Inter-annual Variability in Delaware Marshes and the Effects They Show with Sea Level Rise

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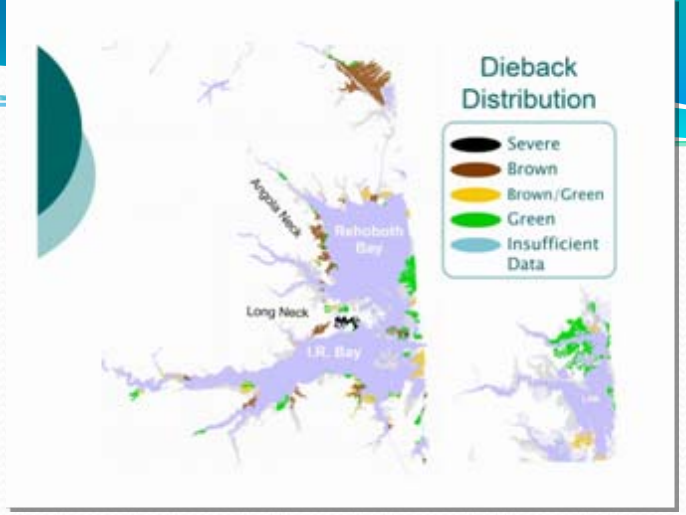
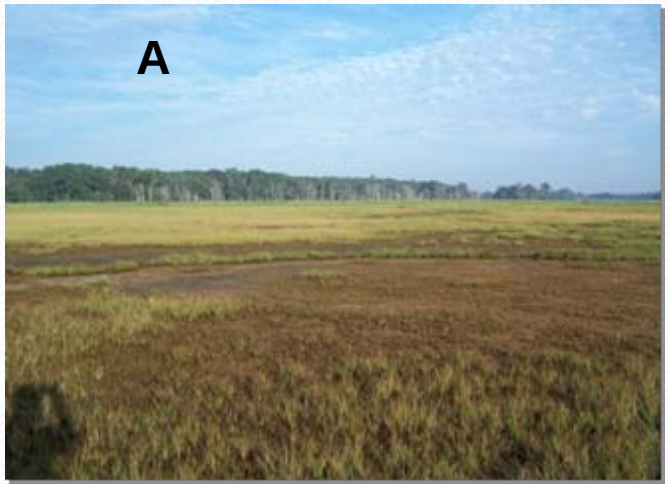
Sudden Dieback In Delaware



