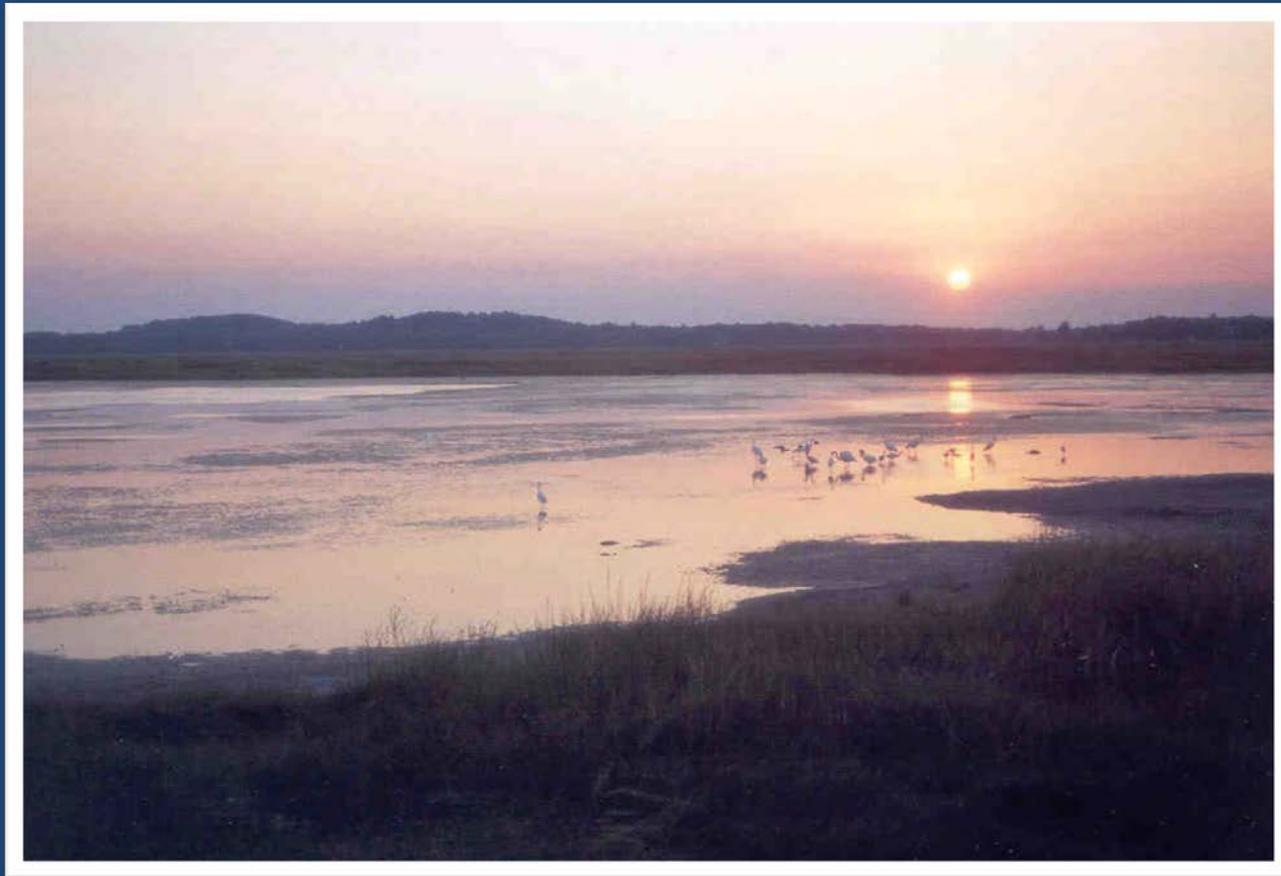
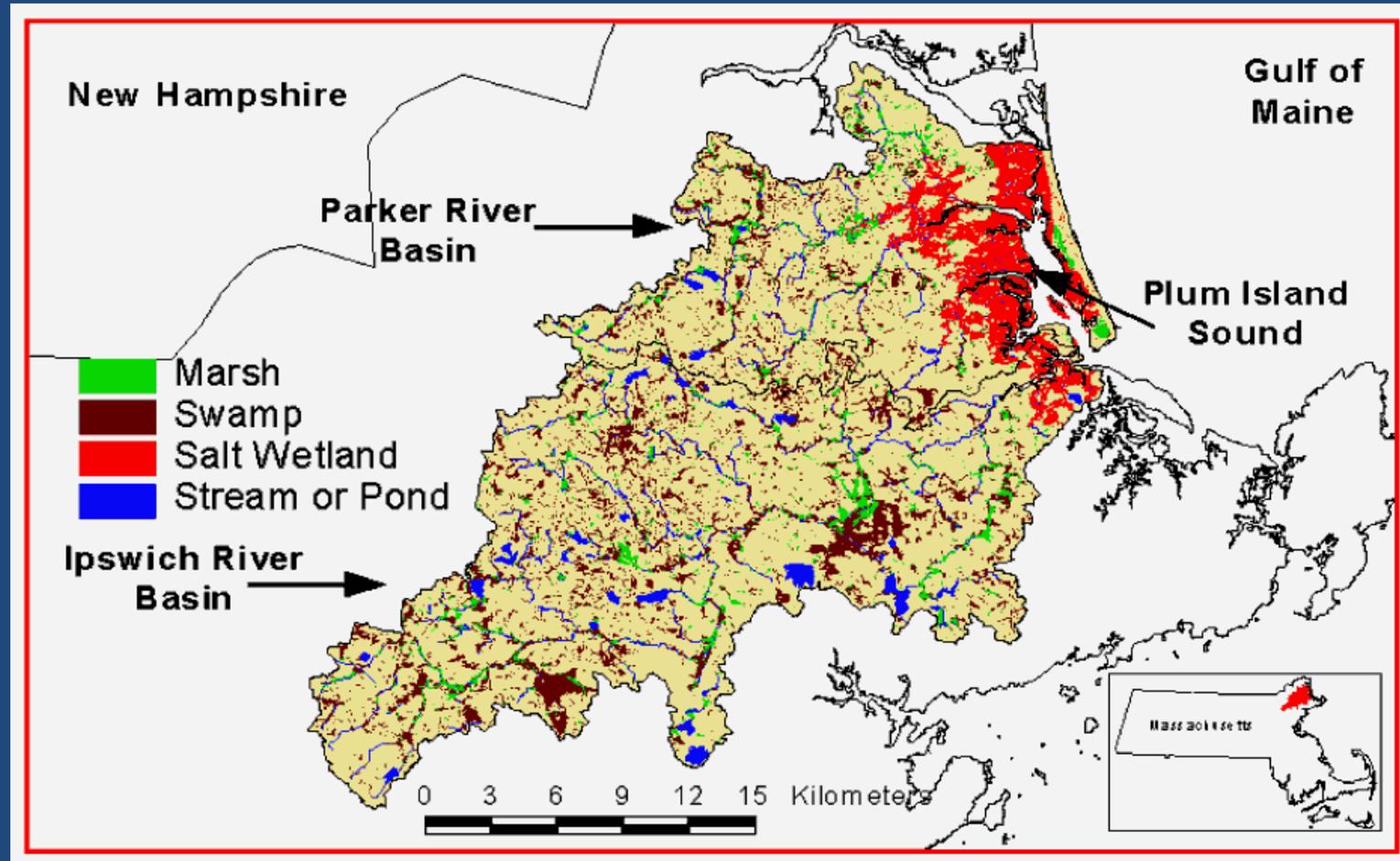


# Climate Change at the Great Marsh: Overview of vulnerable natural communities and species



Robert Buchsbaum  
Mass Audubon

# Plum Island Ecosystems (PIE) LTER Study Area



Coupled watershed (600 km<sup>2</sup>) and estuarine system (60 km<sup>2</sup>)

Watershed – 38% urban + 45% forest

Estuary – macrotidal –high tides (3m), salt marsh dominated



# The Great Marsh

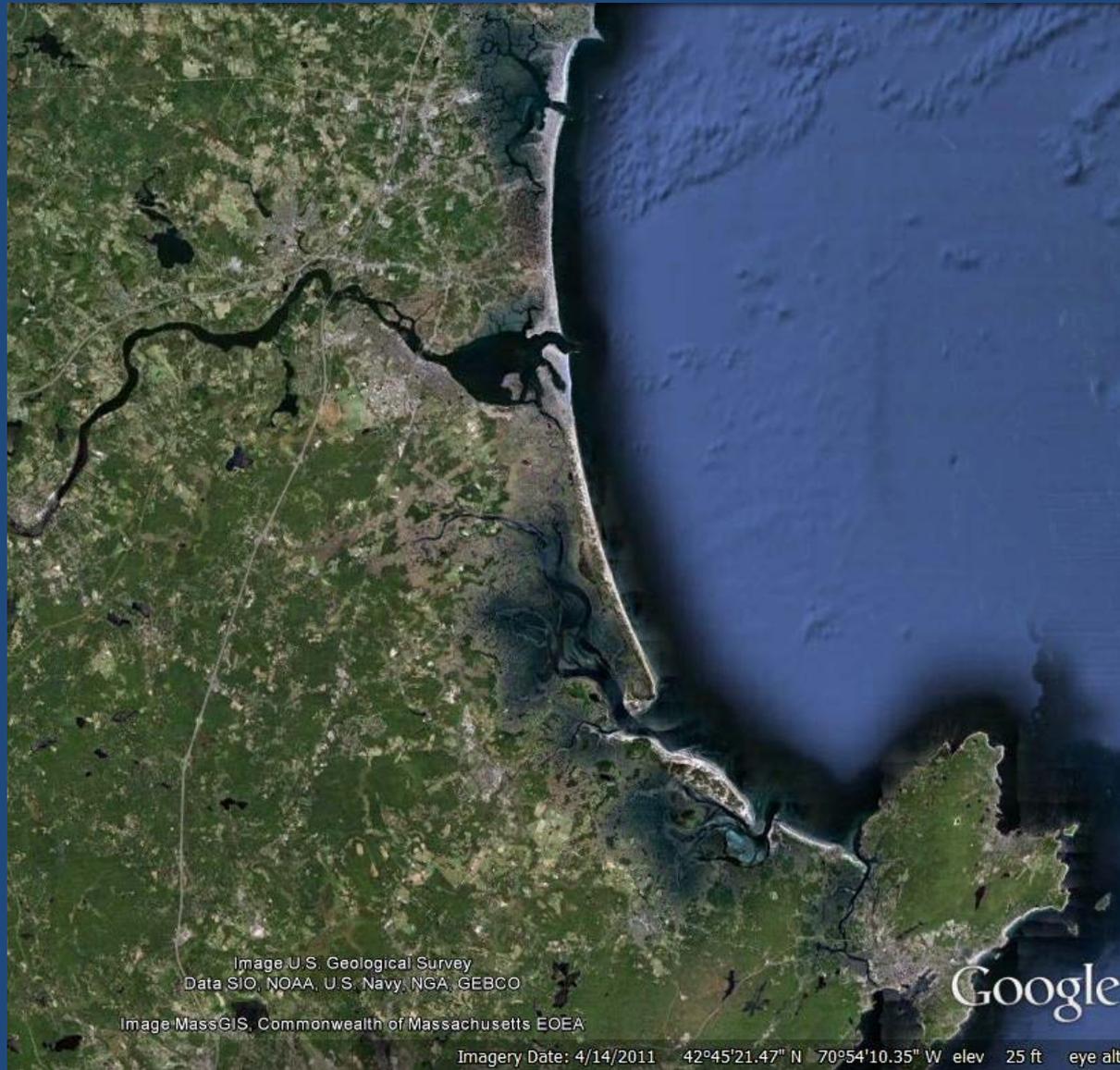


Image U.S. Geological Survey  
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Image MassGIS, Commonwealth of Massachusetts EOEA

