form as well as setting

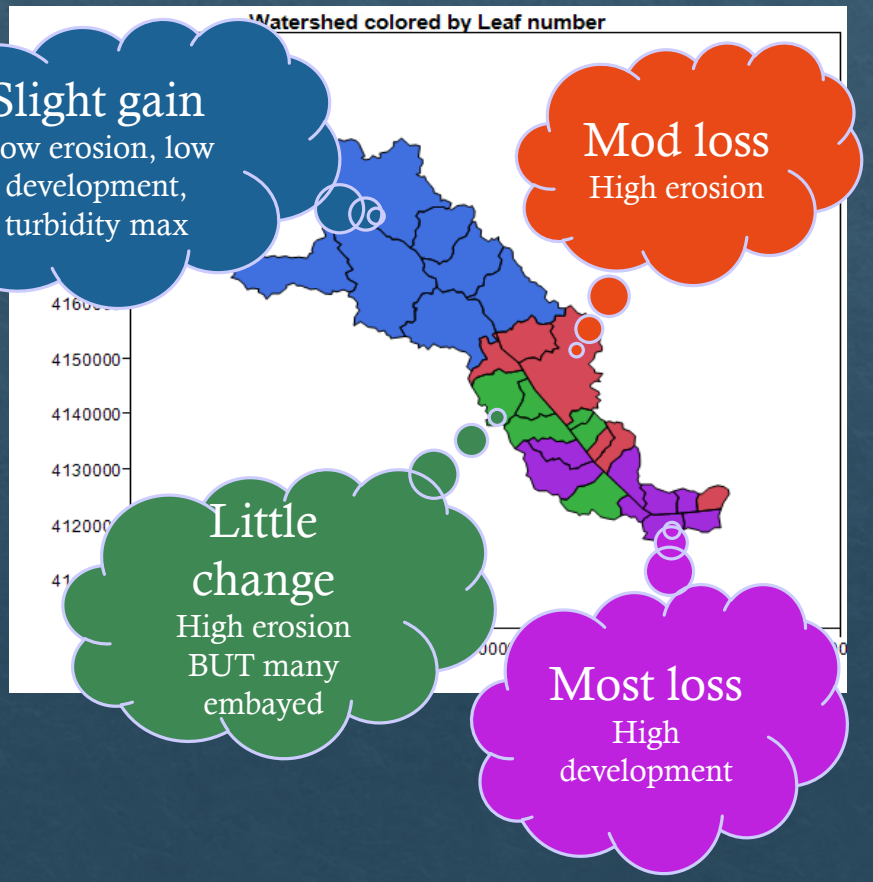
Ecologically important fringe marshes are particularly vulnerable. So are marsh islands…

Historic marsh

Current marsh







Mitchell et al. 2017. Ecosystem Health and Sustainability, 3:10, DOI: 10.1080/20964129.2017.1396009

Center for Coastal Resources Management
Virginia Institute of Marine Science

Community shifts

- 51% of marsh plant communities changed
- 18% of marsh communities showed inundation, salinization or invasion
- Increased inundation:
  - many tidal creeks
  - some extensive marshes (York River, Chickahominy River, and Back River)
- Increased salinity
  - upper reaches of tidal creeks
  - riverine transition marshes (James, Mattaponi, Pamunkey and Rappahannock Rivers)

Take away messages

Accelerating sea level rise is a significant stressor for marshes

Marsh change varies by setting and marsh form – fringe marshes appear the least resilient but extensive/island marshes are also of concern

Human development impedes migration & exacerbates erosion

Future decisions will impact the conflict between marshes and humans

Center for Coastal Resources Management
Virginia Institute of Marine Science

VIMS | William & Mary
Virginia Institute of Marine Science