

# Salt Marsh Adaptation Strategies in Light of Sea Level Rise



**Wenley Ferguson**  
**Land and Water Summit 2015**

**SAVE THE BAY®**

**NARRAGANSETT BAY**





- RI has lost 53% of its historic salt marshes over the last two centuries\* due to filling (loss of about 4,000 acres statewide)
- STB conducted bay-wide assessment of human impacts to salt marshes in 1996 to identify restoration opportunities
- Impacted marshes have since been restored by multiple partners

\* Bromberg and Bertness, 2005

- Monitoring tidally restricted marshes has shown that conditions can change rapidly
- Similar degraded conditions have been found in marshes with no tidal restrictions
- Increased rate of sea level rise could be major driver of change



2004



Gooseneck Cove 2010

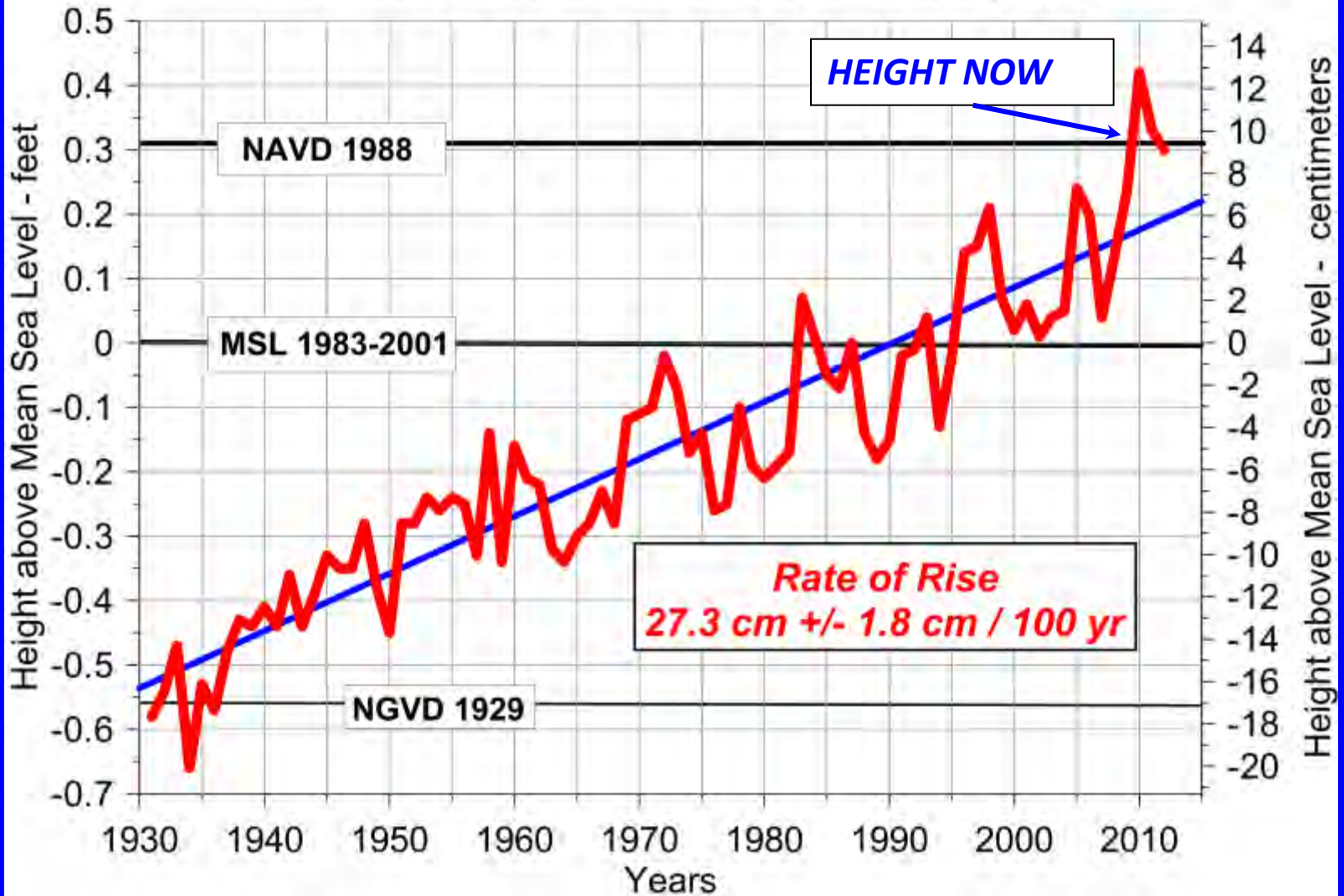


# Initial field and aerial assessment of marshes



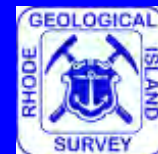


# HISTORIC SEA-LEVEL RISE - Newport, RI



Adapted from:

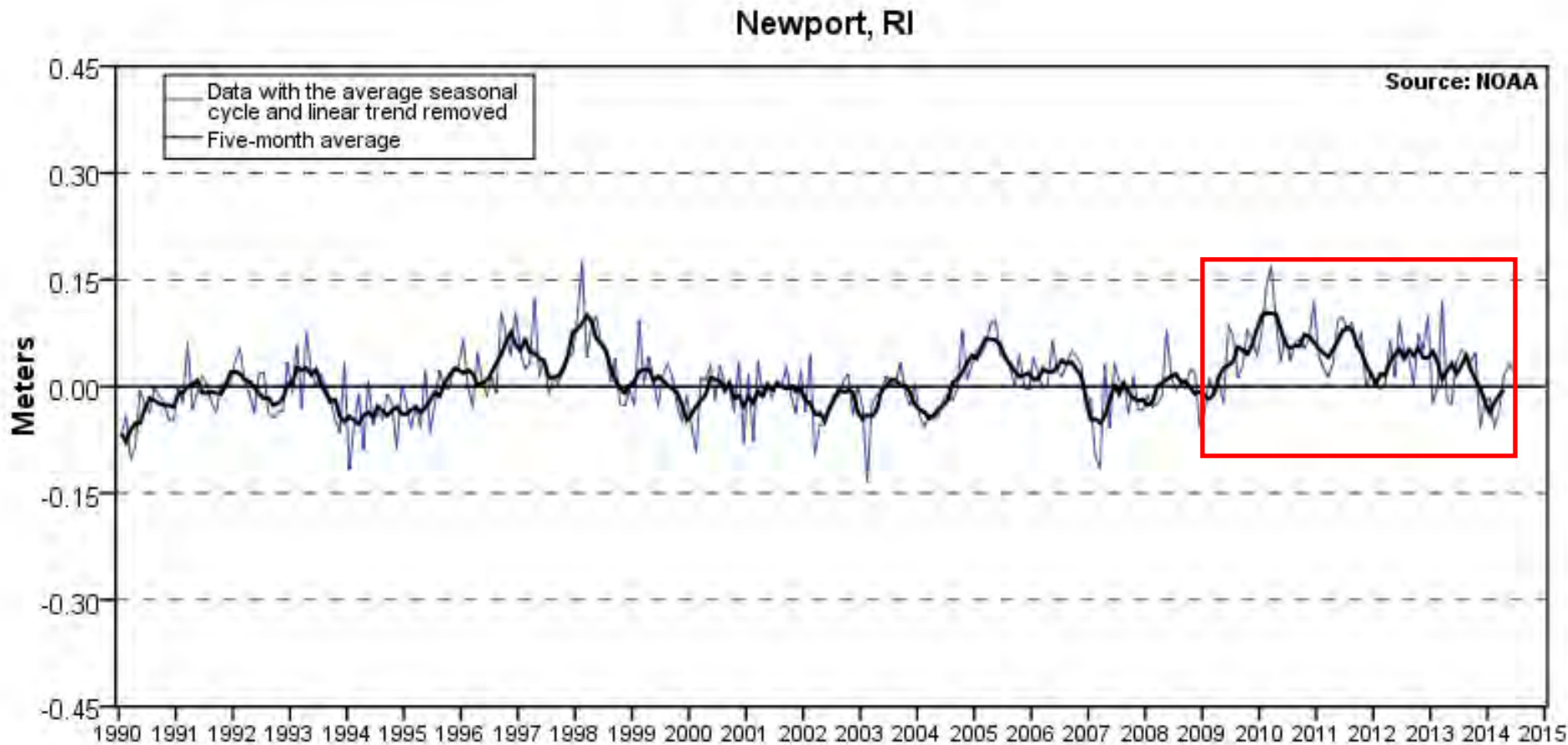
[http://tidesandcurrents.noaa.gov/sltrends/sltrends\\_station.shtml?stnid=8452660%20Newport,%20RI](http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8452660%20Newport,%20RI)