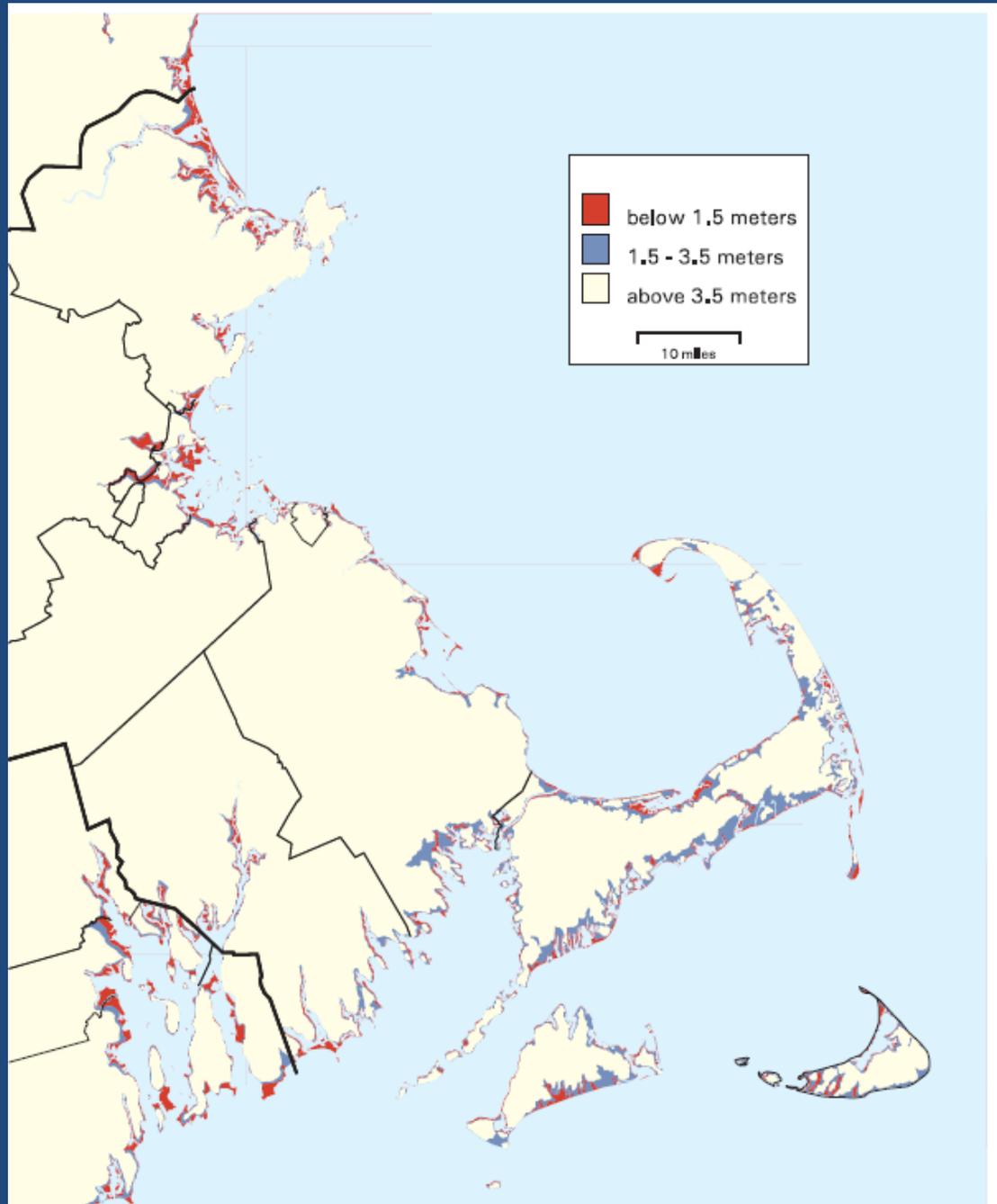
Google

Imagery Date: 4/14/2011 42°45'21.47" N 70°54'10.35" W elev 25 ft eye alt

# Lands vulnerable to sea level rise

From Titus and Richmond  
2000. Climate Research

Based on modeled  
elevations, not actual field  
surveys.



# **Climate Change and the Parker River National Wildlife Refuge:**

## **A Preliminary Assessment of Key Vulnerabilities**



*Working Draft Report*

Prepared By:

Patty Glick, National Wildlife Federation

September 2012

# Conservation value of Great Marsh region

- National Wildlife Refuge (Parker River)
- Long Term Ecological Research site (NSF – MBL+ partners)
- Area of Critical Environmental Concern (State)
- Important Bird Area
- Supports a number of federal and state listed species
- Largest contiguous salt marsh in New England

# Great Marsh Conservation Targets

- Waterfowl – resident and migratory
- Migratory shorebirds
- Saltmarsh Sparrow (indicator of high marsh)
- Beach nesting birds – piping plover
- Other listed species
- Wading birds
- Softshell clams
- Marine fish – esp. striped bass
- Migratory land birds – esp. tree swallows

# PIE LTER research related to climate change vulnerability

- Marsh plant responses to:
  - higher sea levels
  - warmer temperatures
- Tracking marsh elevations and accretion
- Mapping changes in open water v marsh
- Changes in precipitation on freshwater communities
- Responses of fauna and flora:
  - marsh birds
  - fish
  - clams
  - long term changes in vegetation community

# Effects on salt marshes



Can marshes keep up with sea level rise?

Can marshes migrate into the upland buffer?

Are wetter marshes in our future?

Impacts on marsh nesting birds?



# Erosion of marsh platform at PIE



# Marshes “cannabilizing” itself



Sediment eroded from creek banks gets redeposited back on the marsh surface

## Lateral erosion has occurred in lower estuary



## What about the larger spatial picture of the marsh?

We see clear evidence for change – in some areas ponds are changing rapidly but in other areas of the marsh ponds are rarer and the marsh seems more stable.

