CASE STUDIES AND LESSONS LEARNED: THIN-LAYER DEPOSITION

Sam Whitin – EA Engineering, Science, & Technology, Inc. PBC

April 05, 2017

WHAT IS THIN-LAYER DEPOSITION?

- Aliases
  - Beneficial Reuse
  - Sediment Enrichment
  - Thin-Layer Placement
  - Marsh Enhancement

Who?


USACE & USFWS

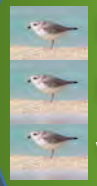

State of NJ


State of Delaware (DNREC)


Rhode Island CRMC


The Nature Conservancy

Initial Results


Limited Initial Success

Future Re-Applications

What are our choices?

Challenges


Permitting


Subsidence


What is “Thin”?


Bulking and Consolidation


Sediment Loss


How Does Sea-Level Rise Fit In?

PEPPER CREEK (2013 ~ $125,000)
DAGSBORO, DE
PROJCT PARTNERS: CENTER FOR ISLAND BAYS & DNREC'S DIVISION OF WATERSHED STEWARDSHIP

- Restore 25 AC area of tidal marsh
- Material hydraulically dredged and pumped to a barge for aerial application
- Approximately 35,000 CY of dredged material was sprayed on the marsh surface at a thickness ranging from 1 to 6 inches
- Marsh is showing signs of recovery, but not a success just yet

Photo Credit: Bart Wilson

PEPPER CREEK (continued)
DAGSBORO, DE

- Sediment placed was 85-90% water
- Installed hay bales/coir logs in ditches
- As a result of spray impacts, replanting of disturbed vegetation was necessary

Photo Credit: Michael Globetti/DNREC Public Affairs

PRIME HOOK (2014-2016 ~$38M)
MILTON, DE

PROJECT PARTNERS: USFWS, State of Delaware, USGS, University of Delaware

- 4,000 AC marsh restoration
- 10 miles of channel dredging
- Thin-layer deposition was secondary facet of project, but project is heavily studied which will help us better understand impact of thin-layering impacts

Photo Credit: Bart Wilson, USFWS Prime Hook NWR

STONE HARBOR, AVALON, AND FORTESCUE (2014-2016) NJ

PROJCT PARTNERS: USACE, STATE OF NJ, NATURE CONSERVANCY

- What
  - Stone Harbor: ~7,000 CY of sediment dispersed over 0.5 AC
  - Avalon: ~50,000 CY of sediment dispersed using aerial and ground applications
  - Fortescue: ~15,000 CY of sediment dispersed to restore 10 AC of degraded salt marsh and 3 AC of beach along Delaware Bay
- Outcome
  - Still in long term monitoring, but initial vegetation response is somewhat positive
  - Lessons learned in regard to elevation control, containment, and sediment contamination

Photo Credit: Joel Pecchioli, NJDEP (Avalon)

STONE HARBOR
STONE HARBOR, NJ

- Dredged material was pumped 1.5 miles
- Dredge material was 96% fine sand
- Ultimately created Black Skimmer habitat rather than true salt marsh

Photo Credit: NJ DEP and The Gazette of Middle Township (Stone Harbor)

AVALON (~ $1,500,000)
AVALON, NJ

- Developed biological target elevation
- Thickness ranged from 0.5 to 20 inches in pools
- Dredge material was 16% clay, 50% silt, and 34% fine sand
- Bulking, consolidation, and settlement rates made it clear that preference would be to model first, if possible

Photo Credit: Joel Pecchioli, NJDEP (Avalon)

FORTESCUE (~ $3,800,000)
FORTESCUE, NJ

- Thickness ranged from 0 to 48 inches in pools
- 33,000 CY material dredged (greater volume than was dispersed via thin-layer deposition)

Photo Credit: Phillip Tomlinson South Jersey Times (Fortescue)

JOHN H. CHAFEE NATIONAL WILDLIFE REFUGE (2016/2017 ~ $1,700,000) NARRAGANSETT, RI

PROJECT PARTNERS: USFWS, THE NATURE CONSERVANCY, RHODE ISLAND CRMC

- 24,000 CY of reclaimed material
- Placement of 3,000 bags of clam and oyster shells to protect against marsh edge erosion and to hold sediment and water on the marsh platform
- Initial indications are that the project should be successful

Photo Credit: Greg Thompson/USFWS

JOHN H. CHAFEE NATIONAL WILDLIFE REFUGE (continued) NARRAGANSETT, RI

- No more than 6-inch placement thickness
- Shallow water levels made dredging and equipment transportation difficult
- Custom made machinery and in-field equipment modifications
- Dredge material dispersal will be accomplished via amphibious excavator

Photo Credit: The Nature Conservancy

NINIGRET POND SALT MARSH RESTORATION & ENHANCEMENT PROJECT NARRAGANSETT, RI (2016/2017 ~ $1,400,000)

PROJECT PARTNERS: RHODE ISLAND CRMC, USFWS, SAVE THE BAY

- 25 AC of degraded salt marsh
- 60,000 CY of dredge material was split in half between beach nourishment and marsh restoration

Photo Credit: J. F. Brennan

NINIGRET POND SALT MARSH RESTORATION & ENHANCEMENT PROJECT NARRAGANSETT, RI (continued)

- Material was placed between 0 and 12 inches higher than existing elevations
- Dredging window (winter); required dredging activities persist 6 days a week, 24 hours a day
- Additional planting is neccesary

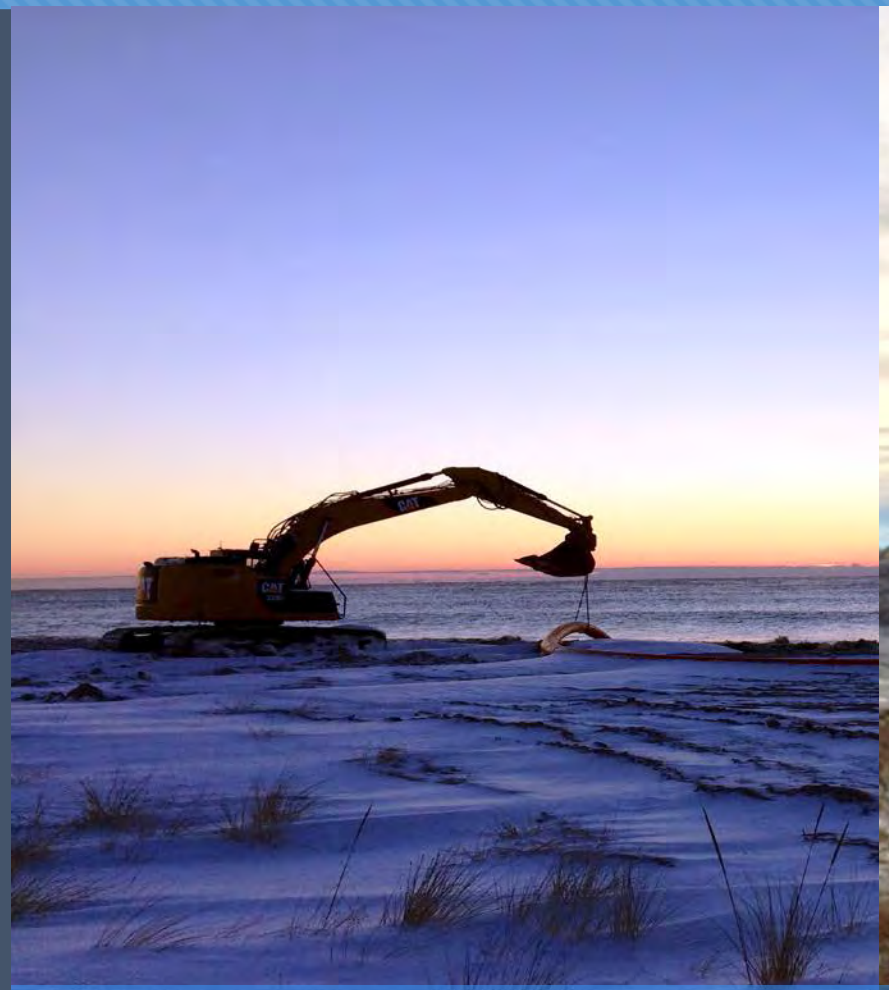


Photo Credit: J. F. Brennan

SACHUEST POINT NATIONAL WILDLIFE REFUGE (2016 ~ $644,000) MIDDLETOWN, RI

PROJECT PARTNERS: U.S. FISH & WILDLIFE SERVICE & THE NATURE CONSERVANCY

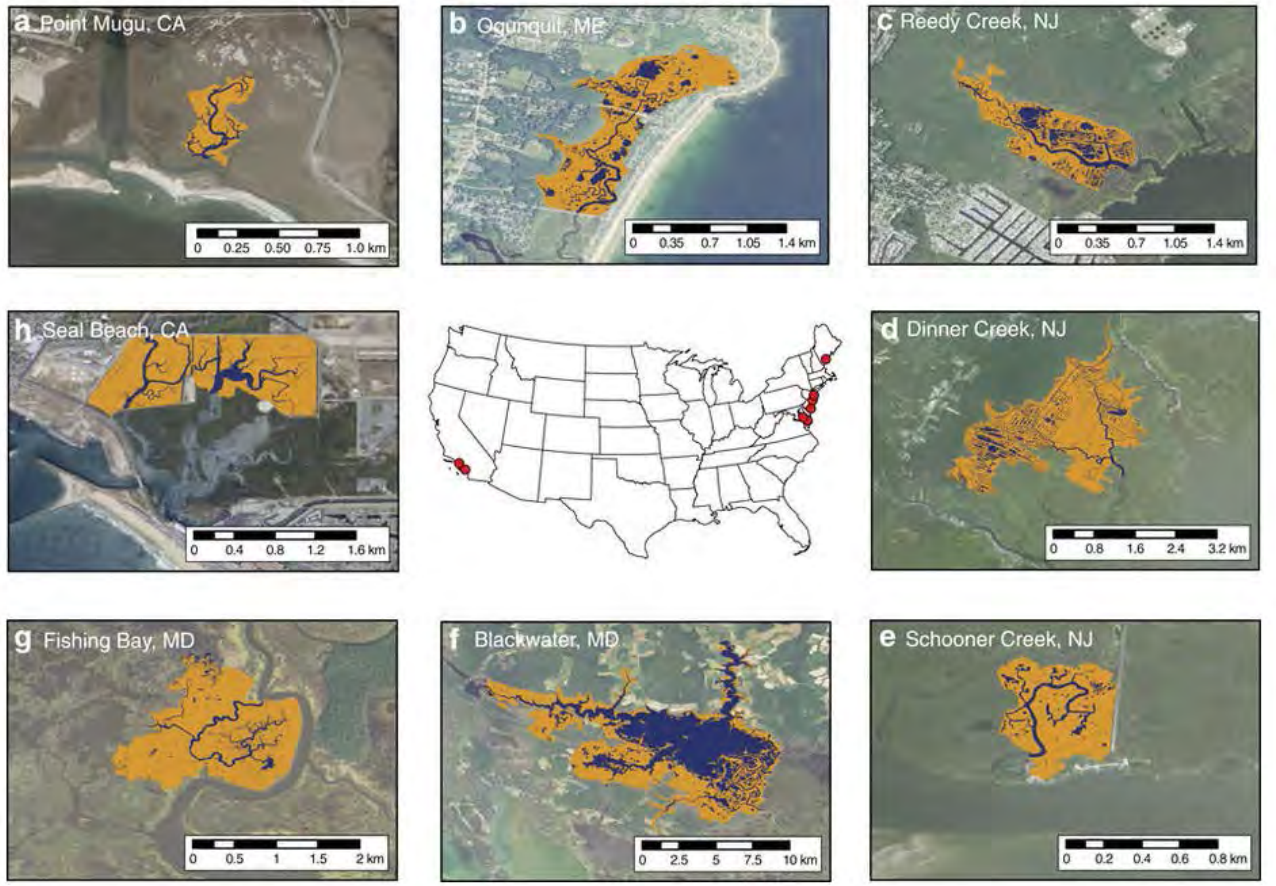
- 11,000 CY of dredged material was applied to 11 AC
- Material was dredged hydraulically and placed on the marsh platform to dry out; placement occurred by means of spreading and grading the material with a lightweight amphibious excavator
- Encouraging results with deposition thickness from 1 to 12 inches across the marsh surface

