Impacts of Sea Level Rise on Coastal Wetlands in the U.S. Northeast

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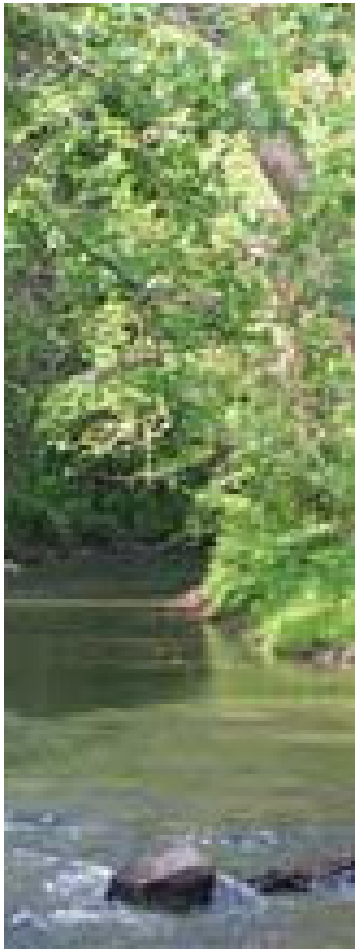
Introduction

- Coastal wetlands can act as buffer against climate change, but ….
- They are vulnerable to sea level rise, and disappearing at a rapid pace.

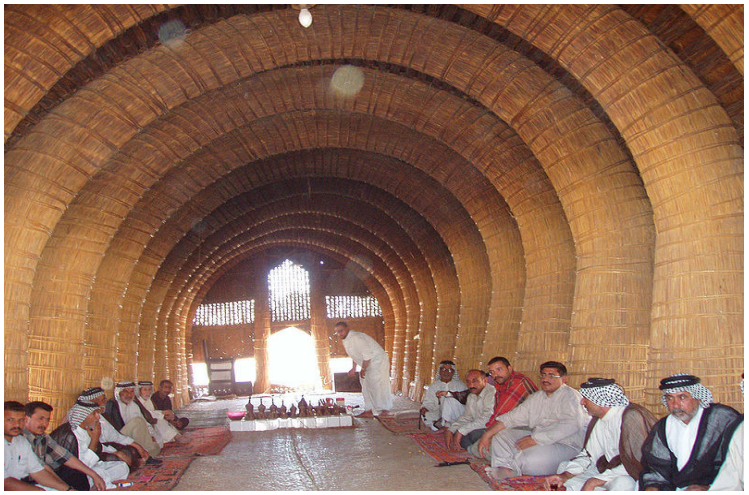
Importance of coastal wetlands

Water purification and nutrient removal




Importance of coastal wetlands

Ecosystem services

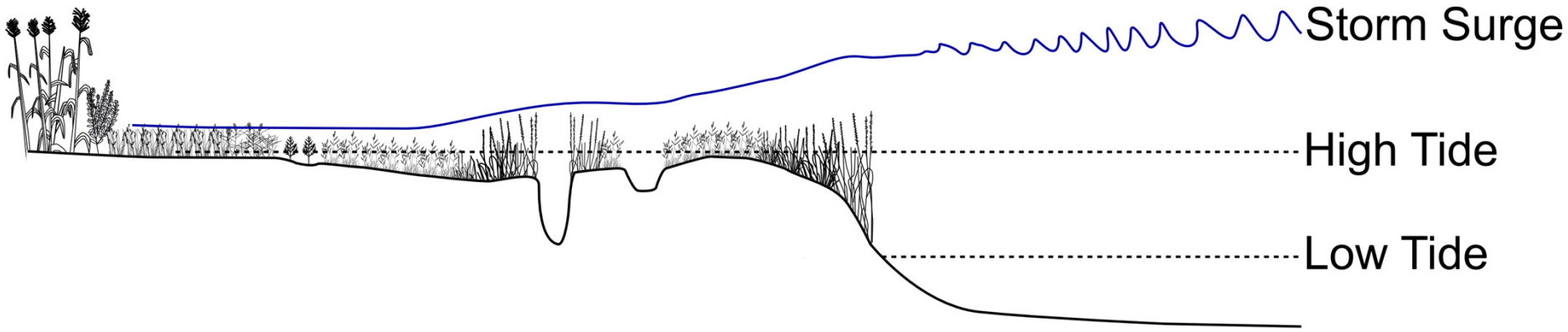


Importance of coastal wetlands

Flood mitigation

Importance of coastal wetlands

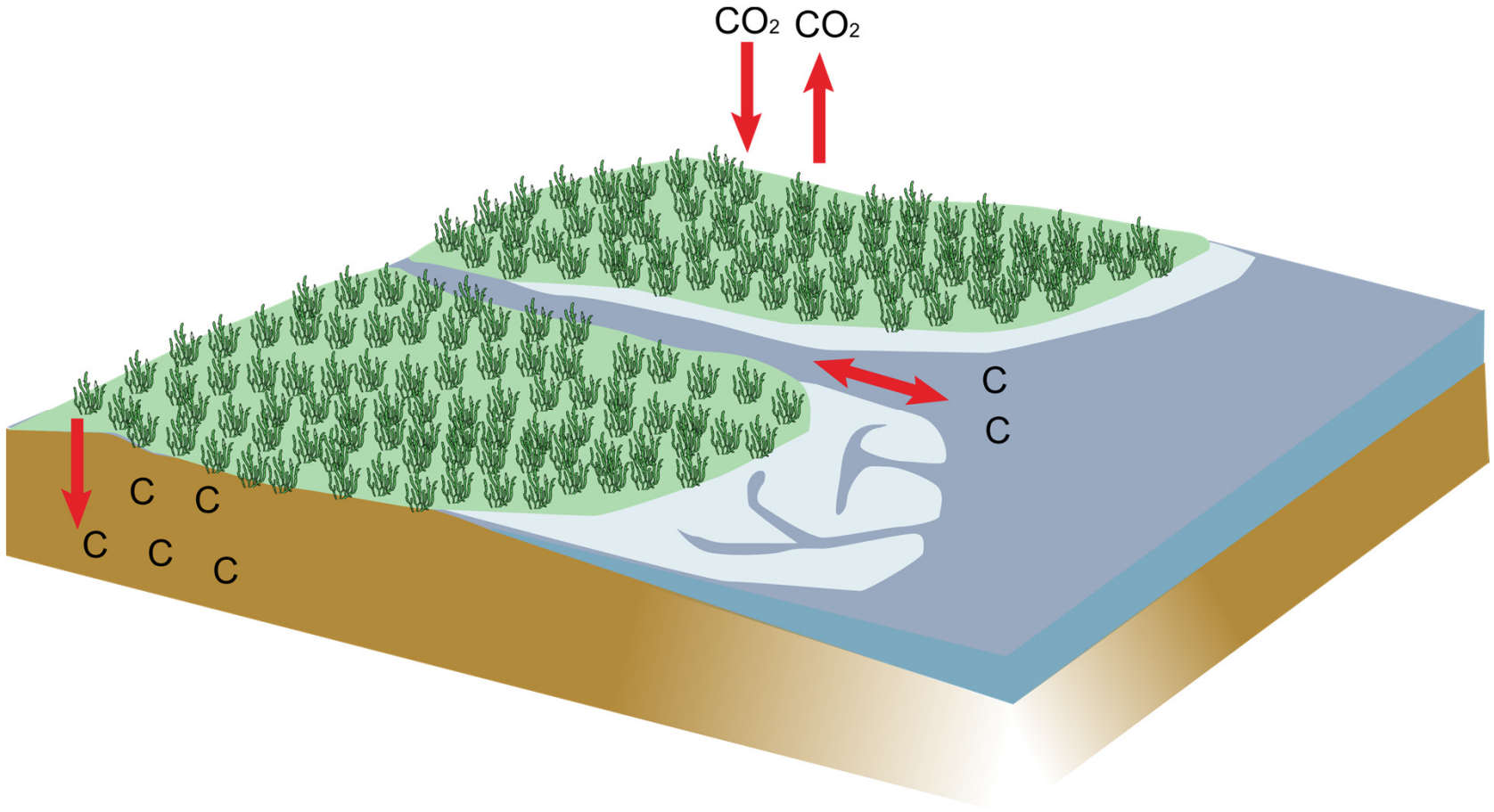
Flood mitigation



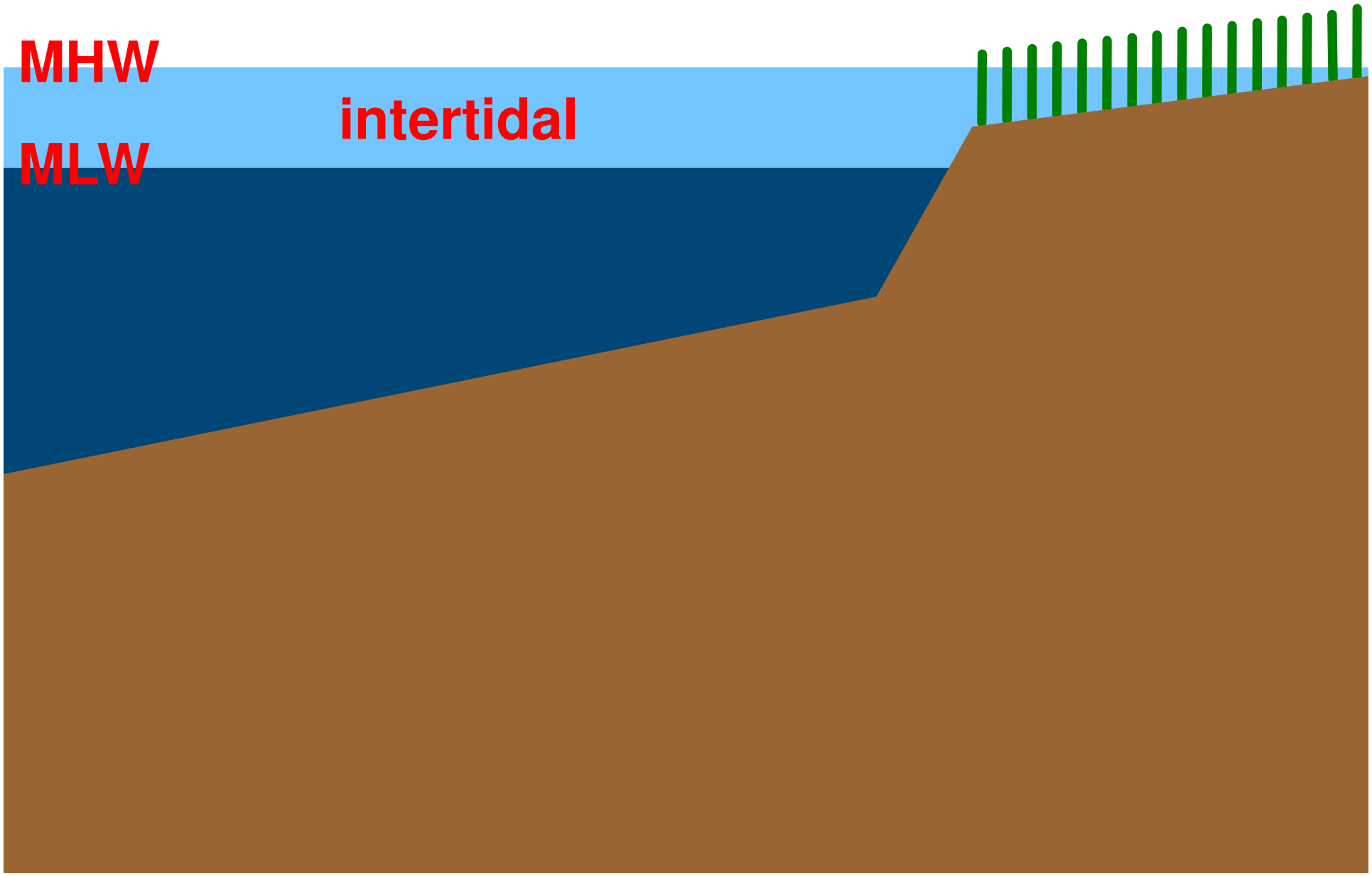
- Coastal wetland cohesion reduces erosion
- Porous soils store floodwater
- Wave attenuation by friction