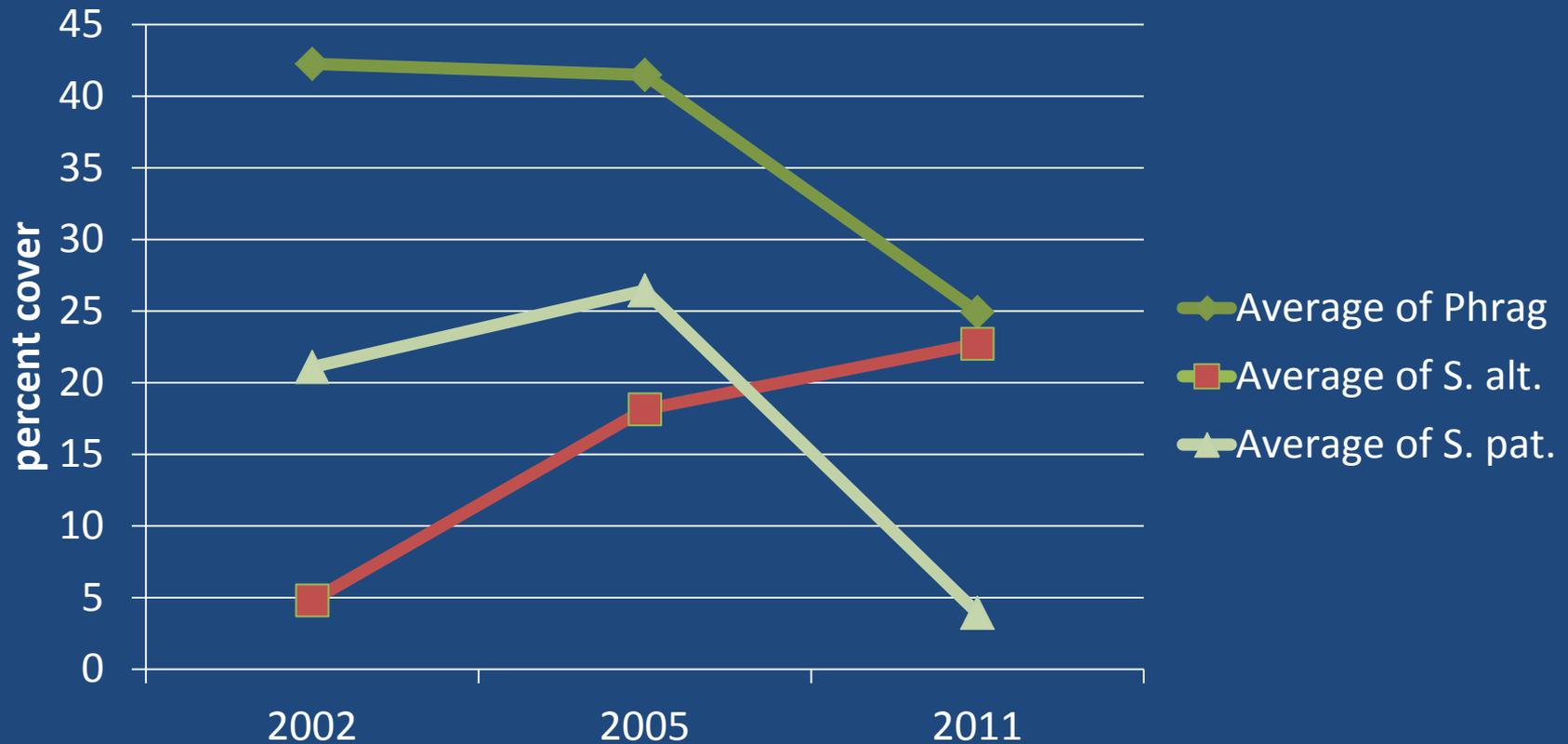


West Creek



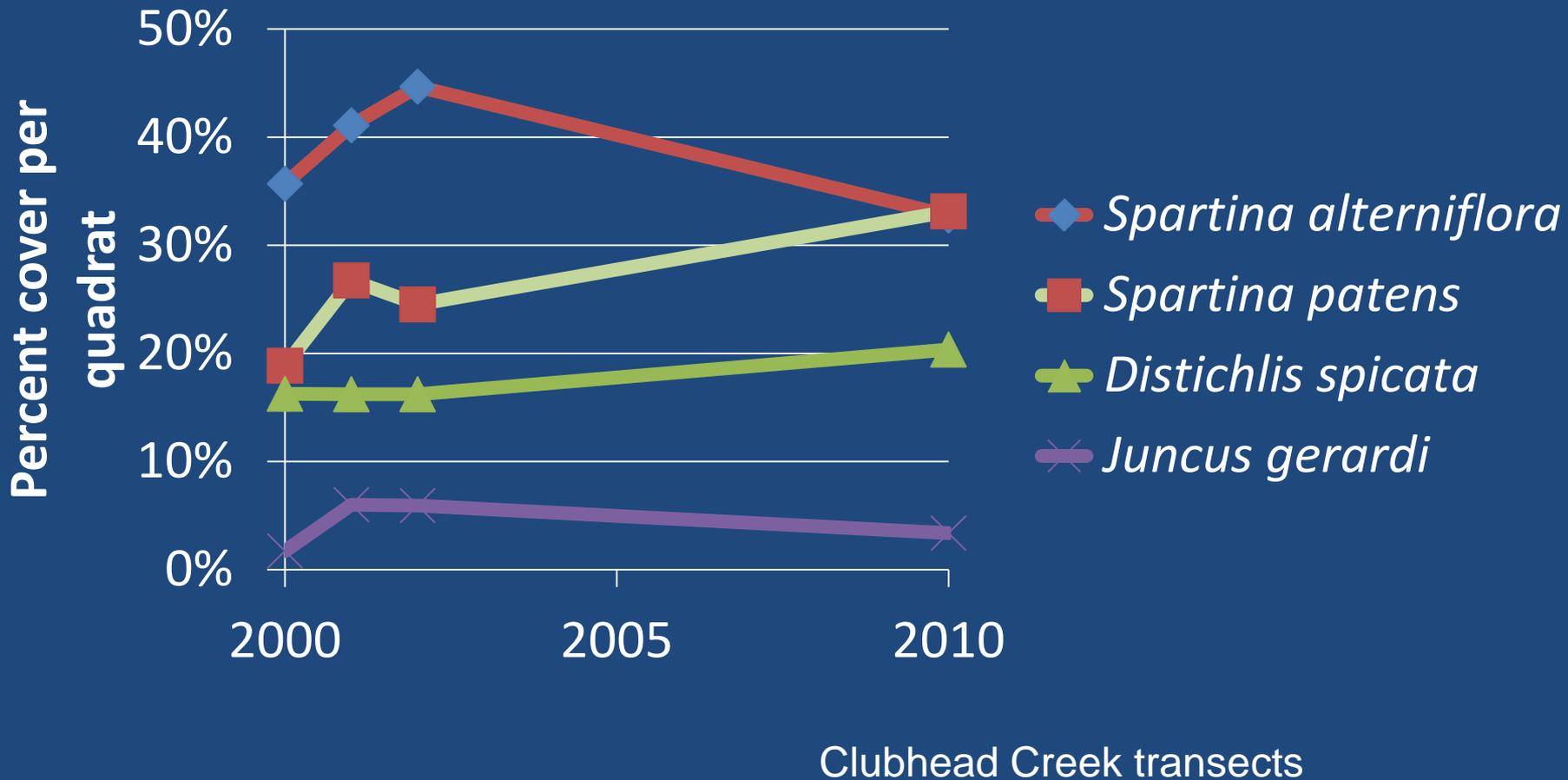
Nelson Island Creek

# Heterogeneity of responses in our long term vegetation plots

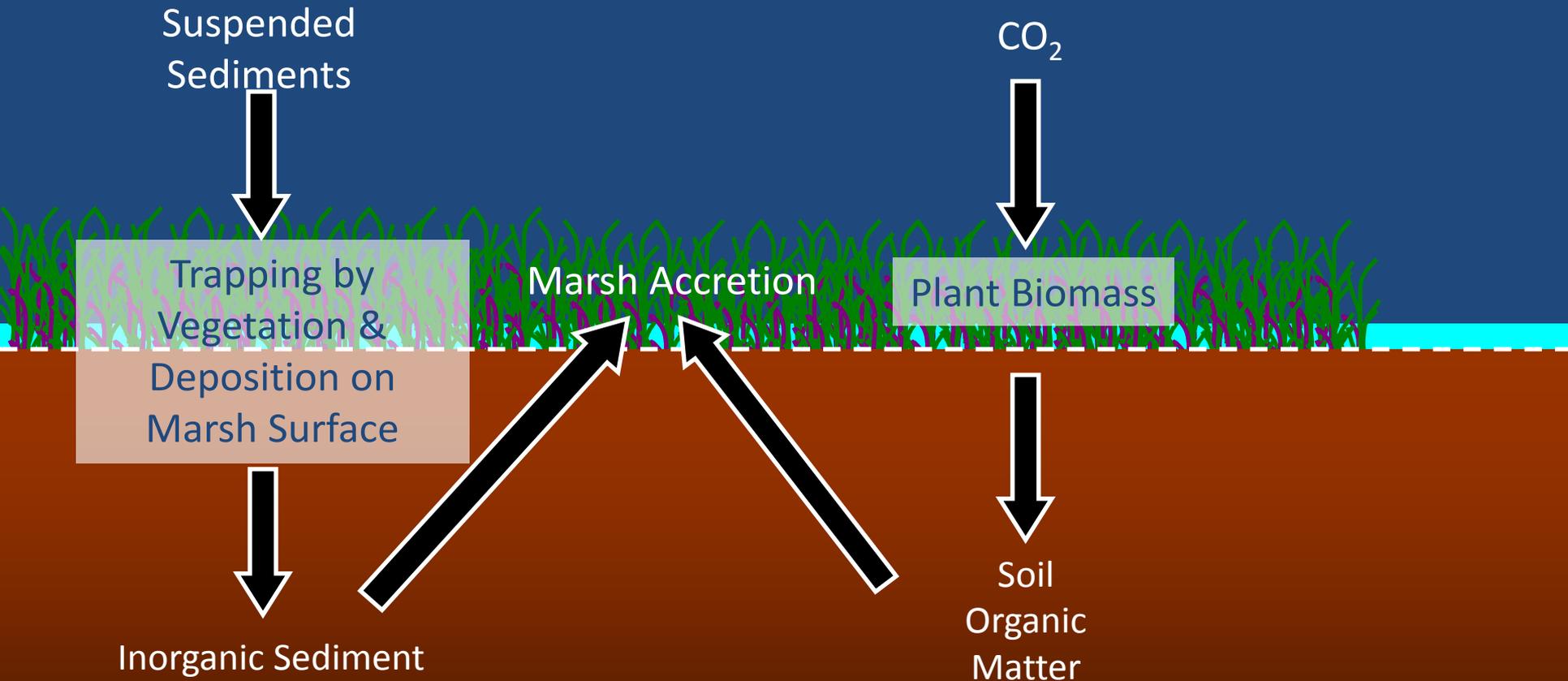


Railroad Ave Marsh – decline in high marsh species

# A marsh where high marsh species are still doing fine

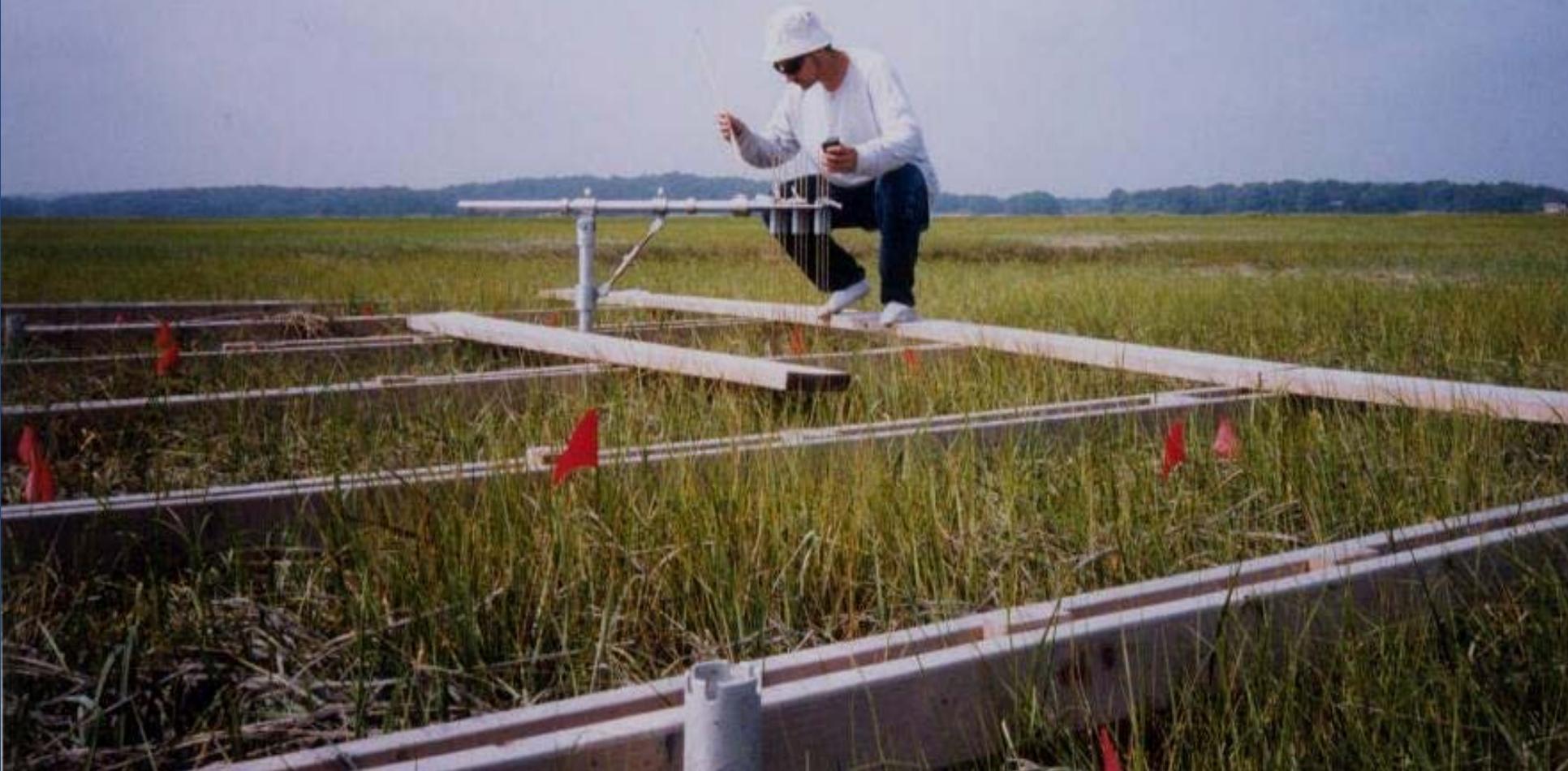


# Marshes keep up with SLR by building up belowground organic matter and by trapping sediments



Thanks to Nat Weston, Villanova Univ.

