

# “Community Risk Reduction through Comprehensive Coastal Resiliency Enhancement for the Great Marsh Ecosystem, Upper North Shore Massachusetts”

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## The Great Marsh Resiliency Partnership

Comprised of stakeholders from the various Great Marsh organizations  
To address flooding issues and coastal problems in the Great Marsh



# Background

## Hurricane Sandy Relief

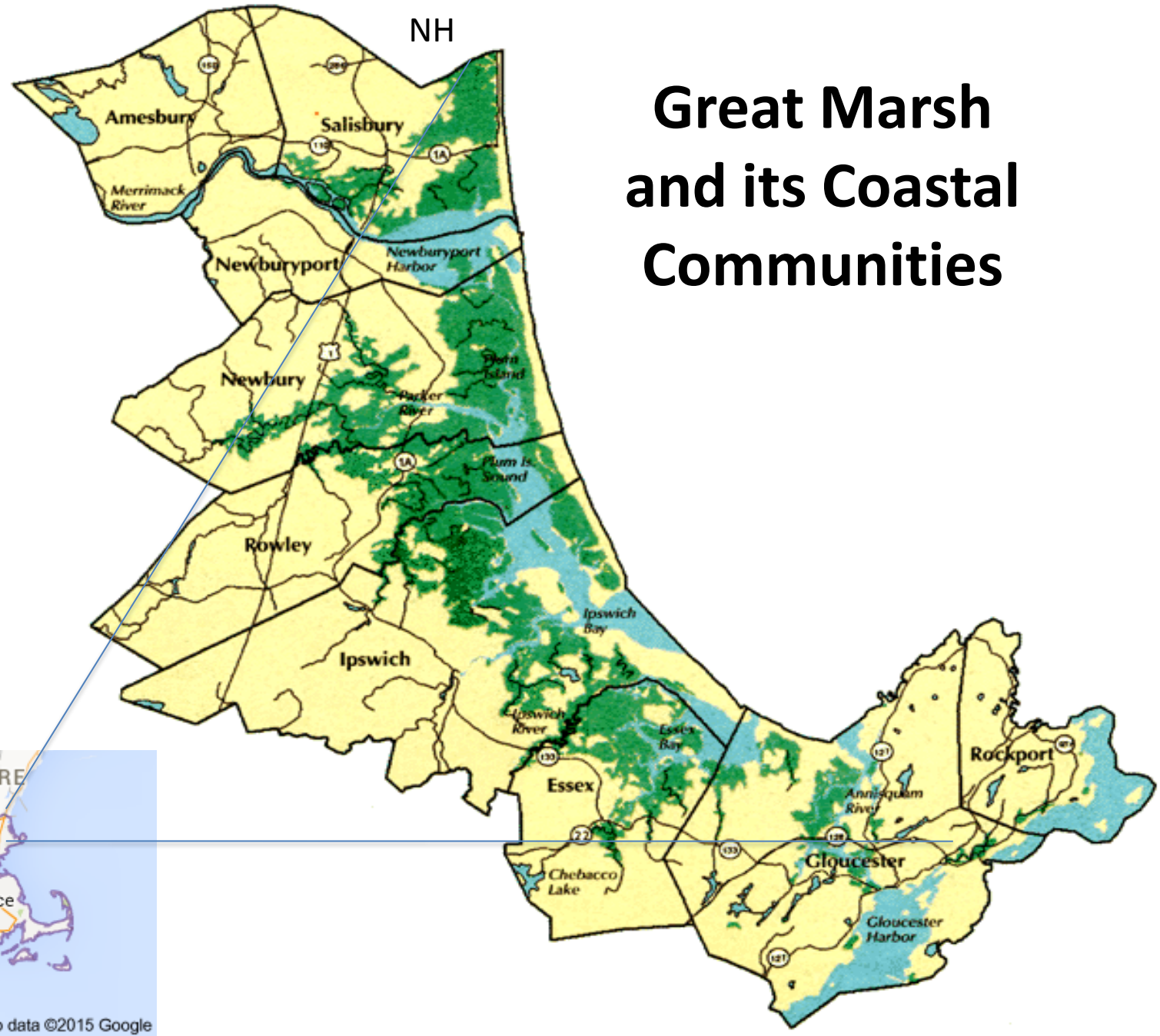
- **The Disaster Relief Appropriations Act of 2013 - \$829M**
- **\$100 million in “resiliency” oriented funding**
  - Focused on “**reducing communities’ vulnerability to coastal storms**, sea level rise, flooding, and erosion through strengthening natural ecosystems that also benefit fish and wildlife”
  - Administered by **NFWF**
- **Four awards in MA**

## Great Marsh Hurricane Sandy Proposal:

The Great Marsh and its watersheds are a **relatively healthy ecosystem**, yet there are some aspects that are beginning to break down as a result of adjacent human activities. These compromised areas were identified as the areas to direct the focus of our proposal.

- **National Wildlife Federation and GMRP Core Partners;** PRNWR, MVPC, MBP, MAS, DCR, UNH, BU, CCS, IRWA
- **65 Supporting Partners**
  - Communities
  - Federal and State Agencies
  - Academic Institutions
  - Not-For-Profit Organizations
  - Federal and State Legislators
  - Private Partners

# Great Marsh and its Coastal Communities

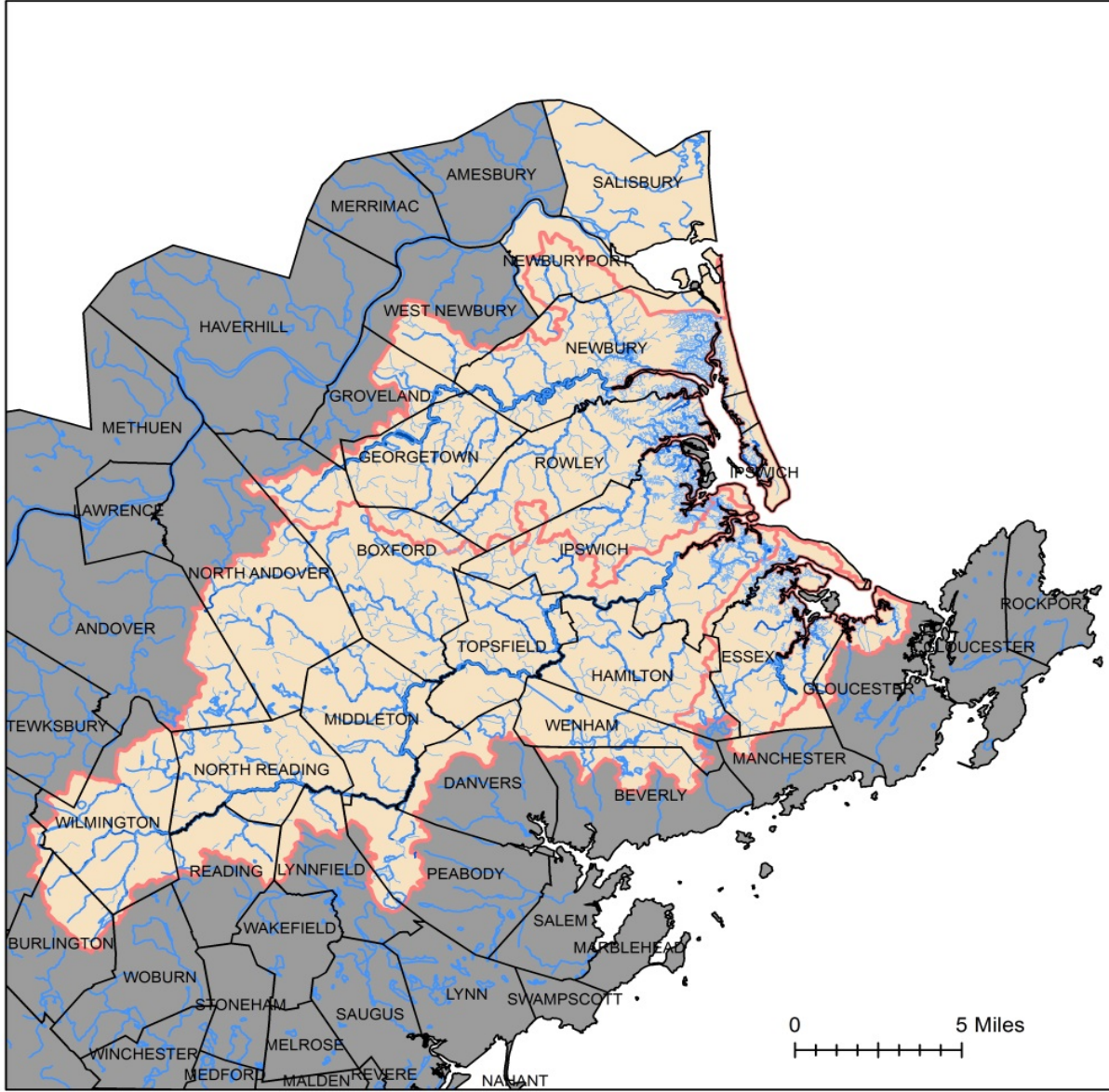


# Great Marsh Coastal Resiliency Project Area



## Legend

-  Project Area
-  PIE Watershed Boundaries
-  Town Lines
-  Major Rivers
-  Named Tributaries
-  Unnamed Tributaries





**Goal:** Community Risk Reduction through Comprehensive Coastal Resiliency Enhancement

## **Community Resiliency Planning**

1. Coastal Community Adaptation Plans

## **Assessment and Modeling**

2. Hydrologic barriers assessment & prioritization
3. **Hydrodynamic sediment transport & salinity modeling**
















## **Ecological Restoration and Enhancement**

4. Dune nourishment & revegetation
5. **Saltmarsh & Sub-aquatic vegetation restoration**
  - A. **Native Saltmarsh Restoration**
  - B. **Eelgrass Restoration**
6. **Student Conservation Association assistance**