Boothroyd 2013



# Interannual variation since 1990 at Newport, RI





# Region-wide assessment of Narragansett Bay and RI South Shore salt marshes: 2012-2014

## Goals of RISMA:

- Establish baseline marsh condition
- Monitor changes over time of vegetation communities
- Identify adaptive management opportunities



Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image © 2012 TerraMetrics

41°37'07.79" N 71°22'37.83" W elev -2 ft

Google earth

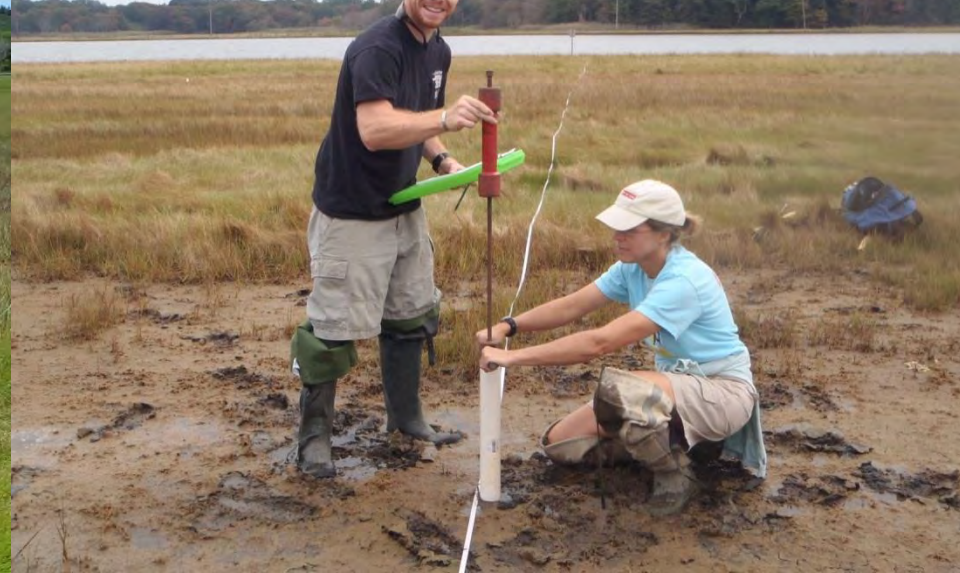
Eye alt 67.69 mi



# Belt Transect



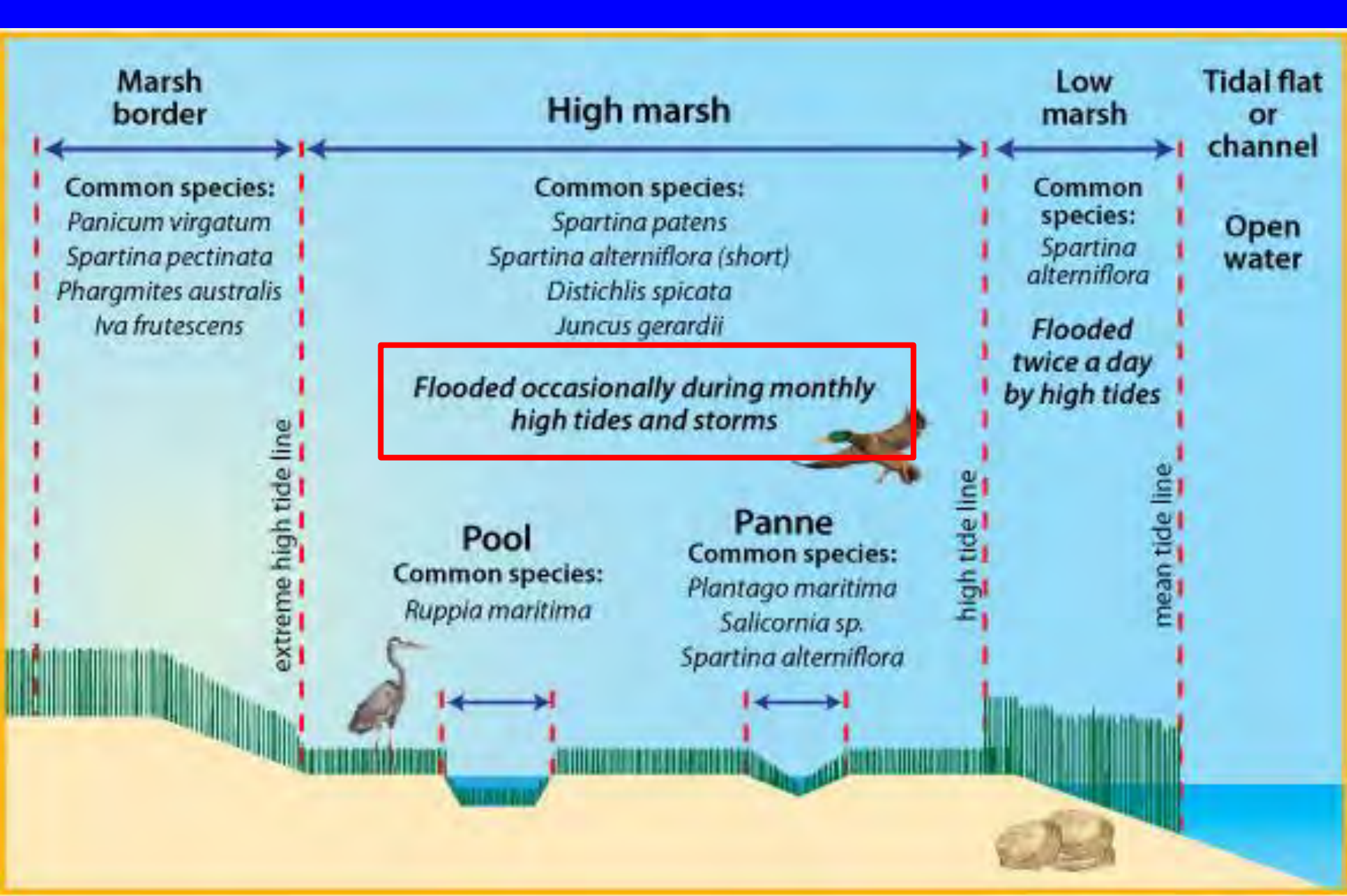
# Bearing Capacity



- Monitored vegetation every 10 meters and width of plant communities
- Measured bearing capacity
- Additional data: salinity, mosquito density, fish presence









# Shallow ponded water



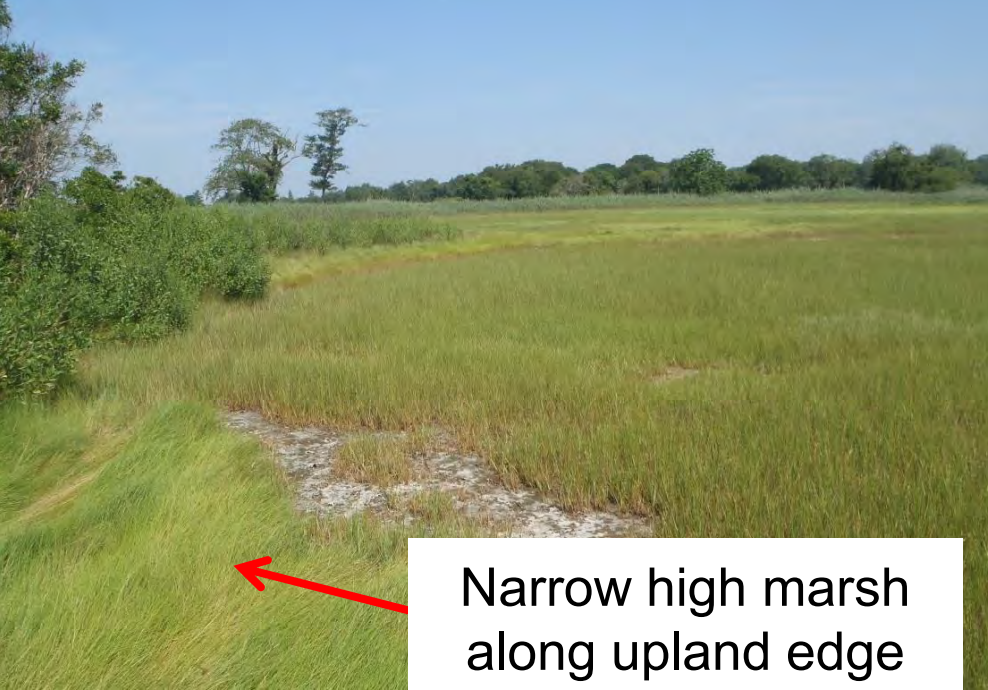
Defined pool in foreground versus shallow standing water