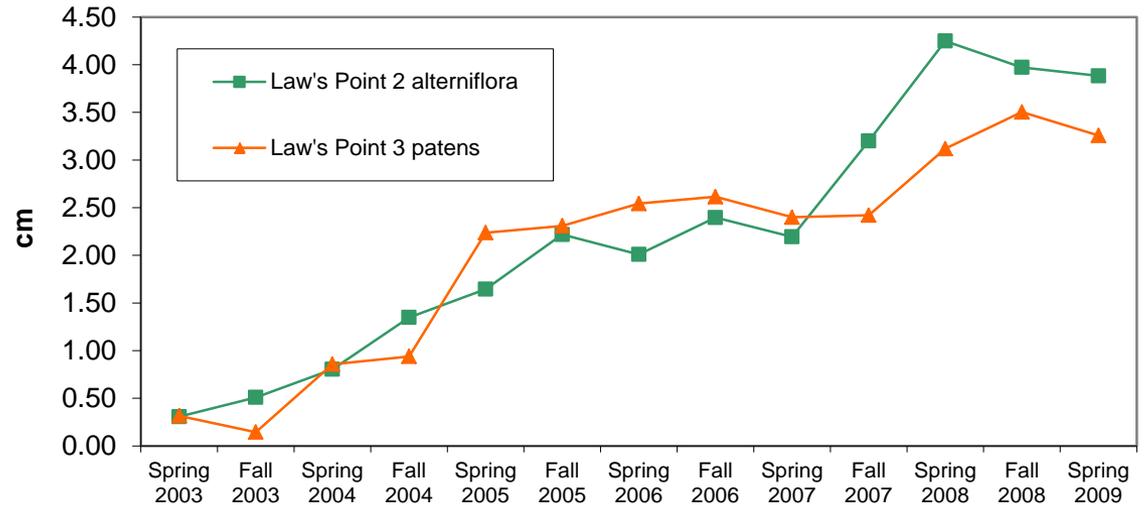
**“Sediment Elevation Tables” or SETs measure rates of sediment accumulation and to see if marshes can keep up with sea level rise.**



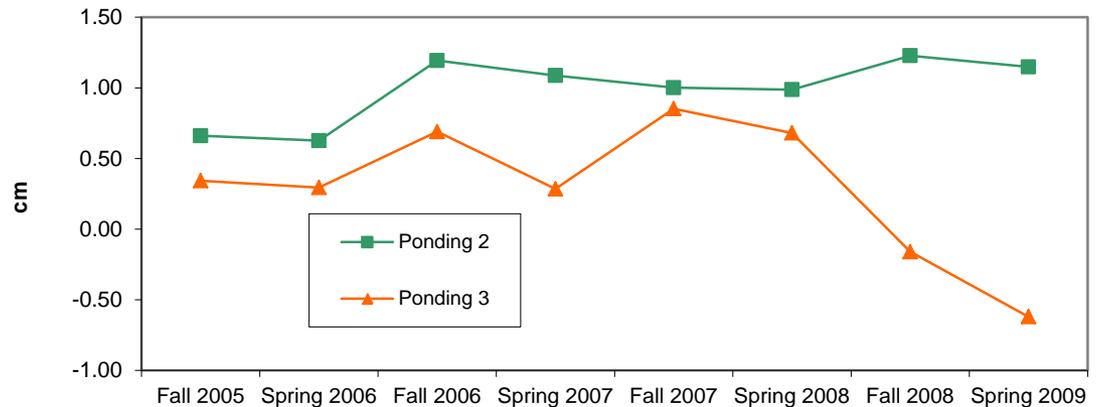
# Is the marsh keeping up with current rates of sea level rise?

Using the SETs the answer is yes in the top graph and no in the bottom

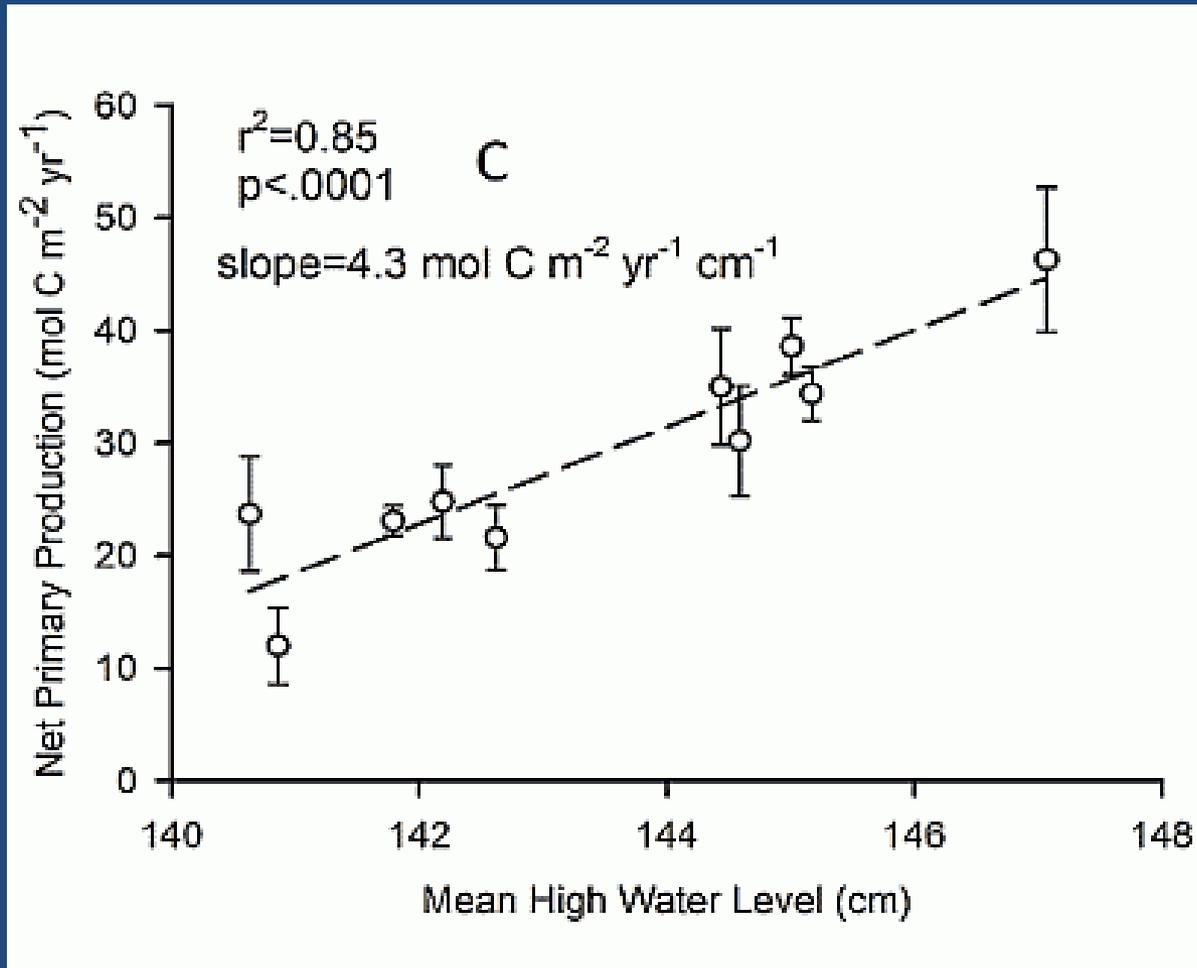
Law's SET Cumulative change averages



Levine's Ponding RSET Cumulative change averages



# Feedback mechanism



Marsh plants respond to increased sea level by growing more

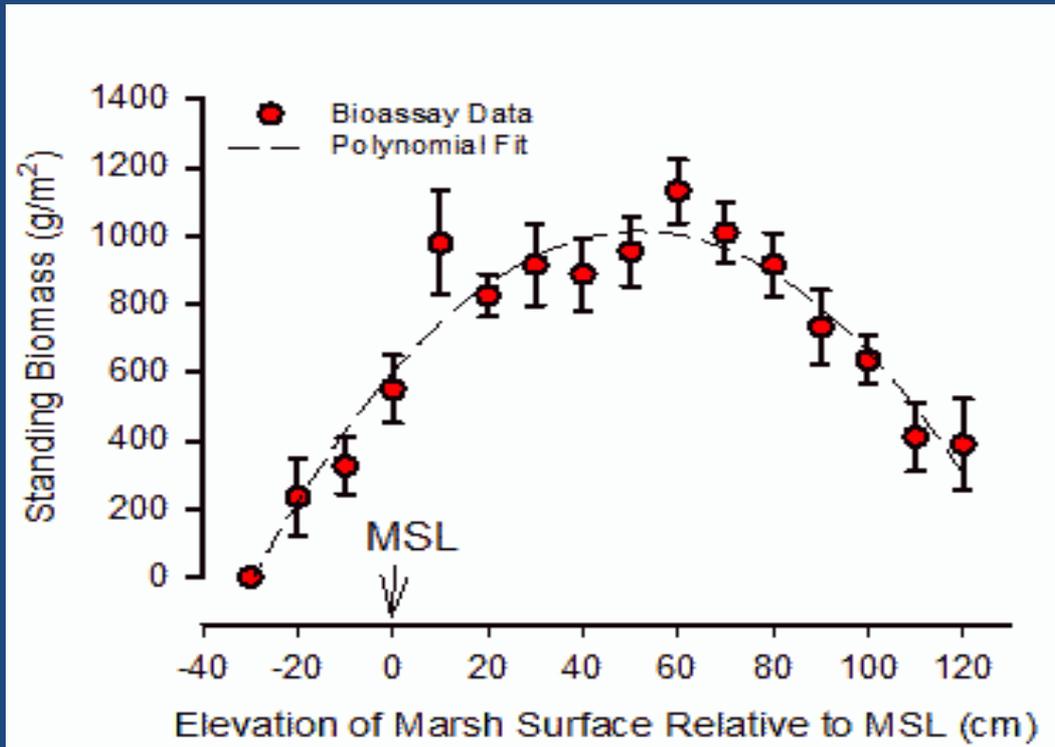


Data from Jim Morris, Univ. S.Car.

