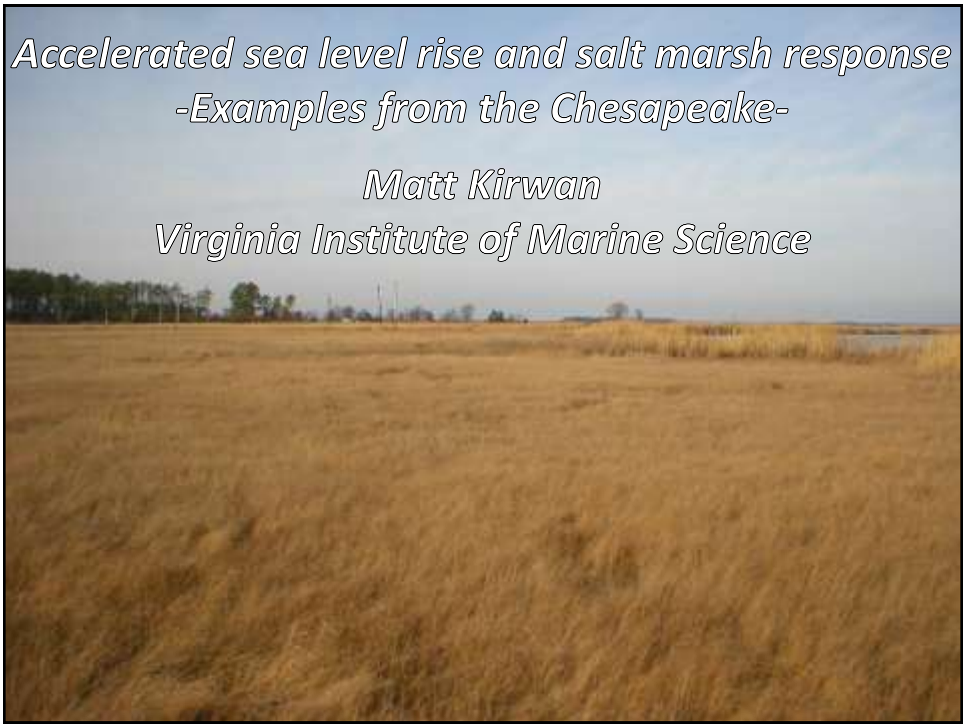
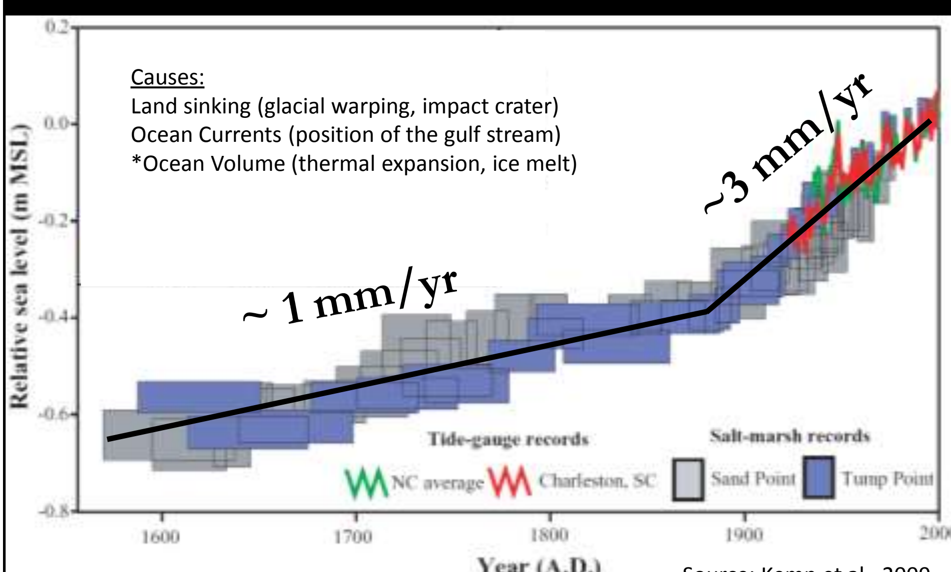


Historical Sea level Rise



Source: Kemp et al., 2009

Mid-atlantic region even faster!