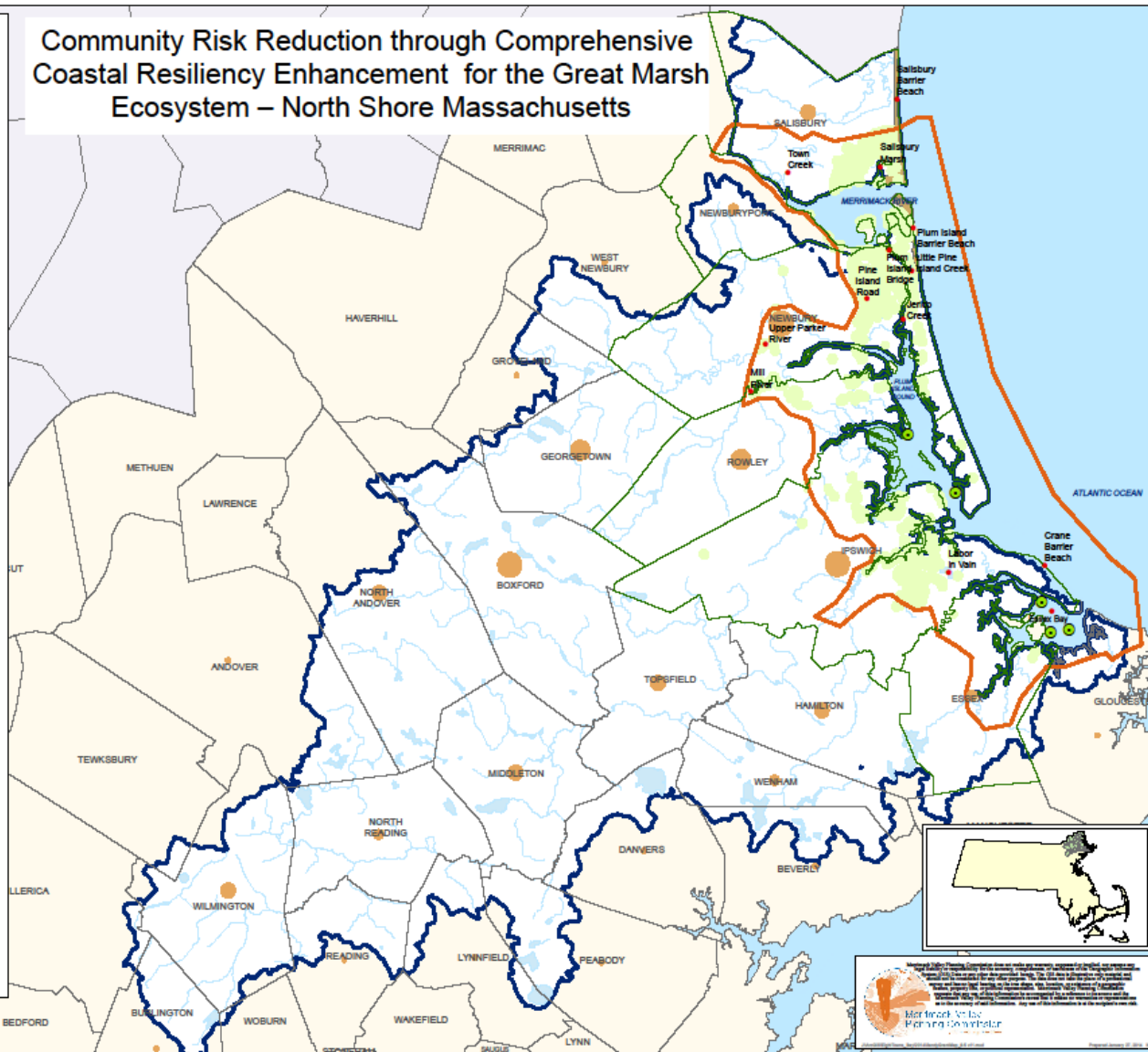
**Outcome:** 6 projects components that together comprehensively reduce risk to coastal communities and enhance the resiliency and adaptive capacity of the ecological systems those communities depend upon.

# Community Risk Reduction through Comprehensive Coastal Resiliency Enhancement for the Great Marsh Ecosystem – North Shore Massachusetts

## Legend

-  Project Boundary
-  Town Boundary
-  Rivers and Streams
-  Ponds, Lakes and Ocean
- Restoration and Resiliency**
-  Dune Restoration
- Marsh Wetland Plant Restoration Areas**
-  SAV (Eelgrass)
-  Emergent Vegetation
- Assessment Components**
- Hydrodynamic Model**
-  Model Boundary Limit
-  Focus Areas of Detailed Discretization
- Infrastructure Assessment Sites**
- Count**
-  1 - 29
-  30 - 59
-  60 - 89
-  90 - 119
-  120 - 199
- Community Resiliency Planning**
-  Resiliency Plan Towns

1 Inch = 13,500 feet  
 0 7,500 15,000 30,000 Feet



Map created by  
 Planning Board

# Community Resiliency Planning

## Target Communities

- Essex
- Salisbury
- Rowley
- Ipswich
- Newbury
- Newburyport

## Strategy:

Implement a “model approach”  
to coastal planning

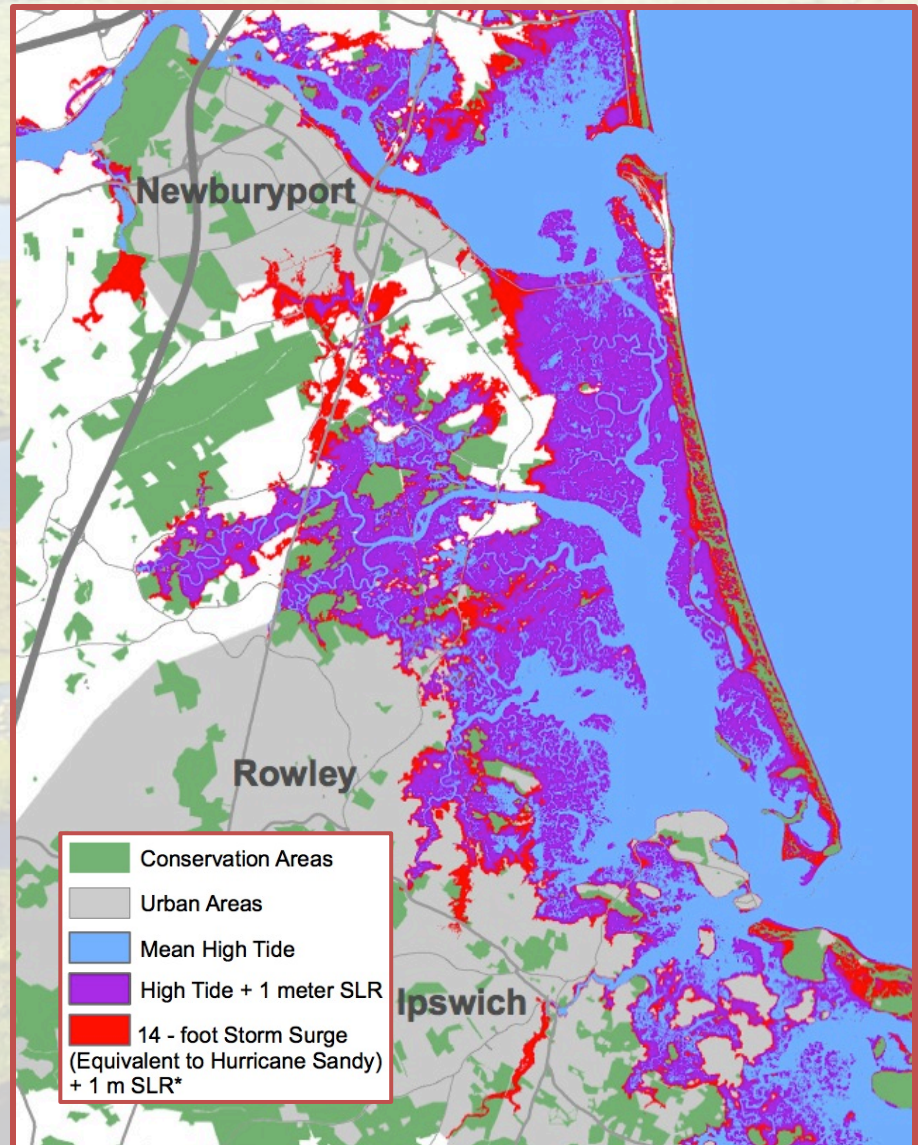
- Facilitated
- Community-specific
- Comprehensive  
(gray/green  
infrastructure)



# Community Resiliency Planning

## The Planning Process:

1. Create Community Planning Task Force
2. Identify target assets
3. Assess target vulnerabilities
4. Develop adaptation strategies
5. Categorize & prioritize strategies
6. Initiate strategy implementation





# Community Resiliency Planning Update

- Established two municipal task forces (MTF) to represent the six towns (Salisbury, Newbury, Newburyport, Essex, Ipswich and Rowley)
- Issues discussed included inland flooding from heavy precipitation and threatened salt marsh species from repeated coastal storms
- General community and additional partner outreach  
PIE River, Great Marsh Coalition