Importance of coastal wetlands

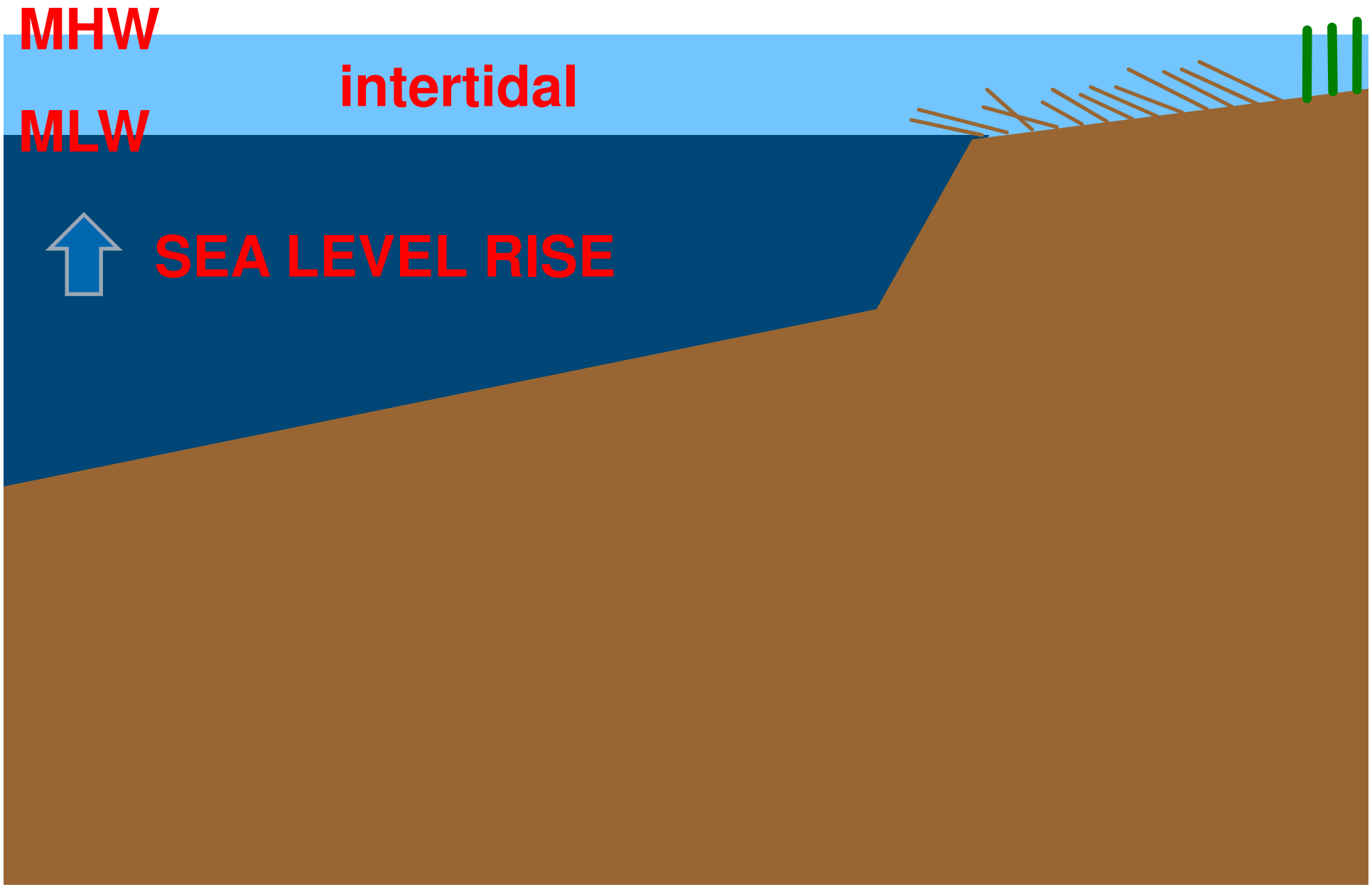
Carbon Sequestration



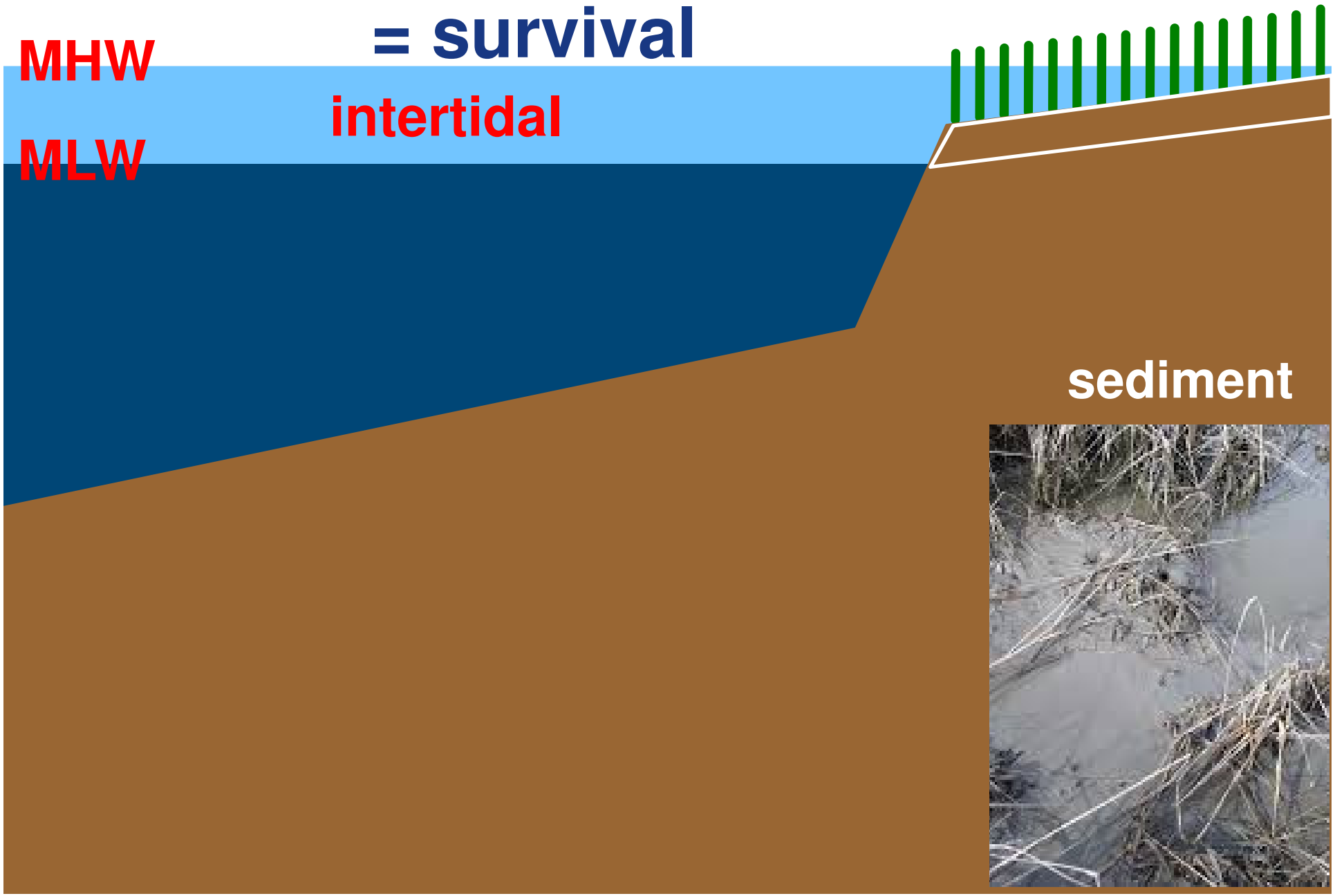
Coastal Marsh



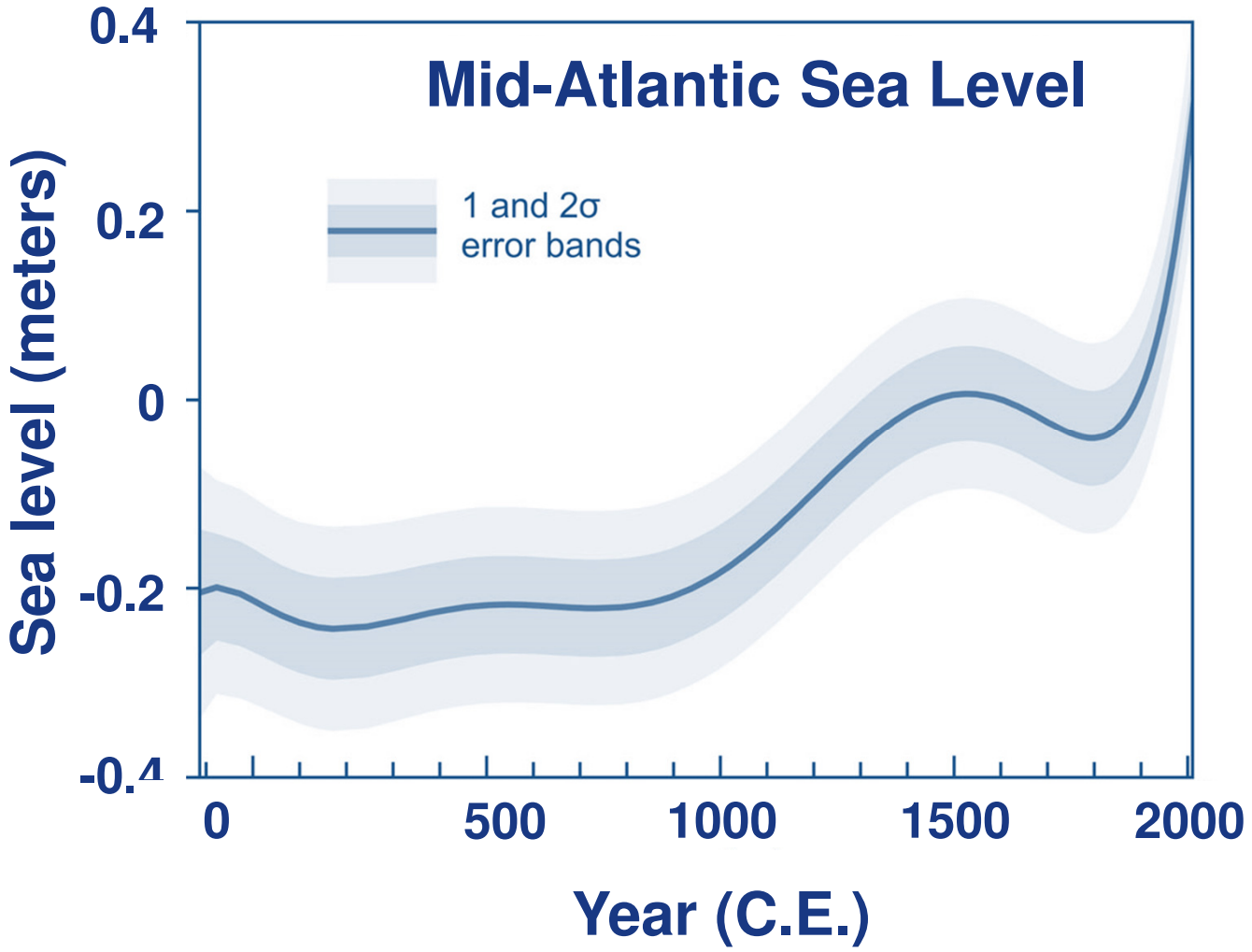
Rapid sea level rise = marsh drowning



Adequate sediment or slow SLR = survival

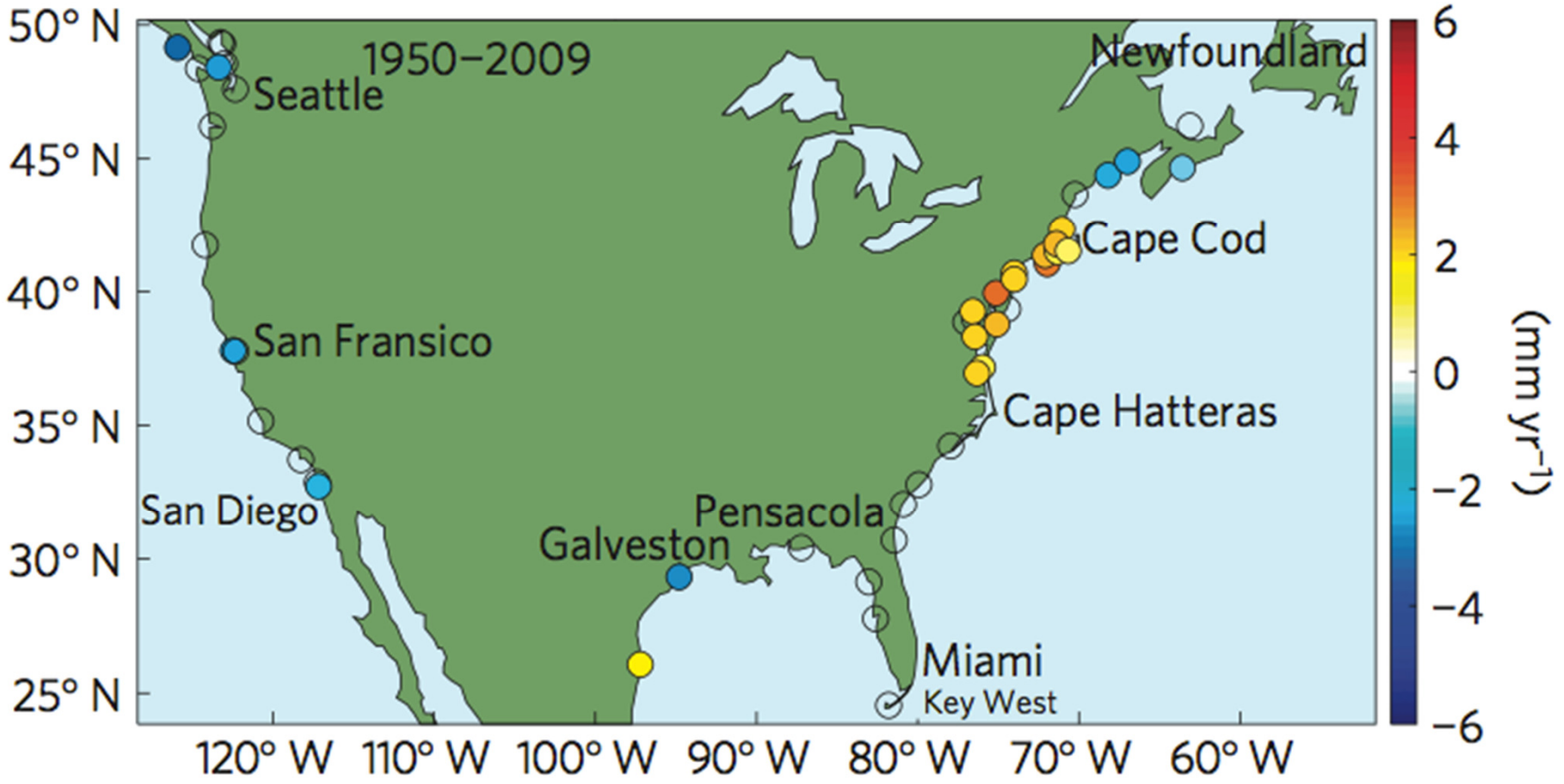


Accelerated sea level rise



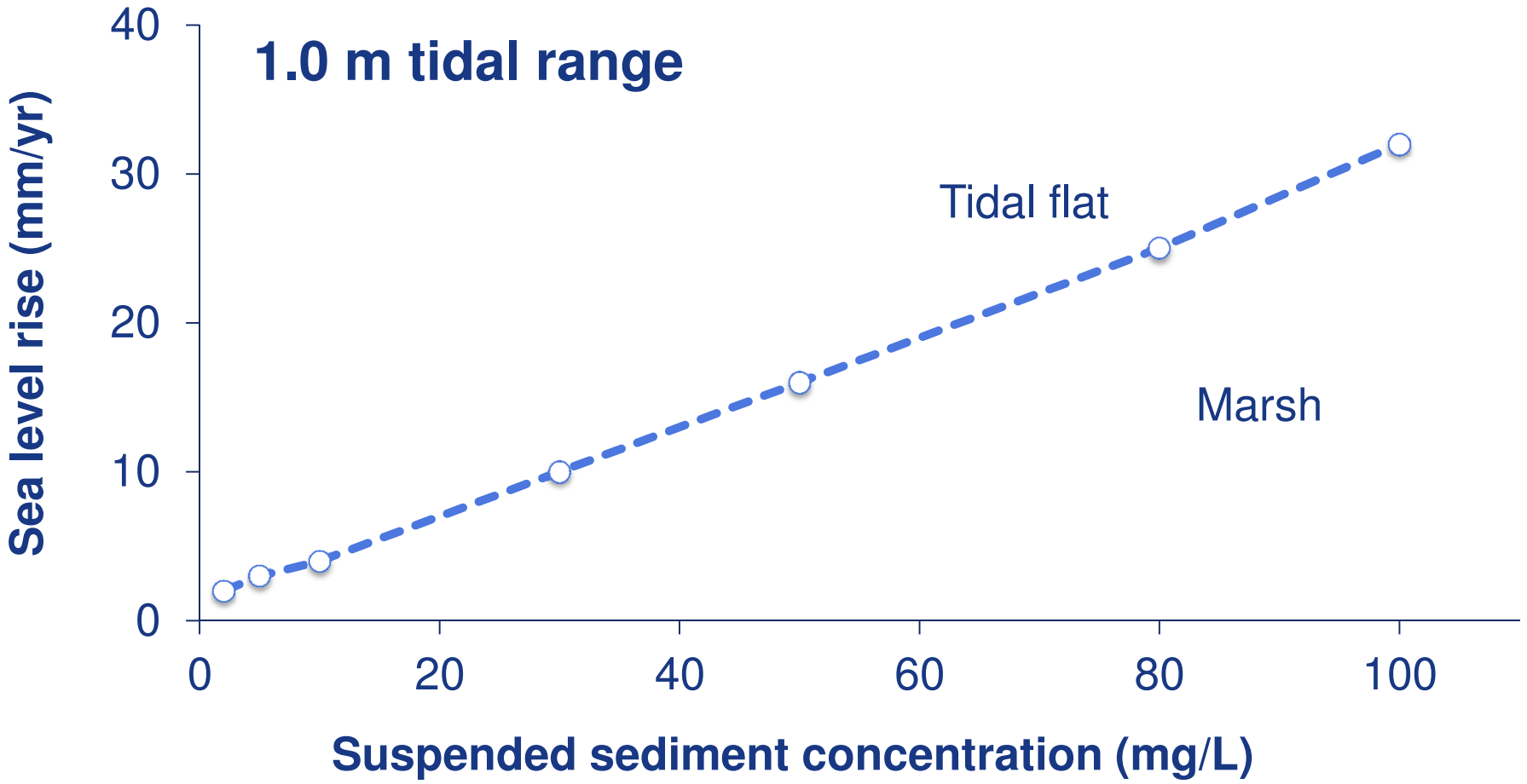