Map: courtsey Chris Bason, Center for Inland Bays



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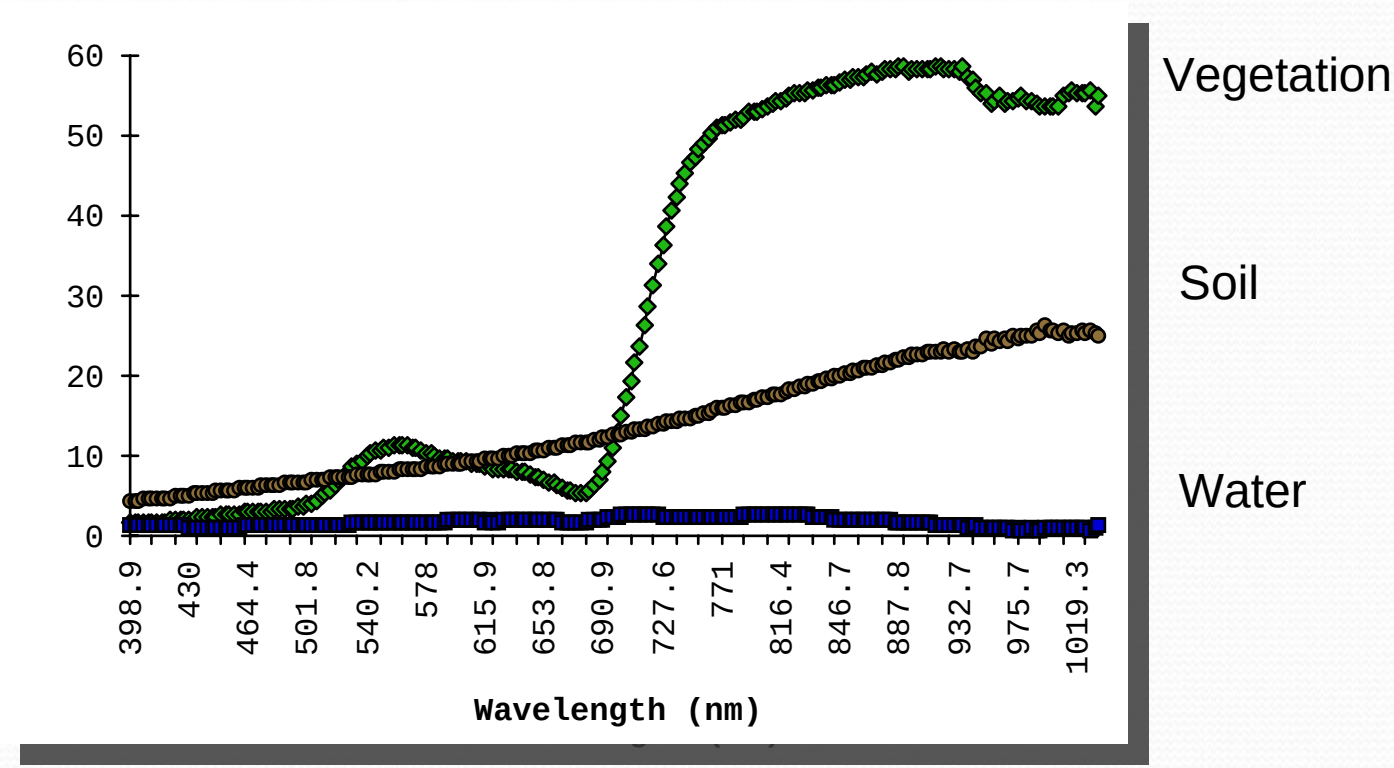


Landsat TM Mixture Model

- Subpixel Look, Decomposes Each Pixel Into :Vegetation, Soil, and Water Elements
  - $X_{w1}f_w + X_{v1}f_v + X_{s1}f_s = R_1$
  - $X_{w2}f_w + X_{v2}f_v + X_{s2}f_s = R_2$
  - $X_{w3}f_w + X_{v3}f_v + X_{s3}f_s = R_3$
- The Indices are Independent, and Do Not Rely On End member Selection

  -A Critical Factor In General PCA-Based Mixture Models

Mixture modeling:
Selection of endmembers, continued

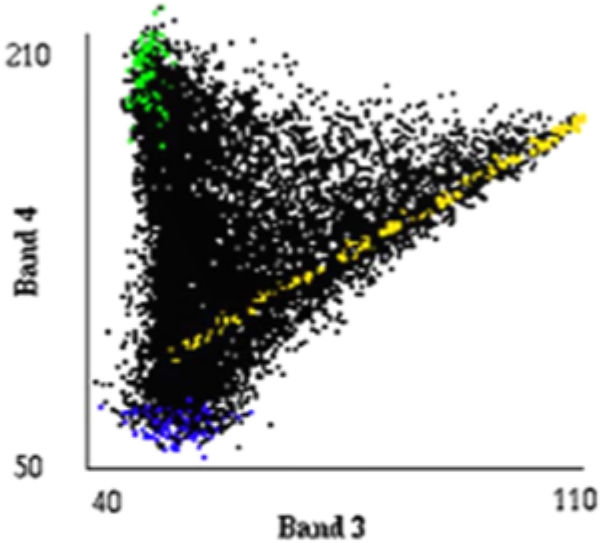


Figure 2. 3-component system: this shows endmembers of water, vegetation, and soil. The yellow stripe represents soil spectra in this spectral space.