# Assessment and Modeling

## Hydrodynamic Sediment Transport and Salinity Modeling

### Scope:

Model Transport and Erosion of Sediment

- Barrier Beach Erosion
- Channel Infilling
- Marsh Deposition for SLR

Model Salinity Movement

- Invasive species control
- Native Plant Restoration

### Goals:

- Identify future sediment and salinity management options



# Assessment and Modeling

## Hydrodynamic Sediment and Salinity Modeling

### Geographic Targets

1. Barrier Beaches
2. Merrimack Estuary
3. Plum Island Sound
4. Ipswich Bay

### Partner-driven Modeling

#### Collaborators

- Boston University
- Virginia Institute of Marine Science
- Woods Hole Group

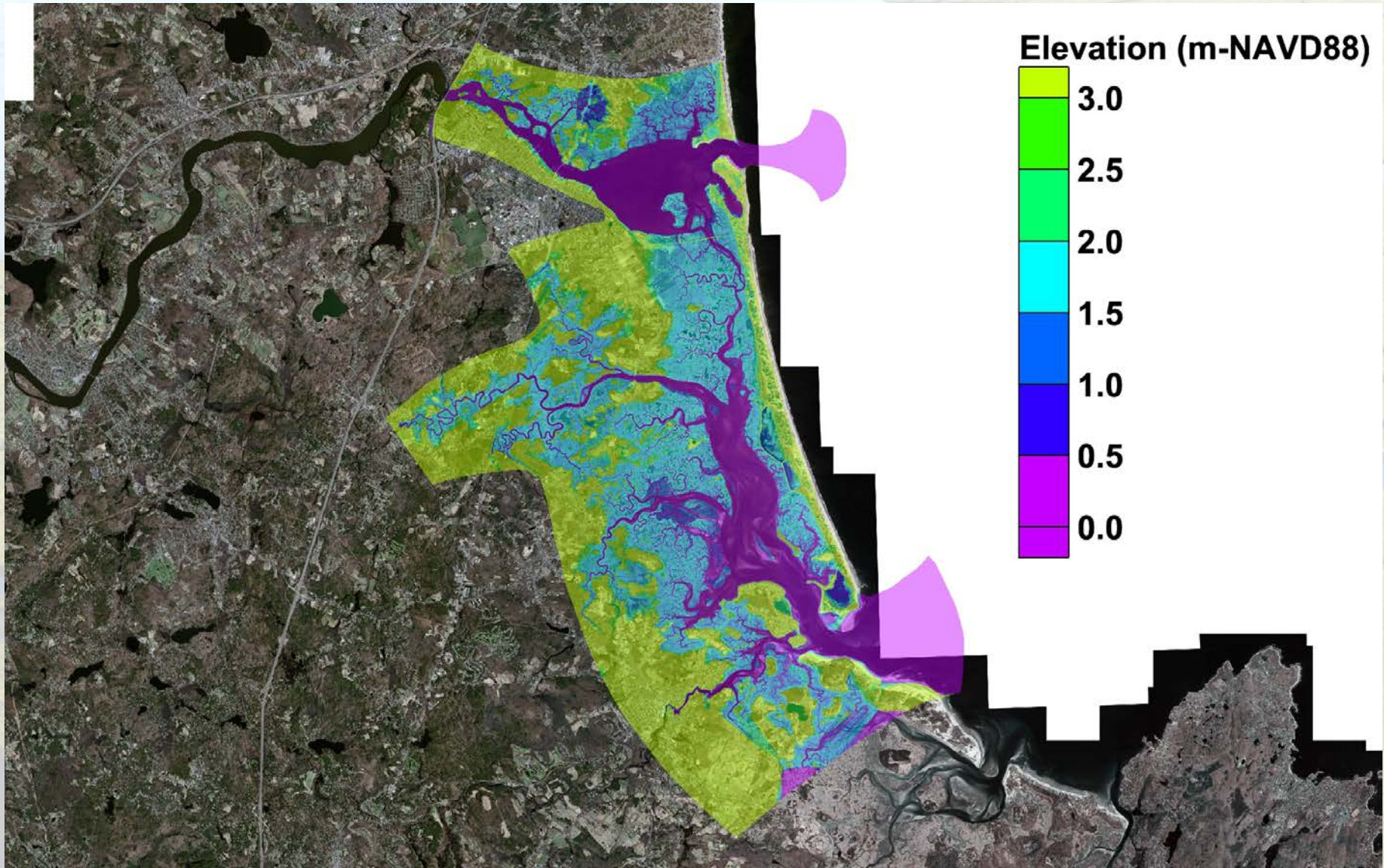
#### Supporters

- USGS, USACE, USFWS

### Modeling Update

1. Testing various resolutions to create a grid
2. Gathered available topographic and bathymetric data from MACZM
3. Boston University data collection





Updated Hydrodynamic Model Study Area

## Model Data Collection Update



- Deployed fifteen instrument platforms throughout PIS and offshore
- Current measurements in addition to the temperature, salinity, and water depth data  
RTK-GPS survey of creeks for bathymetry
- 60 Bed sediment samples taken
- Collected/sampled fifteen cores for accretion rate data
- Water samples and salinity-temperature-depth profiles were collected



# Assessment and Modeling

## Hydrological Barrier Assessment

- Survey and systematically prioritize over 1,200 dams, stream crossings and tidal restrictions across 26 communities and associated watersheds
- Prioritize based on public safety risk **AND** ecological impact
- Important tool to help towns and other entities set repair/upgrade schedules within limited budgets



# Hydrological Barrier Assessment

- Between IRWA and DEP, over 800 crossings have been assessed in the three watershed area.
- Crossings are being scored based on how well they meet the MA stream crossing standards for aquatic organism passage. Of the 550 or so that we have scores for:
  - 9% (52) are "severe" or "significant" barriers
  - 35% (195) are "moderate barriers"
  - 39% (214) are "Minor" barriers
- **Most stream crossing issues relate back to the structures being undersized**
- **Undersized crossings ALSO tend to be problematic for road failure/infrastructure issues.**
- Road-stream crossings tend to be the biggest problem for small streams and tributaries. These tributaries hold more miles of habitat and are crucial for many early life stages of fish and other aquatic critters
- Not just an issue for aquatic organisms, more than 75% of road-kill is found at stream crossings
- Crossings that are built to the ecological standards seem to be fairing better during extreme storm events. Green Mountain National Forest had installed a number of crossings before Hurricane Irene and they were unfazed by the event.



## Barriers Assessment Update

- Three seasonal staff hired, SCA Researchers engaged
- Trout Unlimited have trained eight individuals on the survey field protocols
- 40 of the 1000 or so potential barriers in the Great Marsh Watershed in the first two weeks
- Engaging DPWs to gather existing data and engage them in the prioritization process





# Ecological Restoration and Enhancement

## Dune Nourishment & Revegetation

- Salisbury, Newbury & Newburyport
- Plant 1000's native species over 15 acres of dune spanning 6 miles of coast
- DCR will renourish 1,800 c.y. of dune in Salisbury Beach State Reservation
- Develop a robust outreach and training program for local stakeholders



Outcome: Strategically stabilized dune system as a catalyst for further natural flood protection

**Unique, Site Specific Fencing  
and Plant Palette Combinations,  
Couple with an Extensive  
Outreach Campaign**



# Dune Restoration Outreach and Restoration Update

- Developing strong working relationships with coastal communities  
Salisbury, Newburyport, Newbury
- In the Town of Newbury, dune management actions  
80 volunteers, 400 hours of planting and fencing
- SCA Researcher involvement



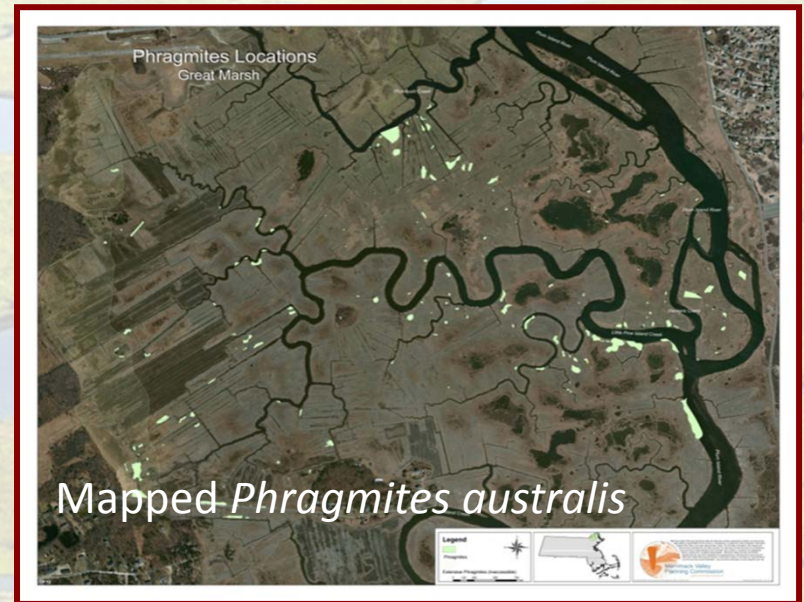
Figure 1: Dune plantings with a host of volunteers from local area school and the community in Newbury.



Figure 5: Training SCA students to plant dune grass in one of our nearby community gardens.