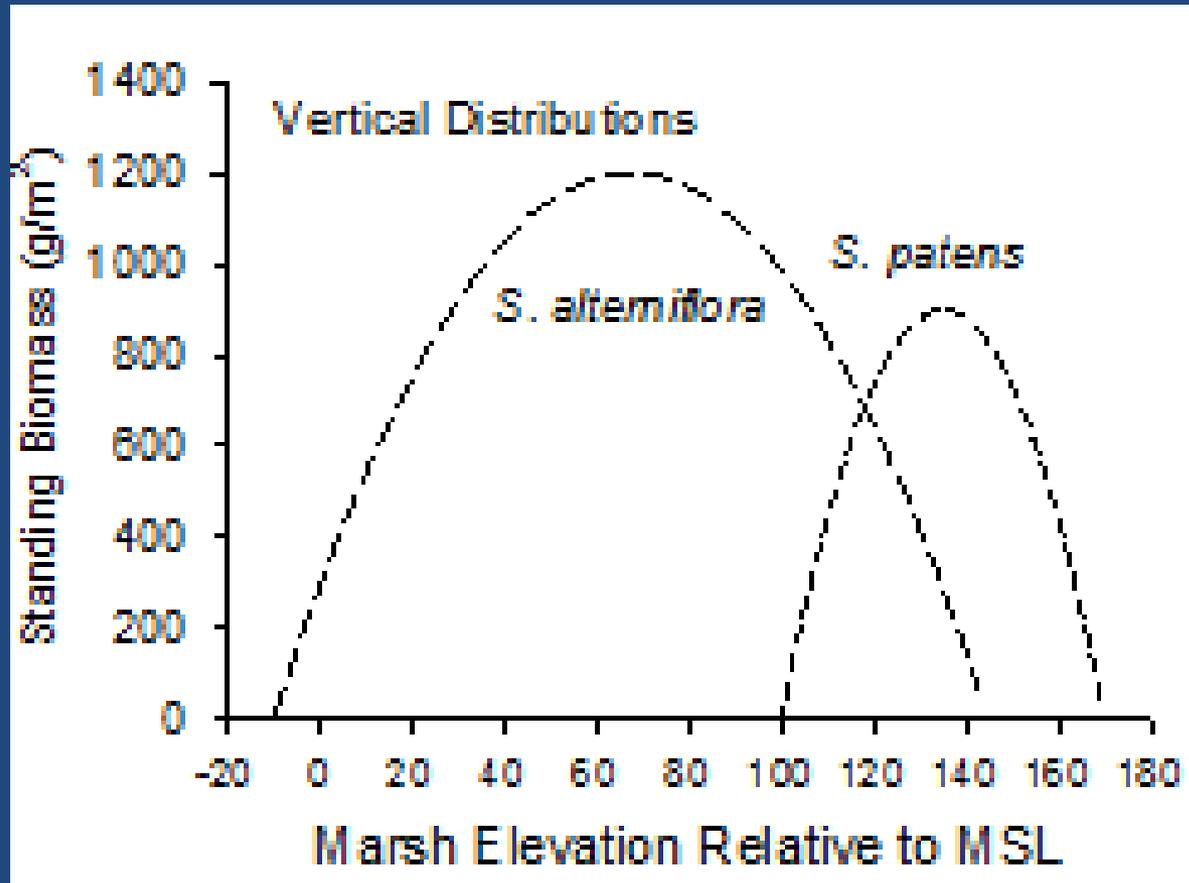
# Marsh Organ Experiments



# Marsh elevation experiment

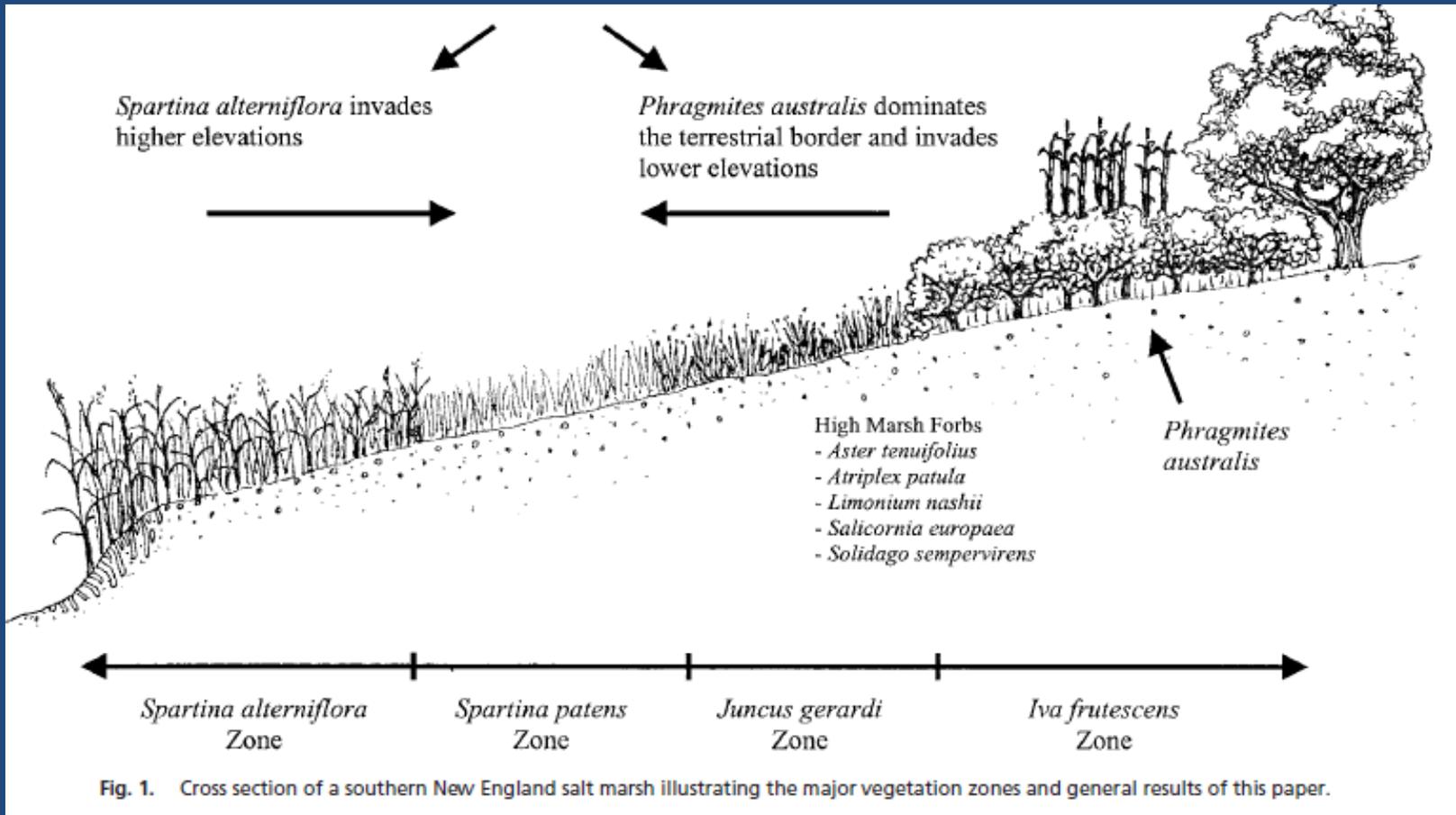


# Relationship of Sea Level and Marsh Production



Thanks to Jim Morris

# High marsh habitats are most vulnerable



From Bertness et al 2002  
PNAS

# High Marsh dominated by salt marsh hay (*Spartina patens*)



# Salt Marsh Sparrows: Vulnerable to rising sea levels

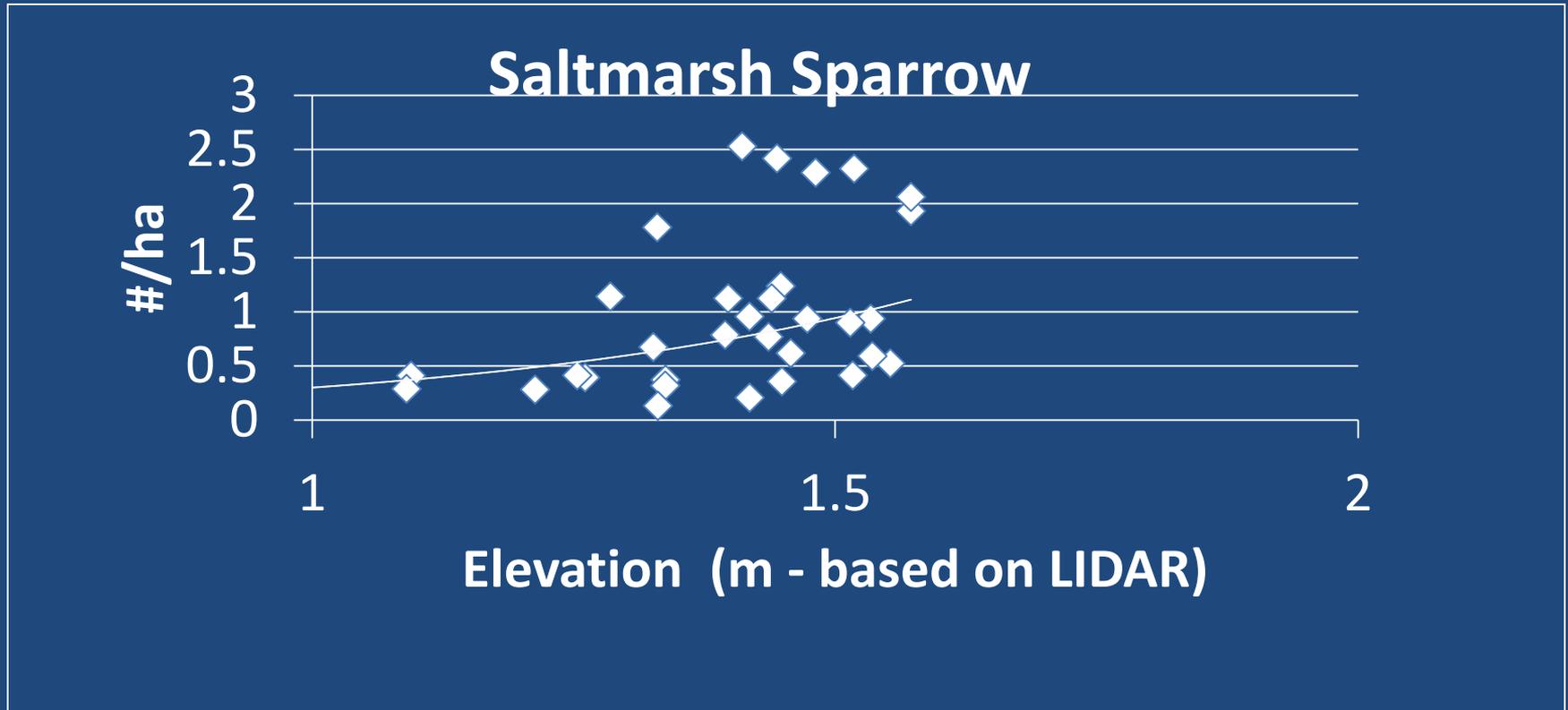


Seaside Sparrow



Saltmarsh Sparrow

# Saltmarsh sparrows nest within a narrow elevation range



Nest failures due to flooding are common  
- e.g., Long Island Sound marshes (Elphick, pers. comm.)