Mosquito breeding habitat



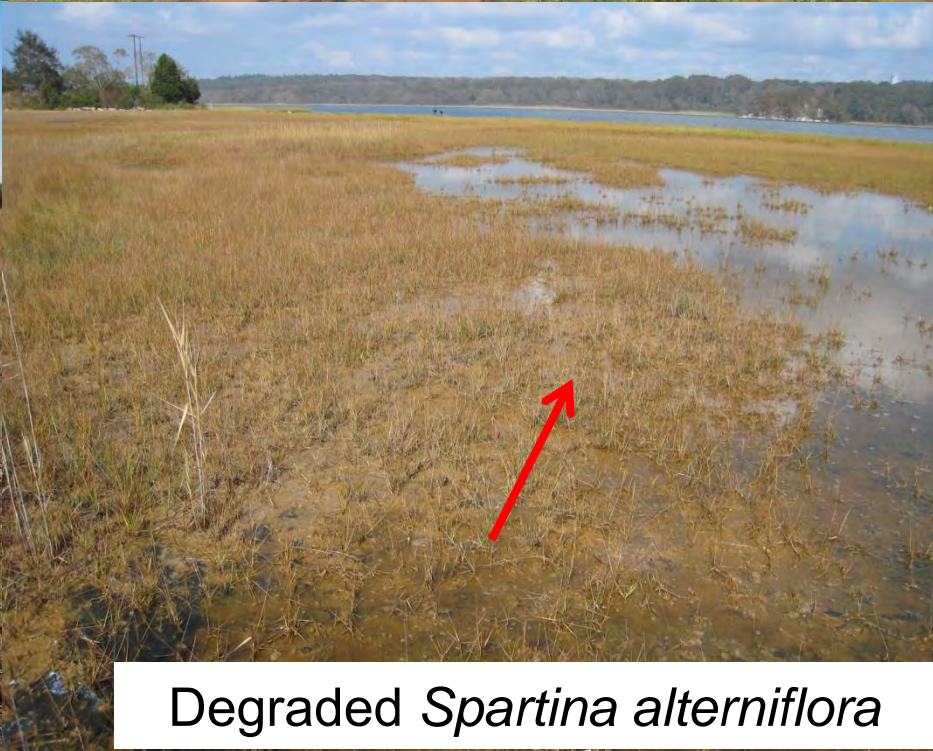




Narrow high marsh  
along upland edge



Barren peat



Degraded *Spartina alterniflora*



# Marsh erosion





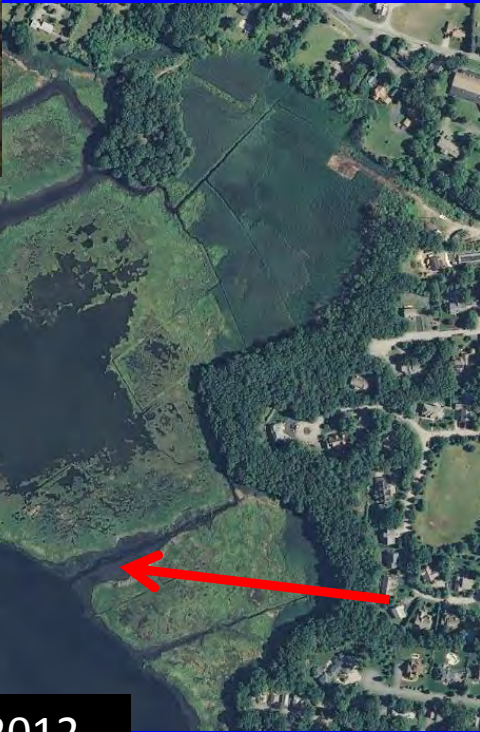
Mars

Cove,



1939

US Army Corps of Engineers (USACE), 2010, University of Florida  
Florida State Park