Factors that control wetland size

Transgression
(elevation/connectivity)

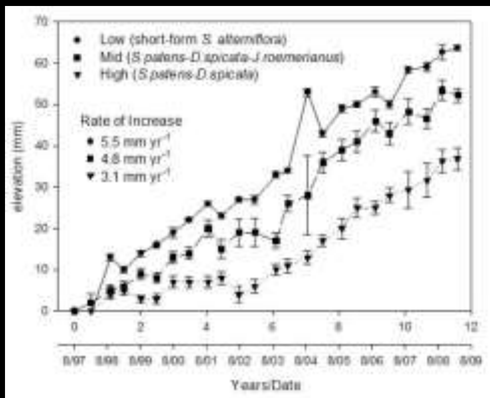
Vertical Maintenance
or Submergence

Edge Erosion

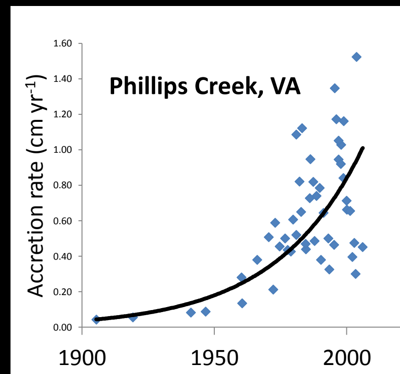
Source: Linda Blum, UVA + LTER

Vertical Dimension: Marshes tend to be resilient

Feedbacks between sediment transport, plant growth, and hydrodynamics allow coastal wetlands to adapt to changes in sea level



Elevation change at Phillips Creek (Linda Blum)



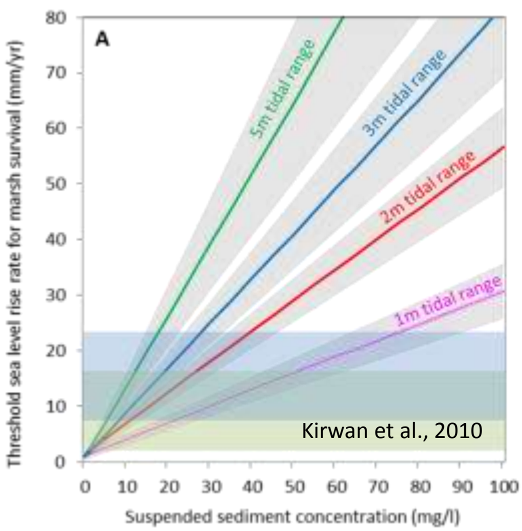
Source: Kirwan and Kolker

Elevation change rates increase with flooding frequency!

Mainland marshes keeping up
Accretion rate increases with sea level rise!

Vertical Dimension: Marshes tend to be resilient

Modeled threshold rates



Kirwan et al., 2010

- Threshold rate of SLR increases with sediment concentration and tidal range
- In general, marshes survive rates > 10 mm yr^{-1}
- Measures local SSC

Factors that control wetland size

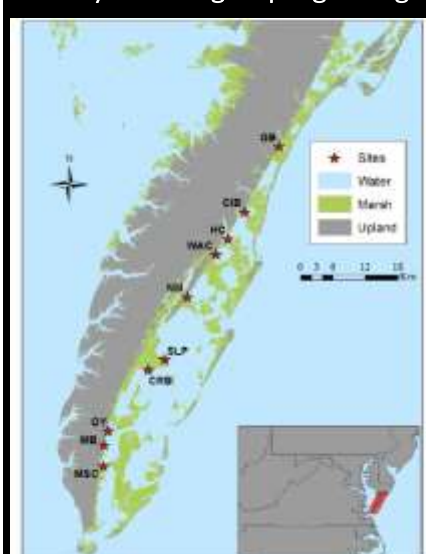
Transgression (elevation/connectivity)