Source: Kemp et al., *JGR*, 2011

Regionally high rates of SLR acceleration



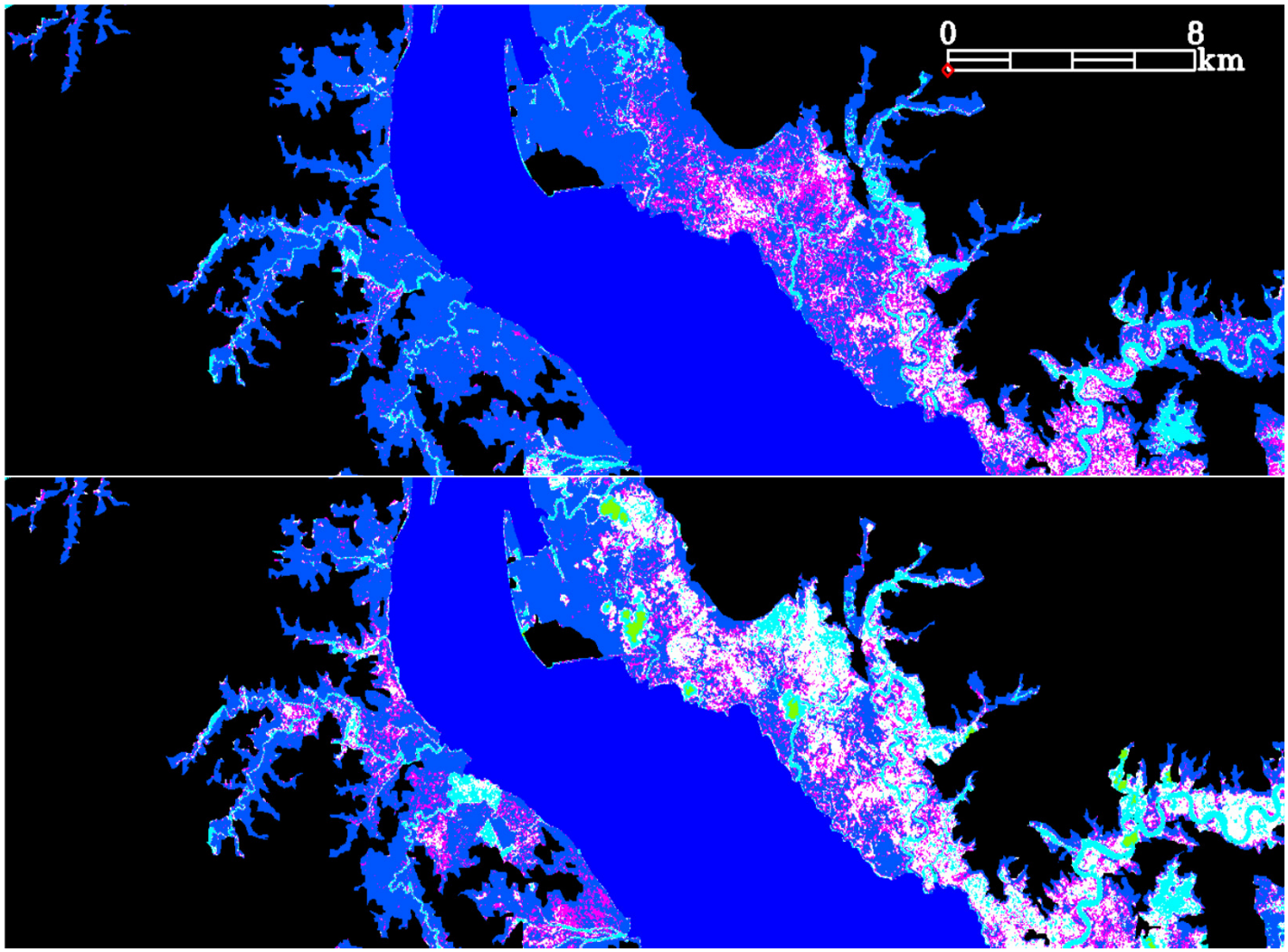
Source: Sallenger et al., *Nature Climate Change,* 2012

Threshold rates of sea level rise



Kirwan et al. 2010; Fagherazzi et al. 2012

Coastal wetland integrity: Delaware Bay



% vegetation

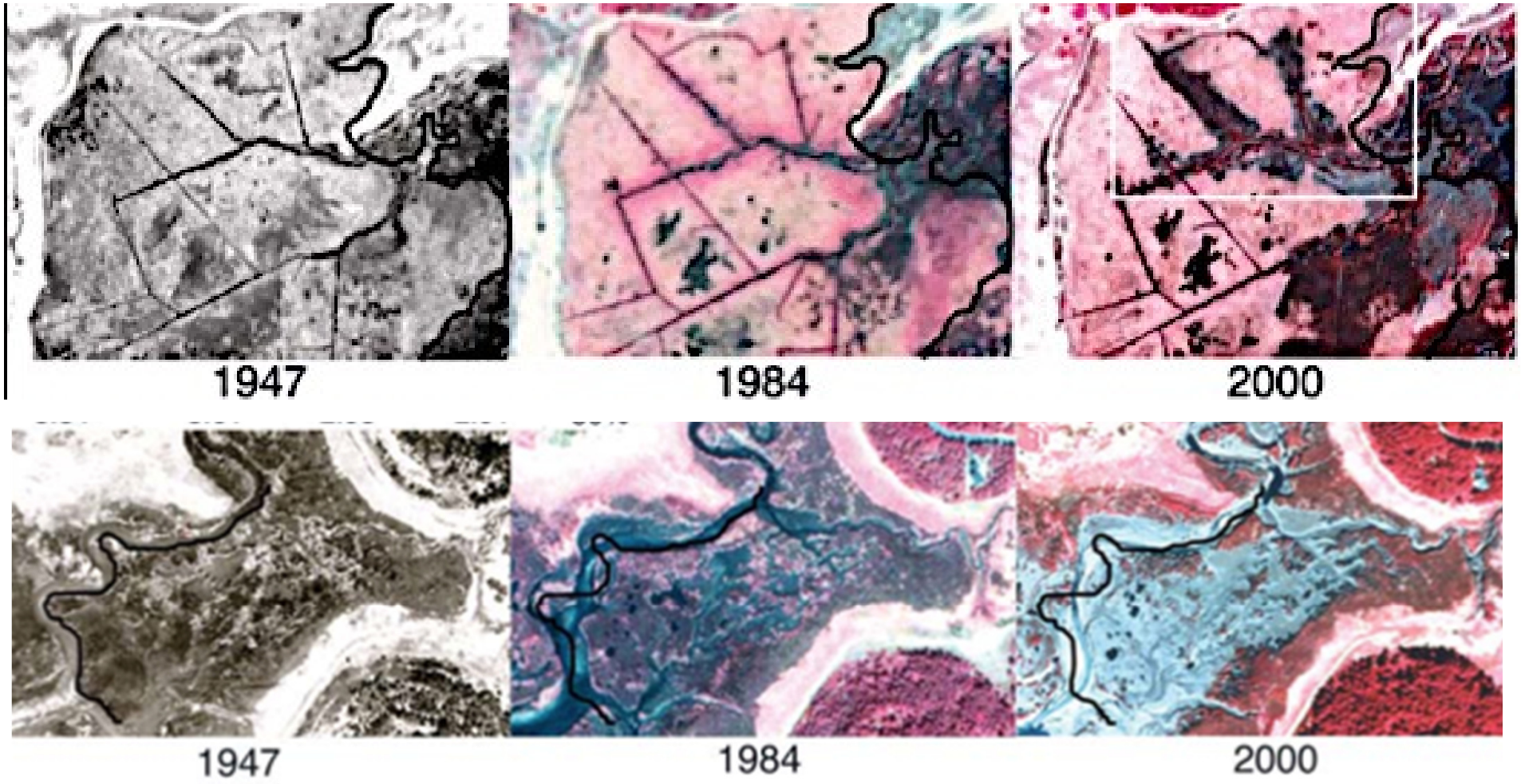
- < 20%
- 20 - 39.9%
- 40 - 50%
- > 50%
- Delaware Bay