Photo Credit: Anne Post/USFWS

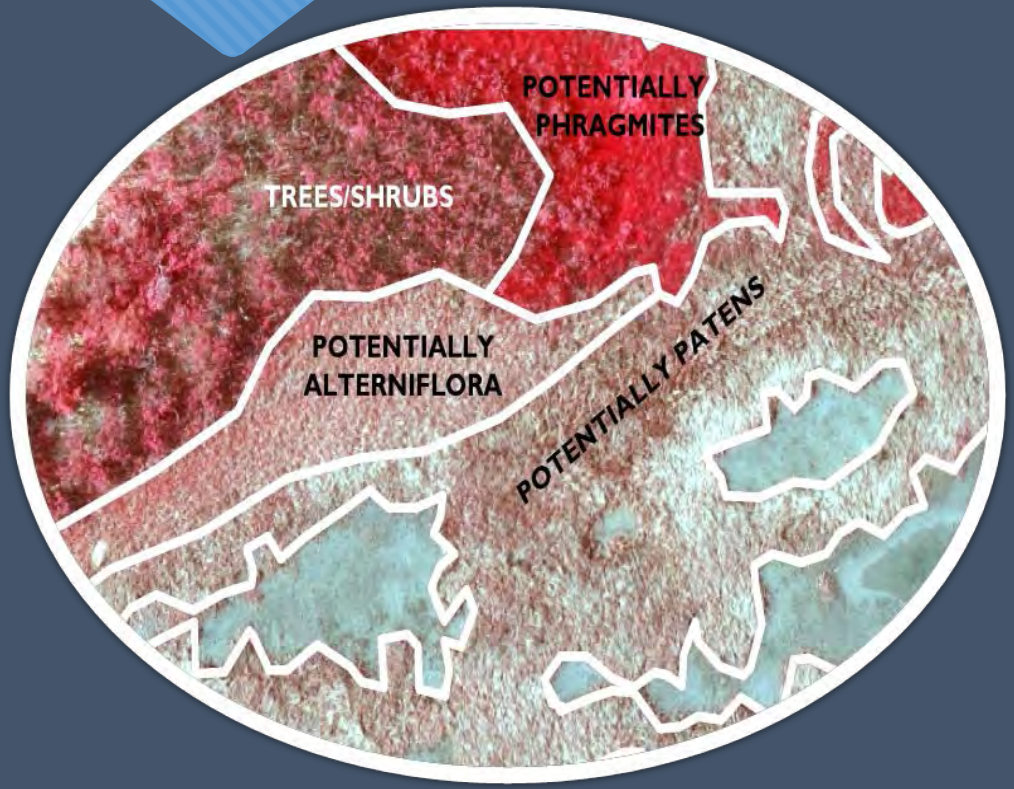
WHAT IS THE FUTURE APPROACH TO THIN-LAYER DEPOSITION LOOK LIKE BASED ON CASE STUDIES?

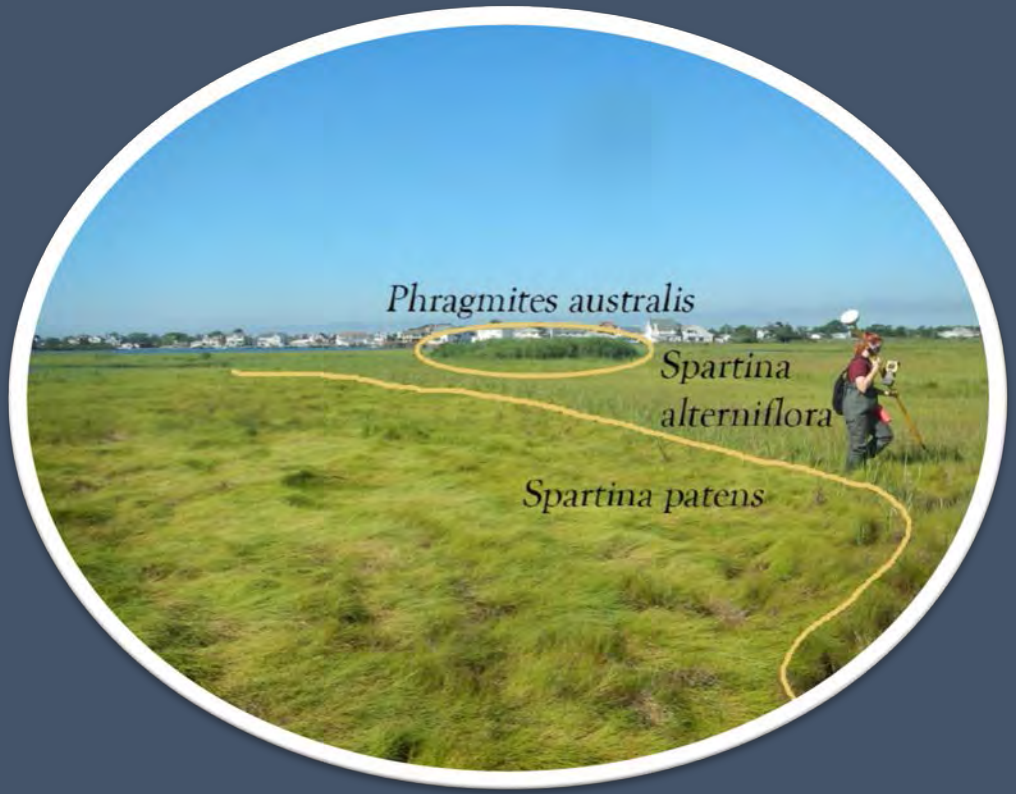
- USGS and Neil Ganju, et. al paper
- Sediment starved marsh system can't keep up with sea-level rise
- Use of unvegetated/vegetated marsh ratio in microtidal environments to determine potential need for TLD

From: Spatially integrative metrics reveal hidden vulnerability of microtidal salt marshes



ESTABLISHING A BIOLOGICAL TARGET ELEVATION
INITIAL VEGETATION & ELEVATION SURVEYS

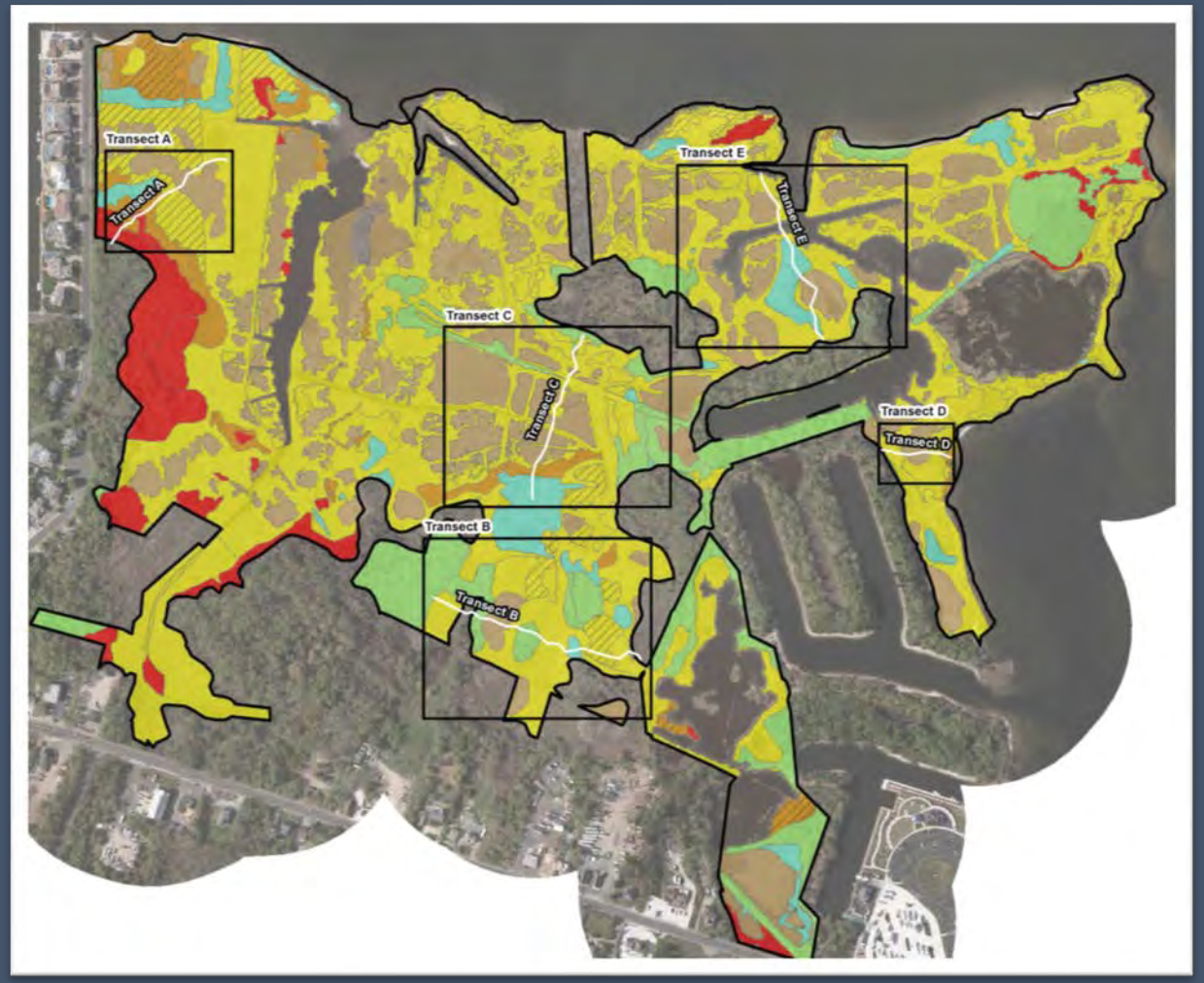




- Traditional aerial photointerpretation using infrared photography and LiDAR elevations
- Spatial and temporal scale and budget all greatly influence approach
- As always, field-truthing elevation and vegetation to the greatest degree possible is critical

ESTABLISHING A BIOLOGICAL TARGET ELEVATION VEGETATION MAPPING & STAKEHOLDER CHOICE

- Under short deadlines, data collection is aimed at developing designs, not necessarily assessing conditions
- Verify vegetated marsh zones along with an establishment of a local tidal datum
- Stakeholders to choose target biological elevation (MCDA tool can be useful)