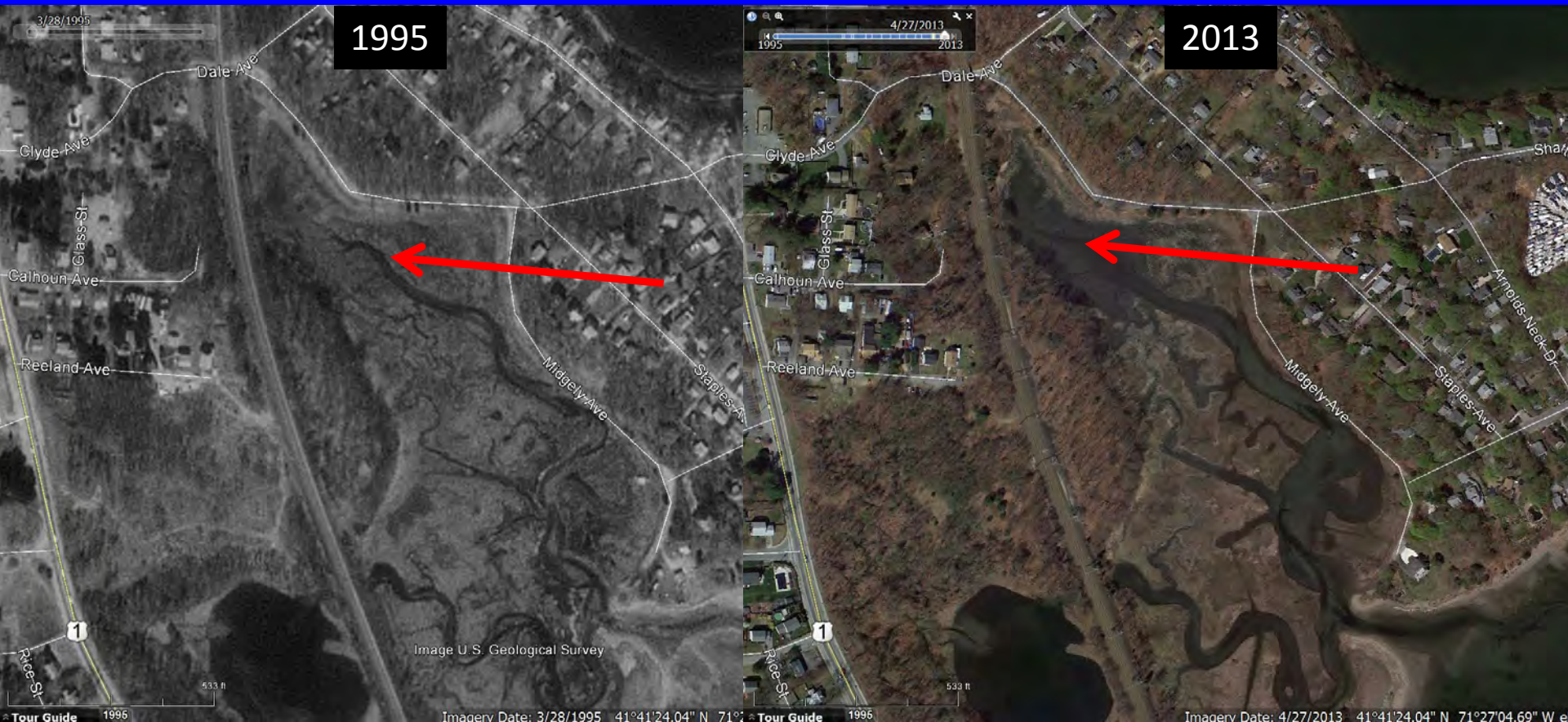


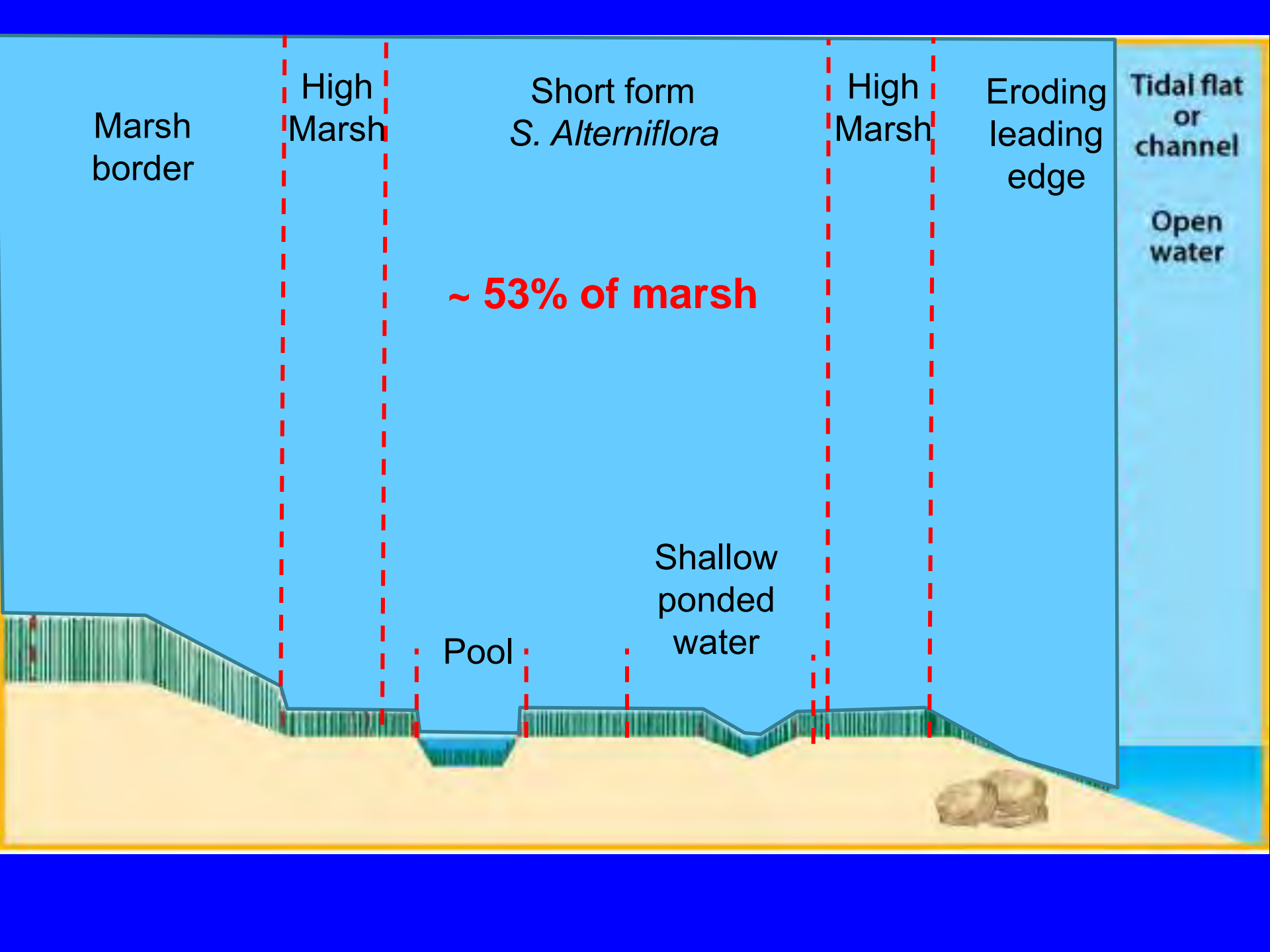
2012



# Marsh Loss: Mary's Creek, Warwick

## 1995-2013





Marsh border

High Marsh

Short form  
*S. Alterniflora*

High Marsh

Eroding leading edge

Tidal flat or channel

Open water

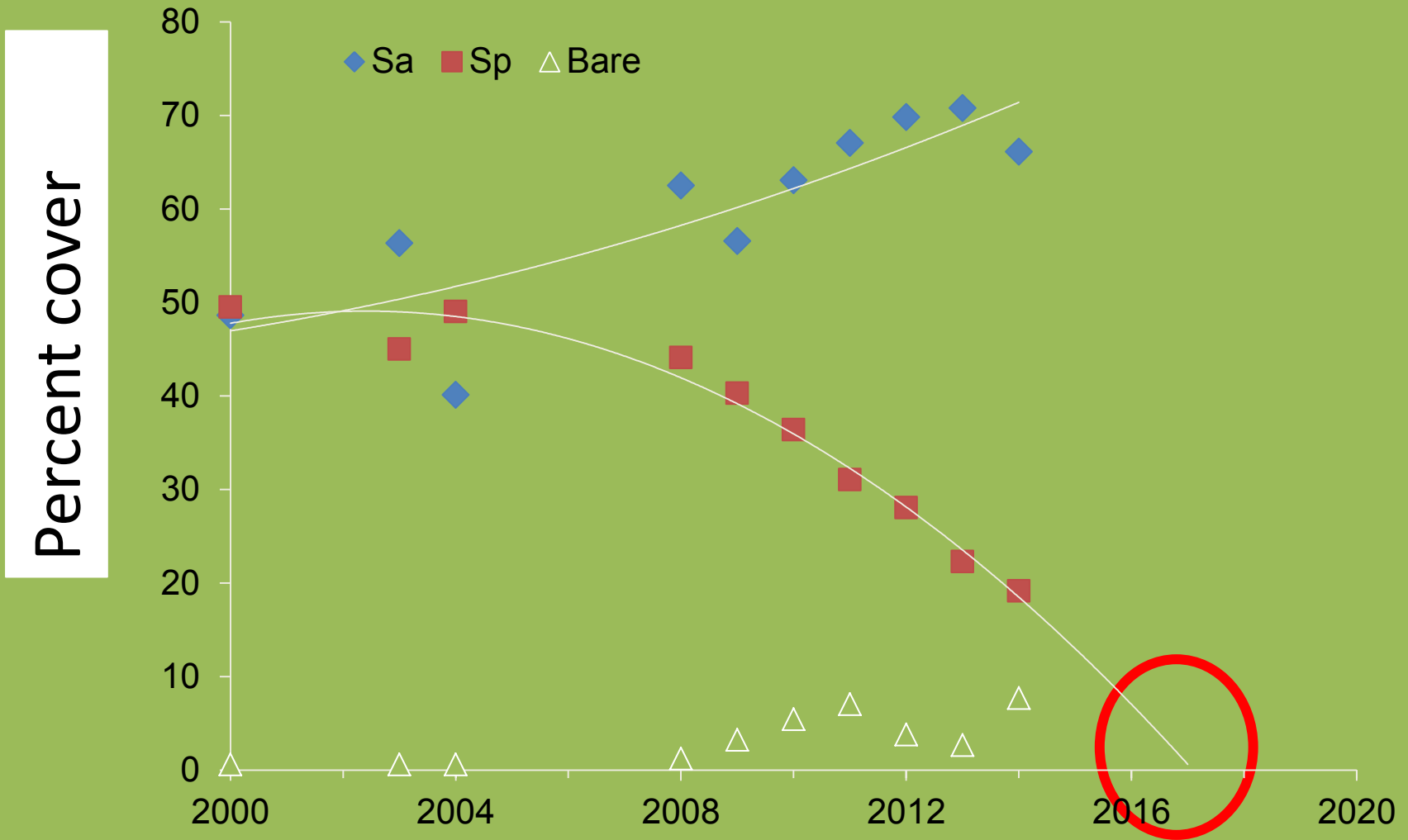
~ 53% of marsh

Shallow ponded water

Pool

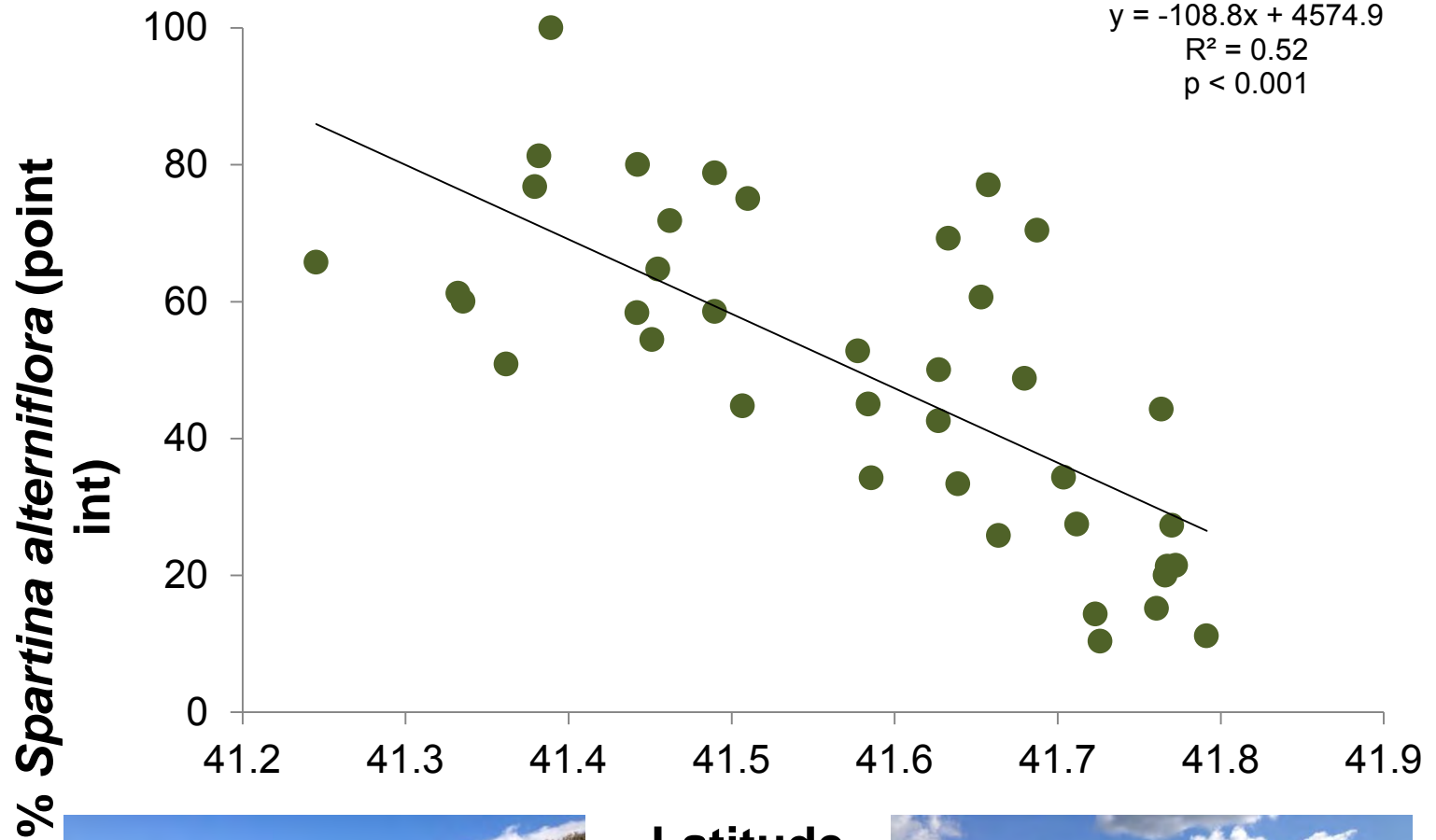


# Coggeshall Marsh: Rapid loss of *Spartina patens*



Data courtesy of Narragansett Bay Estuarine Research Reserve

# Latitudinal gradient

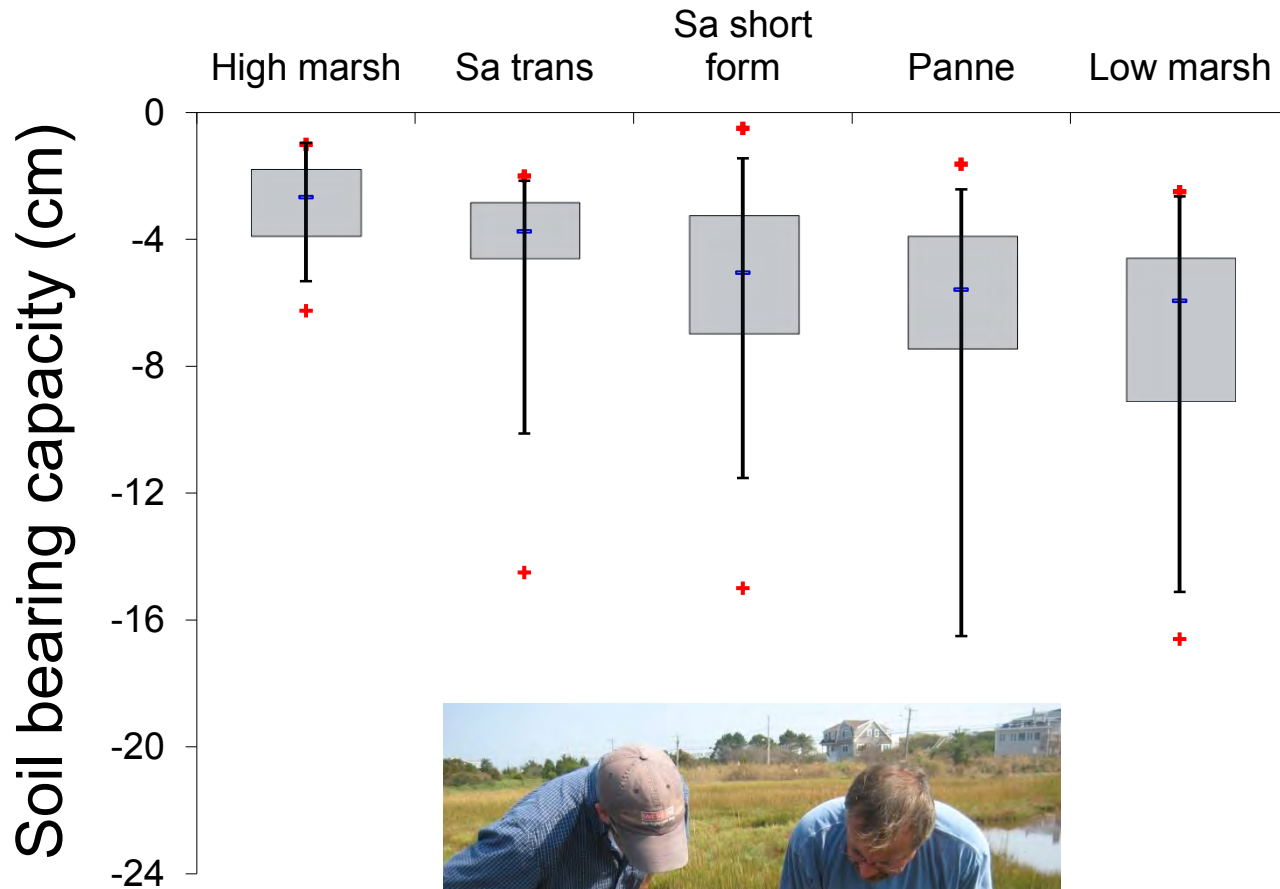


**Latitude**



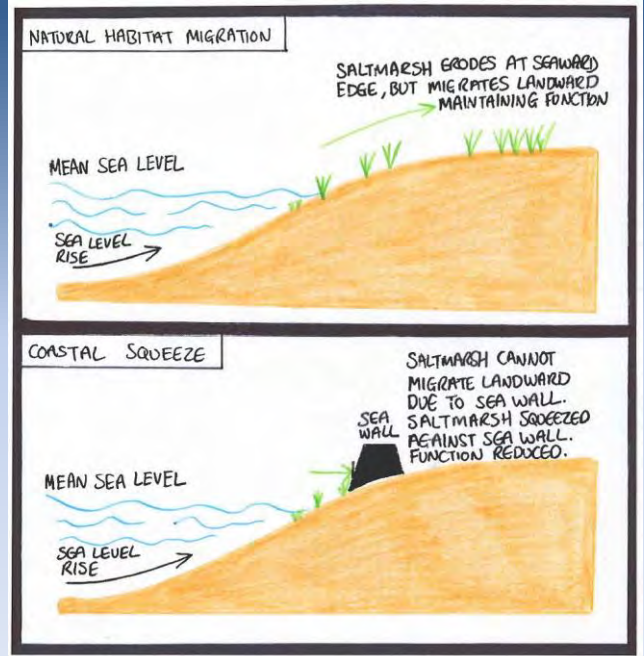


# Bearing Capacity Results





# Marsh migration





# Winnapaug Pond Marsh

Marsh migration occurring yet impounded water creating mosquito breeding habitat



© 2014 Google

Atlantic Ave

415 ft

Google ear



# Adaptation Strategies

- In-Marsh
  - Drainage improvements (small creek excavation)
  - Elevation enhancement
- Upland
  - Adopt activities that facilitate marsh migration
  - Change/move land use activities that inhibit marsh migration
  - Remove physical barriers



# In marsh adaptation

- Small creeks and runnels excavation
  - Partners include: municipalities, land trusts, Save The Bay and RIDEM Mosquito Abatement Program
  - STB provides project design, permit preparation, organization of volunteers for “dig days”, and restoration monitoring
  - RIDEM provides low ground pressure equipment
  - RI CRMC Habitat Fund and NRCS has provided funding (range from \$5K to \$15K)