What does future wetter marsh mean to waders and shorebirds?





Kettle Island Heronry



Low tide feeding in a salt panne by a Snowy Egret, a “SWAP” species in MA

# High tide on the marsh surface



# Tidal flats and marsh on Rowley River



© 2010 Google

© 2010 Google

Imagery Date: Jun 19, 2010

42°43'55.15" N 70°49'53.74" W elev 0 ft

Eye alt 2956 ft

# Long Distance Migrants from High Latitudes



Photo by D. Gordon E. Robinson



Photo from Wikipedia

# Wintering Waterfowl

Many high arctic nesters



# Future changes in marsh geomorphology: Striped bass v wading and shorebirds?

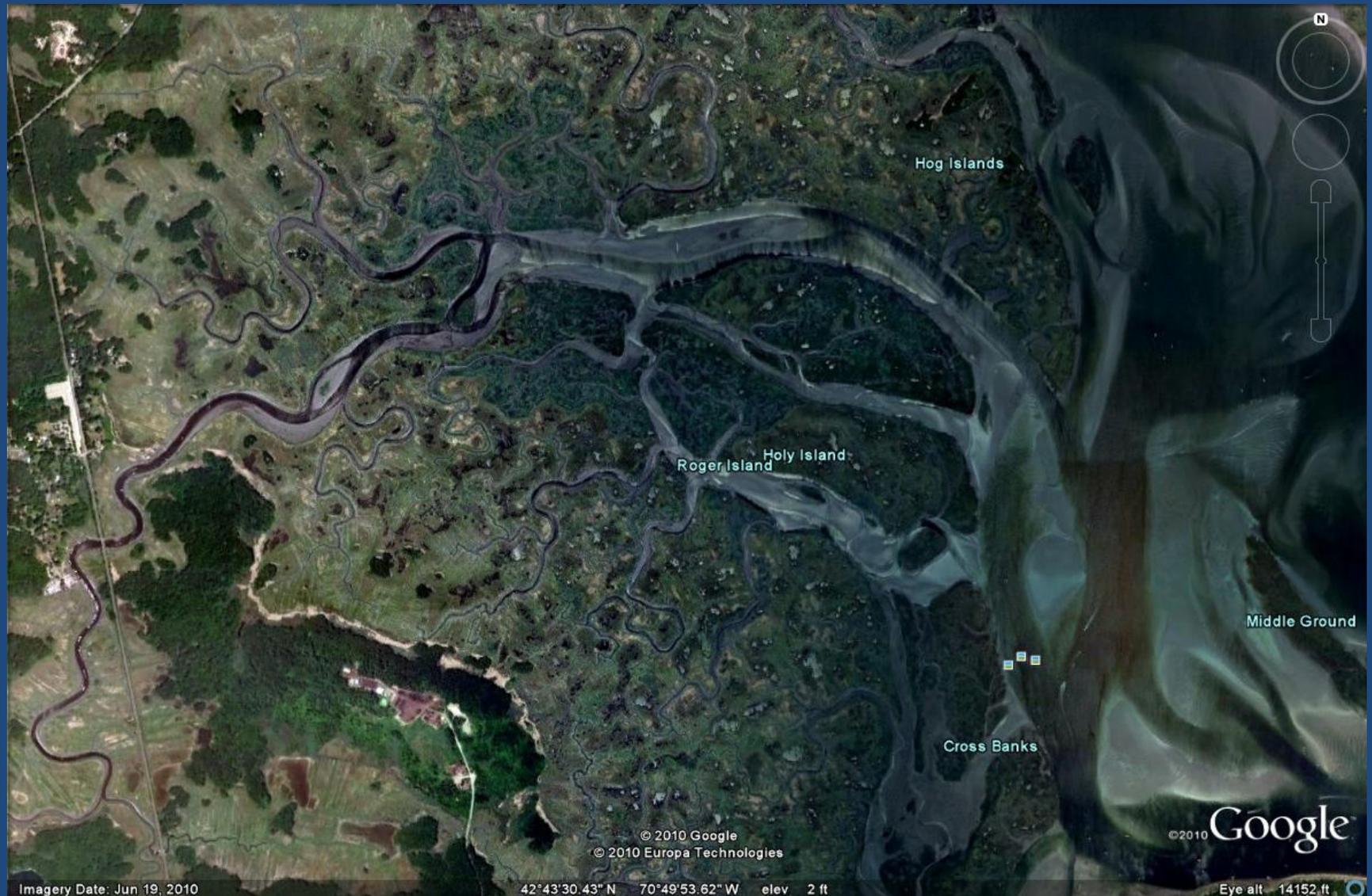


Deep holes in tidal rivers and  
the Sound



Shallow creeks, pannes, marsh surface

# Tidal flat expansion as marsh erodes?



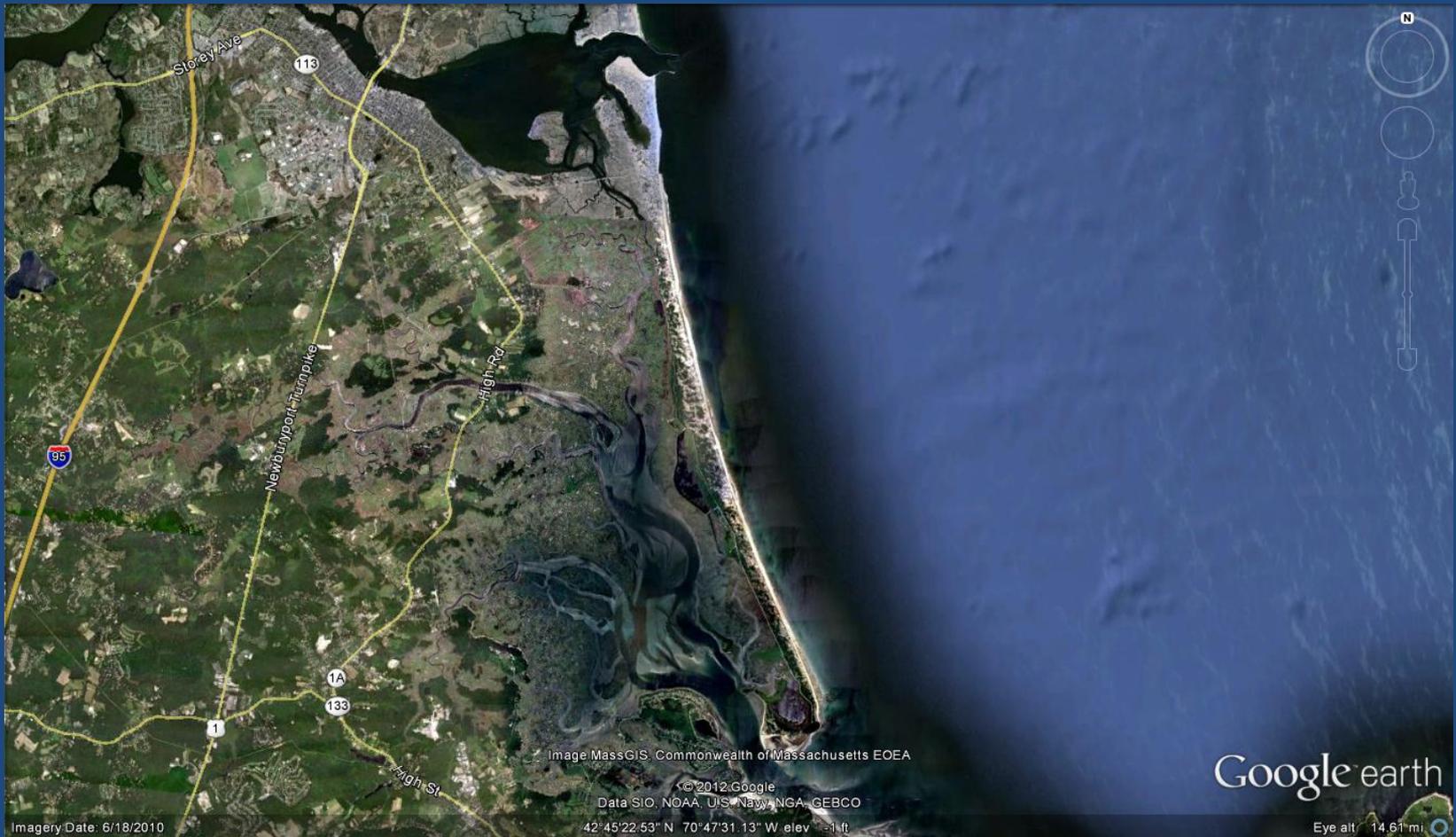
# Effects on open water habitats:

## An example from Narragansett Bay

- Traditional winter-early spring phytoplankton bloom is reduced or no longer occurs
- Zooplankton are grazing on the phytoplankton earlier in the year
- Decline of benthic (bottom-dwelling) organisms
- Earlier invasion of ctenophores which feed on fish larvae



# Barrier Beach



Barrier beach integrity affects its own natural community as well as protecting the salt marsh