Vertical Maintenance or Submergence

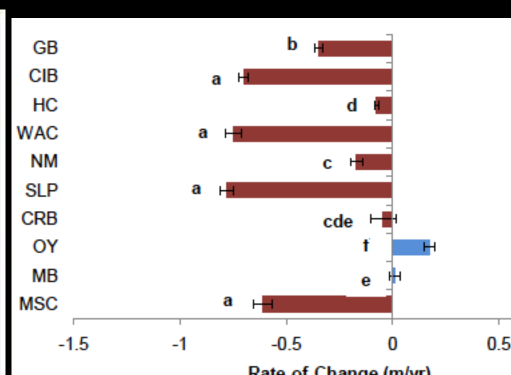
Edge Erosion

Edge Erosion:

Always eroding or prograding



Average erosion rates at 10 sites along the mainland marsh-bay boundary from 1957 - 2009



Average erosion rate along entire mainland marsh-bay boundary from 2002-2009 is 0.2m/y.

Source: McLoughlin, Wiberg et al. 2011

Edge Erosion- Response to SLR:

Wave height tends to increase with sea level rise
But, erosion maximum for a specific water level relative to marsh level (Fagherazzi et al.)

Virginia Coast Reserve, S. Fagherazzi

Orplands, Essex. Credit: James Tempest

Important factors:
Height of marsh relative to water level
Timing of storms relative to tide level

Sea level rise means bigger waves but not necessarily more erosion

Factors that control wetland size

Transgression (elevation/connectivity)