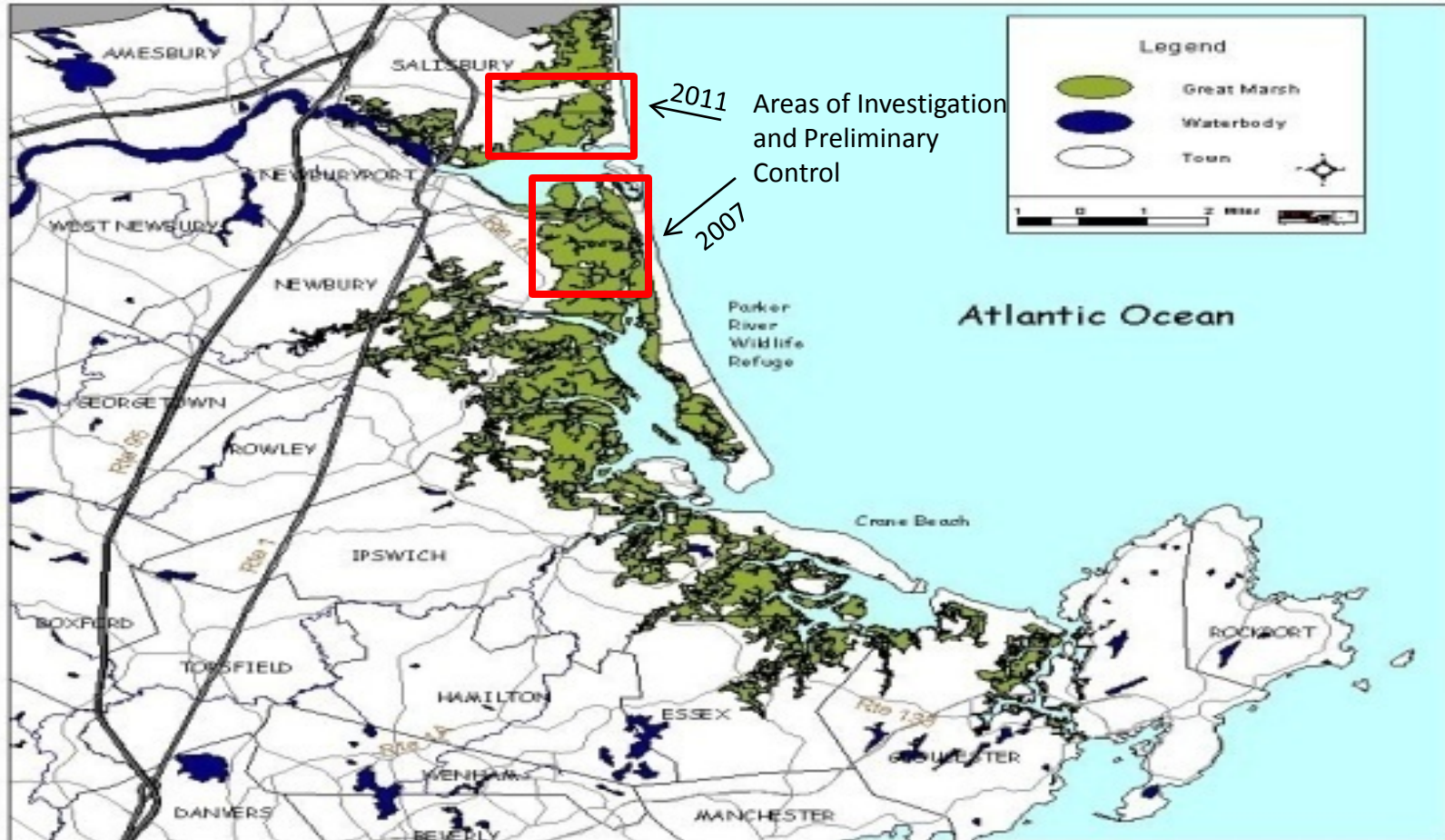
# Ecological Restoration and Enhancement

## Native Salt Marsh Restoration



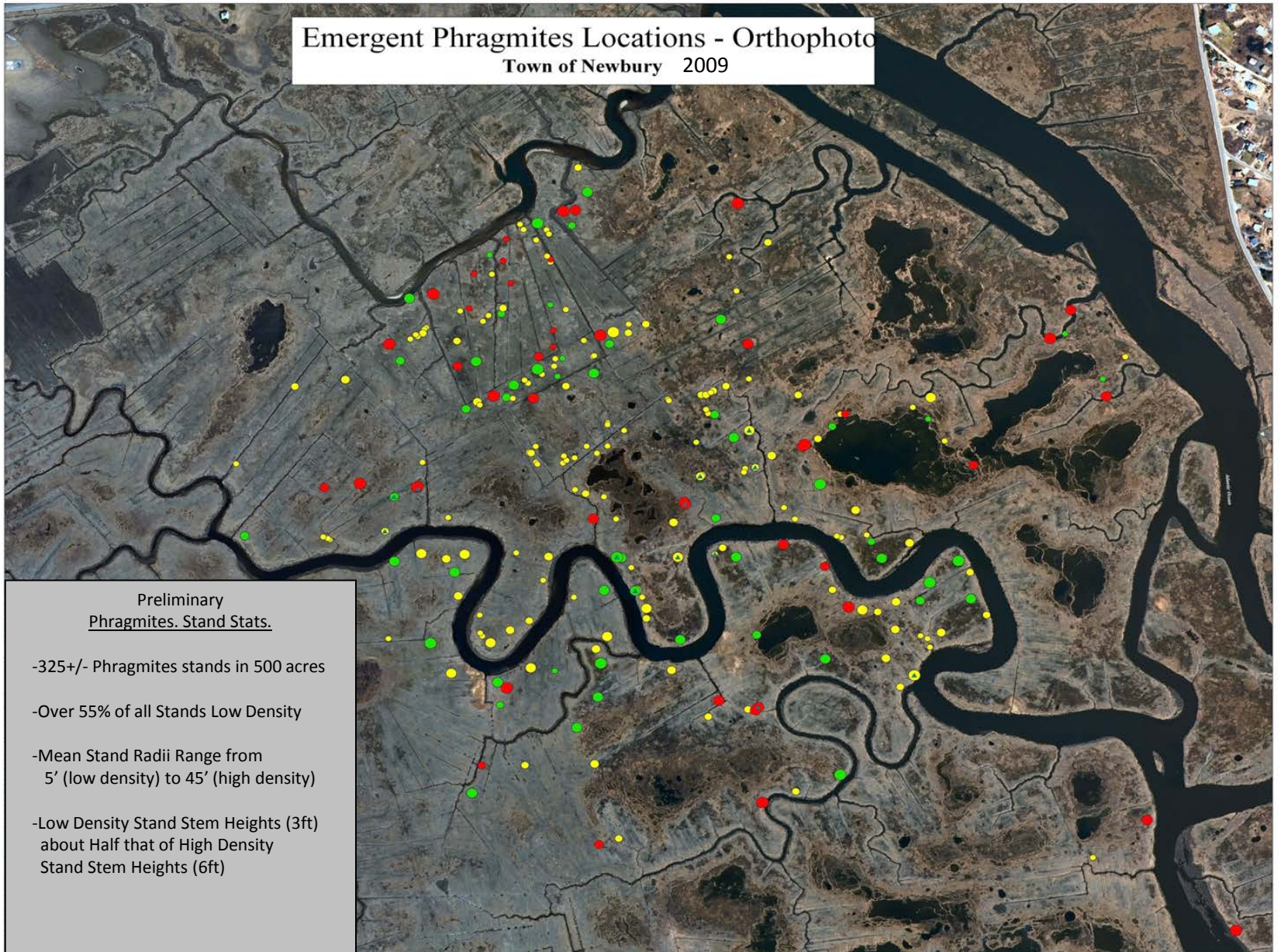
- Restoration of over **325 acres** of native marsh vegetation through the removal of two dominant non-native invasive plants (**perennial pepperweed and Phragmites**)
- Outcome: A stabilized marsh ecosystem affording natural, local flood protection

# Native Vegetation Restoration Invasive Phragmites Management



**Massachusetts Great Marsh  
Salisbury/Newbury Phragmites Treatment Sites**

Emergent Phragmites Locations - Orthophoto  
Town of Newbury 2009



Preliminary  
Phragmites. Stand Stats.

- 325+/- Phragmites stands in 500 acres
- Over 55% of all Stands Low Density
- Mean Stand Radii Range from  
5' (low density) to 45' (high density)
- Low Density Stand Stem Heights (3ft)  
about Half that of High Density  
Stand Stem Heights (6ft)