Source: Kearney et al., *EOS*, 2002, Kearney and Riter, *Wetl Ecol Manag*, 2011

Disappearing coastal marshes: NYC

Reference: Hartig et al., *Wetlands,* 2002

Marsh habitat loss: Cape Cod, MA



Source: Smith, *Northeastern Naturalist*, 2009

Trend reconstruction is difficult

NWI | Orthoimagery | New CCAP

Source: NOAA Coastal Services Center

In Summary

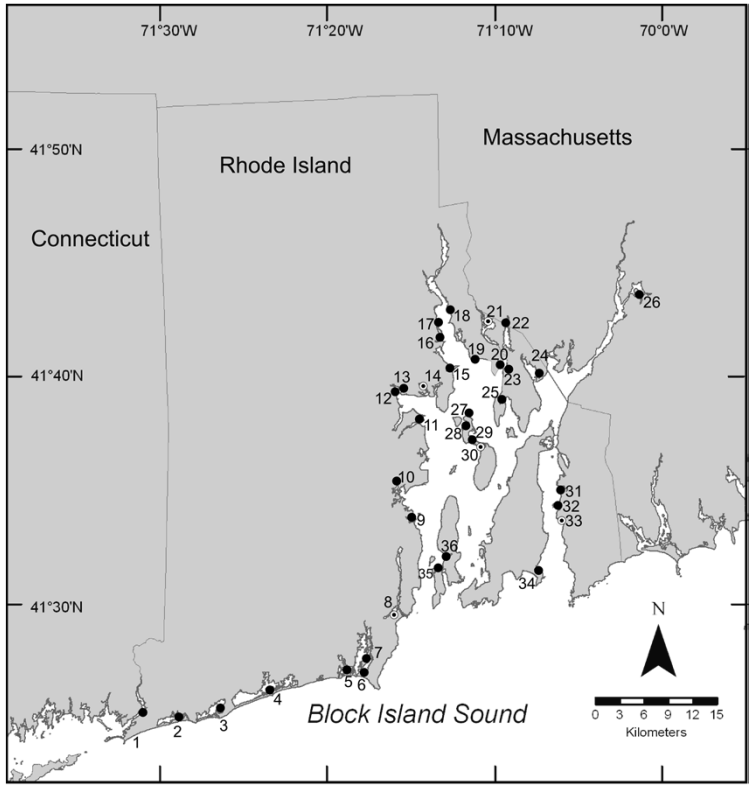
- Coastal wetlands are ecologically valuable
- Coastal marshes are sensitive to the rate of sea level rise and sediment availability
- Sea level rise is accelerating in the mid-Atlantic
- Models suggest that for low sediment supply wetlands, important thresholds have already been crossed
- Wetlands are disappearing, rates uncertain

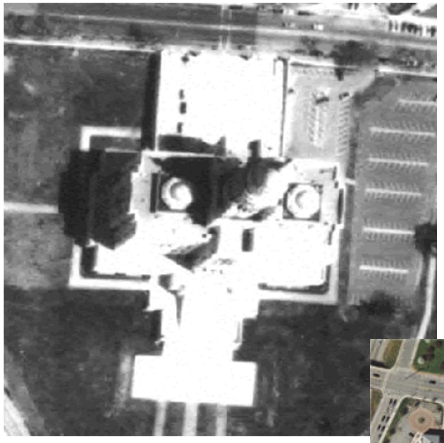
Research Questions

- What are the rates and patterns of marsh vegetation loss?
- Is sea level rise causing marshes in the Northeast to drown?

Remote sensing analysis

- Analyzed vegetation loss for 36 coastal wetlands in southern New England





1972

2011

Watson et al., *Estuaries & Coasts,* In Press

Remote sensing results

- 17.3% vegetation loss for 1972-2011
- 35 of 36 units saw loss of wetland vegetation
- Loss rates ranged from 1.6% to 40.8%

Watson et al., *Estuaries & Coasts,* In Press

Remote sensing results

Watson et al., *Estuaries & Coasts,* In Press

Remote sensing results

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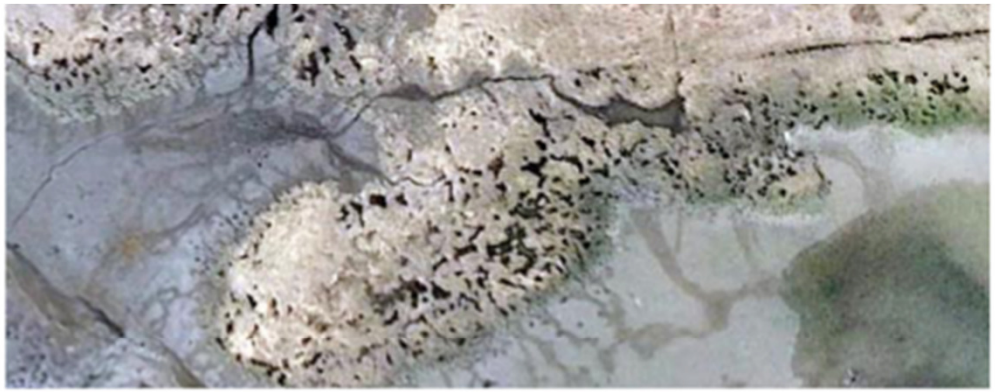
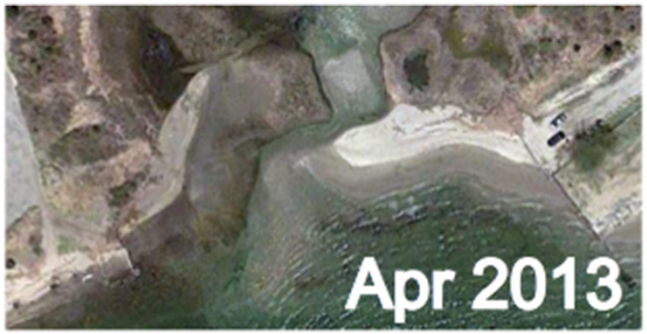
Remote sensing results



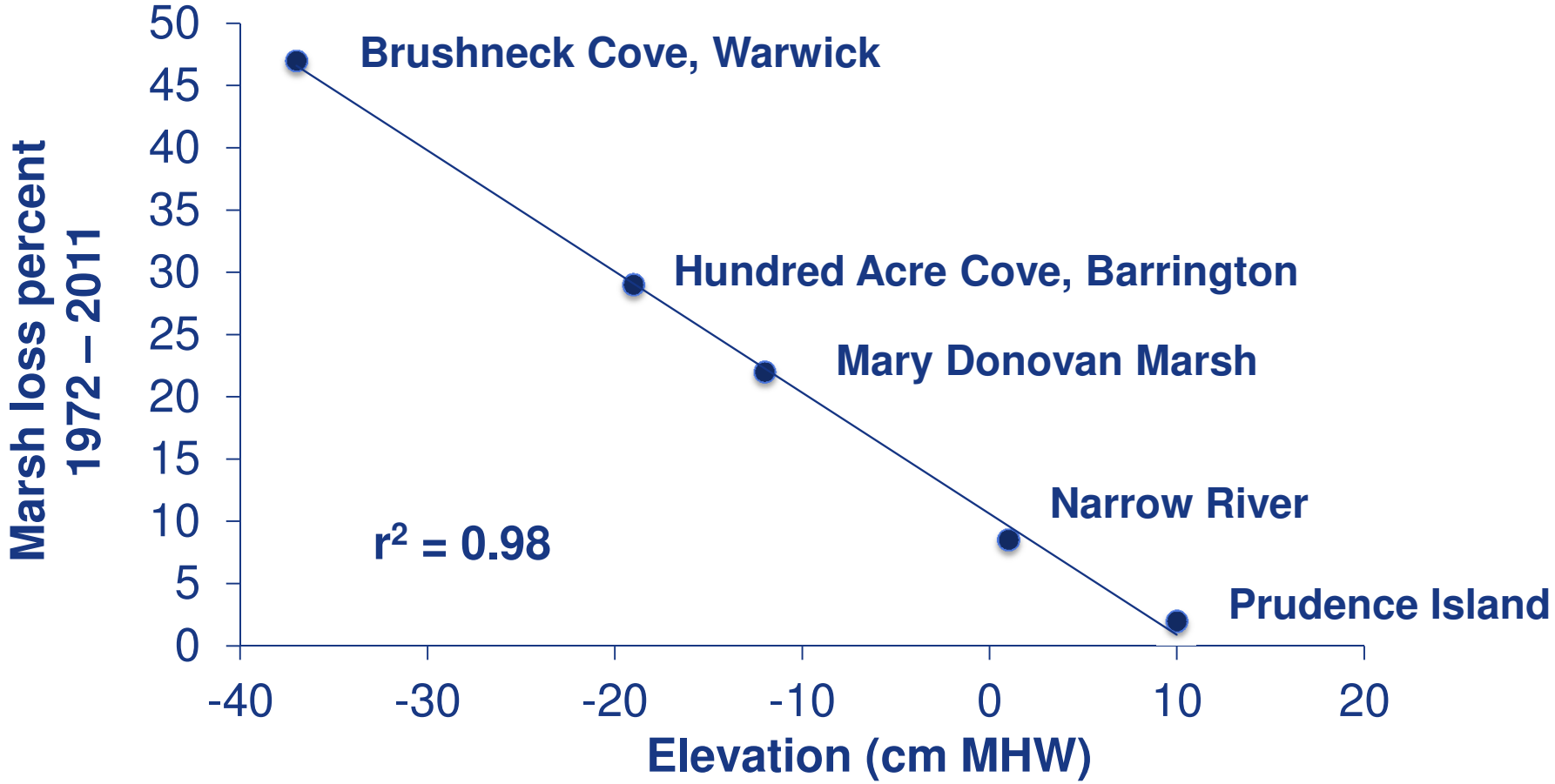


Watson et al., *Estuaries & Coasts,* In Press

Remote sensing results

Remote sensing results

Coastal marsh loss as a function of elevation

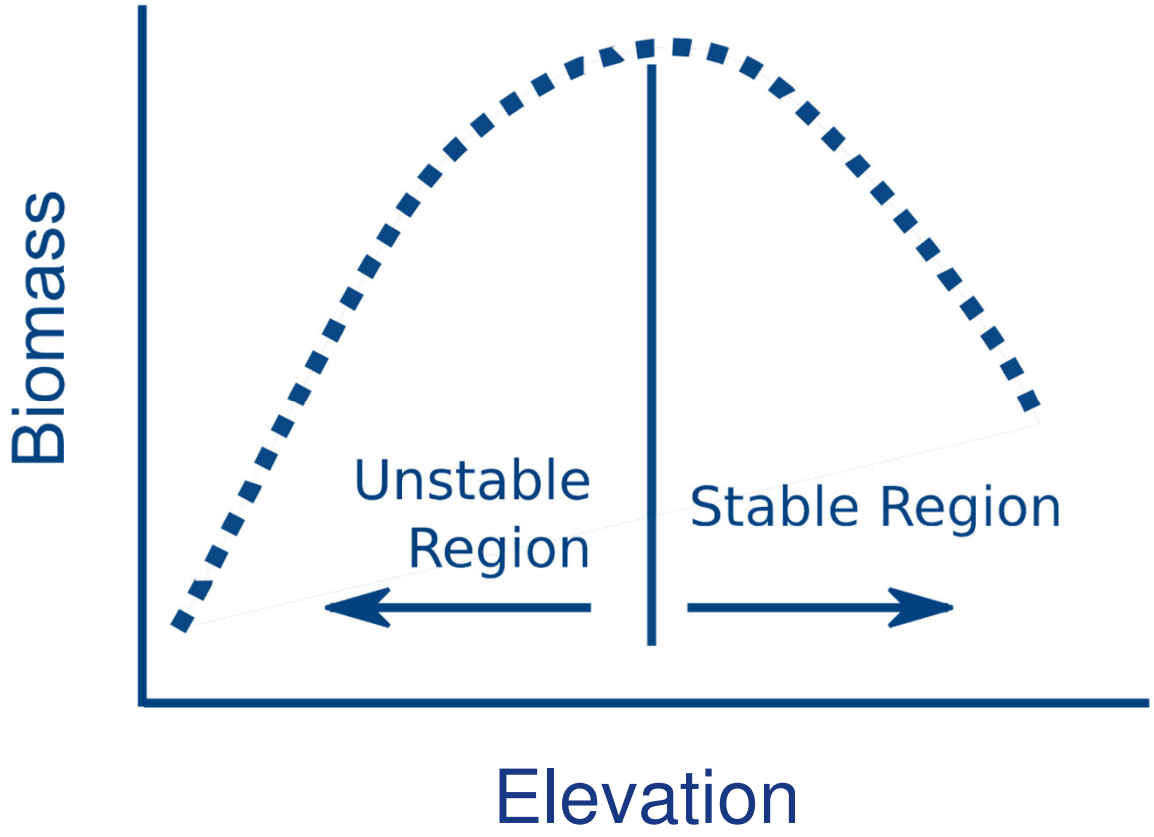


Watson et al., *Estuaries & Coasts,* In Press

In Summary

- Rates of vegetation loss were 17.3% 1972-2011
- Regional pattern of significant loss
- Shore retreat, development and expansion of ponds, enlargement of tidal channels