# Gooseneck Cove adaptive management



2010



Small creeks dug to drain  
impounded water

2012





# Winnapaug Marsh adaptation project







August 2011



Post adaptation: October 2013



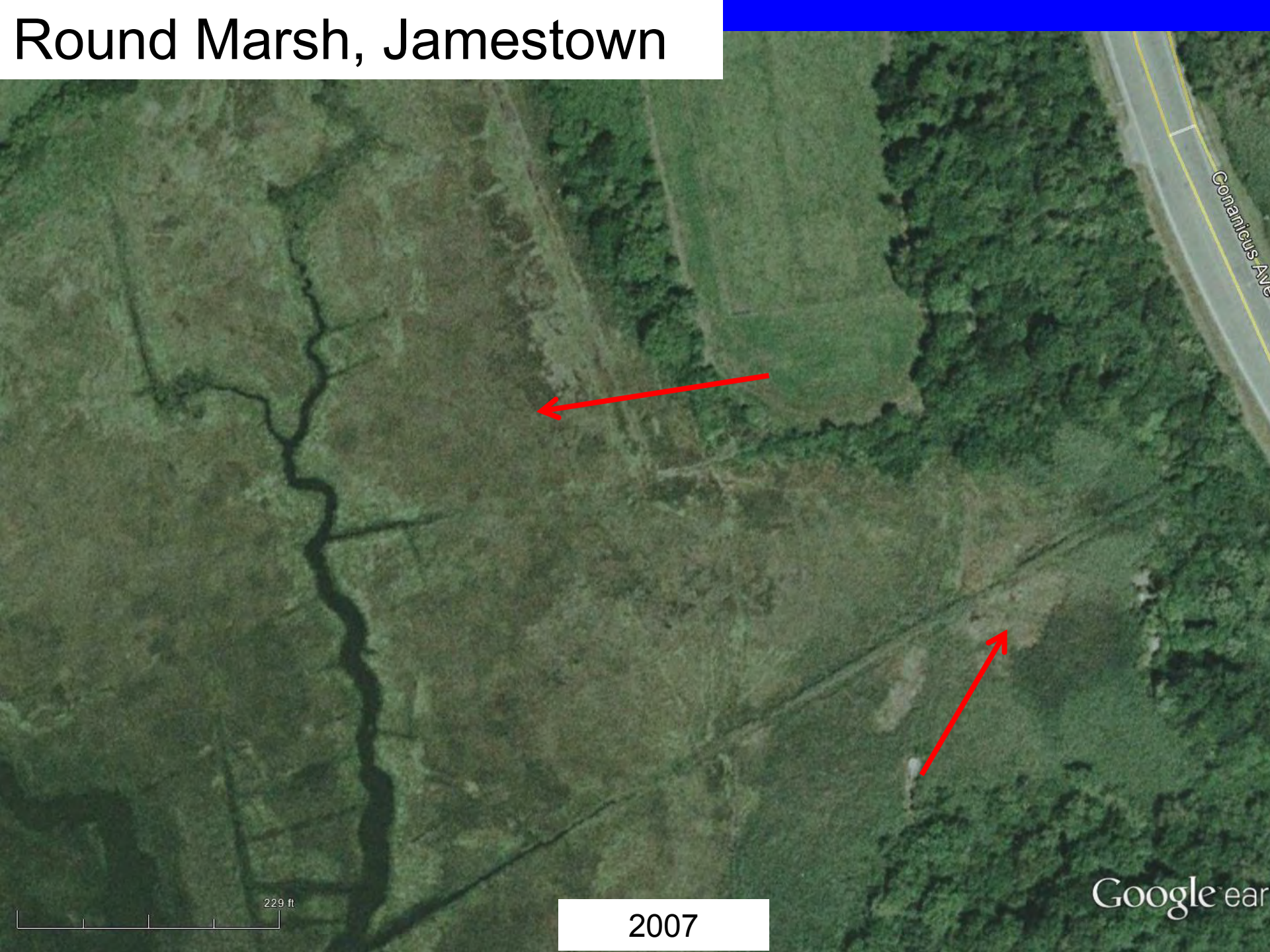
Runnel and revegetation along edge of former ponded area 2014



2014



# Round Marsh, Jamestown



Conanicut Ave



229 ft

2007

Google earth



# Round Marsh Adaptation



Google earth

2012





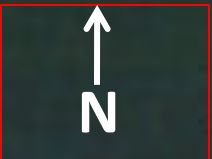
© 2013 Google

Google earth

72 ft



# RISD Beach Salt Marsh Restoration



Small berm created and beach grass planted



Clearing clogged culvert



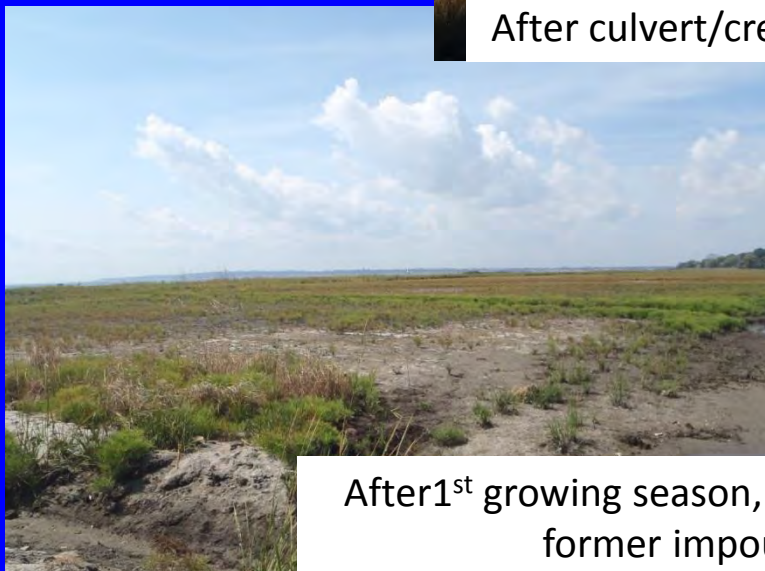




Before culvert clearing and creek excavation: 10.13



After culvert/creeks cleared : 10.13



After 1<sup>st</sup> growing season, *Salicornia* and *Spartina* growing in former impounded water area: 9.14