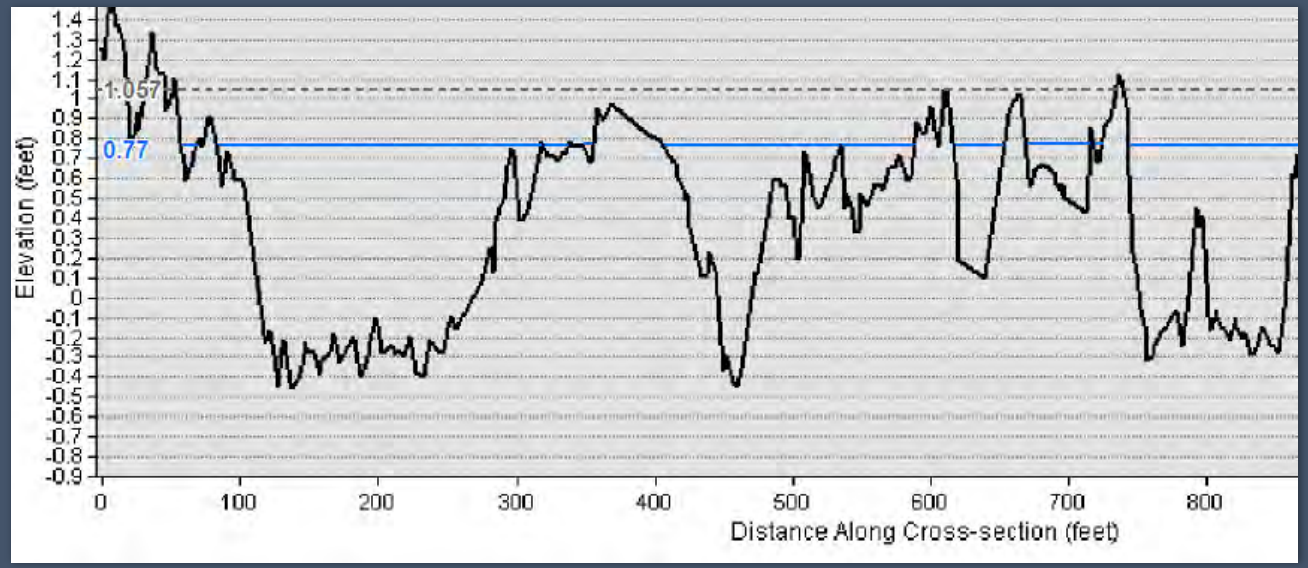


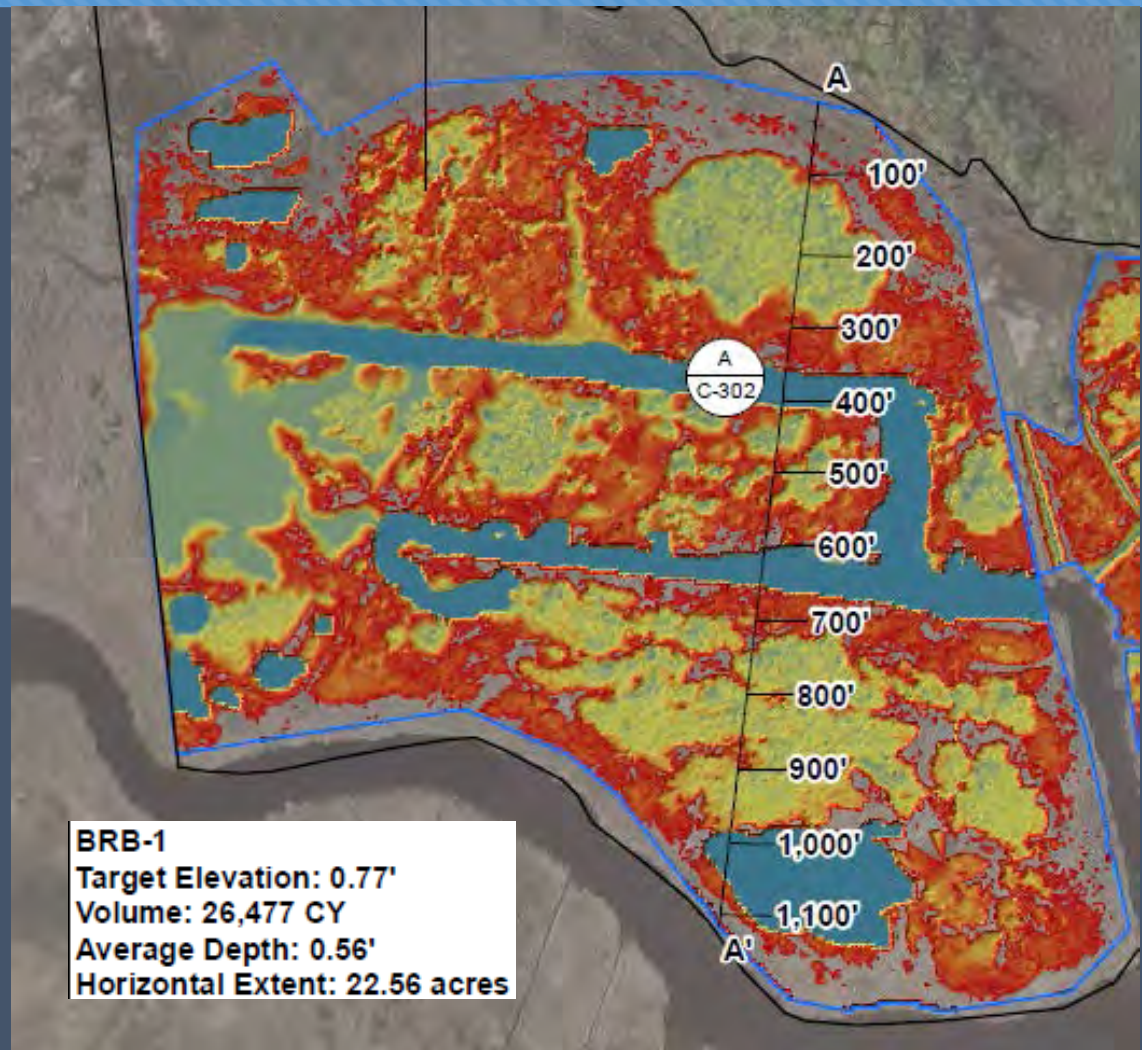
MULTI CRITERIA DECISION ANALYSIS (MCDA): APPLICATION TO THIN LAYER DEPOSITION

- In consideration of sea-level rise – how do you not end up with an elevation which promotes Phragmites growth?
- How are habitat values and decisions made for the long term?

Interests and Sub-Interests	Year 0 SLR Design	Year 5 SLR Design	Year 10 SLR Design	Year 15 SLR Design
Year 0				
Mudflat	5	5	5	1
Low Salt Marsh	1	1	5	2
High Salt Marsh	5	5	2	1
Phragmites	1	5	5	5
Upland	5	5	5	5
Contruction Cost				
	3	3	3	3
Schedule Impacts				
	5	5	5	5

TARGET ELEVATIONS





FINAL THOUGHTS

- Dredge Project vs. Marsh Restoration Project
  - This can't just be a "handshake", the implications must be fully discussed and understood
- Construction techniques still being worked out
- Permitting and especially Essential Fish Habitat and USACE concerns should be fully vetted
- Sea-level rise and implications of setting a high target elevation
- As always – adaptive management is essential to successful completion

Beneficial Reuse and Marsh Elevation Enhancement on Rhode Island's South Shore

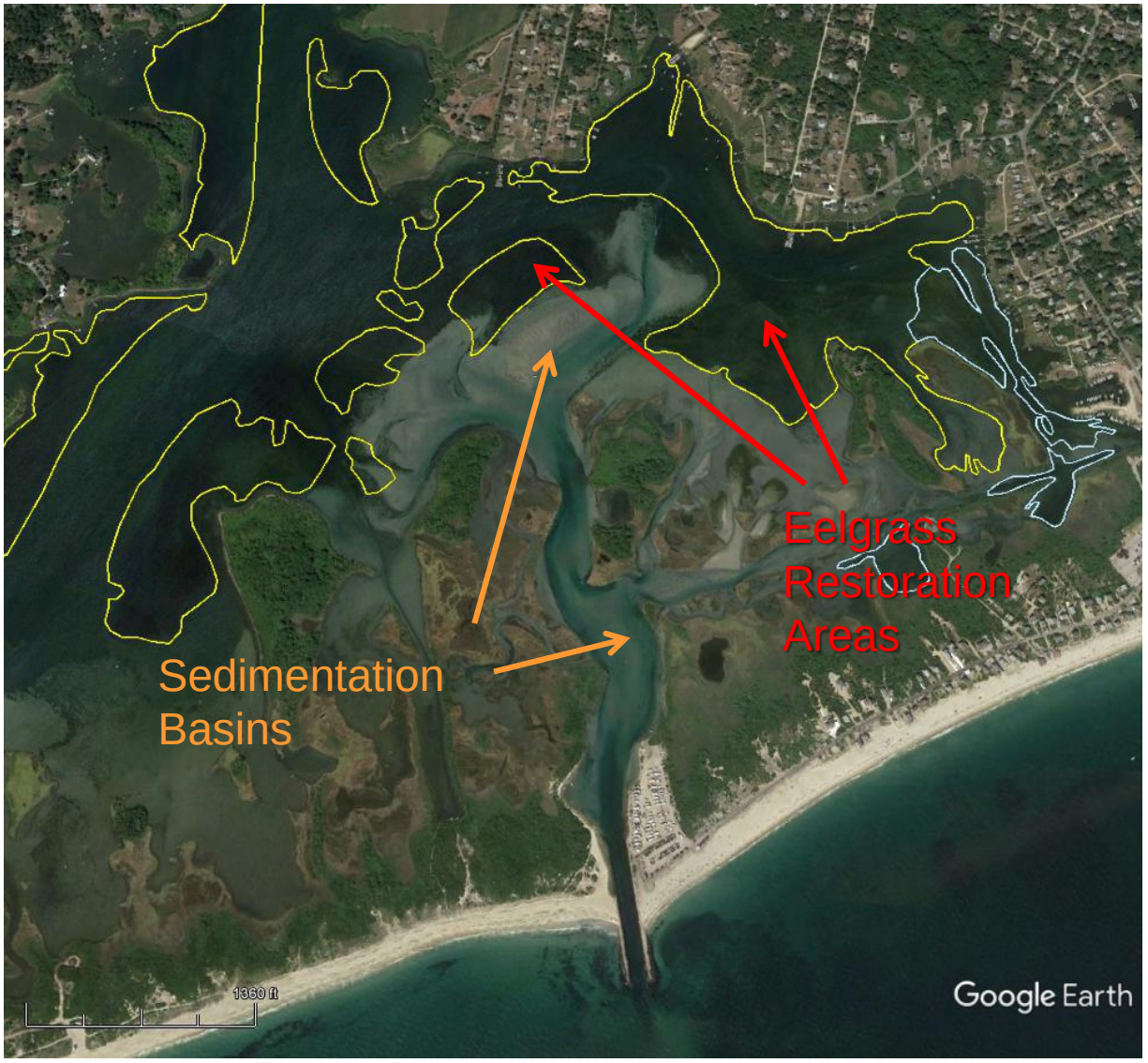
NROC / NALCC Science Delivery Workshop
April 5, 2017

Caitlin Chaffee, RI Coastal Resources Management Council

Maren Frisell, Fuss & O'Neill, Inc.