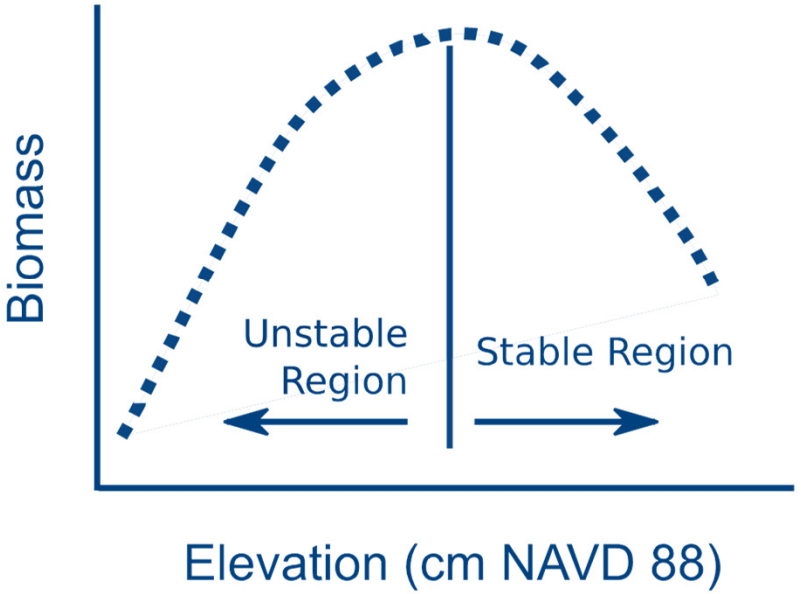
Elevation-productivity relationships



Morris et al., *Hydrobiologia*, 2007

Field Experiments

- Measured belowground growth as a function of inundation/ elevation at three sites

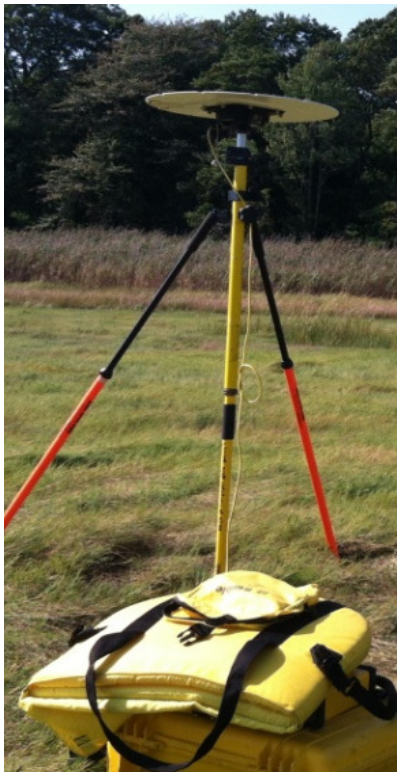


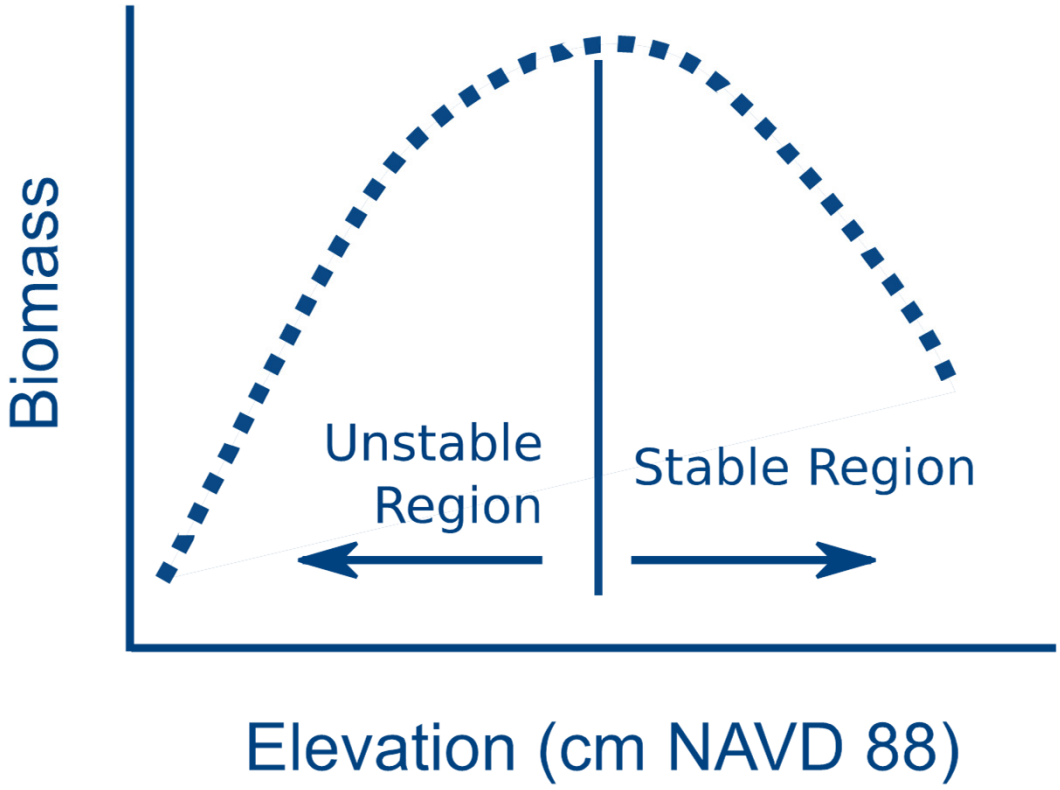
Field Experiments

- Visualized belowground biomass using computer aided tomography (CT) imaging at one site

Field Experiments

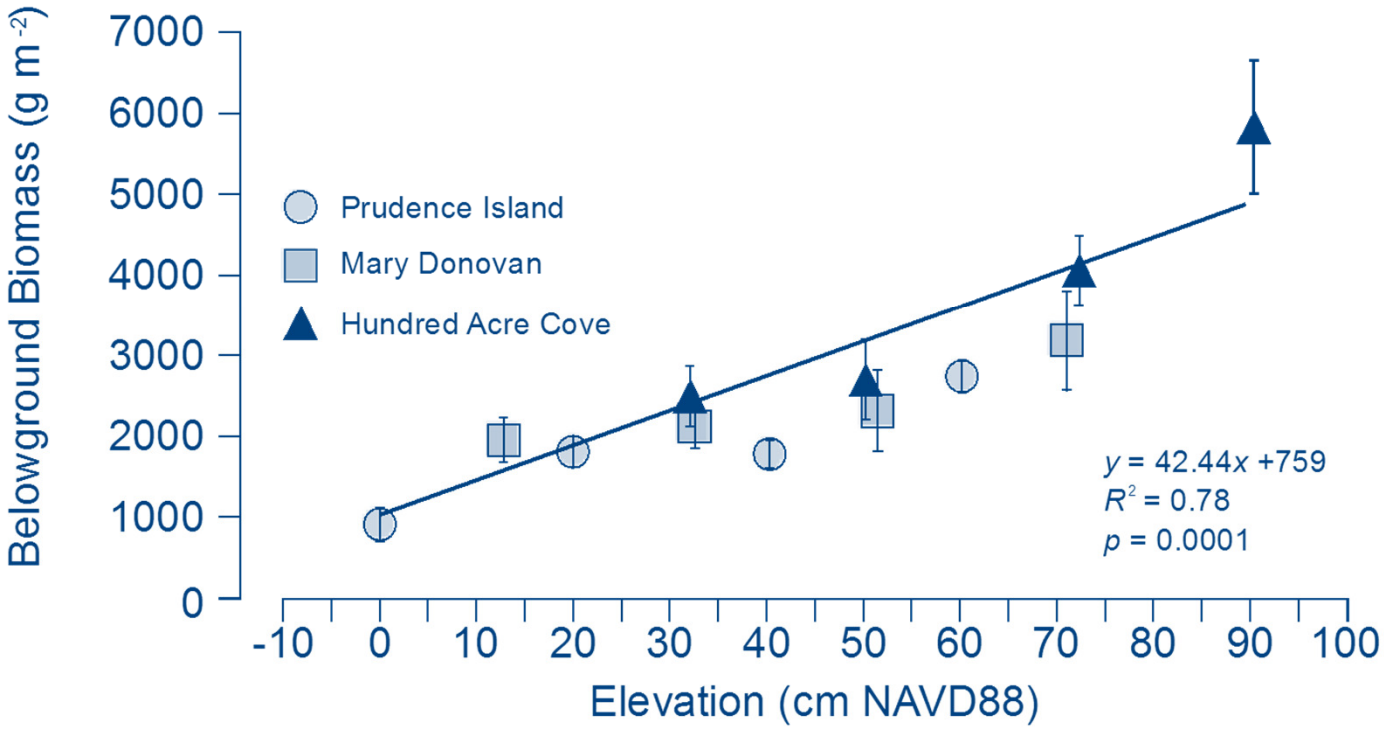
- Measured elevations in same 36 sites, water levels at five sites