# Narrow River Creek Excavation

Control site



© 2014 Google

Google earth



# Jacobs Point restoration, Warren

Existing creeks/ditches  
cleared vegetation which  
impeded flow

New culverts installed





Pre restoration: impounded water  
on marsh surface



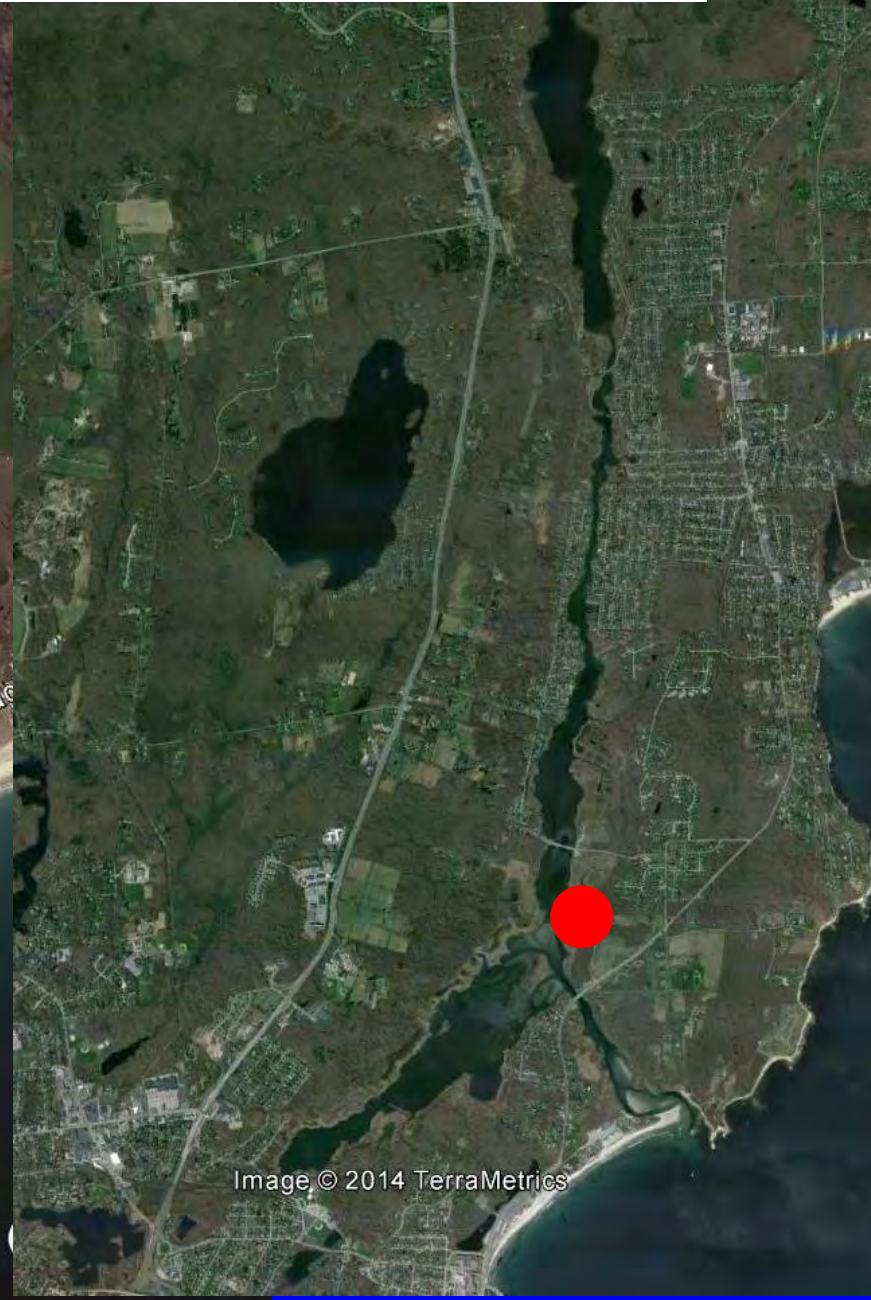
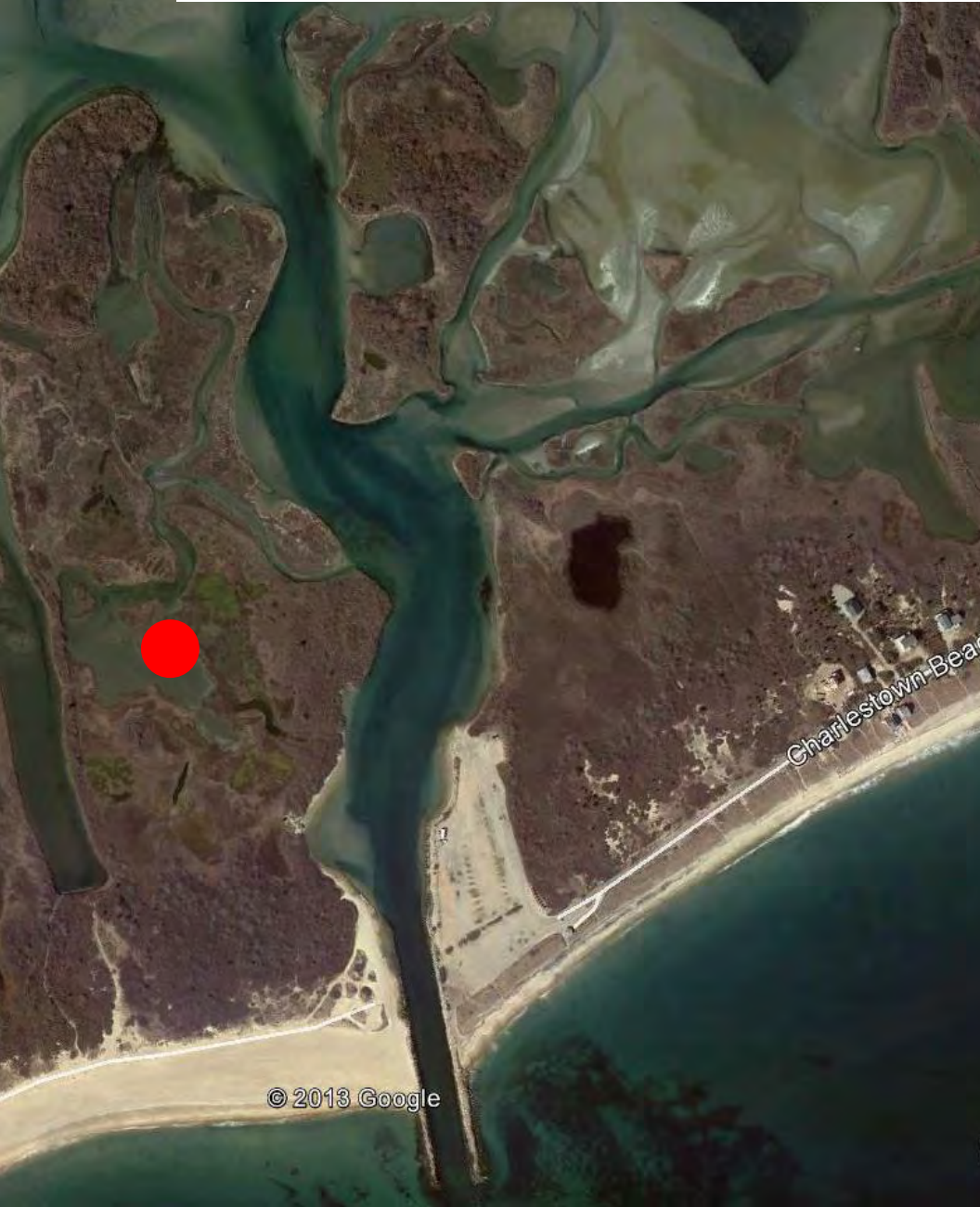


Post restoration: revegetation of formerly flooded areas





# Thin layer deposition projects





**PROPOSED  
NINIGRET POND  
RESTORATION PROJECT  
2013-2016**

Relief Channel  
estimated 7,000 yd3  
(basin area removed)

Secondary Sedimentation Basin  
estimated 40,000 yd3

Marsh  
Restoration  
Area 2  
~40 Ac

Marsh  
Restoration  
Area 1  
~40 Ac

Primary Sedimentation Basin  
estimated 60,000 yd3

Legend:

- Proposed Restoration Area
- Primary Sedimentation Basin ~8 acres
- Secondary Sedimentation Basin ~4 acres
- Relief Channel ~2 acres

0 2

THIS MAP IS NOT VALID

-Parcel boundary

While the Town of... completeness of... data as is, with... claims, no re... reliability, comp... data products f... be liable for a...



# Adaptation Strategies

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# Marsh Migration Facilitation



Marsh migrating into field

Old farm path impediment to marsh migration into red maple swamp

© 2014 Google

Google earth



83

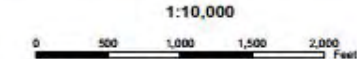
89

90



UNCLASSIFIED

Map 84



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- Potential Marsh Zone
- Persistent Marsh Zone
- Potential Marsh Loss
- Open Water and Tidal Flat
- Current Fresh Wetlands
- Protected Open Space
- Hardened Shores
- Buildings
- Parcel Boundaries
- Developed Land
- CRMC Coastal Barriers

## Tidal Marsh Vulnerability Analysis: One Foot Sea Level Rise Model



Map produced by Kevin Ruddock. 4/1/2014

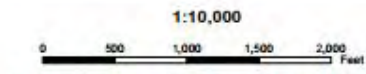
Microsoft Excel 2010 (2)





NOAA/CRMC/2021

Map 84



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-  Developed Land
-  CRMC Coastal Barriers