Vertical Maintenance or Submergence

Edge Erosion

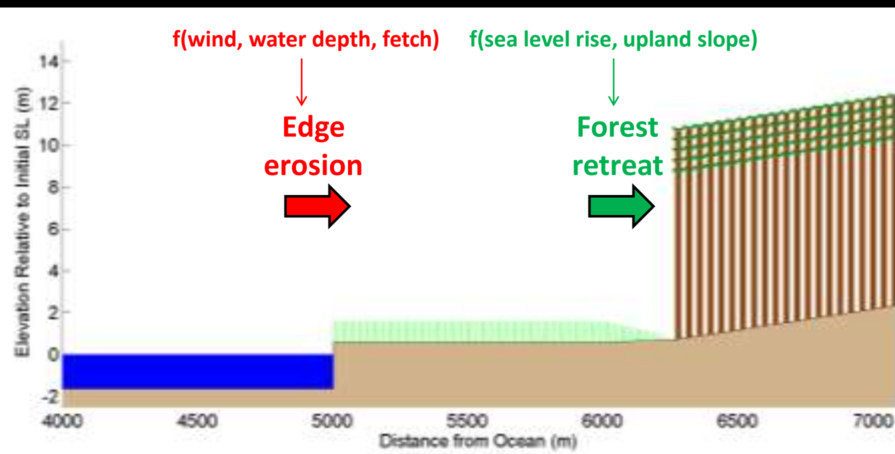
Pictures of active marsh migration

Dying Loblolly Pine forest

Marsh under trees

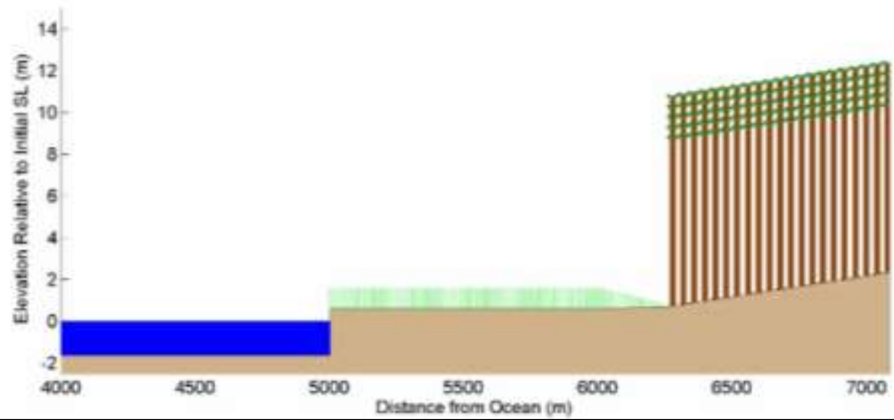
Will look like this in a decade or 2

Marsh Response to Sea Level Rise



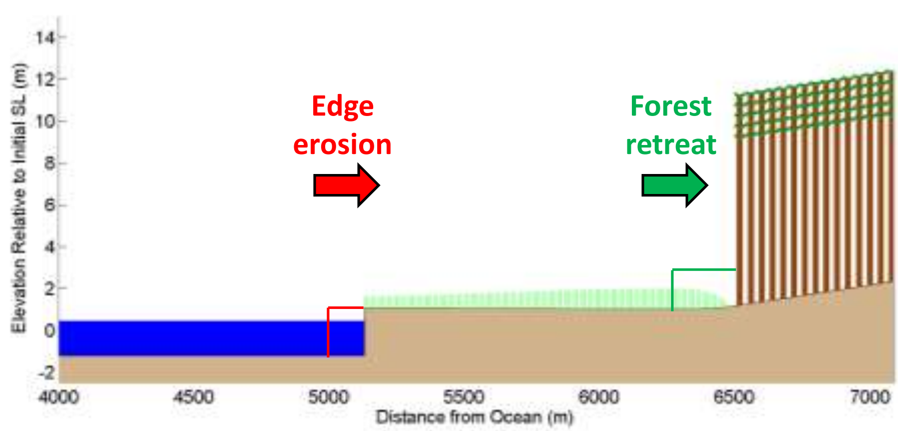
Kirwan et al., in prep

Marsh Response to Sea Level Rise

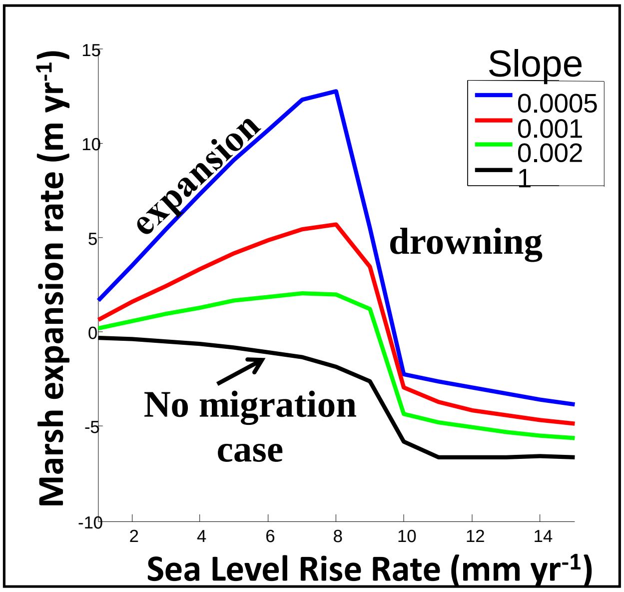


Kirwan et al., in prep

Marsh Response to Sea Level Rise



Kirwan et al., in prep



Expansion, then drowning

Expansion rate related to slope

No migration case- marsh loss inevitable

Erosion even if marsh is keeping up vertically!

For a given wind speed, fetch, sediment supply

Kirwan et al., in prep

How much land available for marsh migration?

(Green = potential land for new marsh under 1m of SLR)

Entire continental U.S.
1m SLR = 11,000 km^2 new intertidal area
Existing marshland= 16,000 km^2
(Morris et al., 2012)

Enough to compensate for almost complete loss of existing marshland. But…

Conclusions/Discussion Points

- **Mainland marshes tend to be stable in vertical dimension (i.e. build elevation with sea level rise). Survive > 10mm/yr.**
- **Inherently unstable at seaward and landward boundaries (erosion + migration)**
- **Enough adjacent land to accommodate severe loss of existing marsh**
- **Loss not inevitable, expansion possible**

So, whether marshes will expand or contract in response to future SLR depends on how we ourselves defend against SLR