Site History

- **2007 USACE Habitat Restoration Project**
  - Dredged 40 acres of tidal shoals for eelgrass restoration
  - Dredged channel sedimentation basins to slow future shoaling and improve navigation
- **2010 Maintenance Dredging Project**



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Observed Impacts to Project Site

- Vegetation die-off
- Shallow ponded areas with algal mats
- Loss of high marsh species

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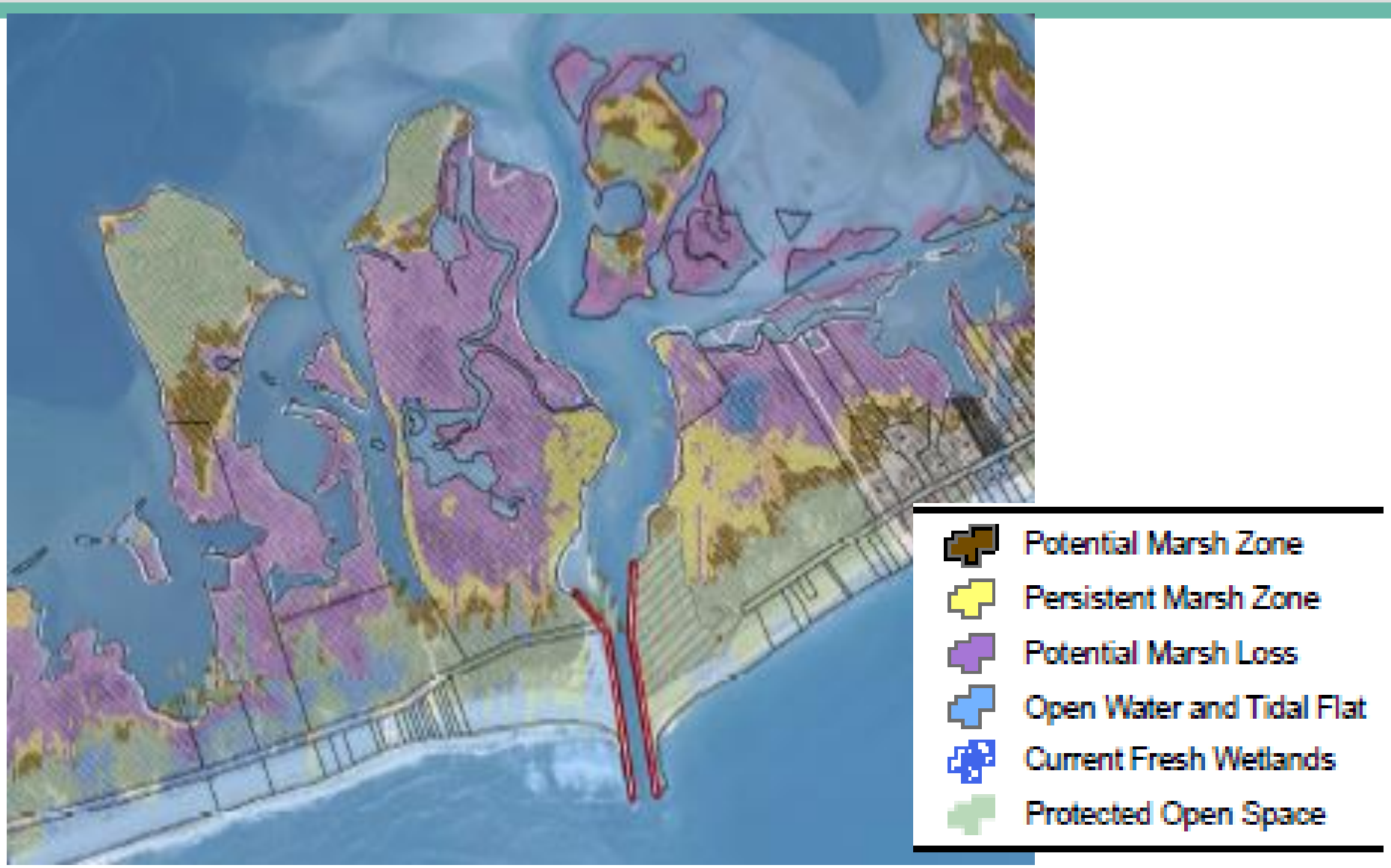
Sea Level Affecting Marshes Model Results



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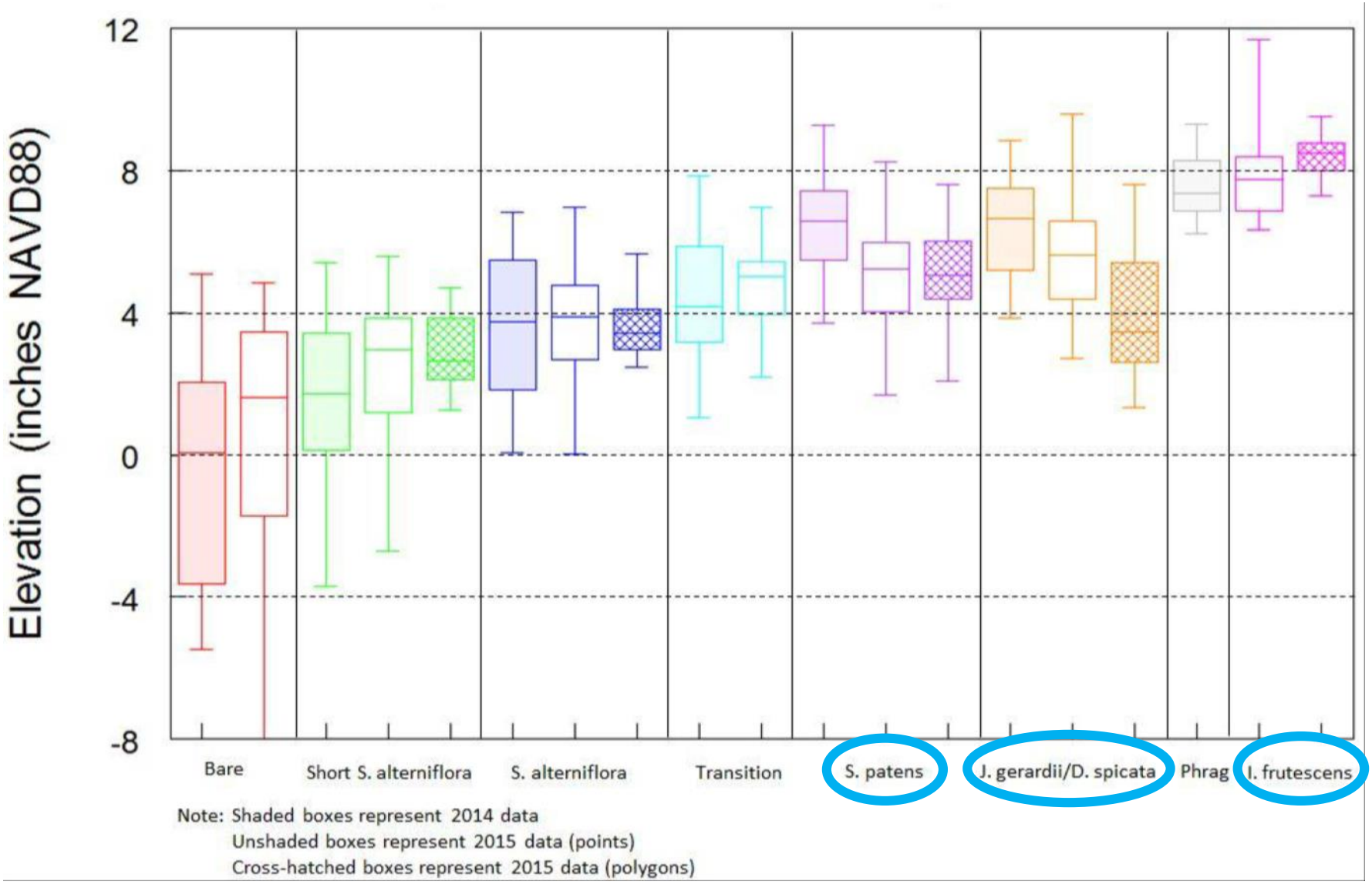
Vegetation Elevation Ranges



Sediment Analysis

- Estimated compaction/ consolidation evaluated based on bulk density and depth of organic layers
  - <0.5” compaction for areas with 6” or less of organic material
  - Up to 1.5” compaction for areas with 12” of organic material

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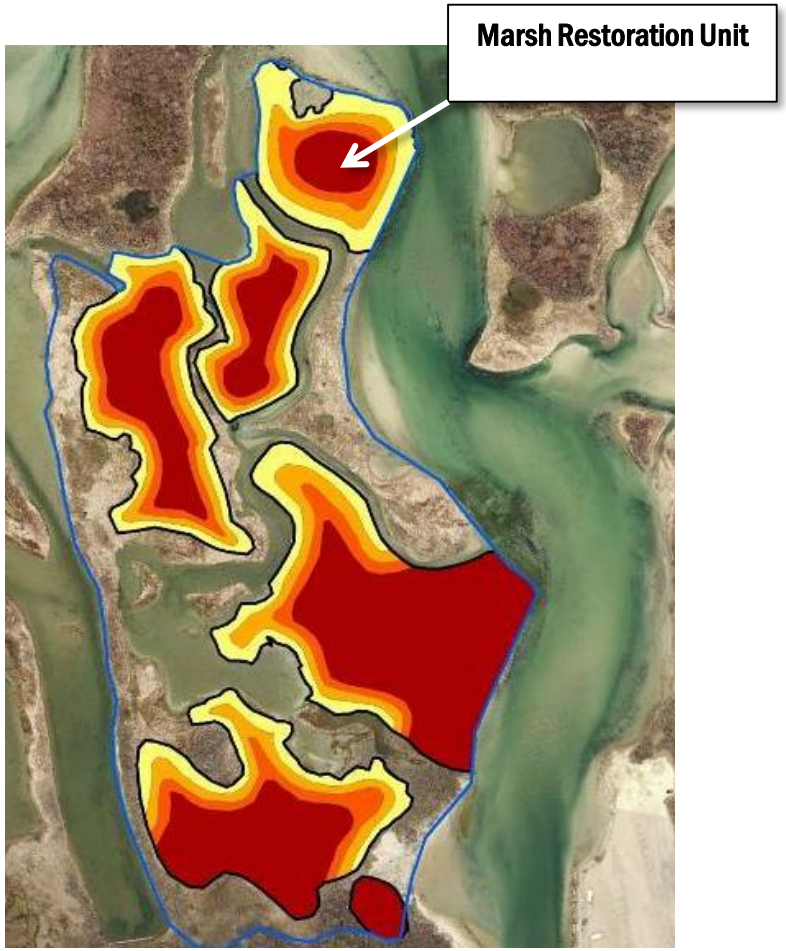
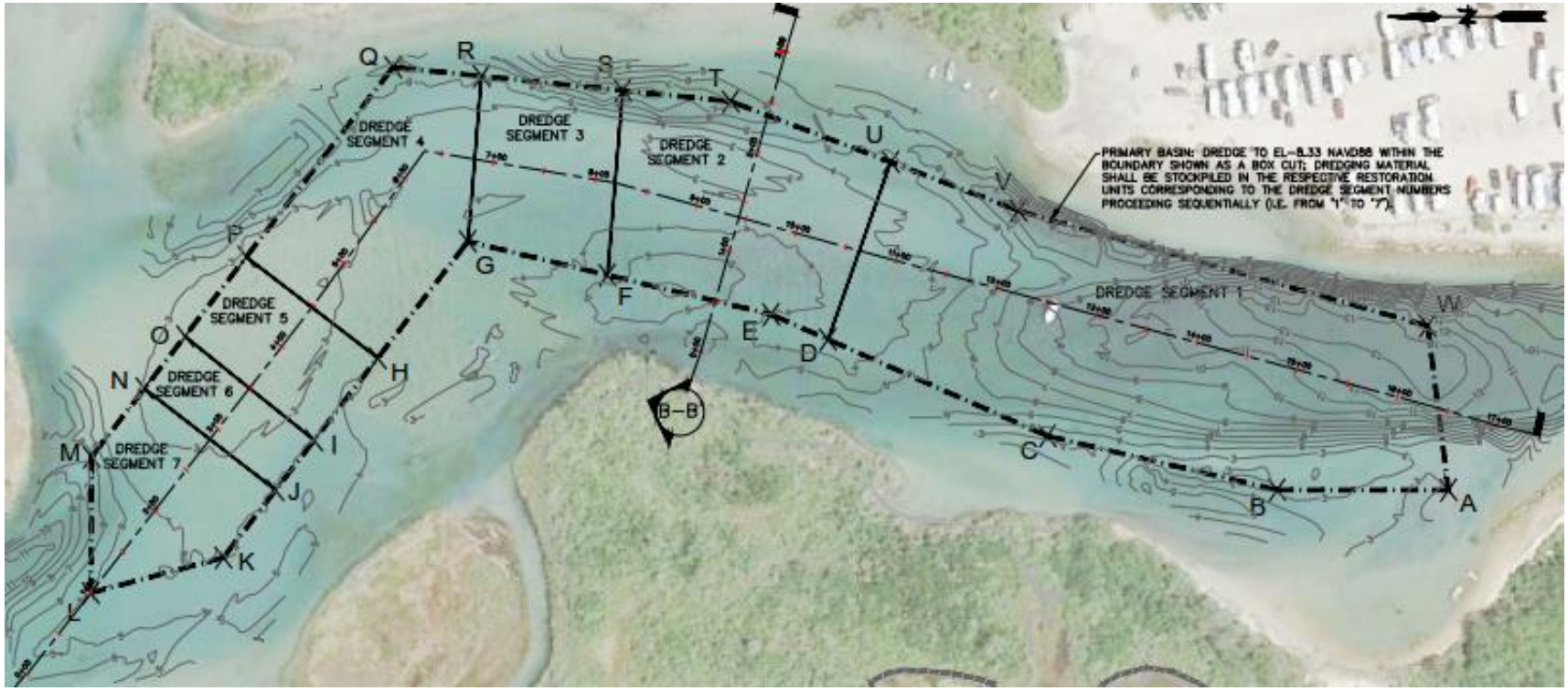
Fill Elevations and Grading