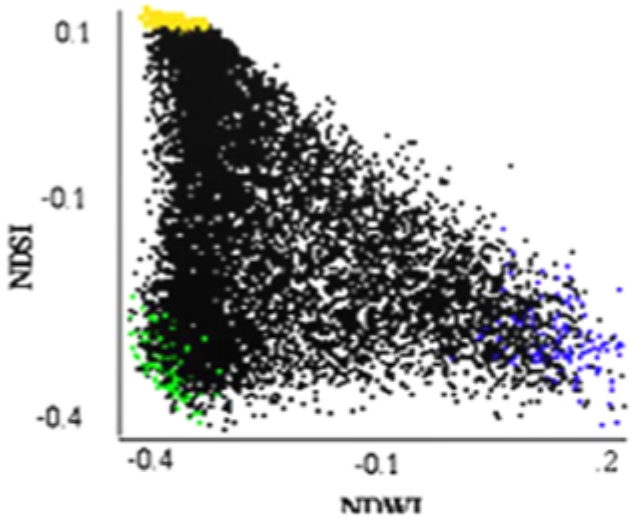
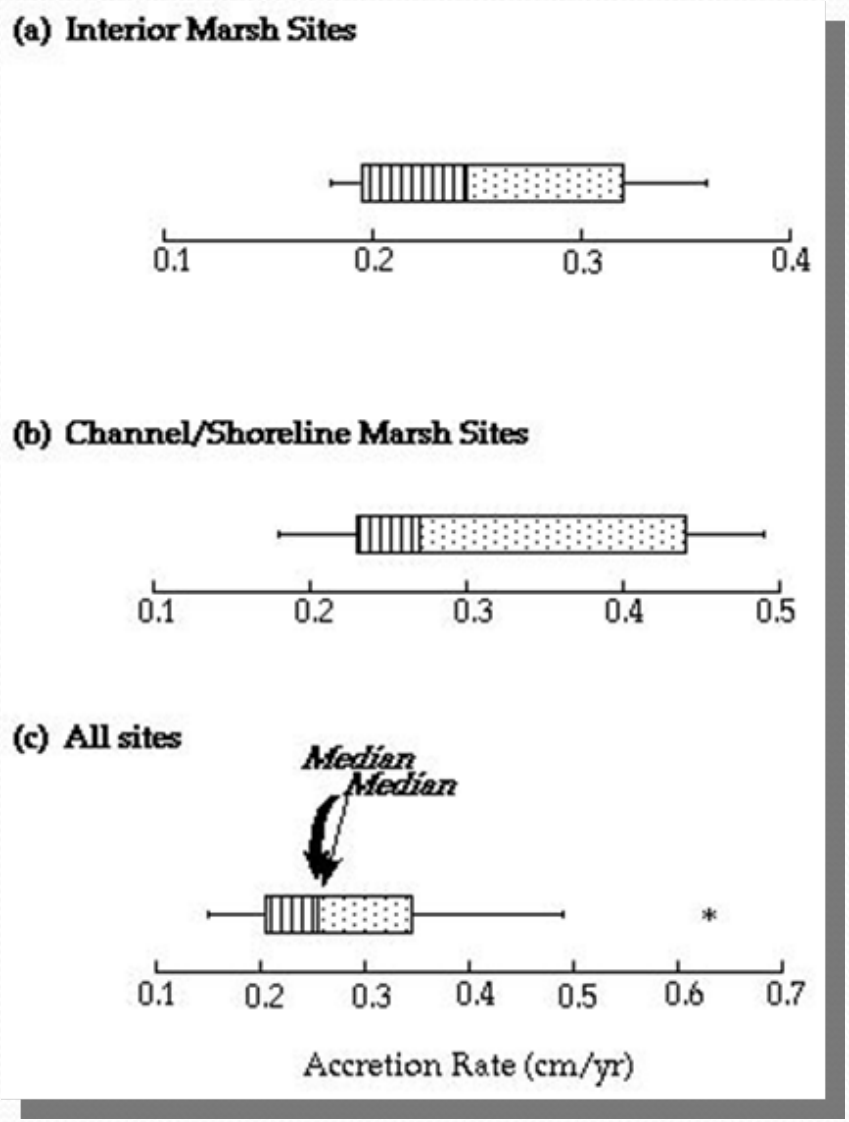


Figure 4. The NDX data space. Note that water, vegetation, and especially soil are all endmembers in this space, so the fractions can be calculated from them.