# Piping Plover



Photo by Jim Fenton

# Least Tern



# Storm impacts on Plum Island barrier beach



WBUR photo

Boston Globe photo



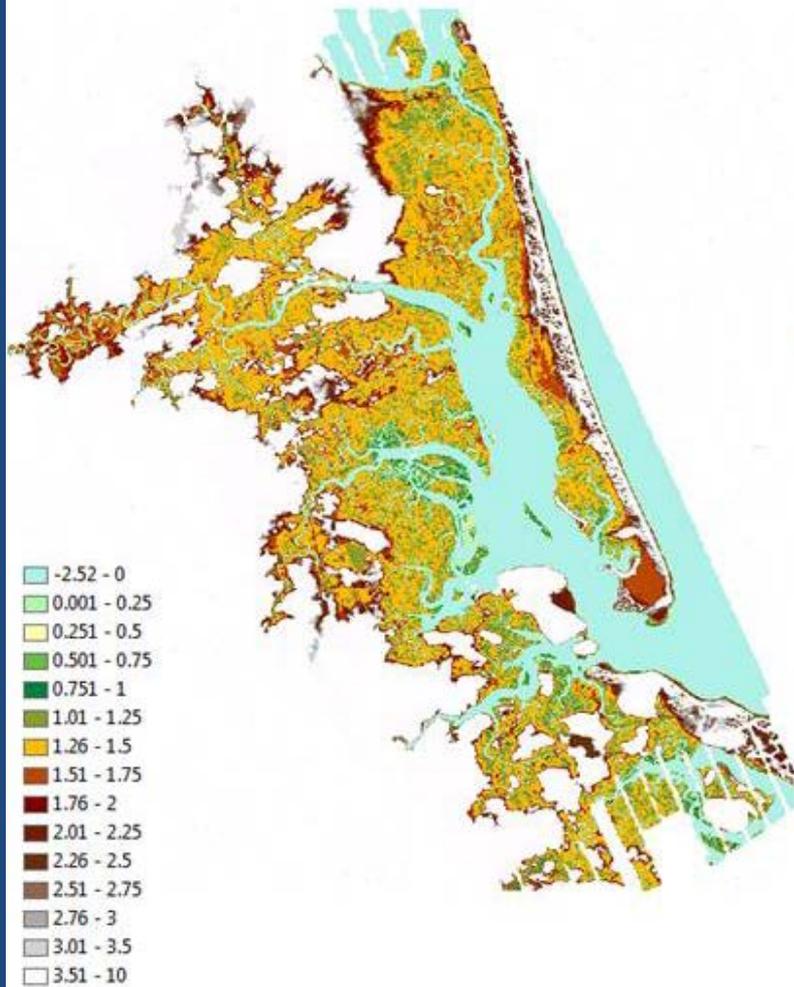


# Some thoughts on adaptation options at the Great Marsh

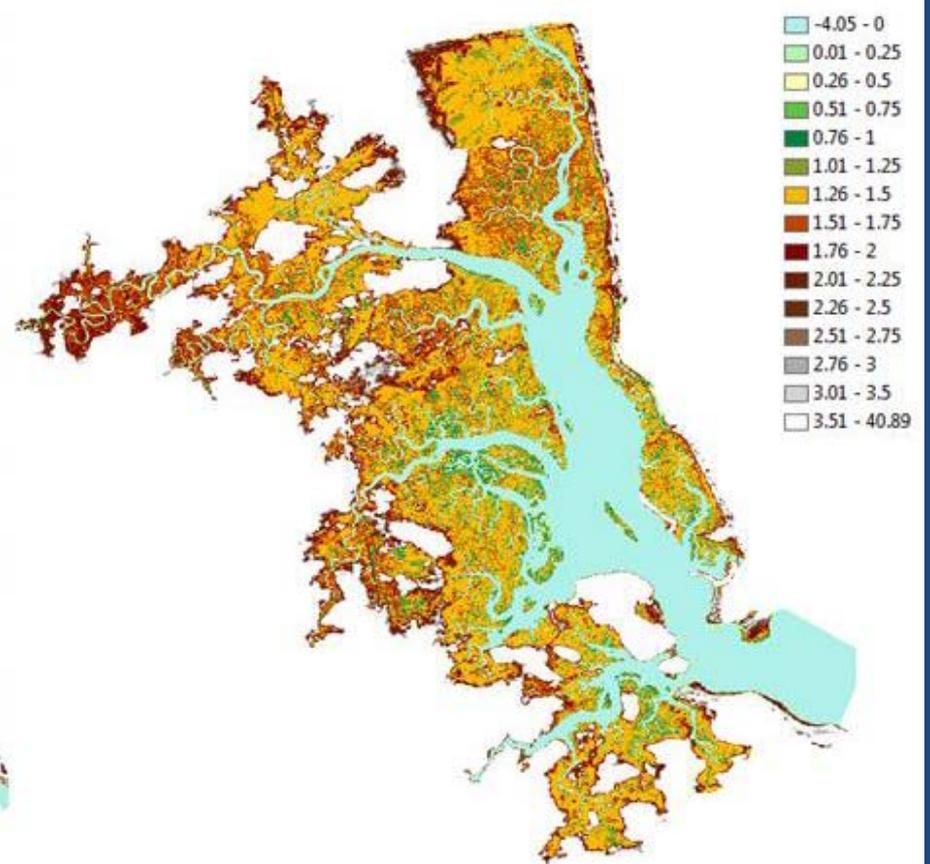
- Land acquisition
- Enhancing hydrological connections
  - Enlarging culverts
  - Removing Dams
- Water management on marsh
  - Ditches and Ditch plugging
- Invasive species control
- Marsh haying to maintain high marsh plants?



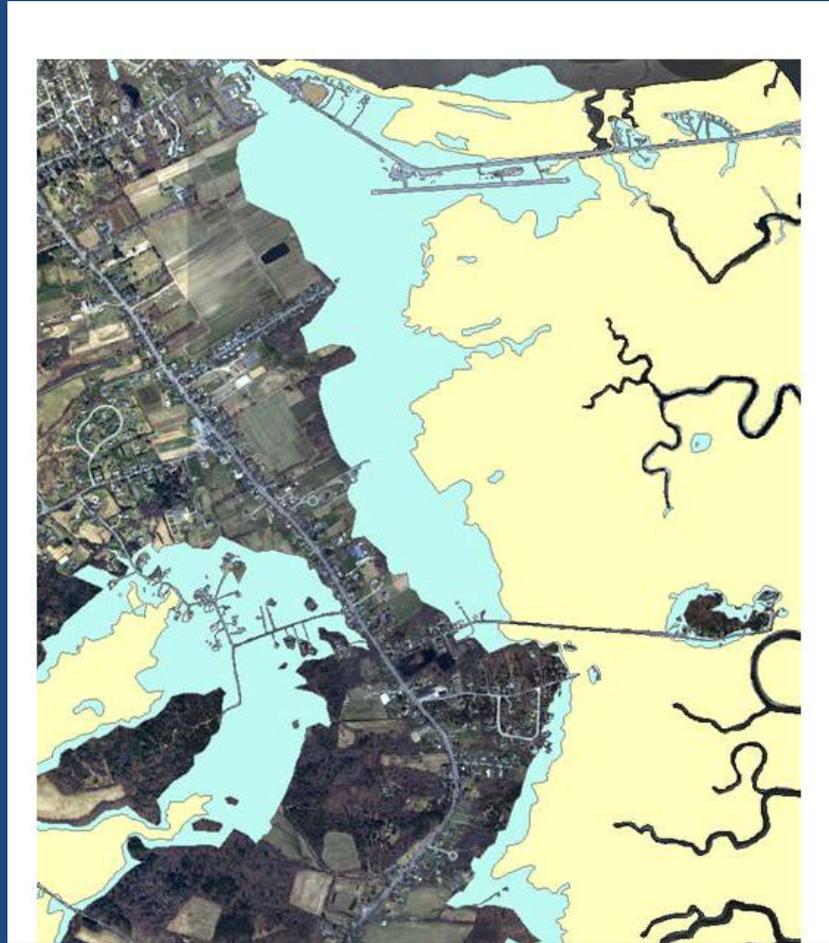
Plum Island Ecosystem (MA) elevation data (meters)  
derived from NCALM (2005) lidar data



Plum Island Ecosystem (MA) elevation data (meters)  
derived from Photo Science, Inc. (2006) lidar data