- Set max target elevation at elevation 1.2 ft NAVD88
  - Compaction
  - Sea Level Rise
  - 20% Contingency Volume
- Grading/ Runnels for drainage
- Historic creeks and pools to remain



Dredging and Stockpiling

- Basin volumes determined using bathymetric survey and target elevations
- Established segments of basin for specific marsh restoration units



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Monitoring/ Adaptive Management

- Pre and Post Restoration Parameters
- Coordination with Save The Bay, SHARP program, EPA AED and USFWS
- BACI design, reference site at adjacent National Wildlife Refuge

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Permitting and Regulatory Compliance

- NEPA EA /Section 106 (USFWS lead federal agency)
- USACE Section 404 Permit (includes sign-off by EPA, NOAA Nat. Marine Fisheries Service)
- State Section 401 Water Quality Certification
- CRMC Assent

US Army Corps of Engineers ®

D·E·M Rhode Island Department of Environmental Management

U.S. Fish & Wildlife Service

CRMC Coastal Resources Management Council

United States Environmental Protection Agency

NOAA Fisheries

Project Costs

Approx. 68,000 cy dredged material to restore approx. 20 acres of marsh

- Design, Engineering and Permitting: $110,453
- Construction
  - Mobilization / Demobilization: $334,400
  - Dredging, spreading and grading of material: $543,900
  - Alternate dredging: $530,812
- Planting: $100,000
- TOTAL: $1,619,565

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Challenges

- Uncharted territory for New England permit team
- Addressing needs and expectations of local partners while meeting project deliverables
- Time-of-year restrictions (for dredging AND placement)
- Limited local pool of expertise / equipment
- Multiple projects in RI pipeline

Lessons Learned

- Manage partner expectations for design and outcomes
- Single contractor for dredging and in-marsh work
- Listen to bidder feedback and be open to issuing addenda
- Contractor should have survey team / capabilities
- Be prepared to make in-the-field decisions about project design / target elevations
- Provide for regular construction oversight
- Provide for immediate and long-term adaptive management measures

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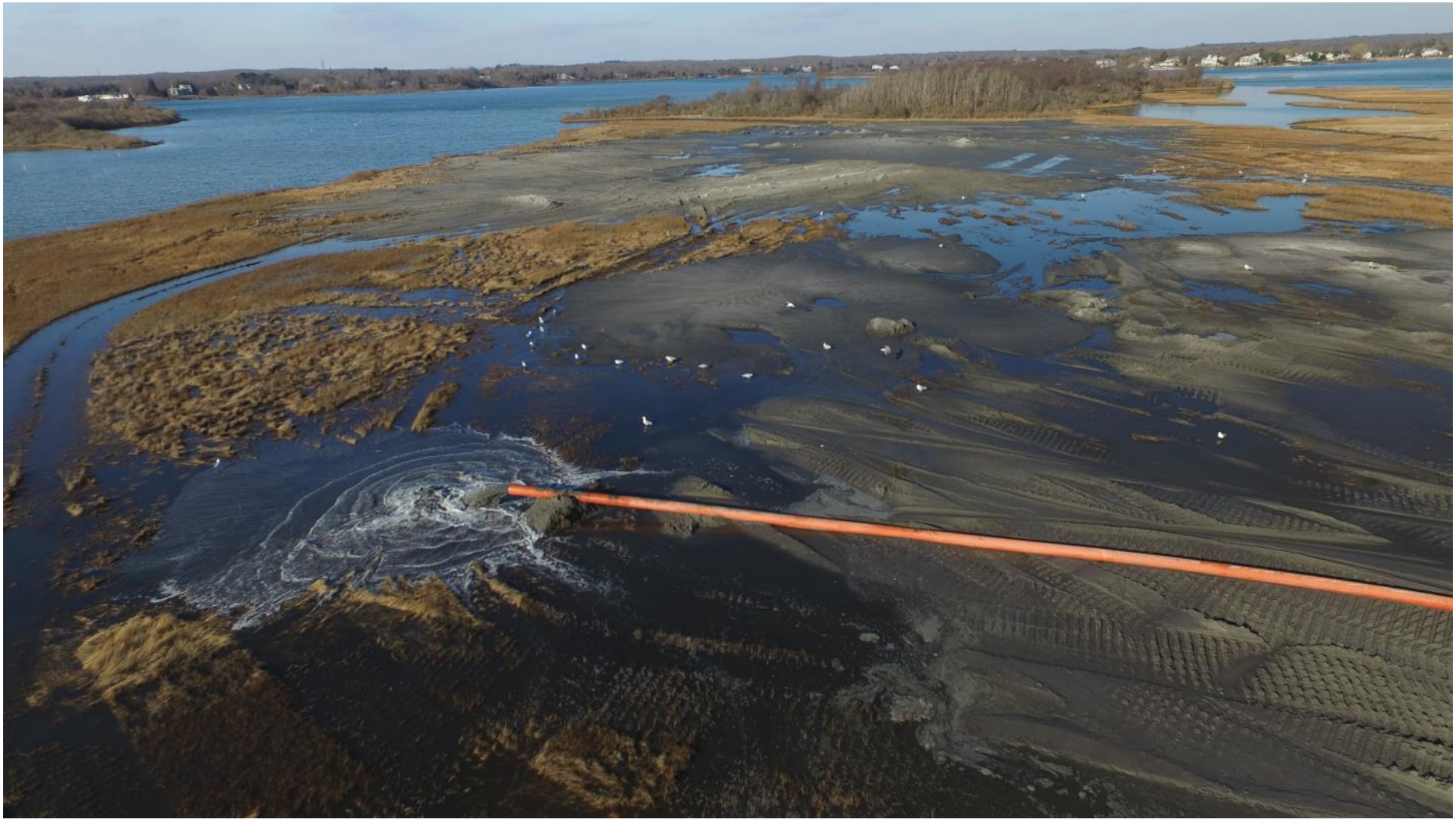

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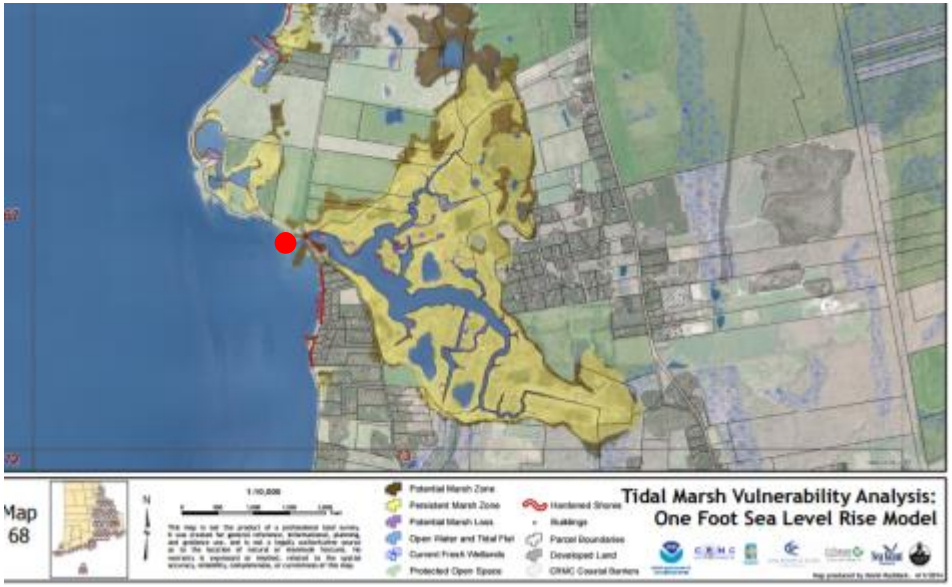
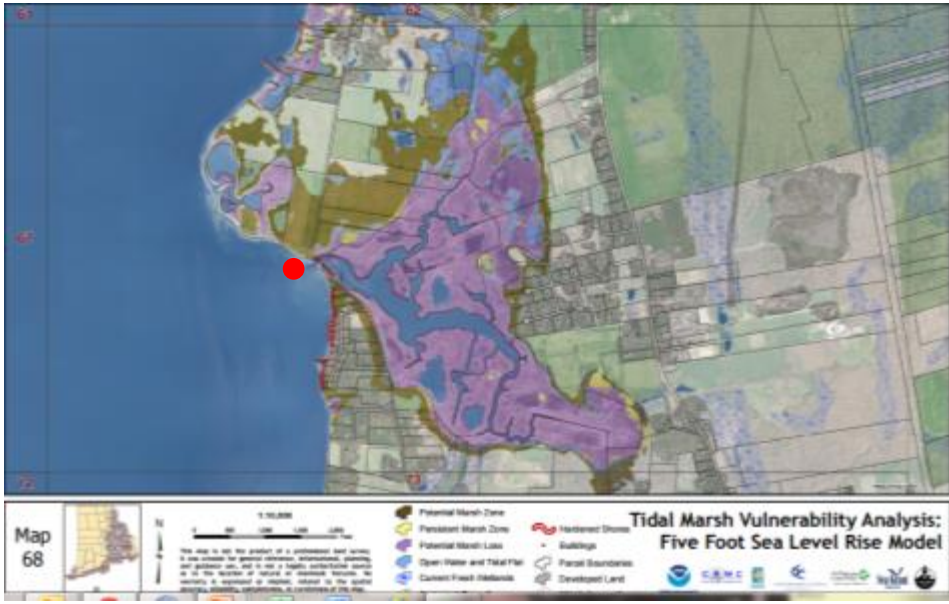
Migrating Shorelines: Opportunities for Coastal Adaptation

Caitlin Chaffee
RI CRMC

Adaptation Strategies

- Regrade banks to create less erosive slopes
- Remove low lying infrastructure
- Install non-structural shoreline protection such as coconut fiber “burritos” or logs
- Remove eroding or flood prone roads and install stormwater treatment
- Restore or create dunes
- Modify activities that prevent migration of coastal habitat i.e. mowing