Rationale of the Study

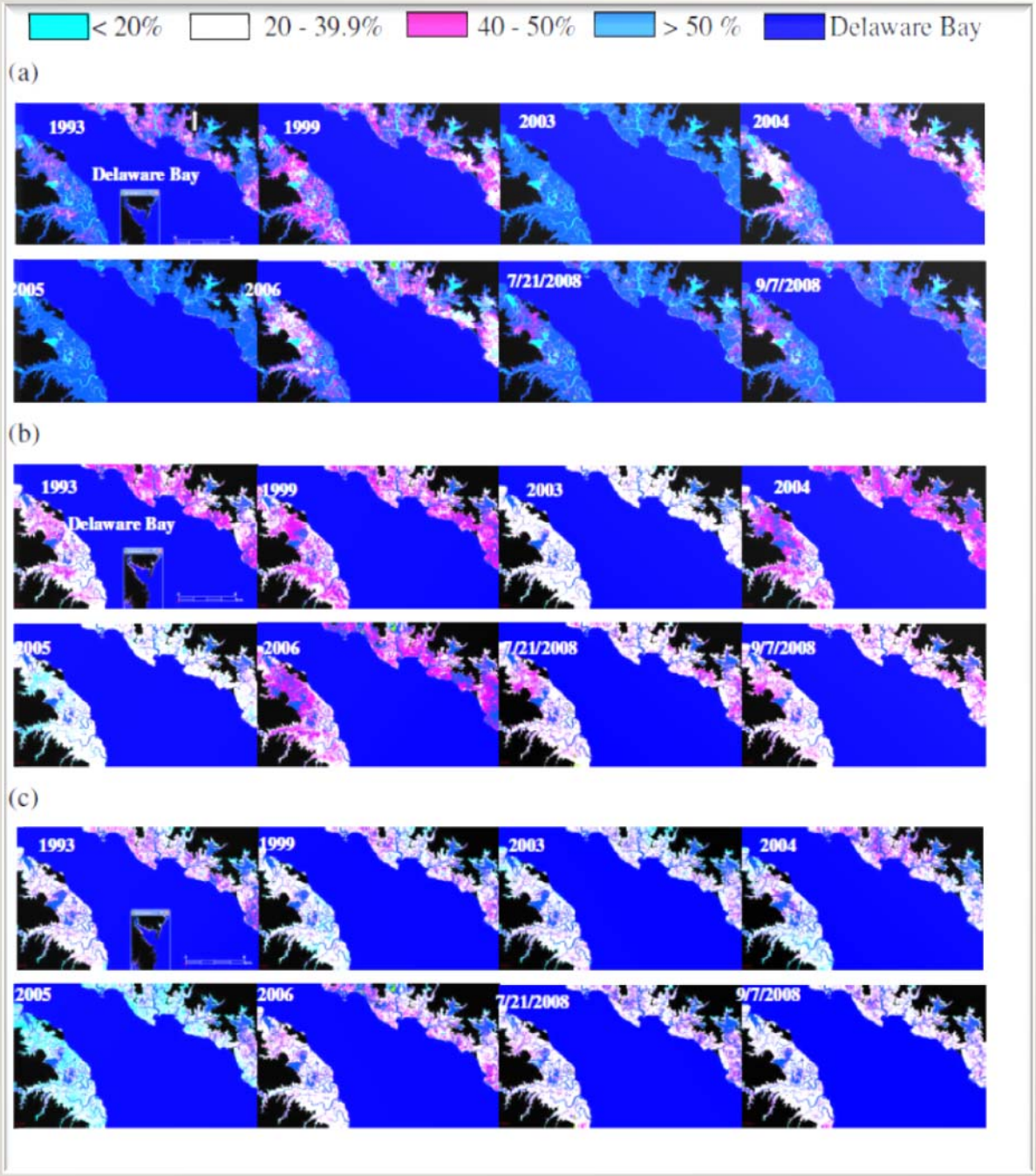
- Examine changes in an area of "healthy" marsh that did not show any evidence of physical degradation over the 15 year period of the study
  - See what how healthy marshes adjusted to one of the highest periods (c. 1989 – 1999) sea level rise in the last 40 years, when sea levels rose at >1 cm per year – what lessons can be learned about how the marshes most likely to survive where to handle the sea level trend
- What factors besides sea level rise may played a factor in changes that may have occurred.