# Management techniques



**Mapping**



**Spray**



**Fire**

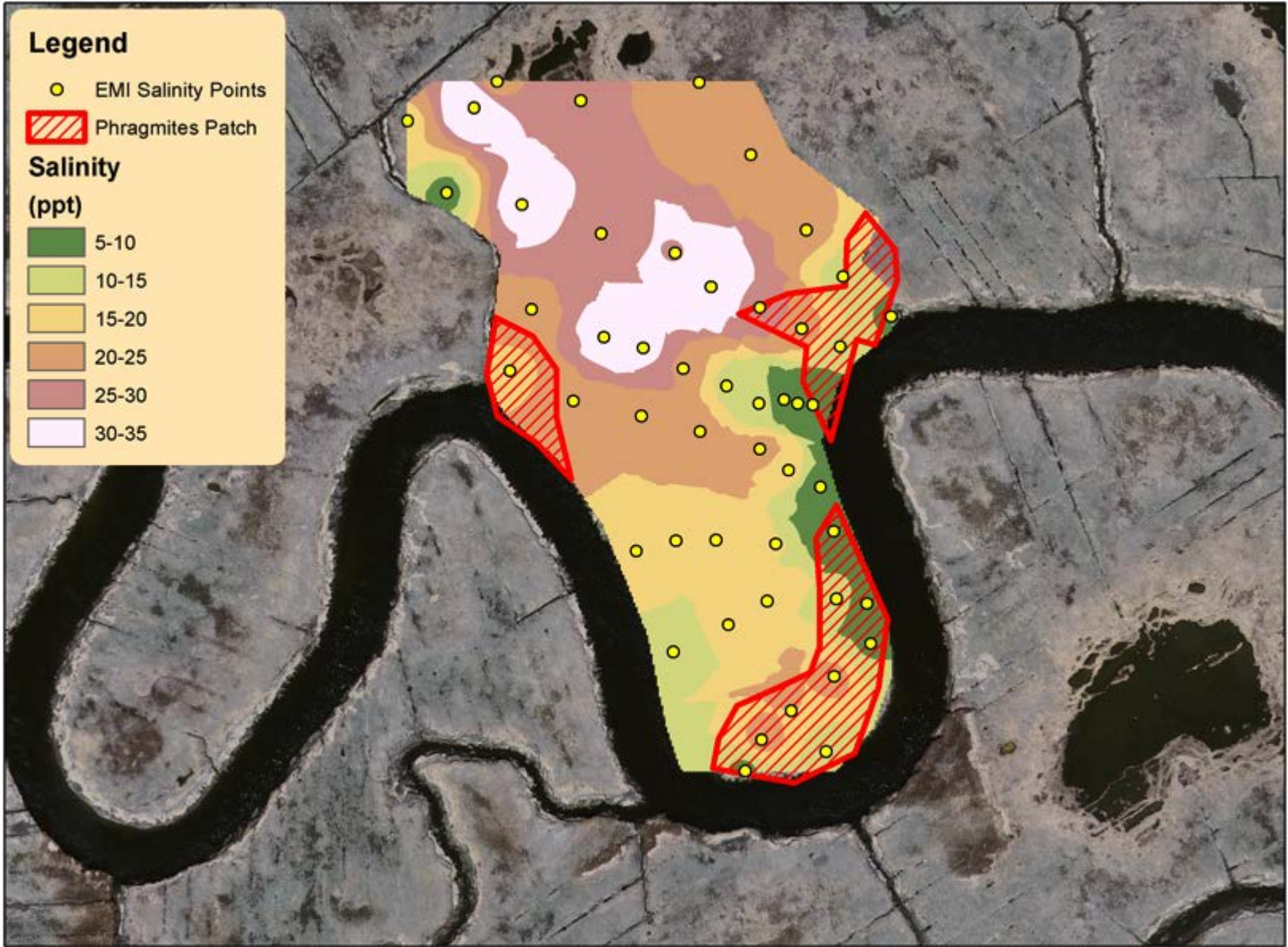


**Cut and Drip**



**Mowing**







# Results in Newbury Marshes

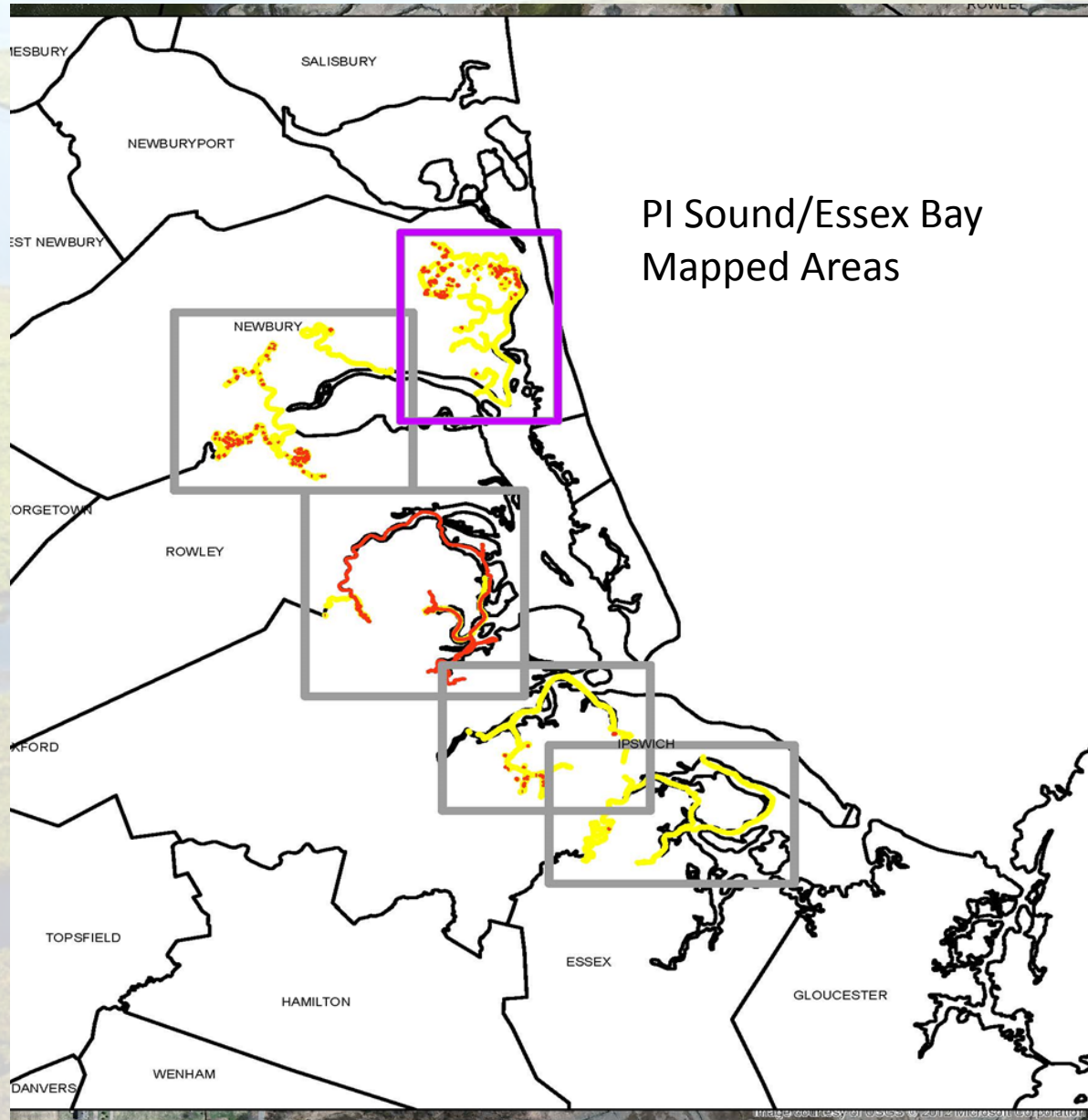
- Approximately 75 stands in the Plumbush Creek to Pine Island Creek open marsh (down from over 300)
- 75% of those are low density stands
- Very few high density stands left
- Robust native vegetation as replacement
- However, new stands emerging every year
- Six years of effort, not full coverage each time