Map
68
Tidal Marsh Vulnerability Analysis:
One Foot Sea Level Rise Model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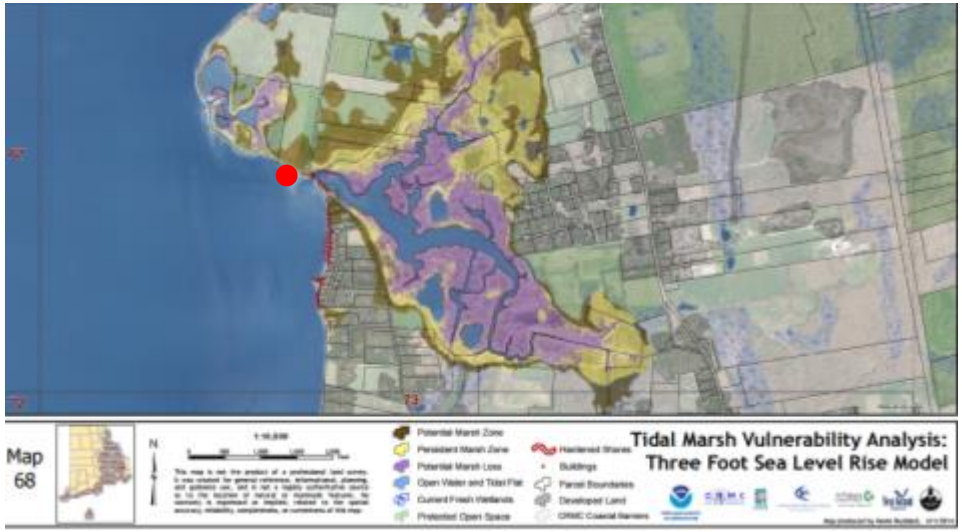
Tidal Marsh Vulnerability Analysis:
Five Foot Sea Level Rise Model


Map
68
Tidal Marsh Vulnerability Analysis:
Three Foot Sea Level Rise Model

Sapowet Point, Tiverton: change vehicle access and move infrastructure inland

Former potato field planted with warm season grasses

Parking area being moved inland closer to Seapowet Road

1: Eroding bluff along parking area; to be moved further east to reduce vulnterability

2: Beach road to headland parking area: vehicular access to be limited while maintain public access

3: Low lying field floods are for marsh and beach migration; planted with native grasses in spring of 2016

1

2

3

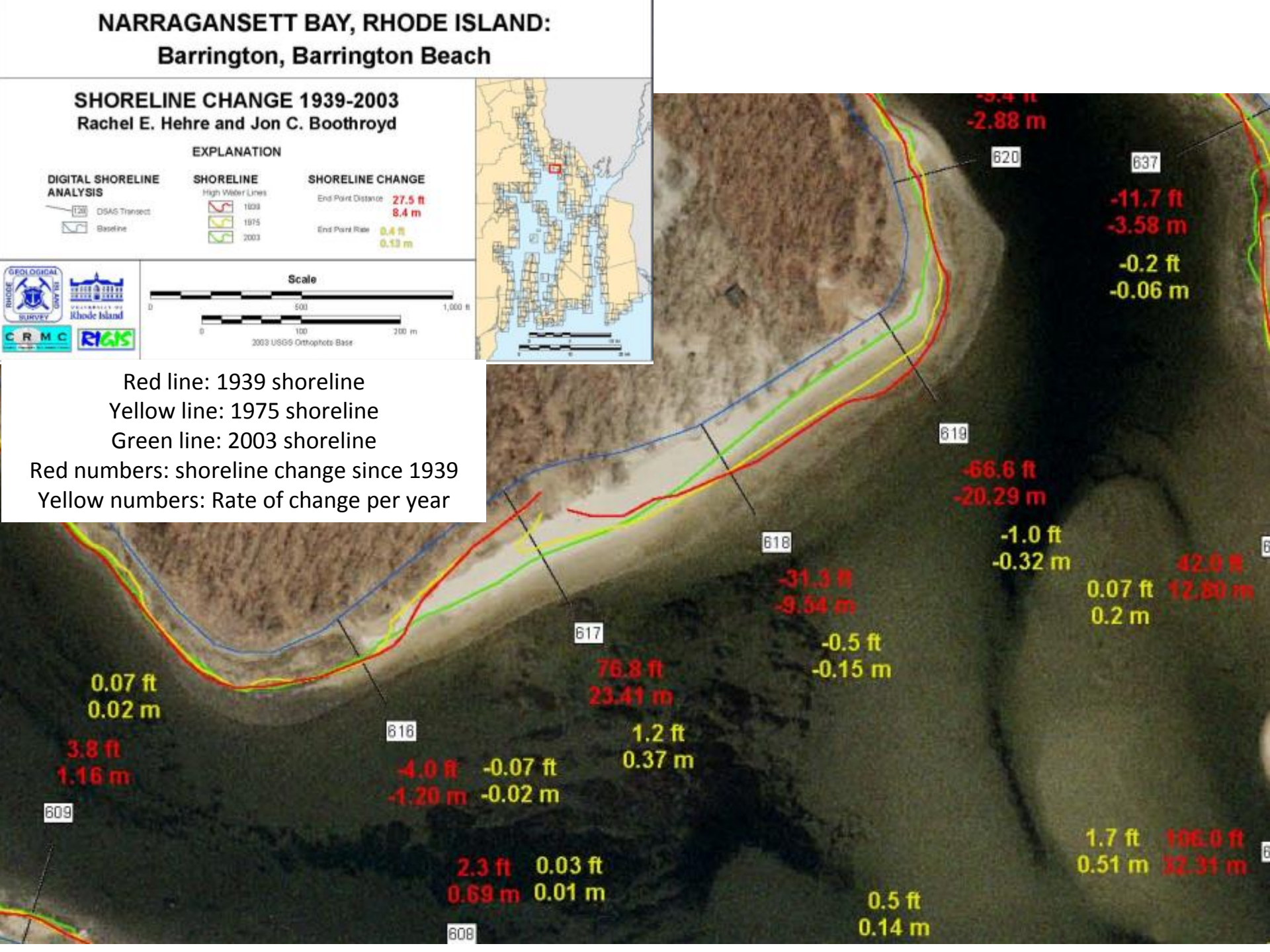
Google

City Park Beach, Warwick: shoreline regrading

Photo taken 9.12

Photo taken 6.10

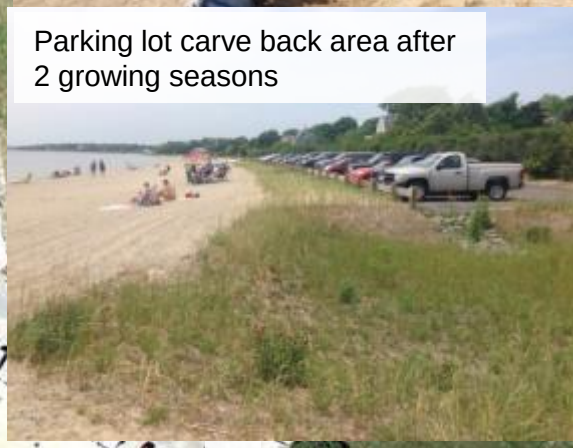
Photo taken 9.11


NARRAGANSETT BAY, RHODE ISLAND:
Barrington, Barrington Beach
SHORELINE CHANGE 1939-2003
Rachel E. Hehre and Jon C. Boothroyd
EXPLANATION
DIGITAL SHORELINE ANALYSIS
DSAS Transect
Baseline
SHORELINE
High Water Lines
1939
1975
2003
SHORELINE CHANGE
End Point Distance 27.5 ft 8.4 m
End Point Rate 0.4 ft 0.13 m
Scale
2003 USGS Orthophoto Base
Red line: 1939 shoreline
Yellow line: 1975 shoreline
Green line: 2003 shoreline
Red numbers: shoreline change since 1939
Yellow numbers: Rate of change per year
-2.88 m
620
637
-11.7 ft
-3.58 m
-0.2 ft
-0.06 m
619
-66.6 ft
-20.29 m
-1.0 ft
-0.32 m
618
-31.3 ft
-9.54 m
0.07 ft
0.2 m
-0.5 ft
-0.15 m
617
76.8 ft
23.41 m
0.07 ft
0.02 m
1.2 ft
0.37 m
616
3.8 ft
1.16 m
-4.0 ft
-1.20 m
-0.07 ft
-0.02 m
609
1.7 ft
0.51 m
2.3 ft
0.69 m
0.03 ft
0.01 m
0.5 ft
0.14 m
608

Barrington Beach: parking lot removal and stormwater infiltration

Asphalt being removed

Dune grass planting in former parking area



Parking lot carve back area after 2 growing seasons

Erosion of western parking area

Erosion from parking lot runoff

Parking lot edge moved inland along entire length of parking lot

1-3: stormwater infiltration areas

Allins Cove, Barrington: bank stabilization


Eroded bank at base of Byway Rd

Bank stabilization using coir envelopes

Stillhouse Cove, Cranston: bank regrading using coir envelopes and native grasses