First Assumption: Variability in Estuarine Marshes is to be Expected – Well Documented in Vertical Accretion Rates

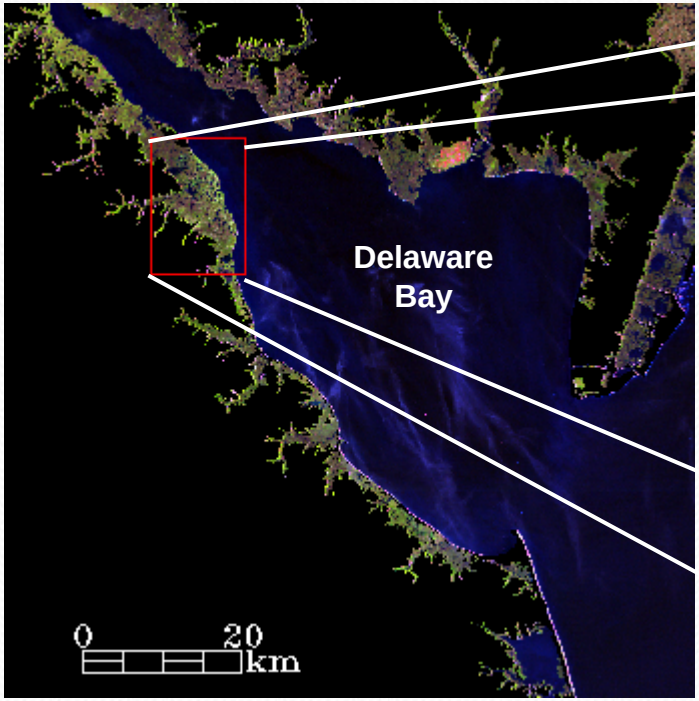


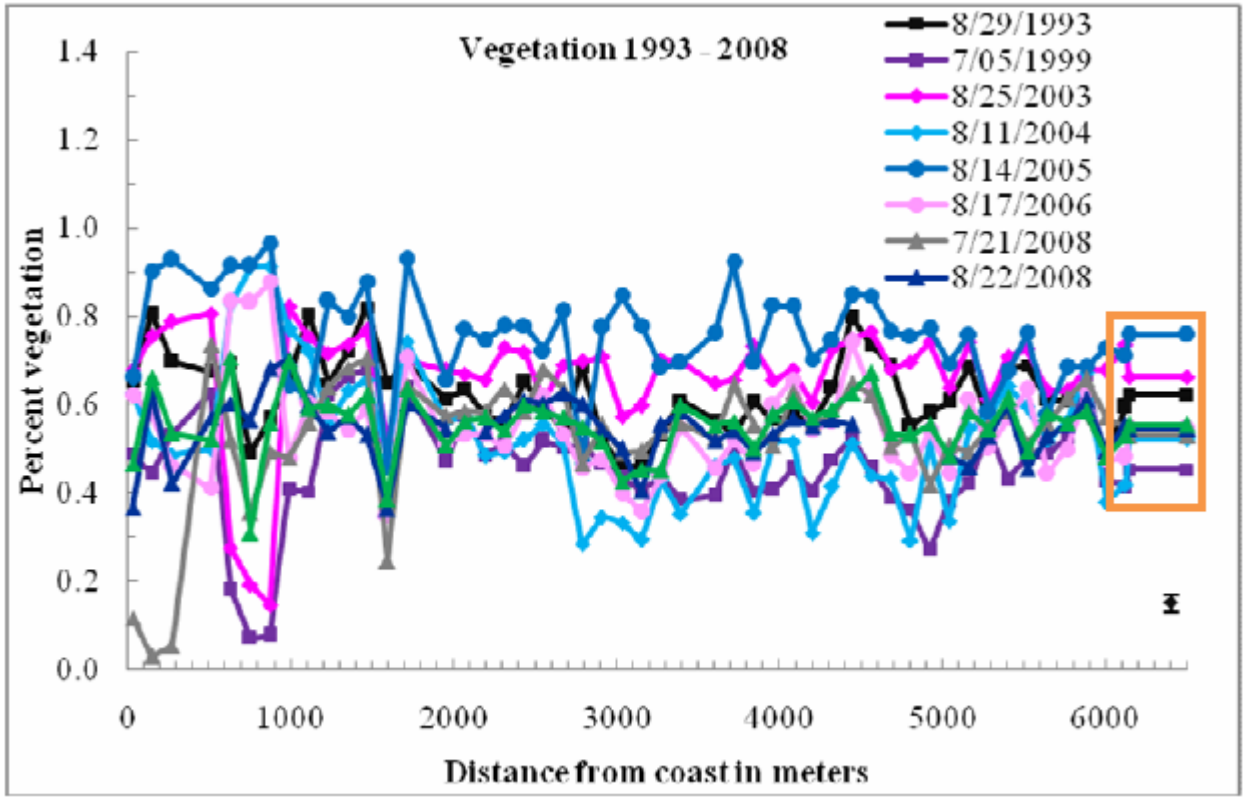
Source: Kearney et al. (1994)