## Results from Previous Year Treatments

- Reduction in Stand Size
- Re-vegetation with Native Plants

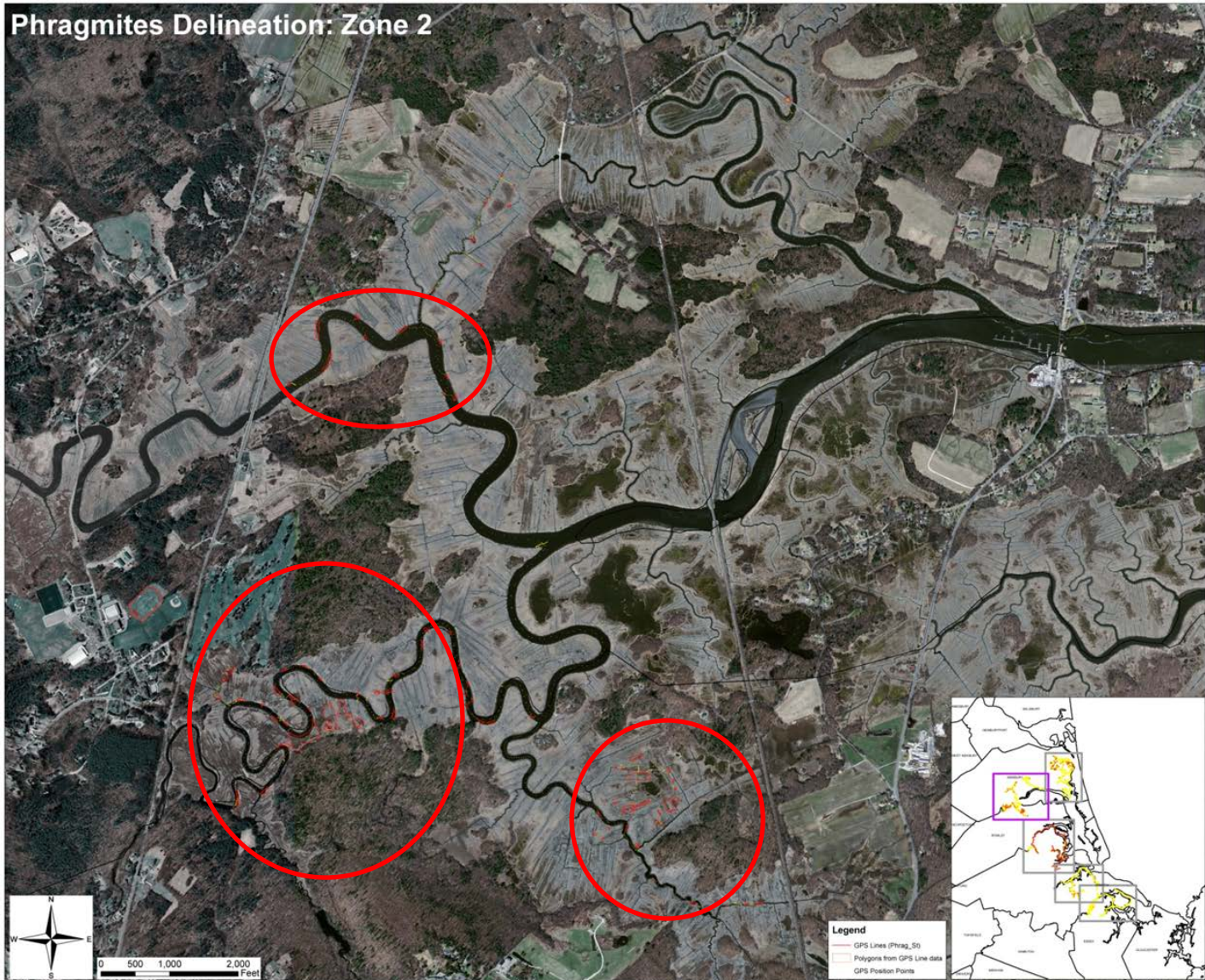


# Hurricane Sandy Resiliency Grant Treatment Areas



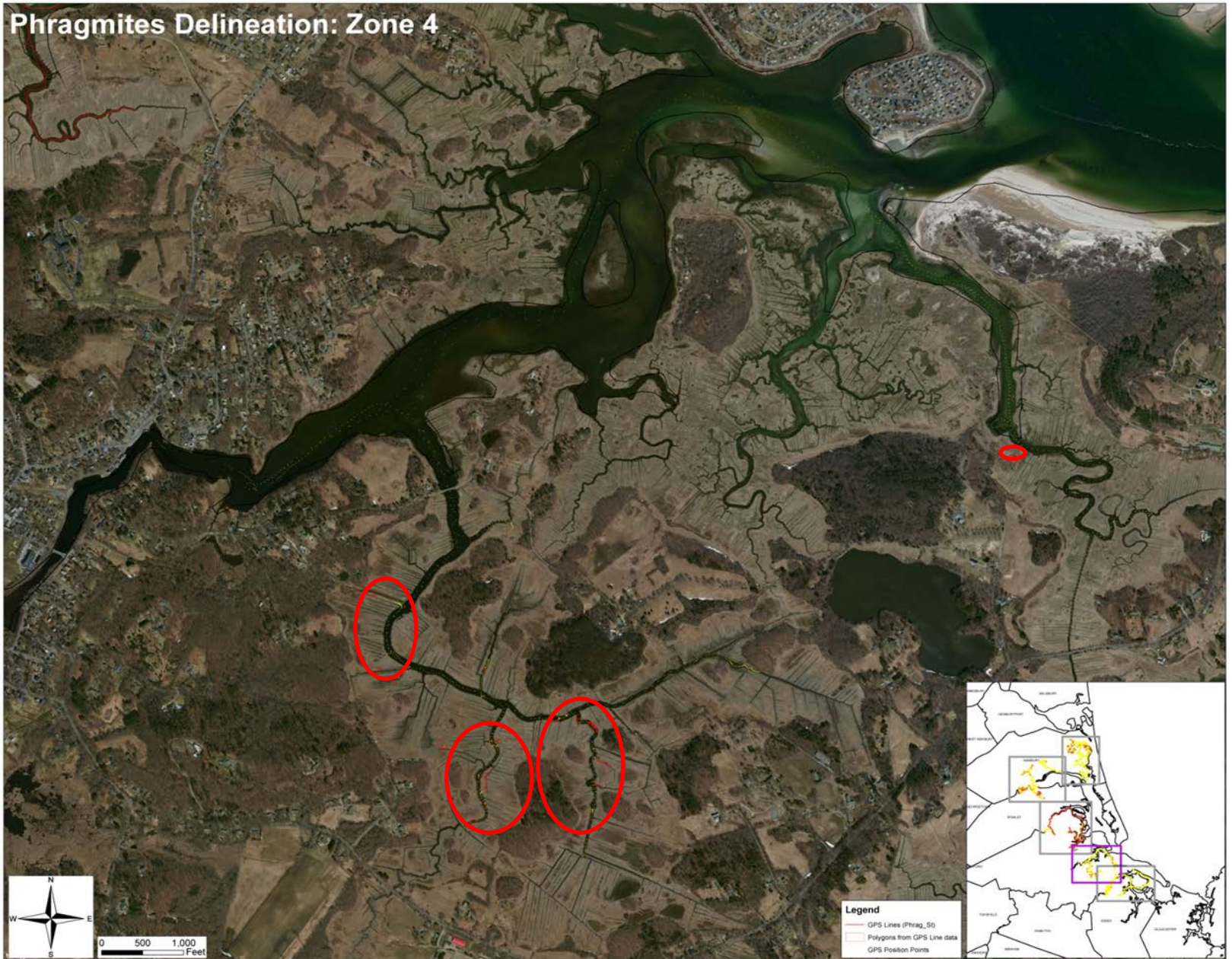
# Upper Parker and Mill River Phragmites Stands

## Phragmites Delineation: Zone 2



# Ipswich River Area

## Phragmites Delineation: Zone 4

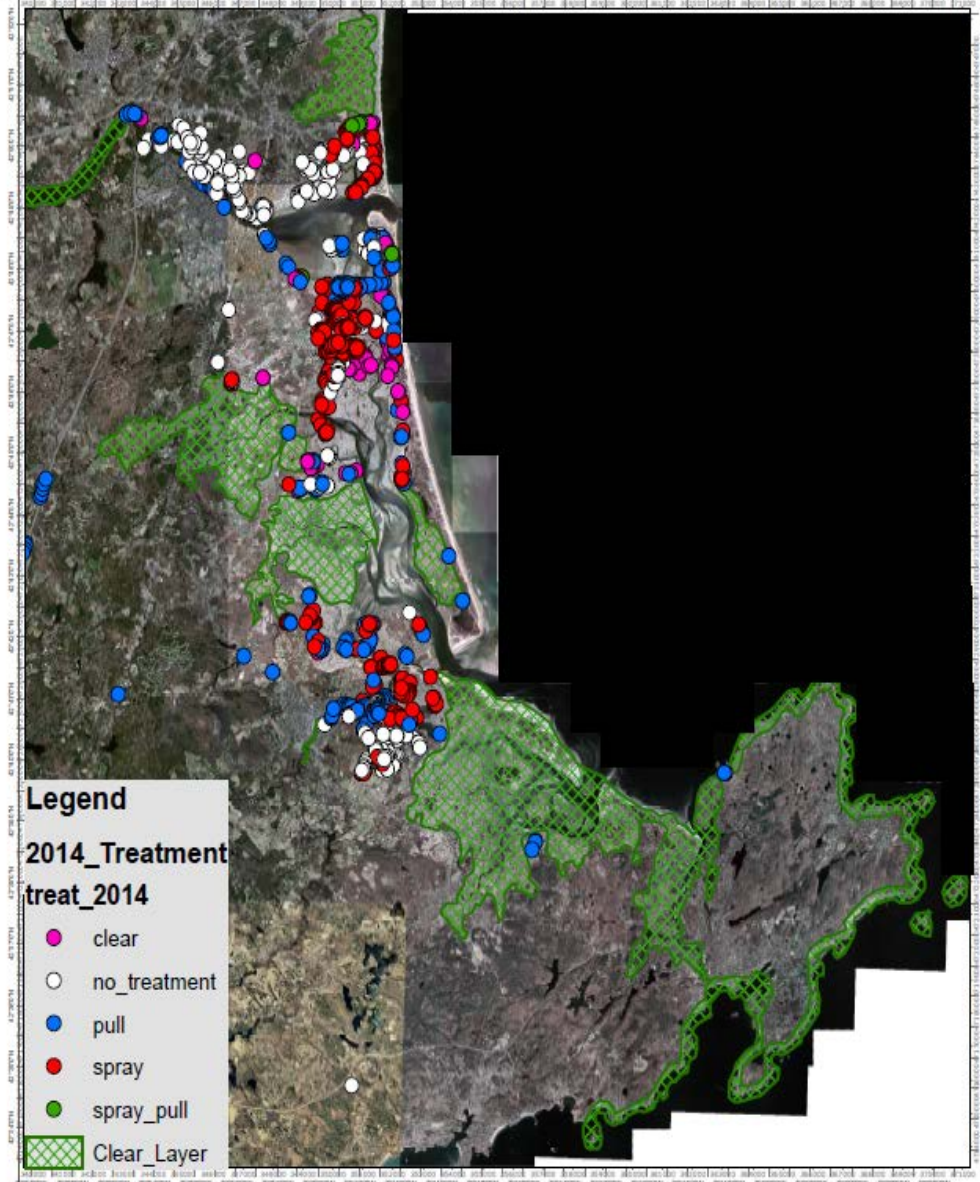


# Summary and Update

- Some sections of the open marsh require two or even three treatments
- We have seen a significant reduction in Phragmites most locations....and emergence of native vegetation
- New stands are appearing in low salinity areas....cannot treat the marsh forever
- Sandy funding has allowed us to develop a hydrodynamic model to identify salinity influx and concentrations patterns in the marsh
- Model recommendations will help us identify solutions to allowing more saltwater flow into the marsh and/or allow trapped freshwater to flow out of the marshes
- **Permits and Permissions in hand**
- **Treatment strategy for 2015 in place**