King Park, Newport

Aerial image 4.2013

Coir envelope installation area

Erosion along boat ramp

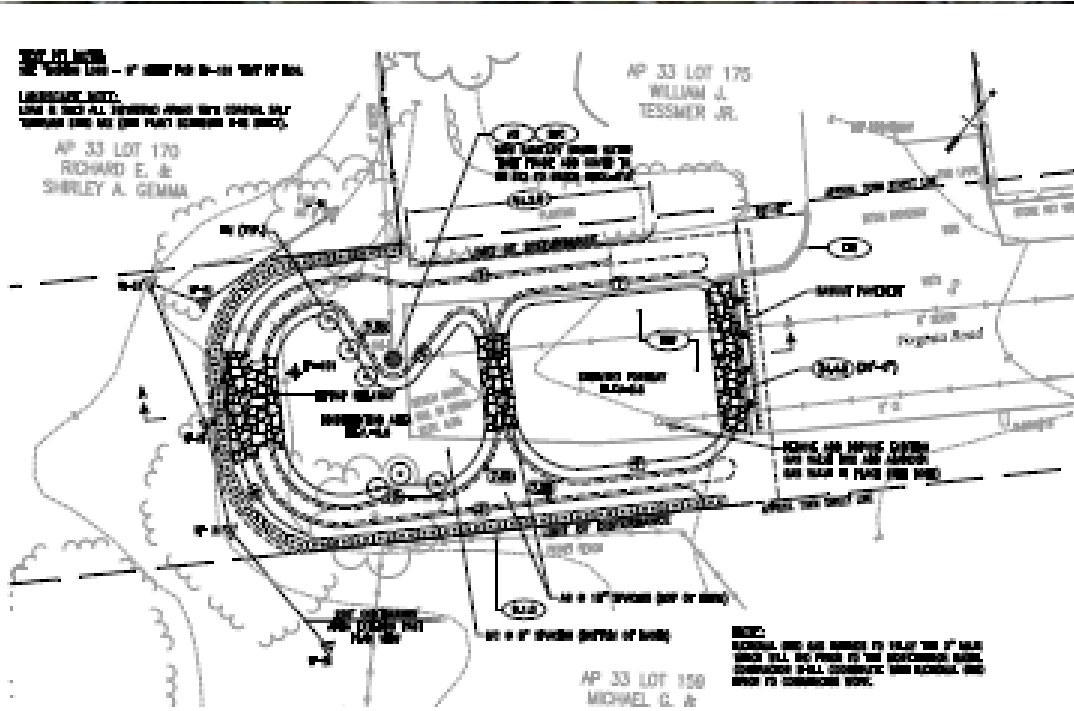
Before

Shoreline looking east

After

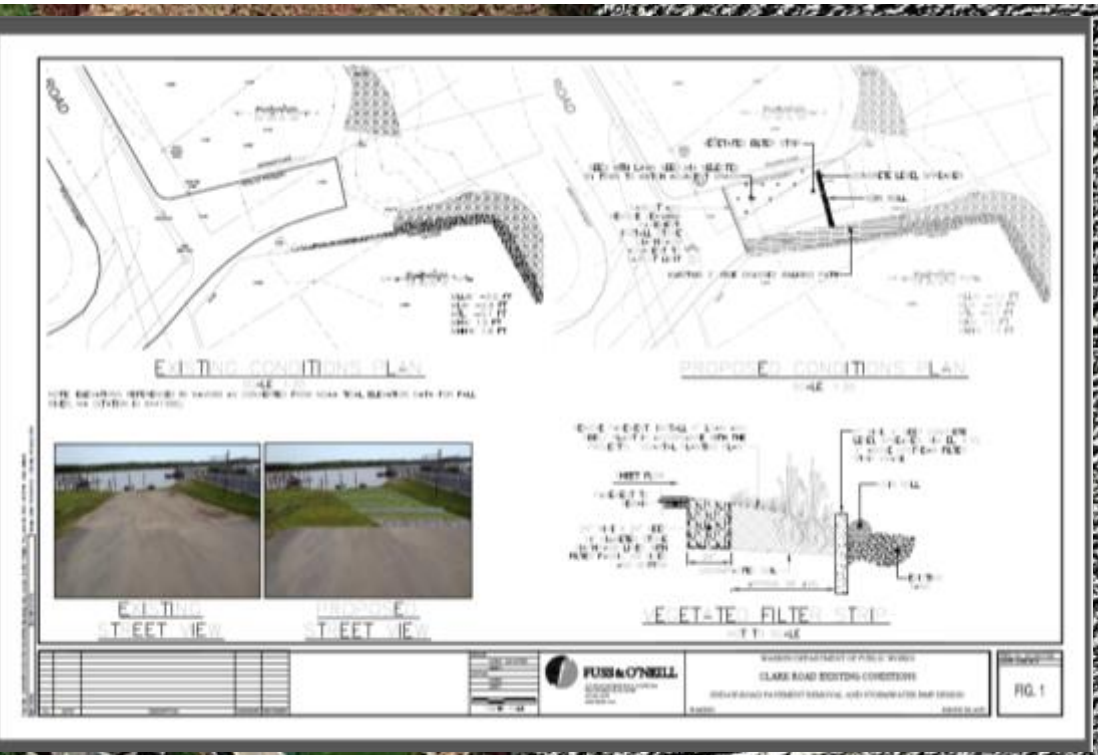
Shoreline looking east after 1st coir envelope installed and covered with sand

End of Road Retrofits:

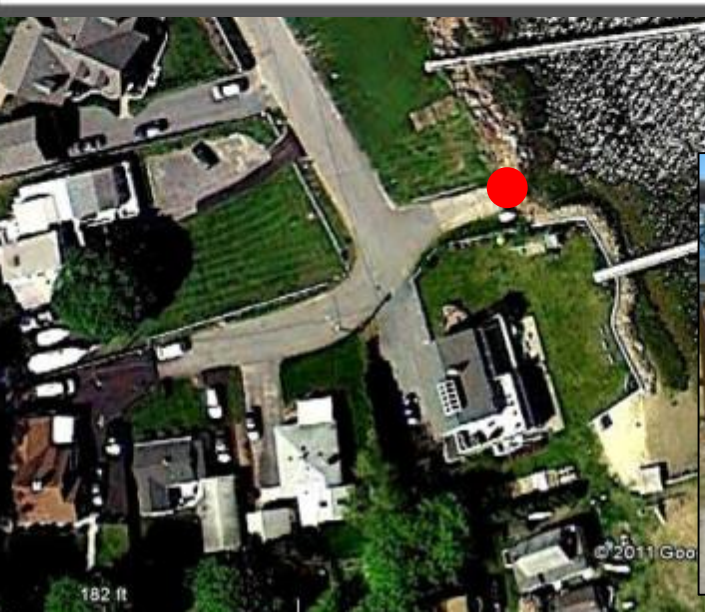


Proposed end of road retrofit to remove pavement and infiltrate stormwater before entering marsh along 100 Acre Cove

Clark Road, Warren: end of road retrofit and filter strip installation



Road removal area



Kickemuit Avenue, Bristol: end of road retrofit and stormwater filtration installation

Mill Cove Road, Warwick: end of road removal and public access enhancement


102 ft
Google earth


Before


April 2013


After
September 2015

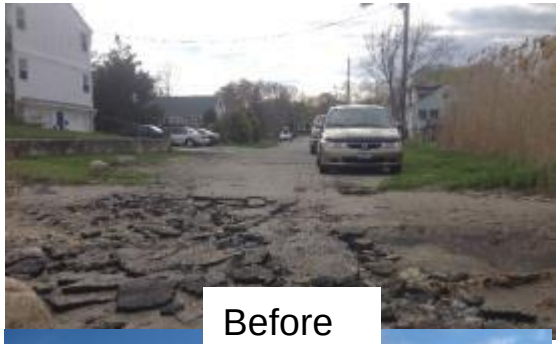

September 2014

Pender Avenue, Warwick: end of road retrofit

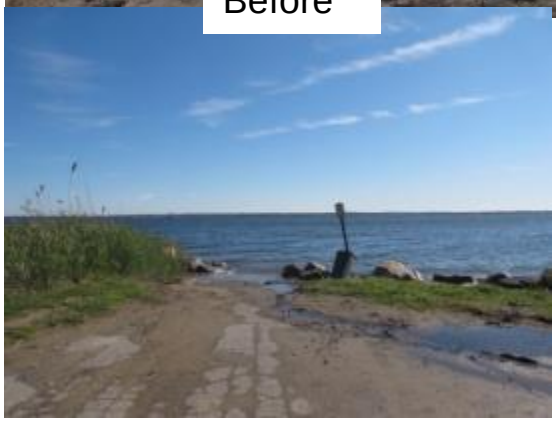
Pettee Avenue, North Kingstown: road removal

Grove Avenue, Warwick: pavement removal and filter strip installation 2014

Aerial image 2012



Before



Aerial image 2016

After

Hazard's Beach, Newport: dune restoration

April 2012 aerial photo

2013 aerial photo

Washover site post Sandy

Dune in front of cedar eroded during Sandy (photos taken 12.4.13)

Dune erosion area, wrack line inland of former dune

Hazard's Beach dune restoration

Before

During

Planting: April 2014

October 2015

Narrow River, Narragansett: moving mow line inland

Thank You

NOAA National Oceanic and Atmospheric Administration US Department of Commerce

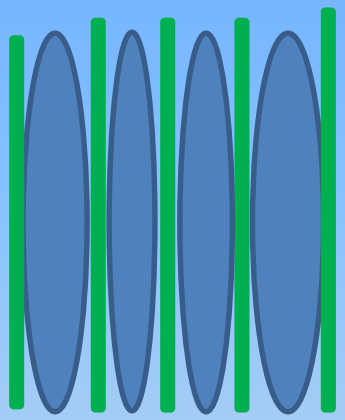
CRMC Coastal Resources Management Council

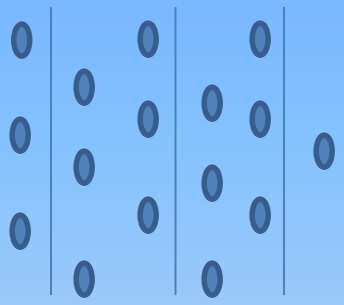
NRCS Natural Resources Conservation Service

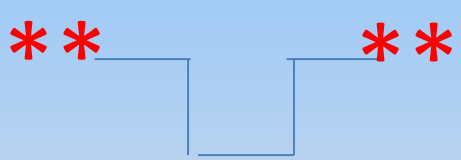
More Thoughts on Legacy Ditches

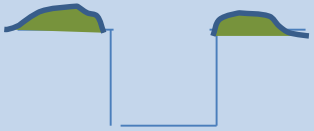
Susan C. Adamowicz, Ph.D.
US Fish and Wildlife Service
Rachel Carson Nat'l Wildlife Refuge

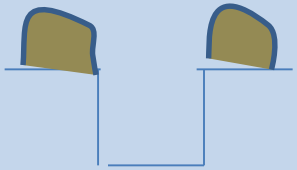
Diagnostics







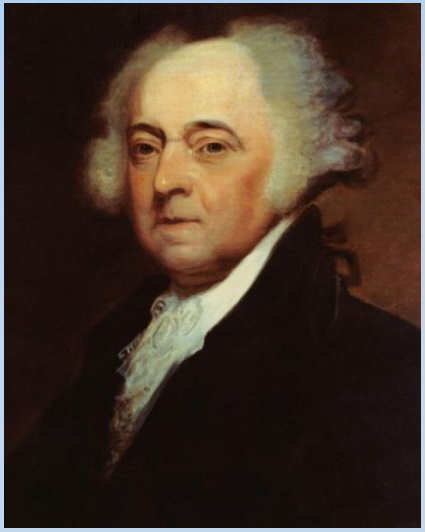




Ditch Formation

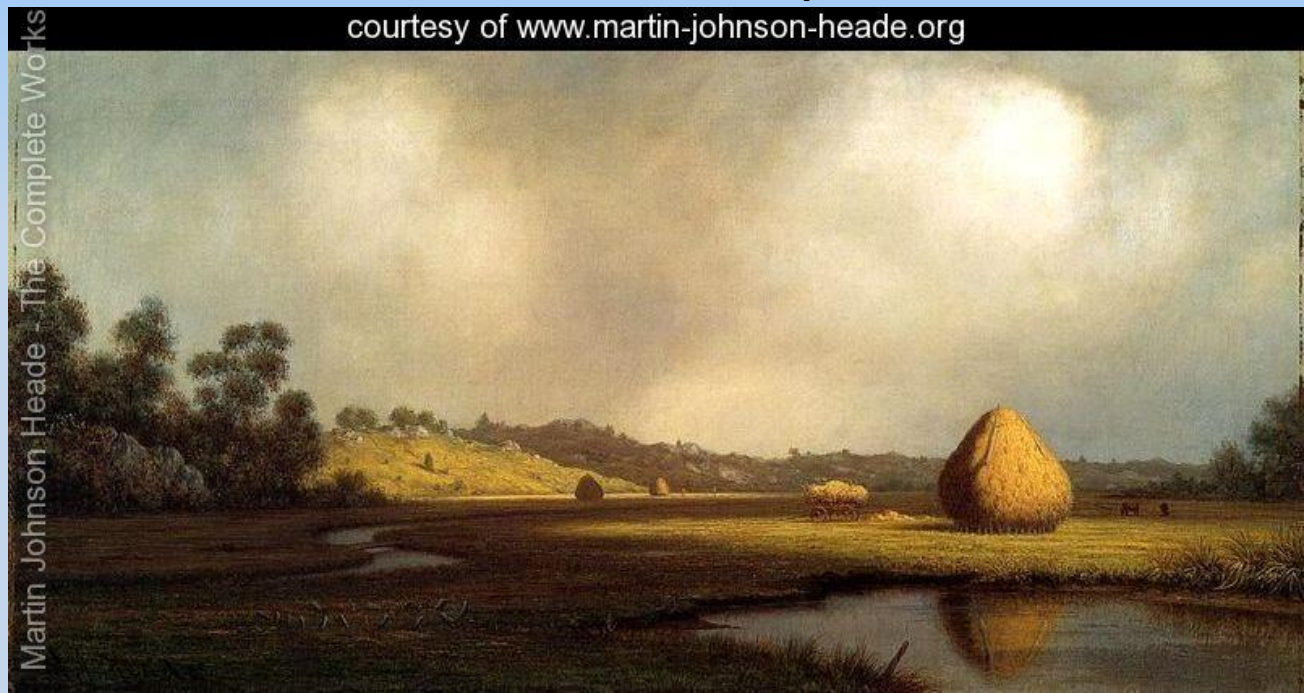
Adams farming

- 1771 “recipe to make manure” which includes mention of ditching salt marshes



Salt hay farming

- Marsh panels were wide enough to turn a horse
- Salt hay ditches were shallow; property boundary ditches were wider/deeper



Ditch Formation cont.