Changes in Percent Vegetation (a), Water and Soil (b), and Water (c) 1993 - 2008

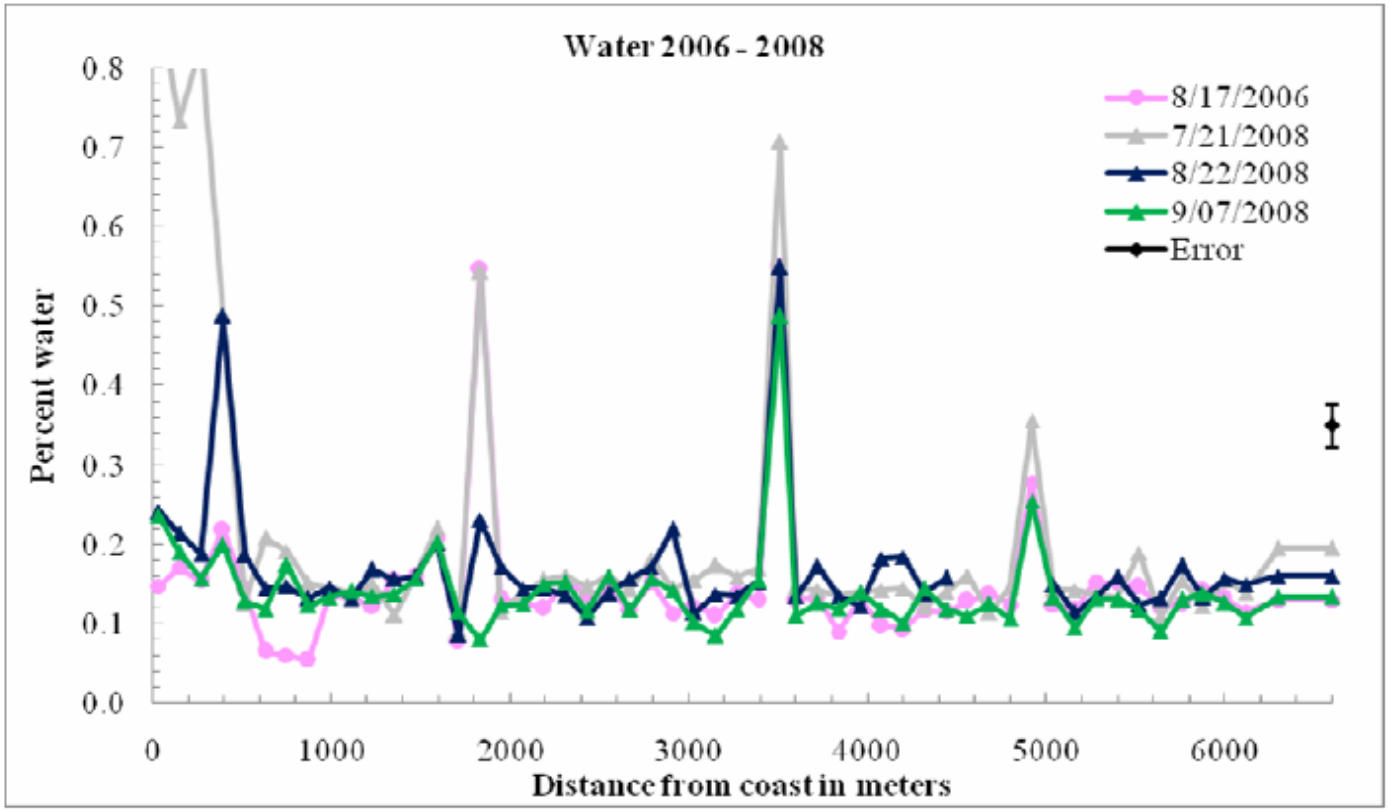


Study Area

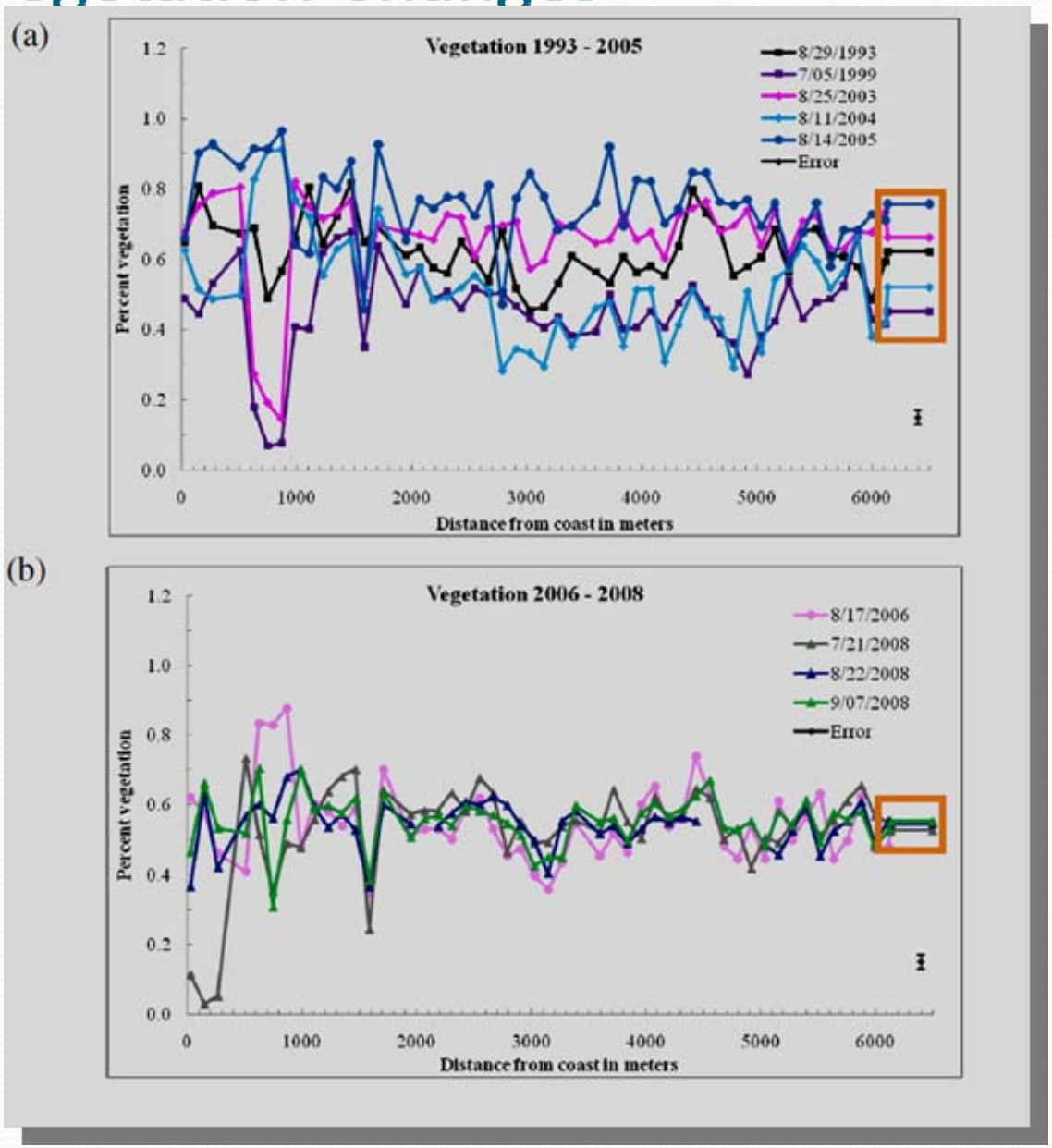



Vegetation 1993 - 2008
8/29/1993
7/05/1999
8/25/2003
8/11/2004
8/14/2005
8/17/2006
7/21/2008
8/22/2008
Percent vegetation
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
1000
2000
3000
4000
5000
6000
Distance from coast in meters

