Chesapeake Bay Marsh Change Under Sea Level Rise

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Chesapeake Bay Marsh Change under Sea Level Rise

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Hampton Roads Sea Level Rise/Flooding Adaptation Forum
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Past research suggests changing communities

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/disintegration
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 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

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

Δ Water Levels

Controlled by:
- SLR
- Land elevation

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

Δ CO₂

Δ Water Levels

Δ Temperature
Erosion?

- Marshes are among most stable Bay shoreline
  - 0.54 – 0.66 m/yr (Rosen 1980)
  - Lower on tributaries ~0.21 m/yr (Byrne and Anderson, 1978)
  - Lowest in creeks
- Erosion rates have been steady over the recent past
- BUT predicted to increase with SLR

What about migration?

What processes interrupt marsh migration?
Organic marsh accretion affected by:

1. Changes in plant community due to changing salinity or inundation (sea level rise driven) & temperature
   - Change in plant type affects production rates or root:shoot ratio and decomposition rate; Changes in inundation affect production rates of roots and shoots (species specific response)

   ![Graph](image)

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

2. Changes in sediment decomposition rates due to changes in temperature

Inorganic marsh accretion affected by:

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

Mid-Atlantic SLR

The average SLR for the Bay:

- 2.5 mm/y for 1953-1983
- 4.7 mm/y for 1983-2013
- 5.4 mm/y for 1996-2014

Ezer and Atkinson 2015

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

- Human mediated marsh loss
- Slight gain: Low erosion, low development, turbidity max
- Mod loss: High erosion
- Little change: High erosion BUT many embayed
- Most loss: High development

SLR mediated marsh gain

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)
Vulnerable marshes are found

Where human development impedes migration & exacerbates erosion

Where shifts in land use have reduced local sediment supply

Where impeded inlets or excessive subsidence exacerbates RSLR

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