# Great Marsh Perennial Pepperweed Control





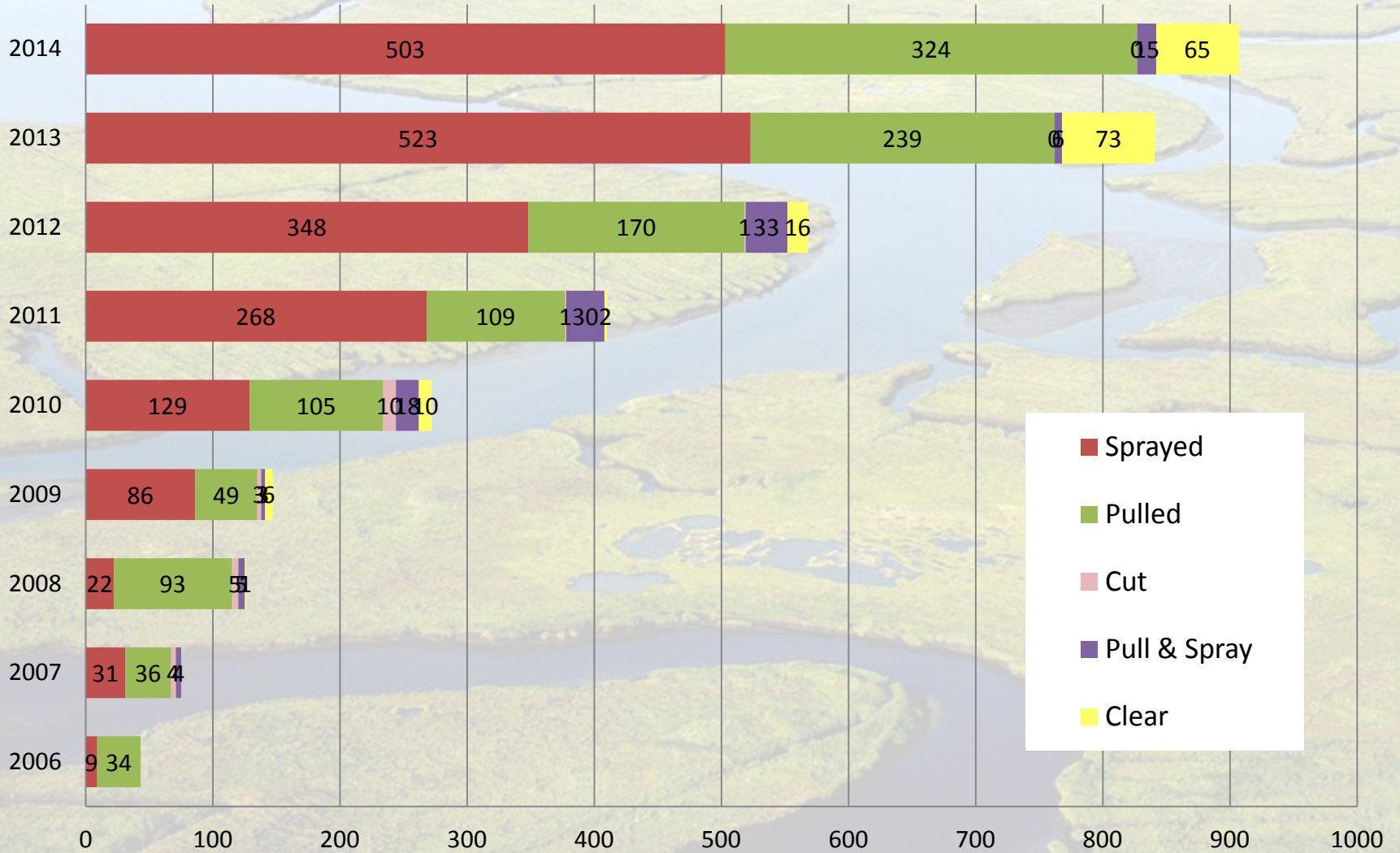
# Great Marsh Treatment 2014

- 30,000 acres have been mapped for pepperweed.
- 22,000 acres have been found clear of the plant.
- 8,000 acres are infested with pepperweed or under imminent threat from it.
- 850 stands were treated protecting approximately 1,580 acres.
- 70% of all sites mapped were treated.



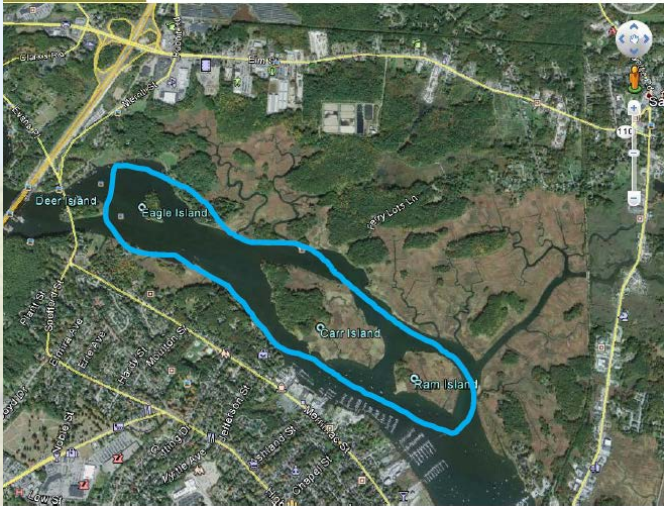


## Great Marsh Pepperweed Sites treated each year

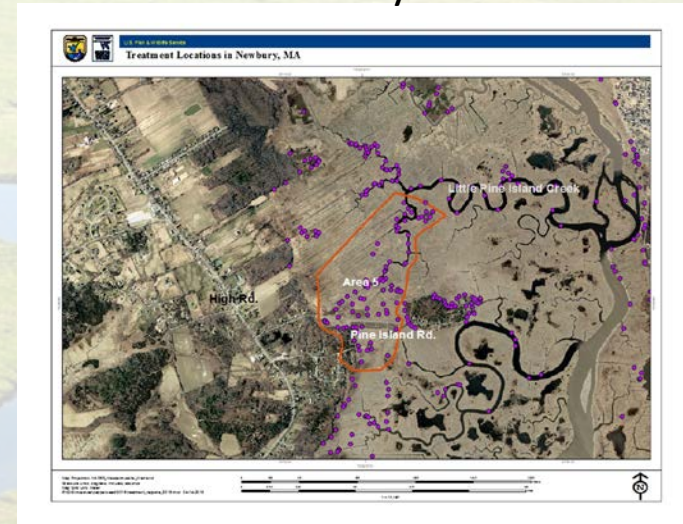


# 2015 Pepperweed Treatment Areas -Ongoing

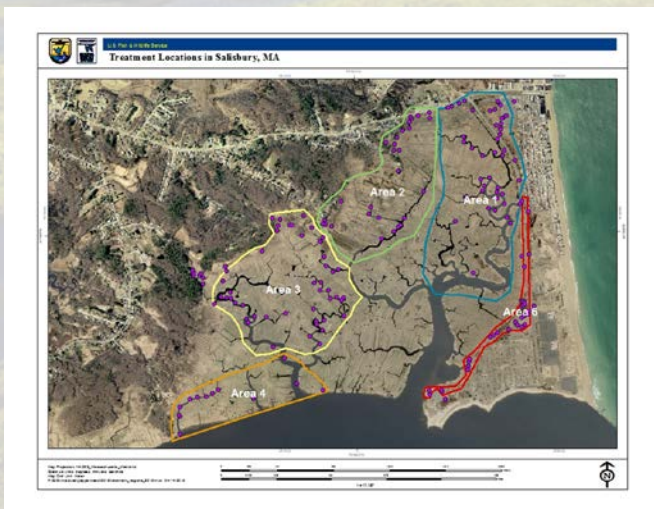
## Salisbury Islands



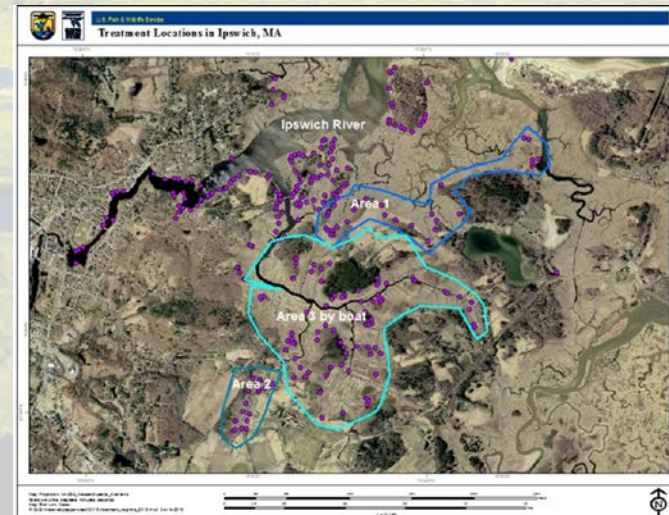
## Newbury



## Southeast Salisbury



## Ipswich

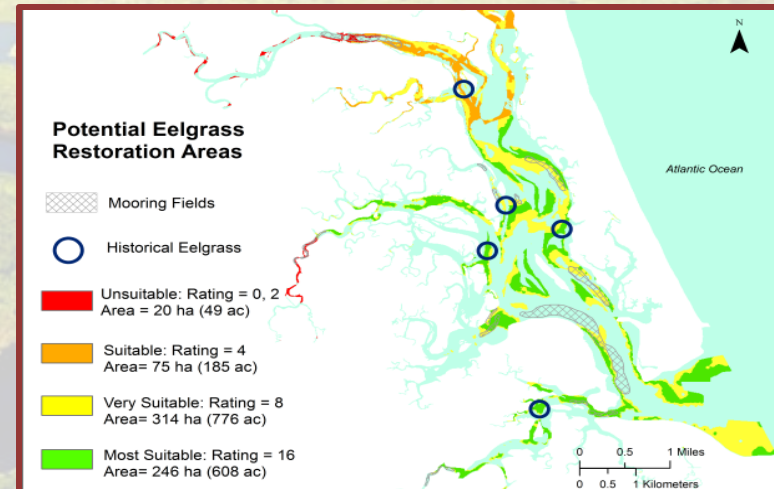


# Ecological Restoration and Enhancement

## Eelgrass Restoration

- Plum Island Sound and Essex Bay
- Transplant sites identified by modeling efforts
- Use multiple donor sources to build a genetically diverse population
- Green Crab Monitoring and Marsh Edge Erosion