## Tidal Marsh Vulnerability Analysis: Three Foot Sea Level Rise Model

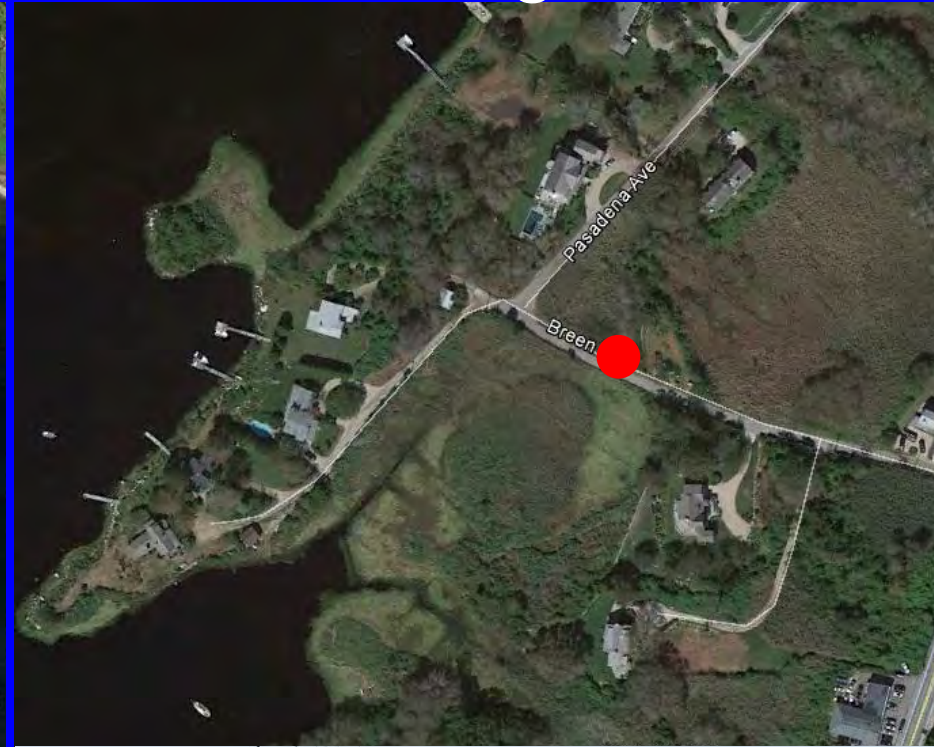
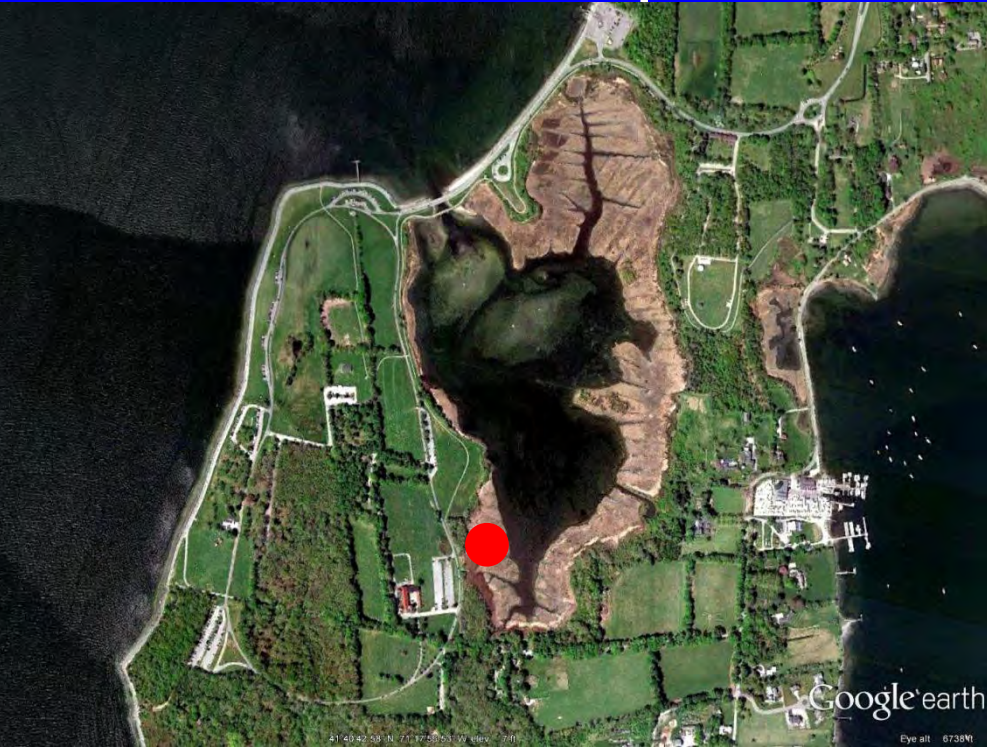








# Infrastructure impediments to marsh migration



Colt State Park



Breen Road, Westerly



# Land protection to allow marsh migration



Point Ave

Salt marsh east of road; land protection of small lots required for road to be closed to vehicular use



Carlwell St

Foster St

© 2012 Google

Google

41°42'54.93" N 71°21'50.83" W elev 9 ft

7/30/2010

Eye alt



# Land protection to allow marsh migration



Map 21



1:10,000  
0 500 1,000 1,500 2,000 Feet

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- Developed Upland
- Undeveloped Upland
- Rocky Intertidal
- Beach
- Tidal Flat
- Open Water
- Swamp
- Tidal Creek
- Salt Marsh
- Brackish Marsh
- Scrub/Shrub Transitional Marsh
- Fresh Marsh
- Hardened Shores
- Buildings
- Parcel Boundaries

## Tidal Marsh Vulnerability Analysis: Current Condition



Map produced by Kevin Ruddock. 4/2/2014



# Ongoing Adaptation Projects

- Assess and compare results of runnel and creek excavation through a BACI design
- Design and implement thin layer deposition
- Identify areas for land protection for marsh migration
- Identify adaptive management activities in upland to facilitate marsh migration





# Thank You









Ninigret Breachway marsh west  
2012 aerial



590 ft

Google earth



# Thin-Layer Sediment Spraying

Big Egg Marsh, Jamaica Bay, NY  
2-Acre Pilot Project



September 2003



COVER PHOTO Photo Credit: D. R. Cahoon



C

Spraying resulted in elevation capital gain of ~19 inches

Thin-spray method after Ford et al. (1999)

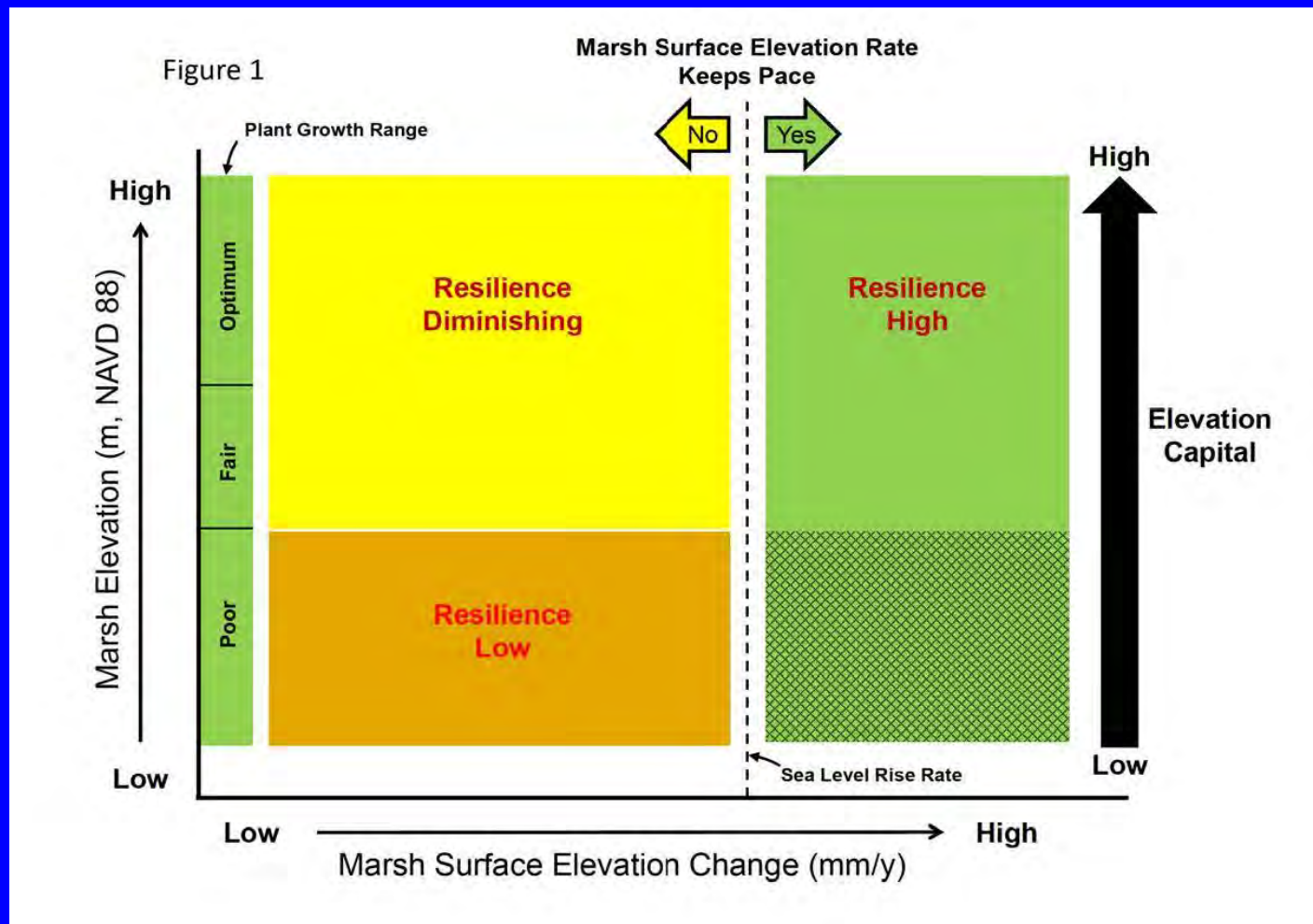
Elevation capital determined by surveys of marsh heights relative to local tidal datums (e.g., MHW).



D



# Recognizing Marsh Elevation Capital: Ecological Resilience



(Cahoon et al., submitted manuscript, Ecological Applications; See also: Reed 2002, Cahoon and Guntenspergen 2010, Cahoon et al. 2011)