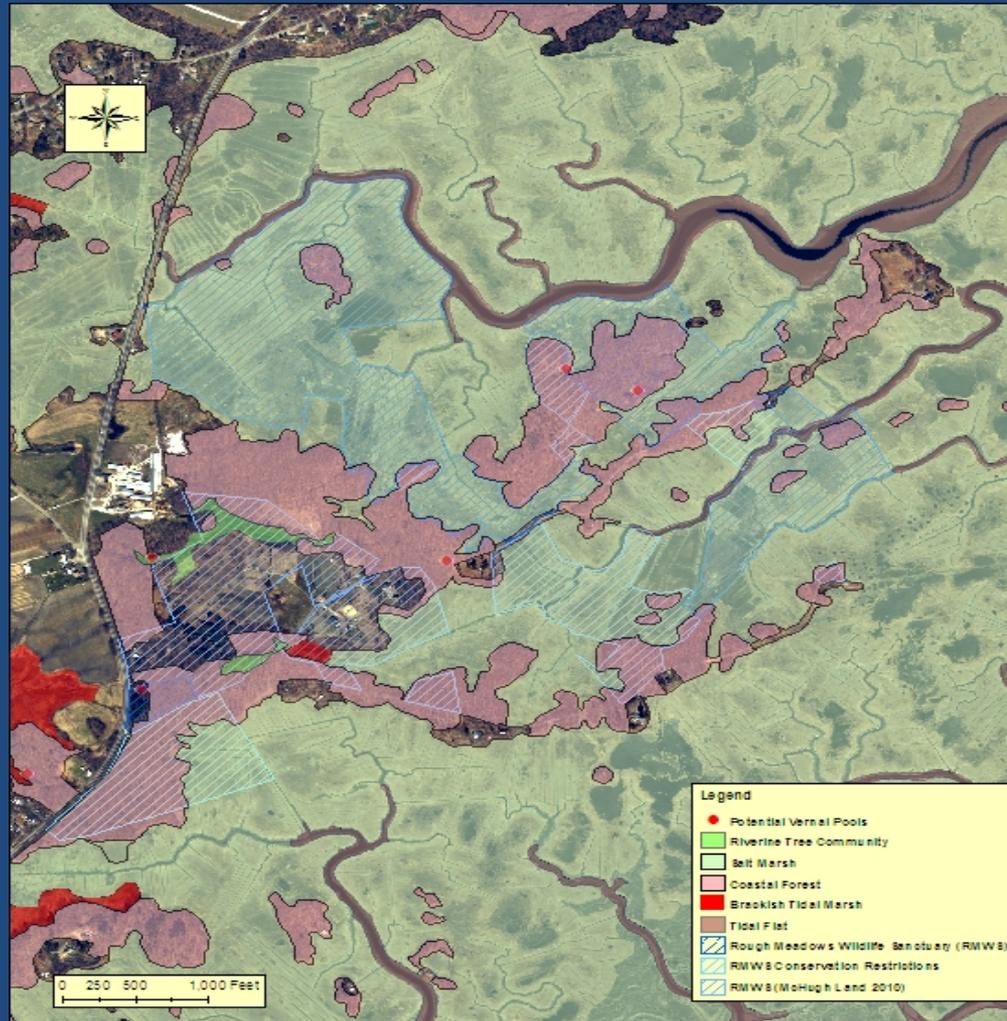
# Coastal Adaptation Zones Newbury



Less than 3.5  
meters in  
elevation minus  
coastal wetlands

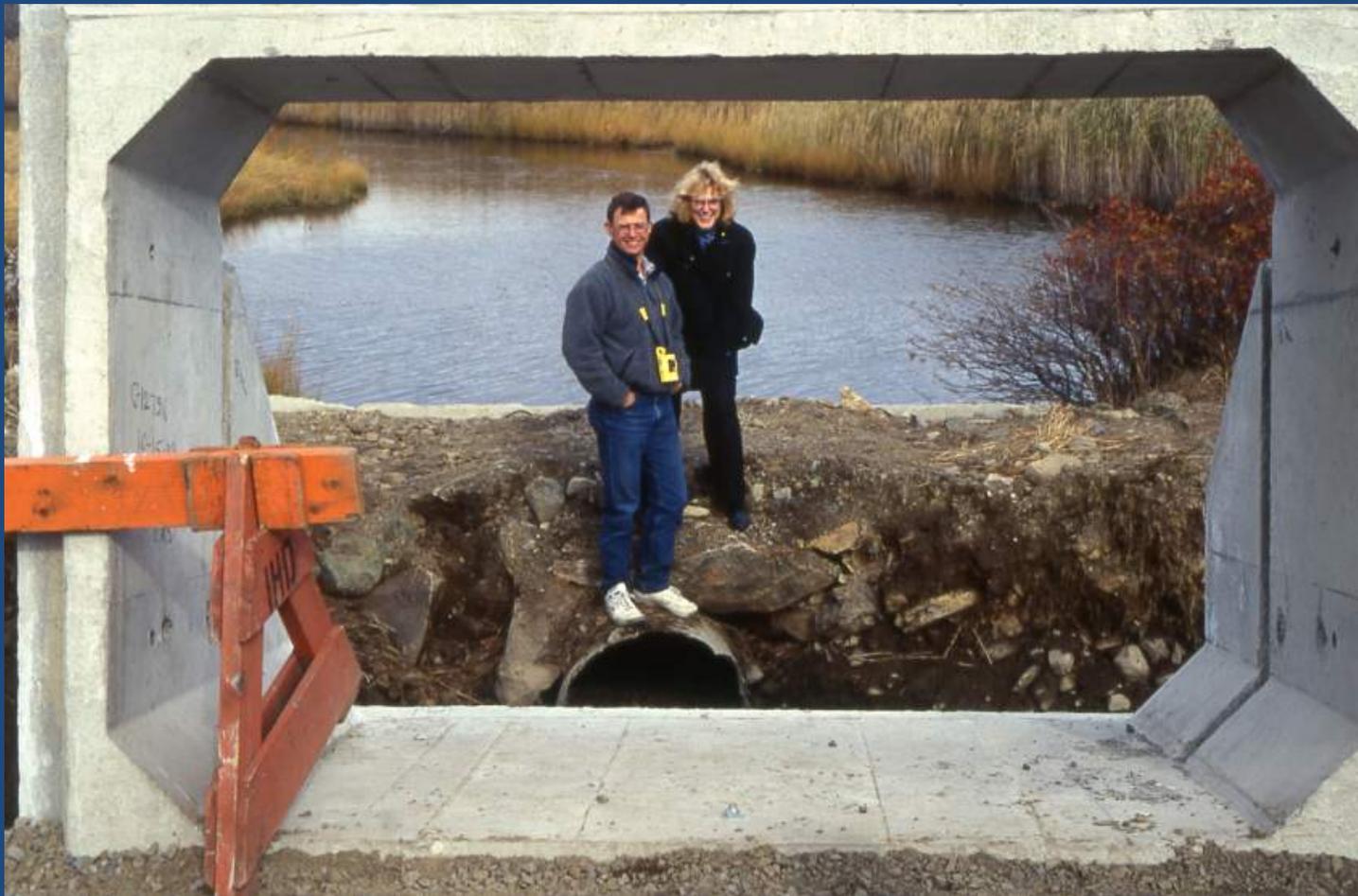
Thanks to Jeanne Anderson

# Land Acquisition in upland buffer



**Figure 6. Priority Natural Vegetation Communities of Rough Meadows Wildlife Sanctuary. Map Source: Mass GIS.**

# Marsh Hydrological Restoration



# Increasing connectivity

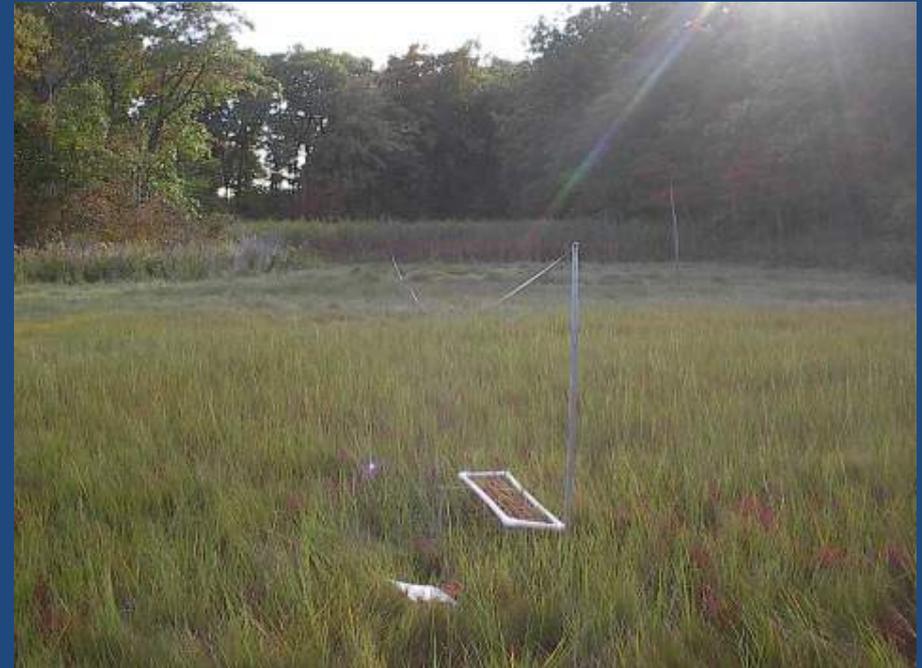
Within the estuary and between river and estuary



Connectivity enhances sediment supply to marshes



# Invasive Plants



*Phragmites australis* –  
Common Reed

# “Modern marsh haying: The detritus removal experiment”

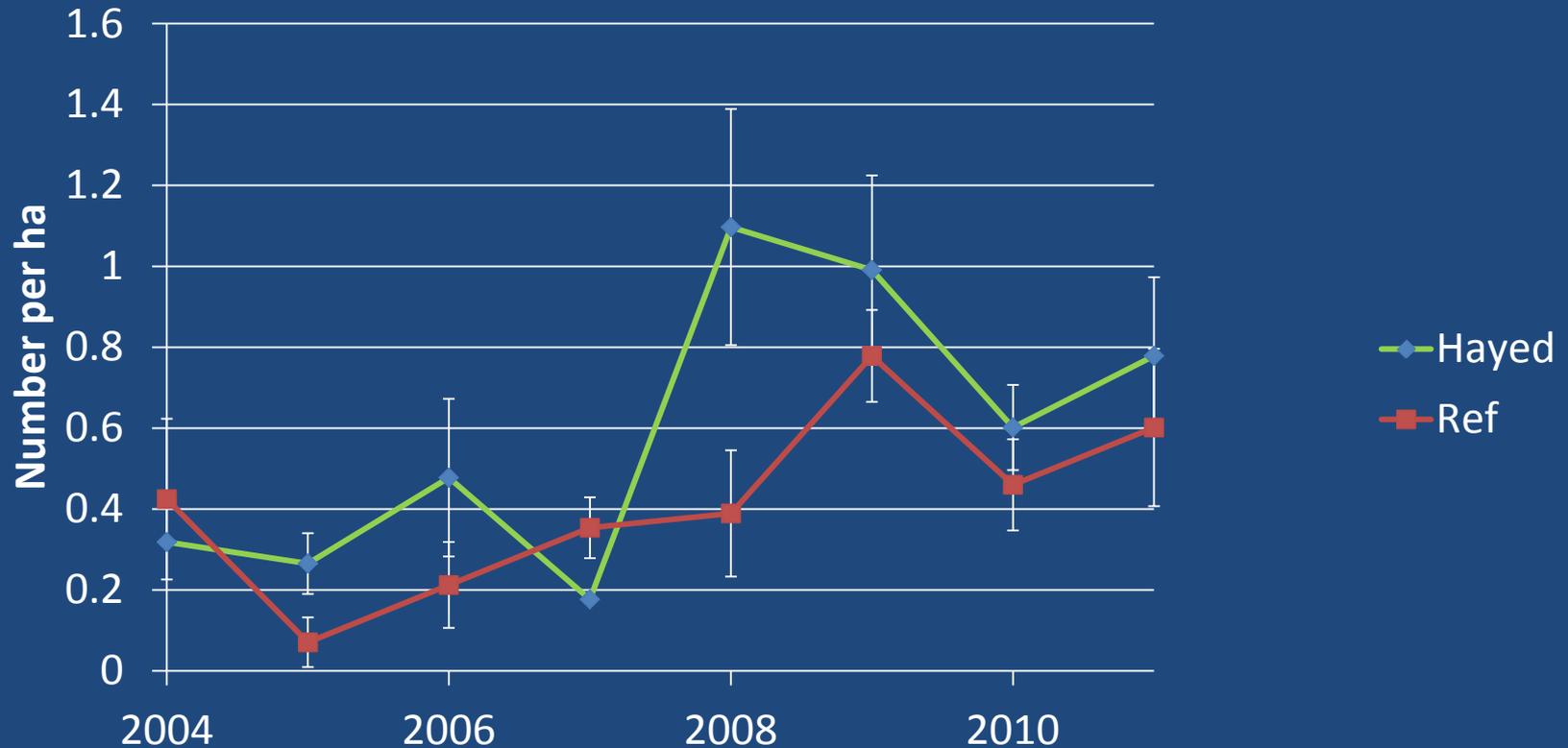


## Observations of the responses of the two major marsh grasses

- *Spartina patens* recovers rapidly from haying
- *S. alterniflora* is more sensitive to the impacts of haying

# Haying has little impact on saltmarsh sparrows

## Saltmarsh Sparrow



# Summary

- The future Great Marsh will likely have more open water
  - how much is still an active area of research.
- The eroding marsh could enhance tidal flat habitats
- Response of the barrier beach is a wild card
- High marsh habitats and their associated species are most vulnerable to SLR.
- Adaptation planning efforts are beginning