Belowground productivity responds to inundation

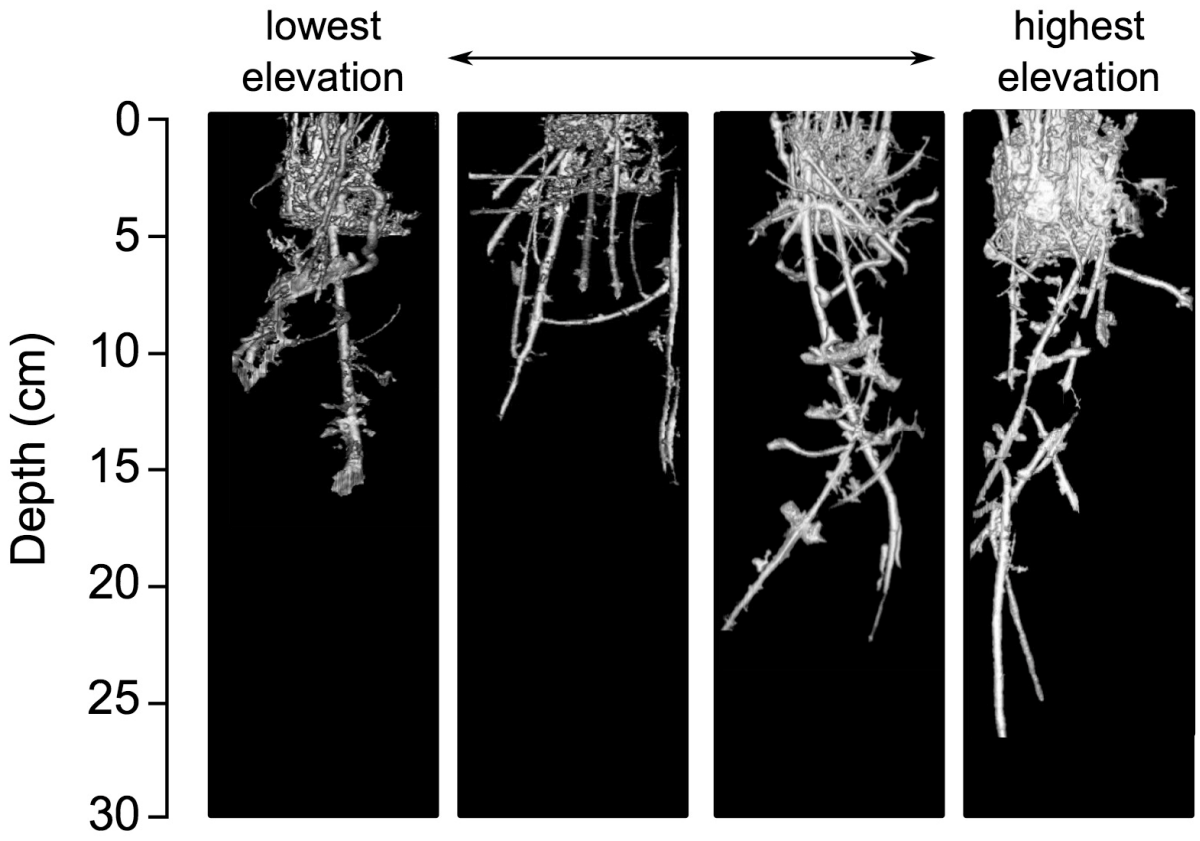
- Lower inundation = more growth



Watson et al., *Estuaries & Coasts*, In Press

Belowground Plant Structure

- Deeper rooting profiles in higher elevation pots



Watson et al., *Estuaries & Coasts*, In Press

Belowground Plant Structure

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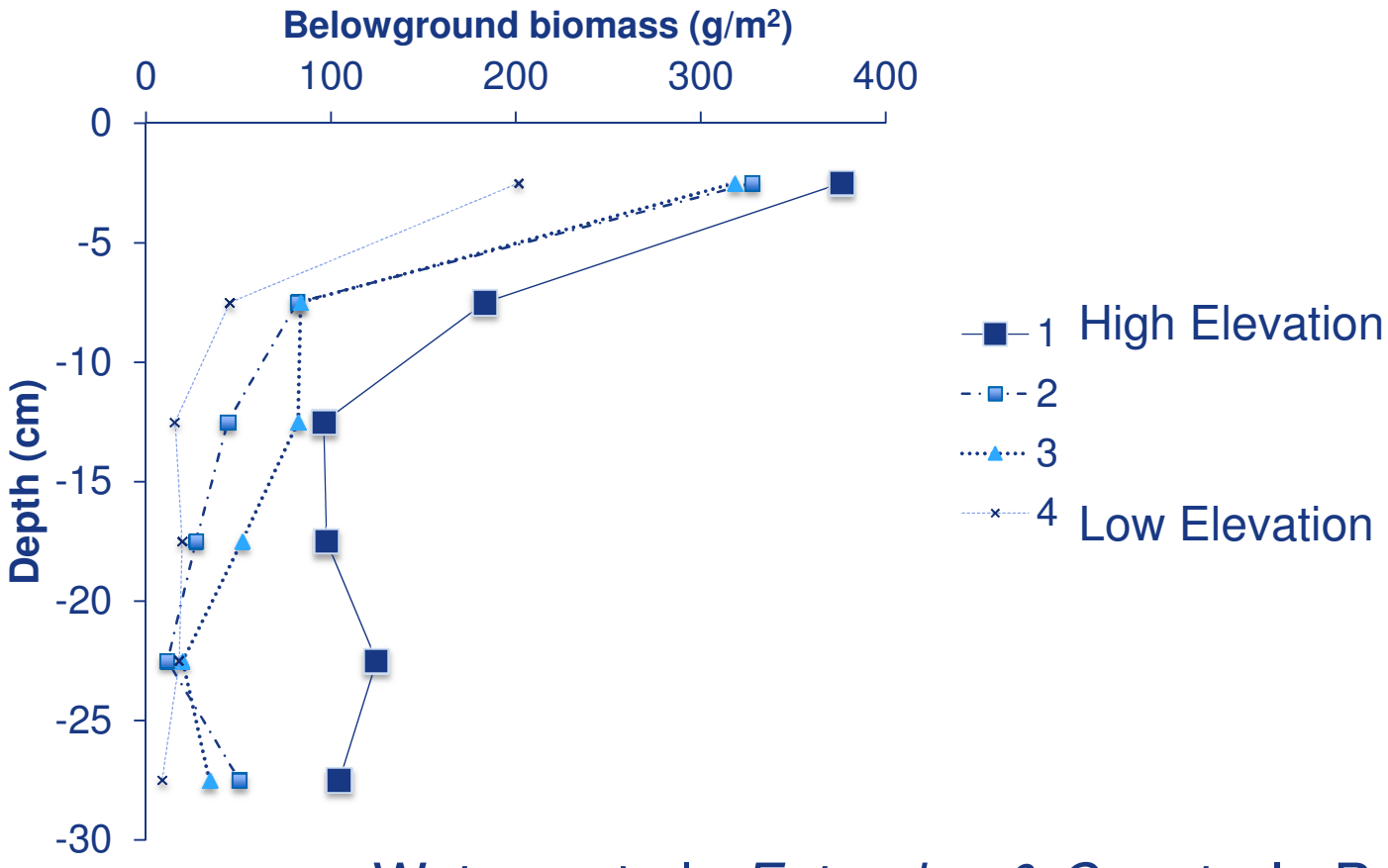
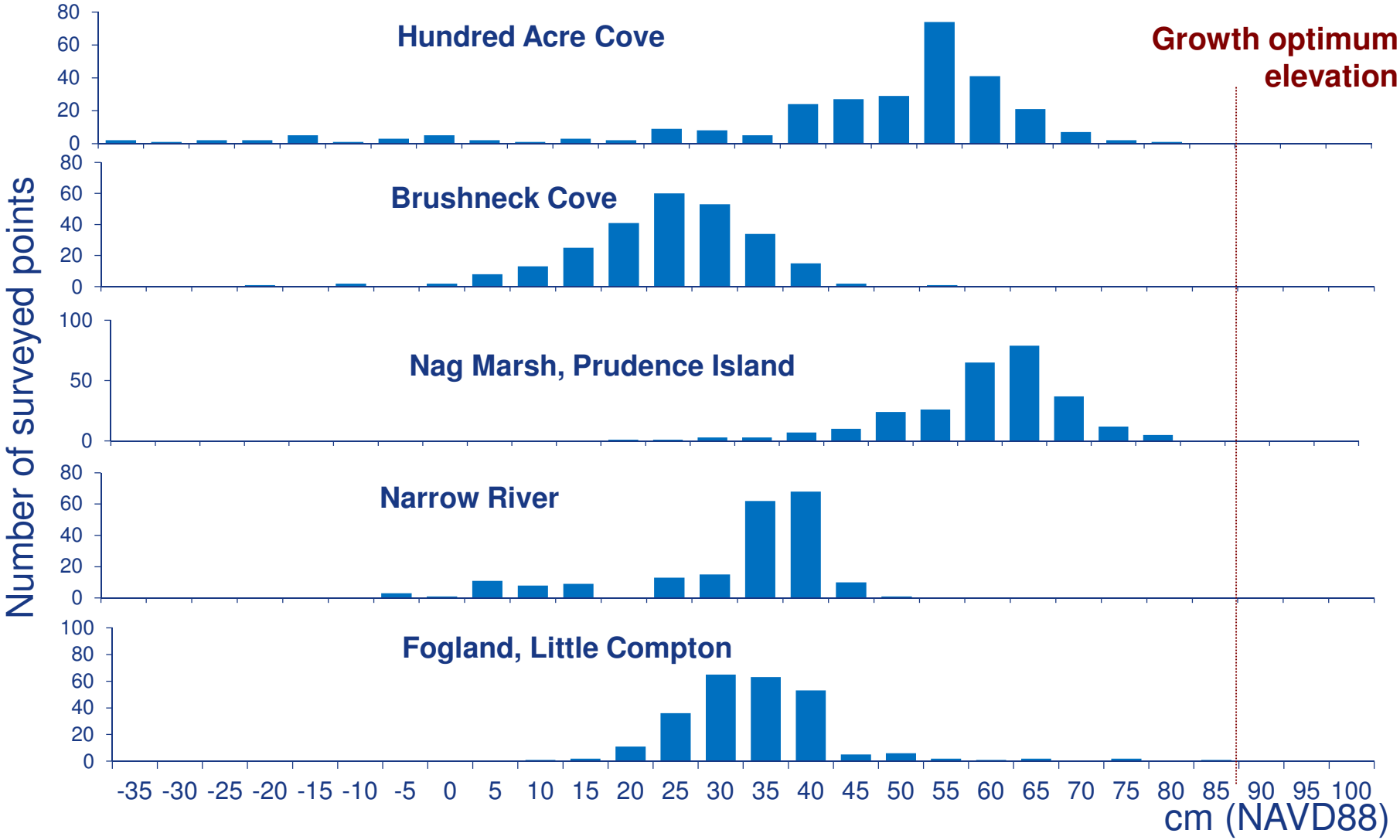
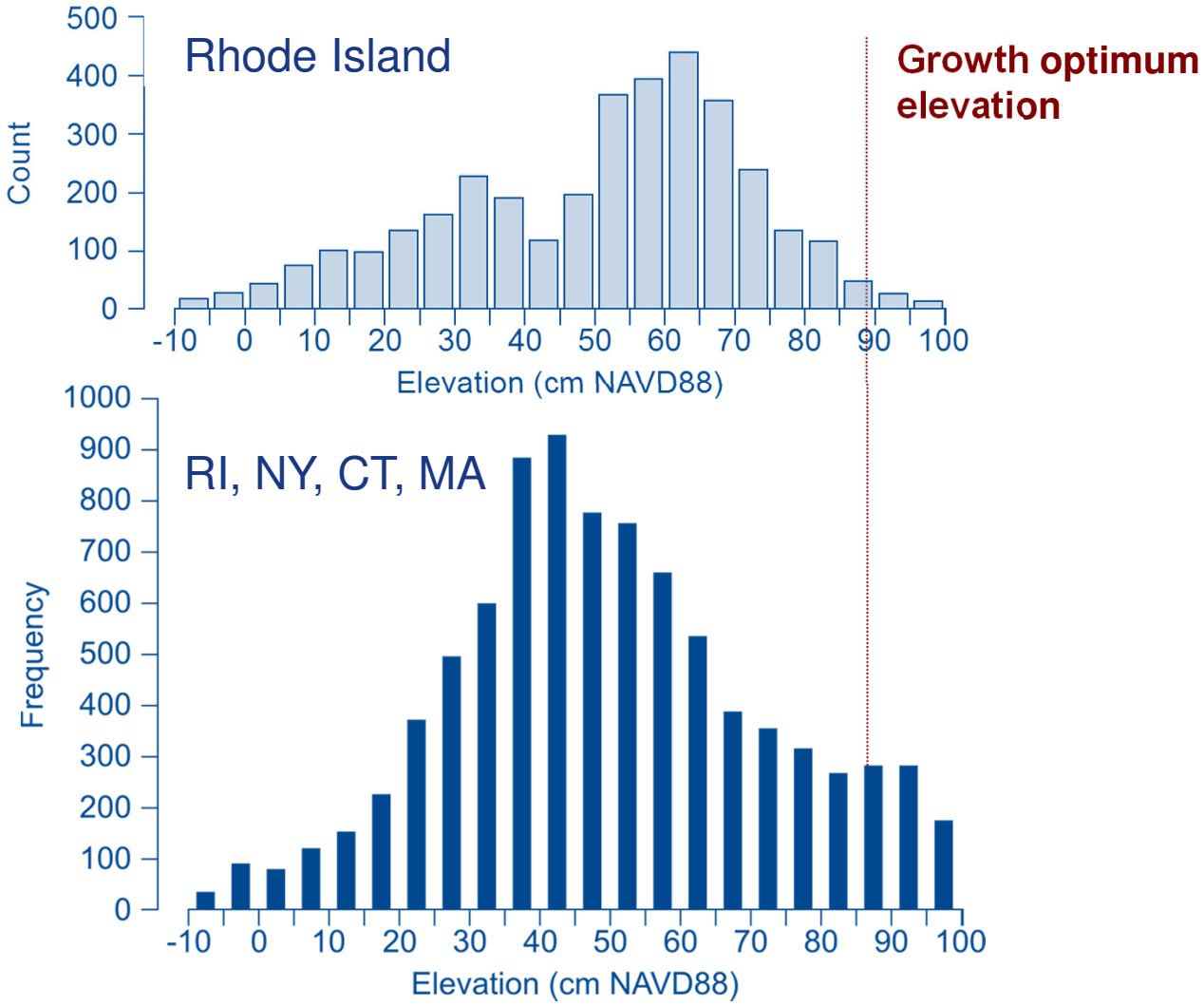