Changes in Percent Water 2006 - 2008

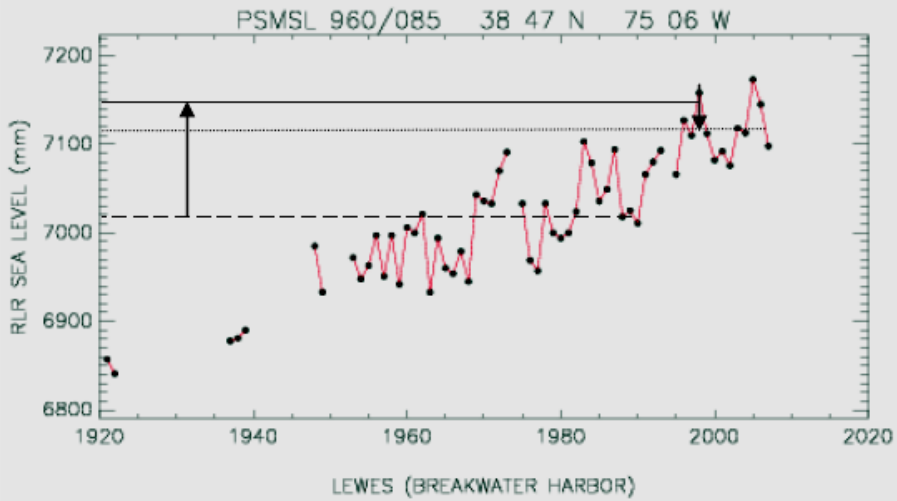


Percent Vegetation Changes

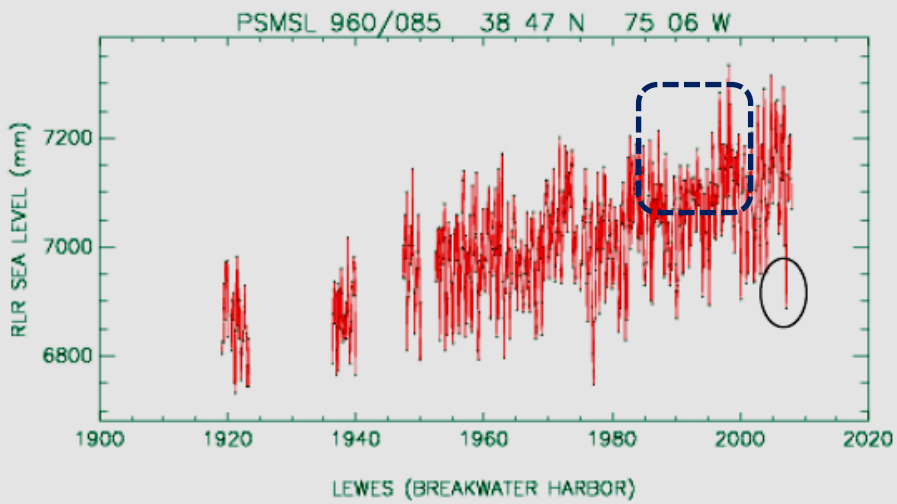


Sea Level Changes for Lewes, DE 1919 - 2008

(a)



(b)



Conclusions

- A high of variability in the sea level trend is one of the outcomes of global warming
- Marshes in Delaware Bay that kept pace with a decade-long "ramp ups" in sea level since the late 1960s may be left "high and dry" once sea level drops
- Increasing nutrient levels in estuarine marshes promotes shallower rooting, and the greater vulnerability to regressive phases
- The weak of tidal flushing characteristic of microtidal coasts makes marshes more vulnerable to low DO and sulfides during late summer in regressive phases
  - This could stress the plant, limit N uptake and lower CHOH storage
  - Soil acidity from oxidation of substrate sediments