Outcome: Restore 3 acres to naturally stabilize creek channels and tidal flats in Rowley, Ipswich, Essex and Gloucester



# Genetic Diversity



- Cape Code
- Scituate
- Nahant
- Great Bay
- Pleasant Bay
- Great Bay

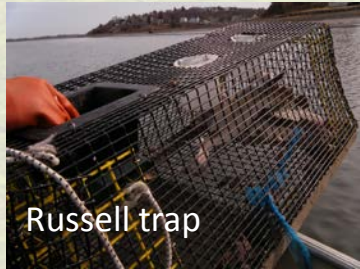


# Plant Sites Under Sandy Grant

- 80% survival mouth of Essex Bay
- 15% survival in other sections of Essex Bay
- 0% survival Plum Island Sound
- First set of 2015 eelgrass transplants completed



# Baseline Monitoring of Green Crab 2014



Russell trap

## Spring 2014

- 1384 total
- 0 to 215 CPUE
- 2 x females
- carapace 1.5 to 2 in

## Fall 2014

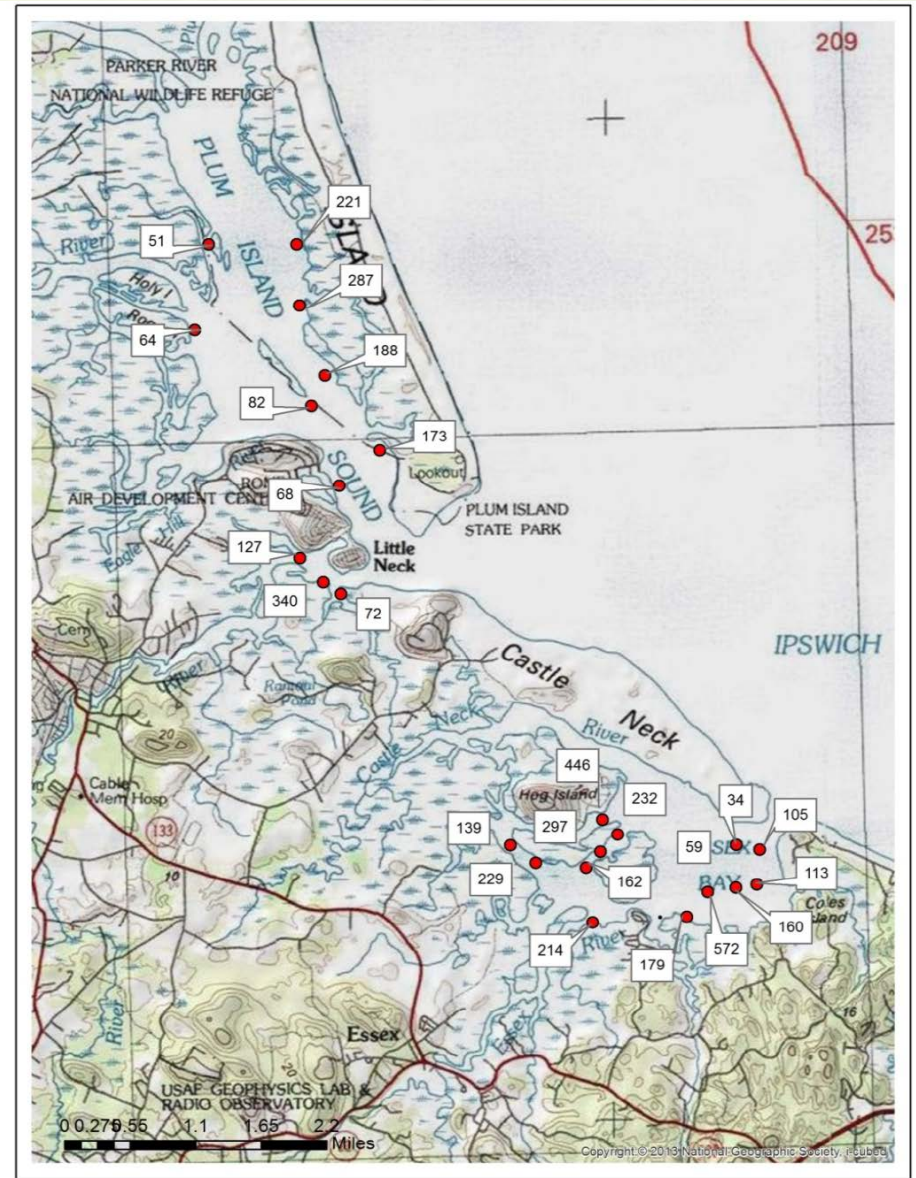
- 1720 total
- 15 to 226 CPUE
- females = males
- carapace 1.5 to 2 in

## Summer 2014

- 4762 total
- 34 to 572 CPUE
- 3 x females
- carapace 1.5 to 2 in

## Spring 2015

- two sampling periods
- less than 100 crabs caught

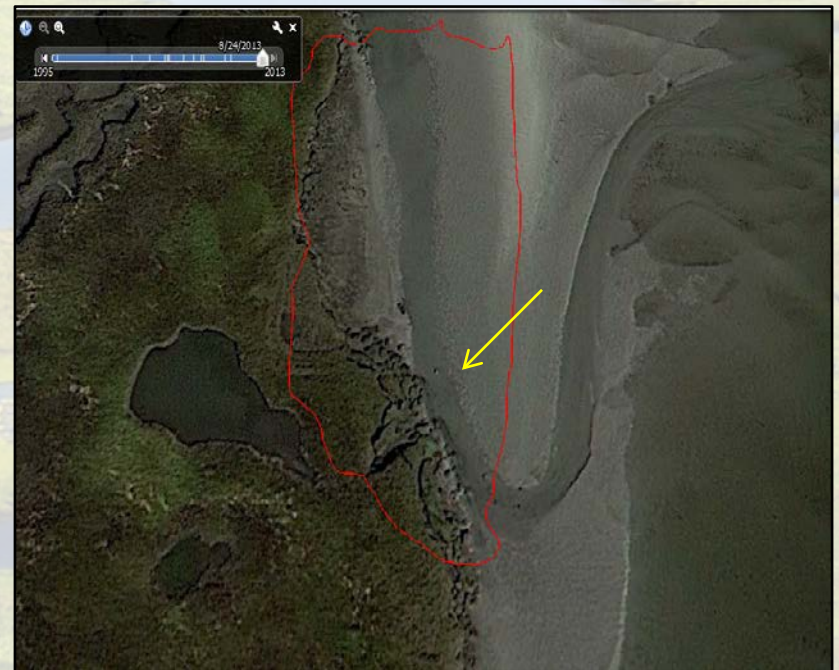
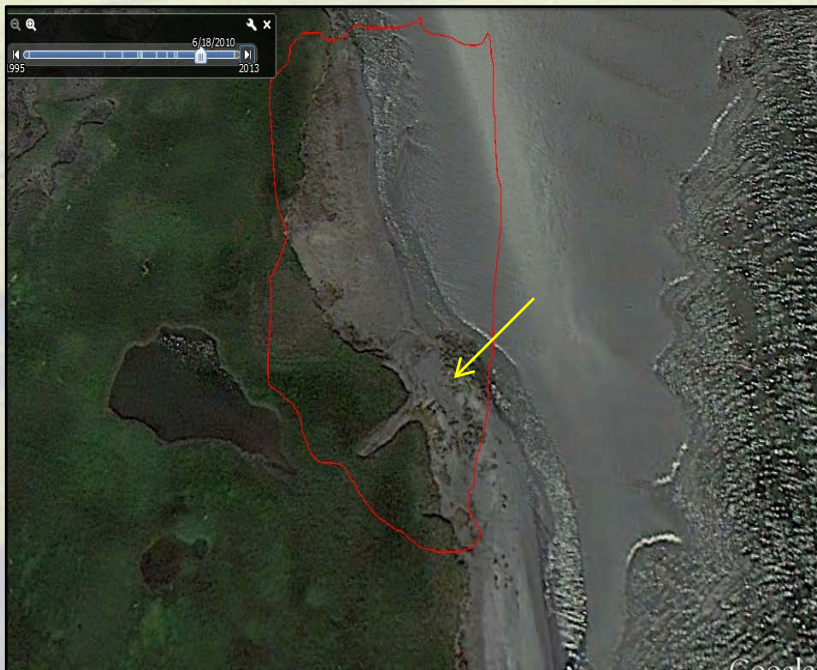


# Impact on Great Marsh Ecosystem



# Marsh Edge Erosion (MEE) in the Great Marsh

- Assess impact of Green Crab on marsh platform
  - loss at Roger's Island (>5 m) between 2010 and 2013



12 Transects being monitored in Essex Bay and Plum Island Sound

- 2015 Sediment cores, shear strength, marsh cameras, RTK, wave erosion tests



# Restoration Support through Youth Engagement Community Resiliency Planning

- Student Conservation Association
- Utilize volunteers
- Hire, train, and employ students for time-critical support project components



# Summation

By 2017, the Great Marsh will be well on its way back to being a healthy, resilient, functioning system; protecting the natural ecosystems and communities infrastructure from SLR and coastal storms



Marsh



## Transferability

In addition to the project actions and lessons learned from this restoration effort, it is anticipated that the stakeholder development and team model approach will be applicable throughout the MassBays geography