Watson et al., *Estuaries & Coasts*, In Press

Elevation distribution for RI marshes

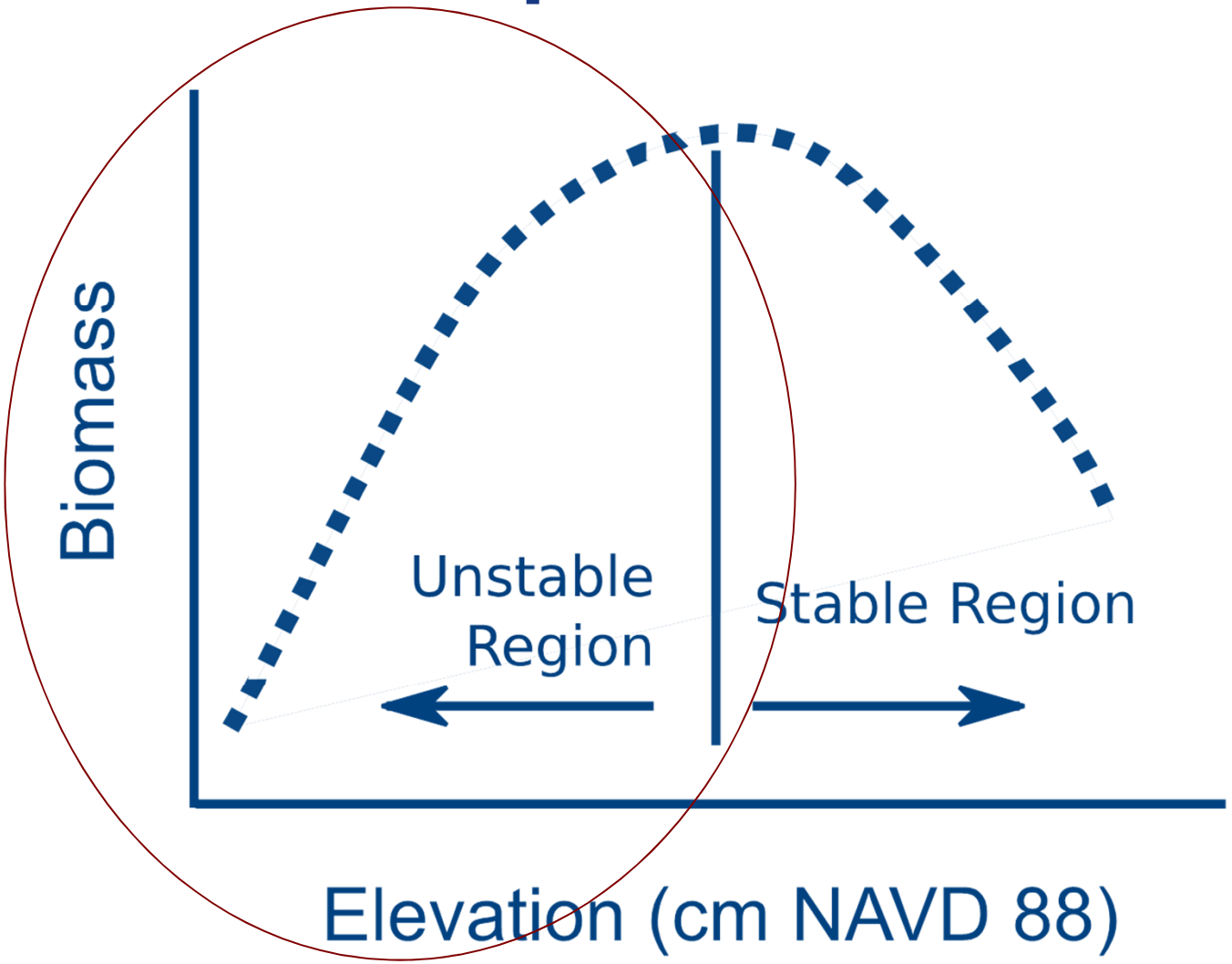


Elevation Distribution for NE marshes

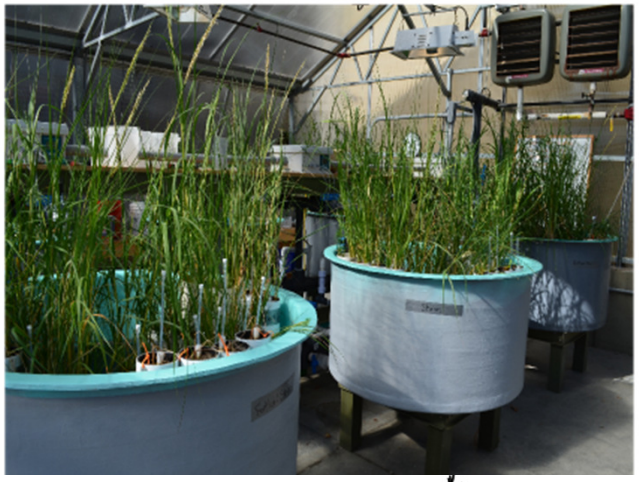


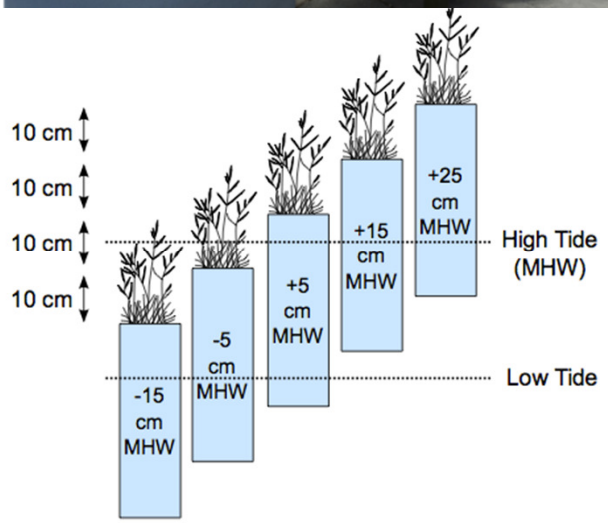
Watson et al. *Climatic Change,* 2014; *Estuaries & Coasts,* In Press

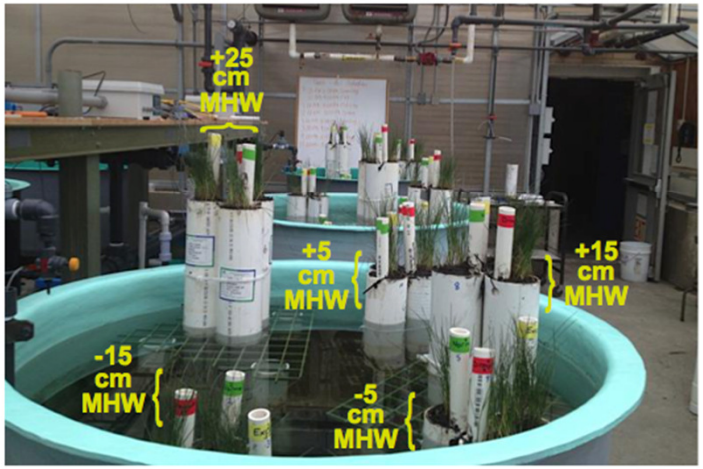
Conceptual Model



Laboratory mesocosms







Conclusions

- Rate of coastal wetland vegetation loss is ~5% per decade
- It appears that increased inundation is contributing to vegetation loss

Responses

- Coastal climate change adaptation techniques
- Identifying when and how to intervene
- Are projects having desired benefits?

Thin layer deposition

Slow marsh erosion

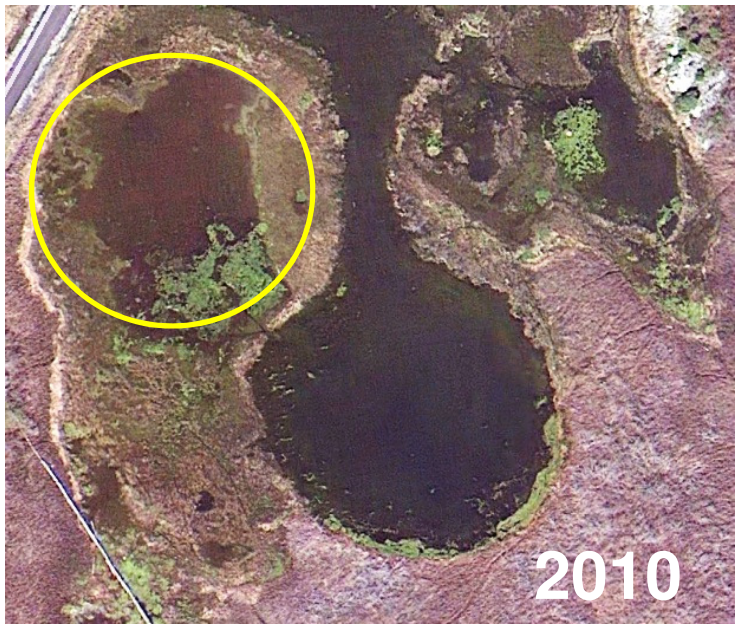
Living shorelines for marsh erosion protection

Hybrid living shorelines

Hydrologic remediation

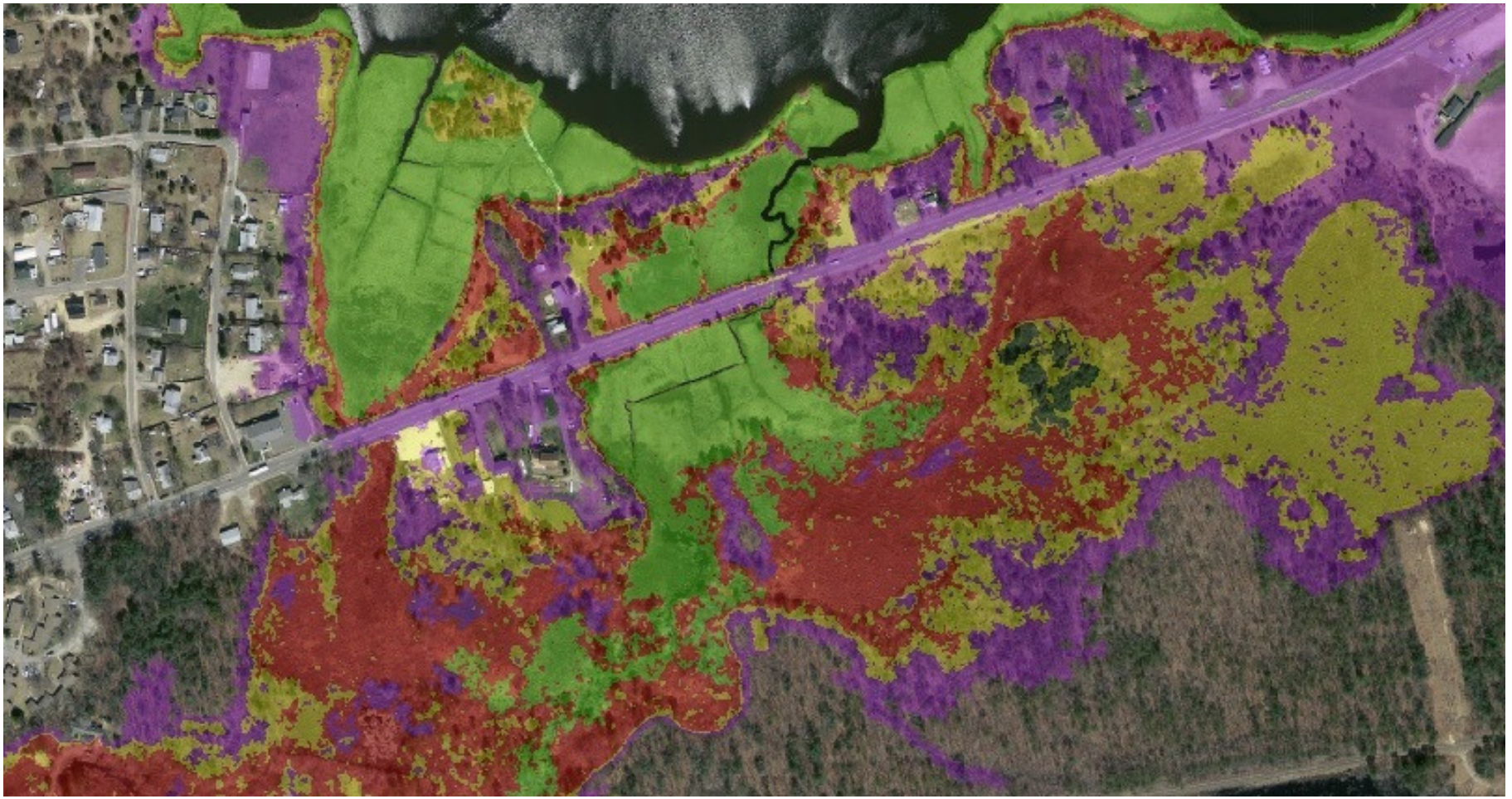
Background | Climate Change | Research | **Climate Change Adaptation**

Hydrologic remediation



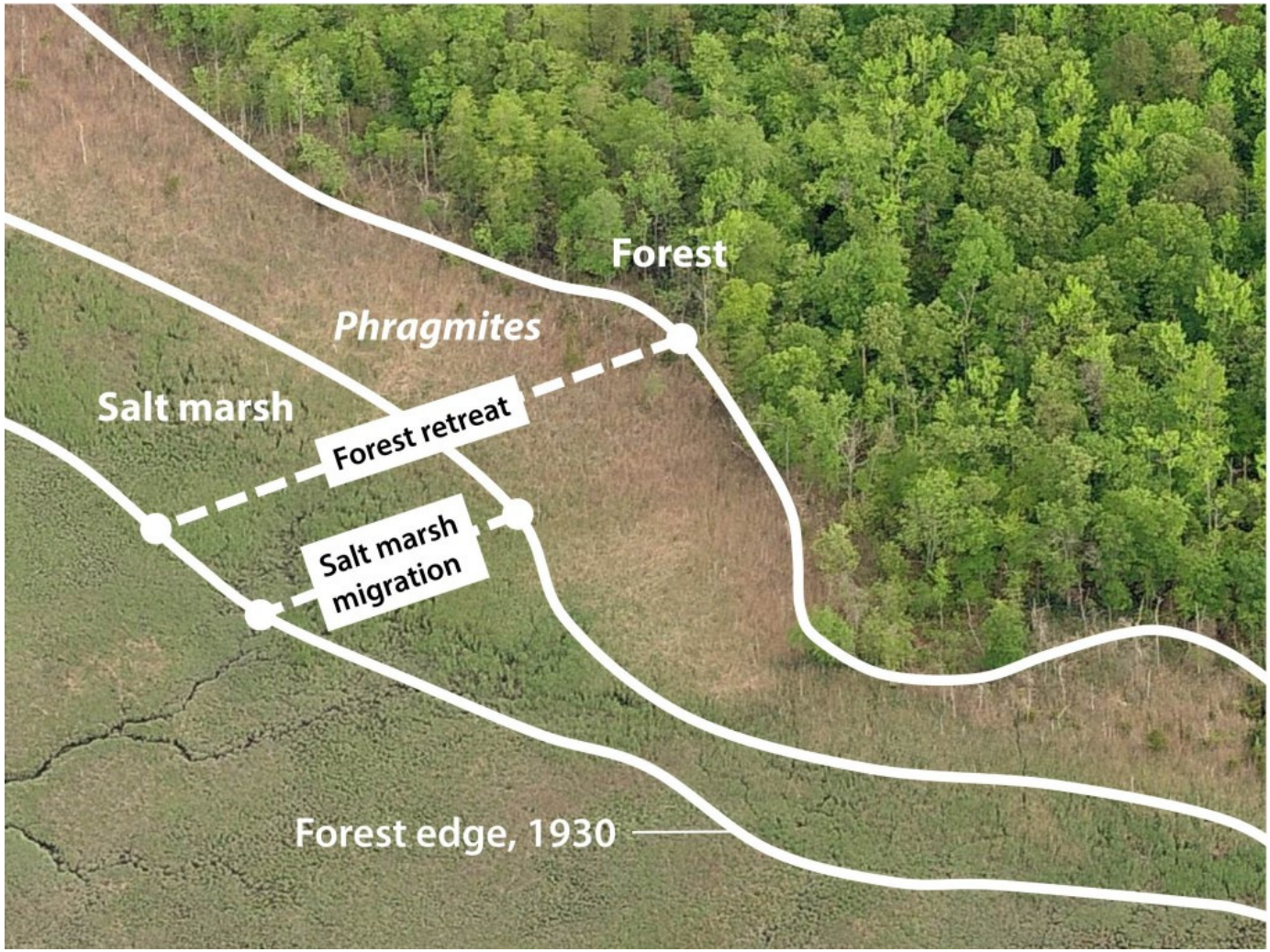
Source: Save The Bay

Marsh migration



Source: Buzzard Bay National Estuary Program

Marsh migration

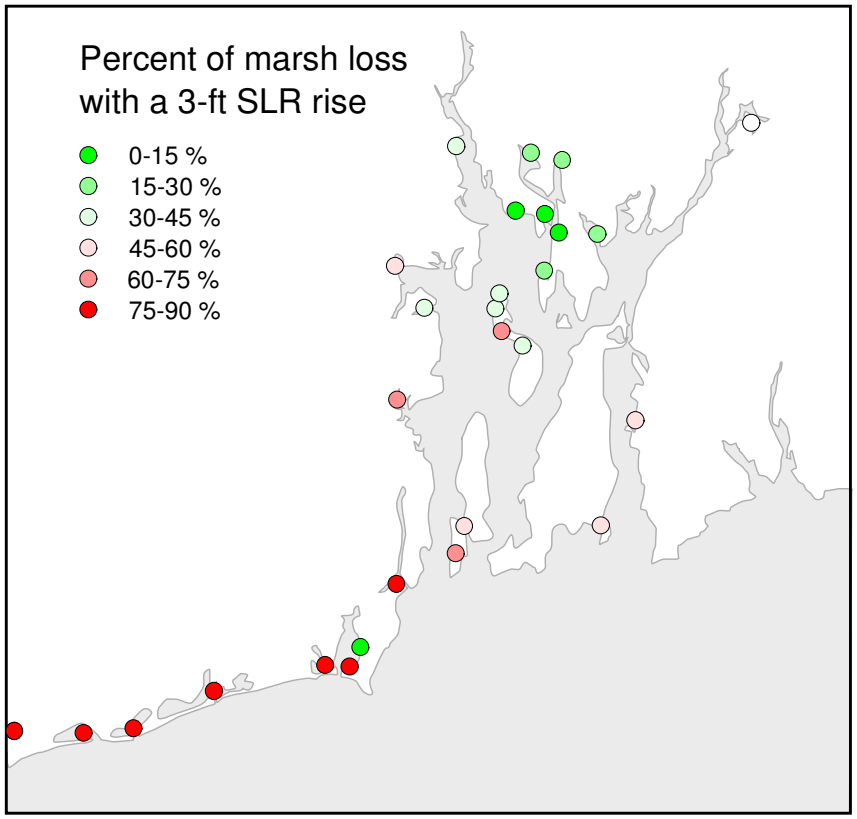


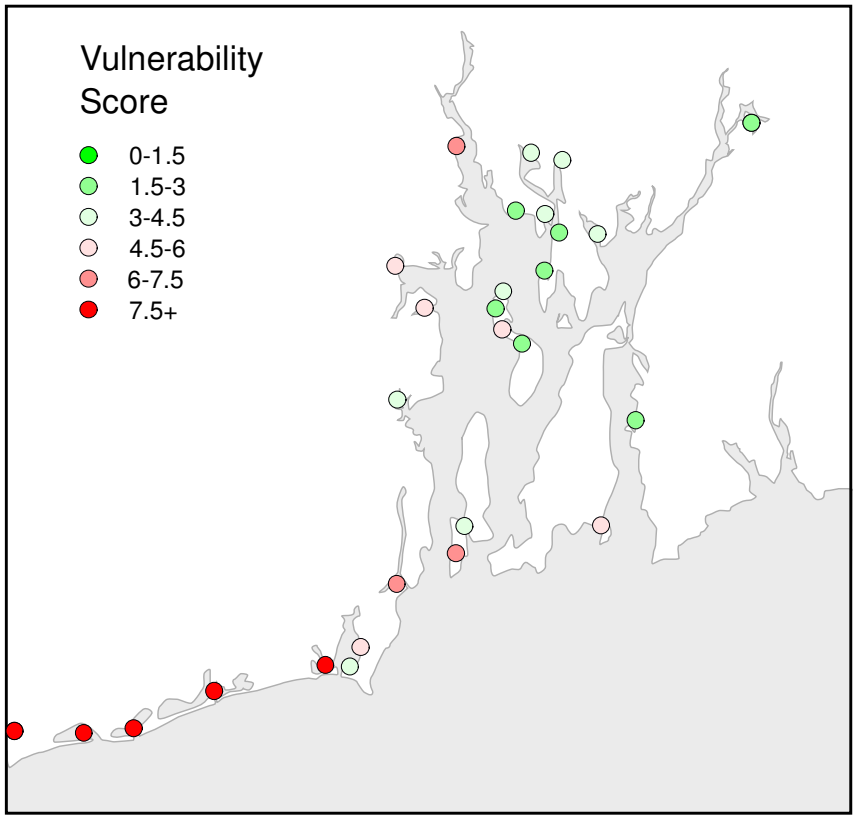
Source: Smith et al., *PlosONE*, 2014

Marsh migration

Pending proposals: NOAA COCA, RI Habitat Restoration Fund

Vulnerability assessments





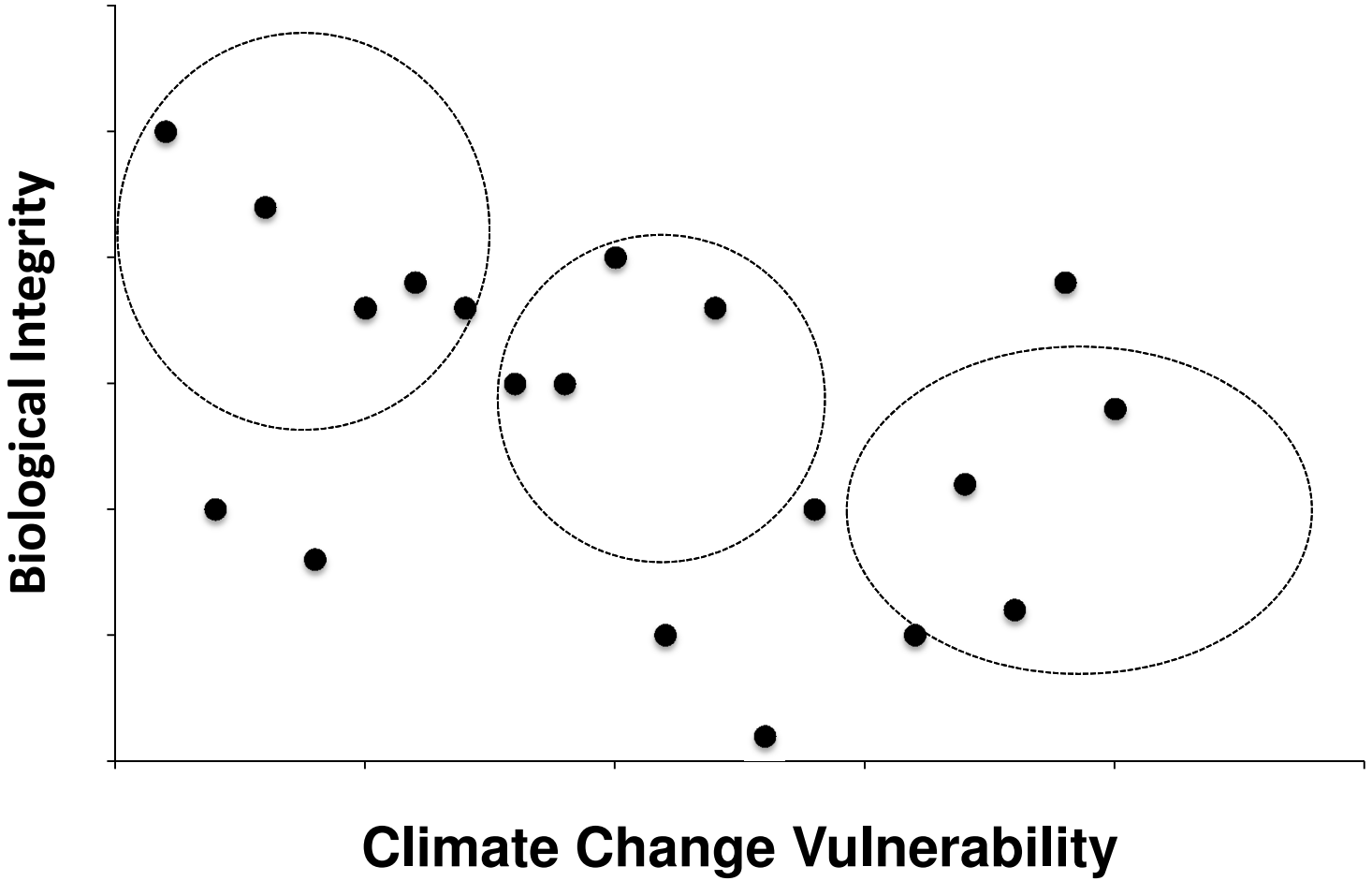
Source: Cole Eckberg et al., In Review

Informatics-based remote sensing monitoring plan

- Image segmentation, use of decision trees to classify image segments / objects
- Extensive data needs for calibration
- But, easy to re-run

Source: NOAA Office for Coastal Management

Ecological Triage



Source: New York City Parks

Summary

Acknowledgements

- US EPA: Cathy Wigand, Autumn Oczkowski, Alana Hanson, Earl Davey, Roxanne Johnson, Saro Jayaman
- USC: Jim Morris, Karen Sundberg
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Questions?
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