- Mosquito: peat knife
- Mosquito peat stacks

CT DEEP

CT DEEP

What happens to the peat?

CT DEEP

Mechanical Ditch Formation

- Scavel plow
- Rotary Ditcher

CT DEEP

http://www.atlantic-county.org/mosquito-control/history.asp

OMWM

- Radial Ditches: closed system

Google Earth
Parker River NWR
Near SubHQ

- Ditch Plugging: closed system

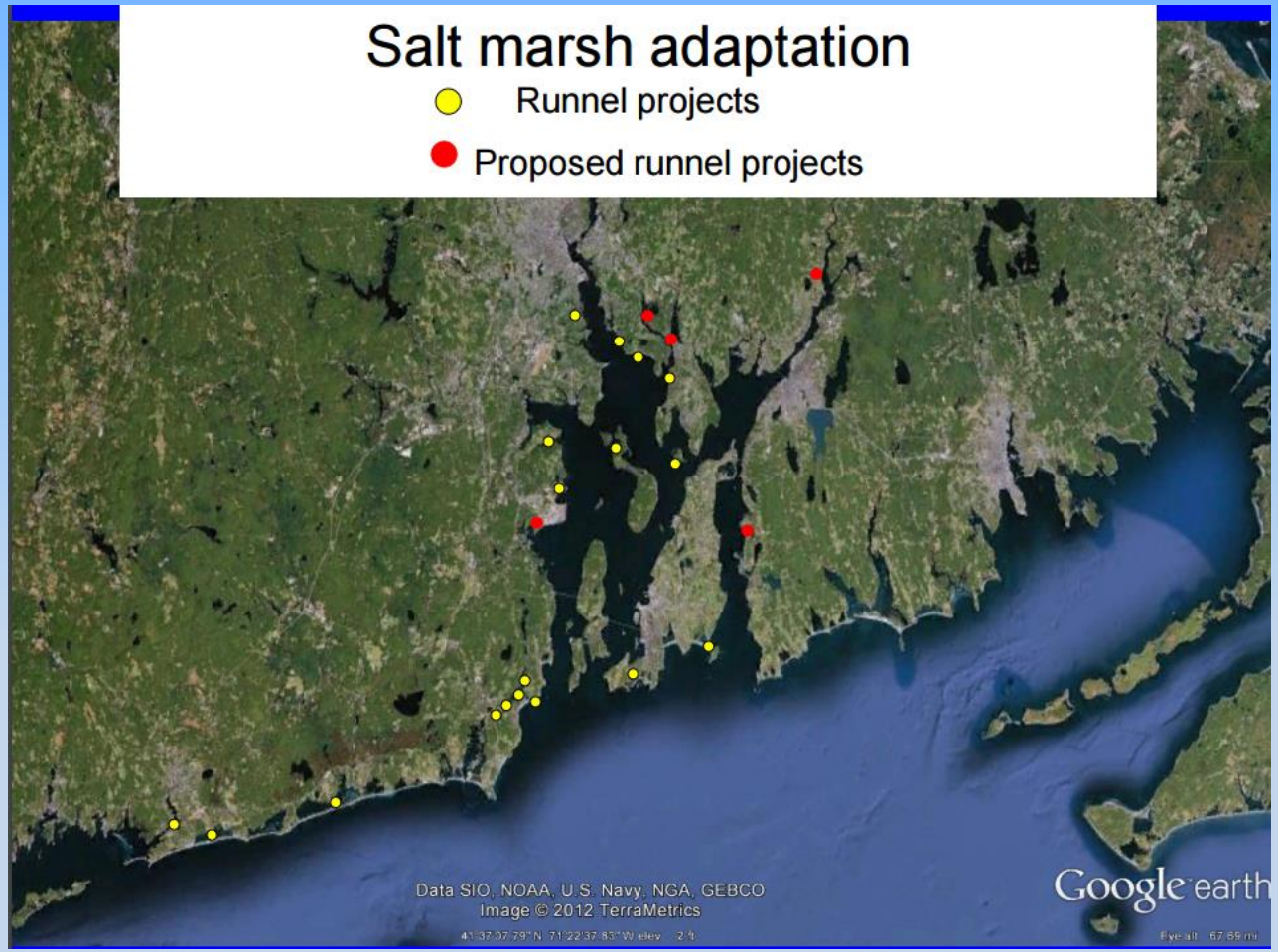
- Effects of ditching –
  - Surface drainage, depressed groundwater tables, changes in vegetation, pot'l loss of elevation
  - Levee formation

- Effects of ditch plugging –
  - Impound water upslope of plug, raise water tables, increase H_2S, loss of vegetation

“Waffles filled with syrup”

Winnapaug Pond, RI

May 2015



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Trends on Long Island Sound

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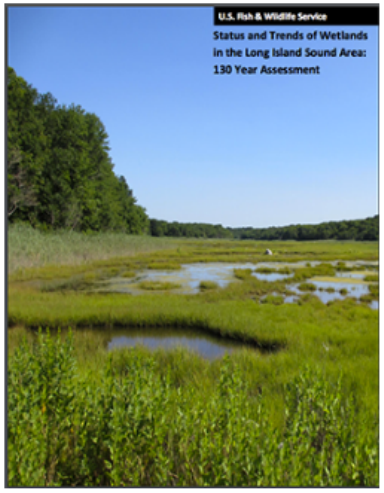
Status and Trends of Wetlands in the Long Island Sound Area: 130 Year Assessment

This report provides the first 130 year assessment of tidal wetland change for the entire Long Island Sound area. The results indicate an overall 31% loss of tidal wetlands with a 27% loss in Connecticut and 48% loss in New York. Despite tidal wetland legislation passed in the 1970s, wetland decline in Long Island Sound continues. After the 1970s New York sustained more wetland loss (a decrease of 19%) than Connecticut (a slight gain of 8%). Current research points to multiple, nuanced and complex causes of present-day tidal wetland changes. A major present-day concern is wetland vulnerability to loss due to potentially increased amounts of open water on the marsh surface. An open water assessment initially conducted in Connecticut indicates an average of 47% permanent open water on the marshes studied –a less healthy status. Understanding the extent and context of tidal wetland change is important for effective future protection. In addition to overall loss, we discuss the historic extent, present-day stressors and importance and implications of wetland decline to the Long Island Sound ecosystem. We summarize other local studies of marsh decline and degradation in portions of the Long Island Sound and conclude with recommendations for protecting this valuable habitat type given historical context and current stressors.

View or download a pdf of the report (PDF-166MB)
View or download a pdf of the Executive Summary (PDF-454KB)



Last updated: March 10, 2016

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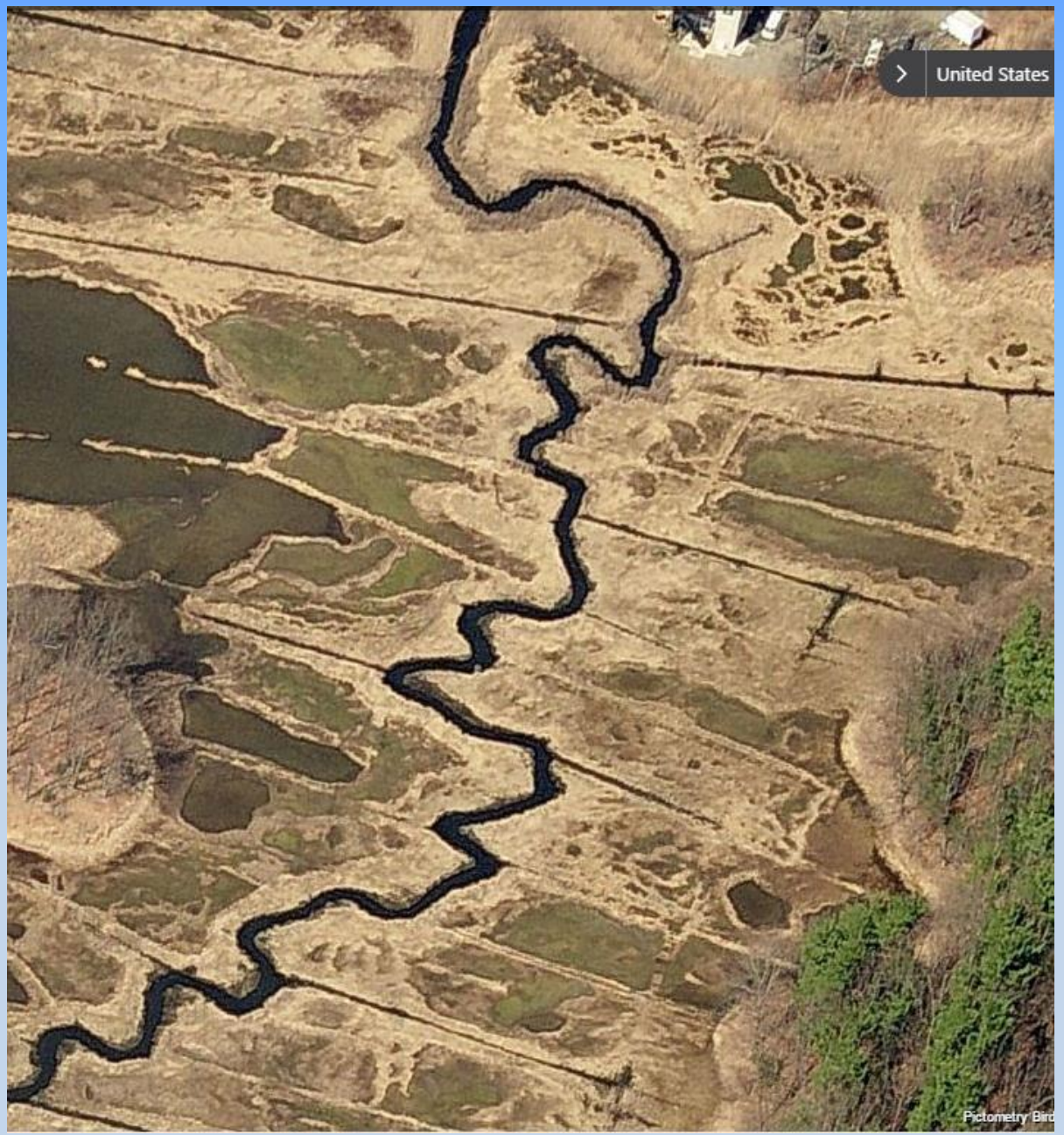
https://www.fws.gov/northeast/science/sciencenews/wetlandslongislandsound.html

Great Marsh, MA (Essex Co.)

Essex Rd, Ipswich, MA (Rte 133)


United States

What's being done?

- Runnels:
  - Save The Bay
  - RI CRMC
  - Chafee NWR
  - Parker River NWR/ UNH

Hazard Rd, Newport, RI

John Chafee NWR, Narragansett, RI

Spring 2015

Fall 2016

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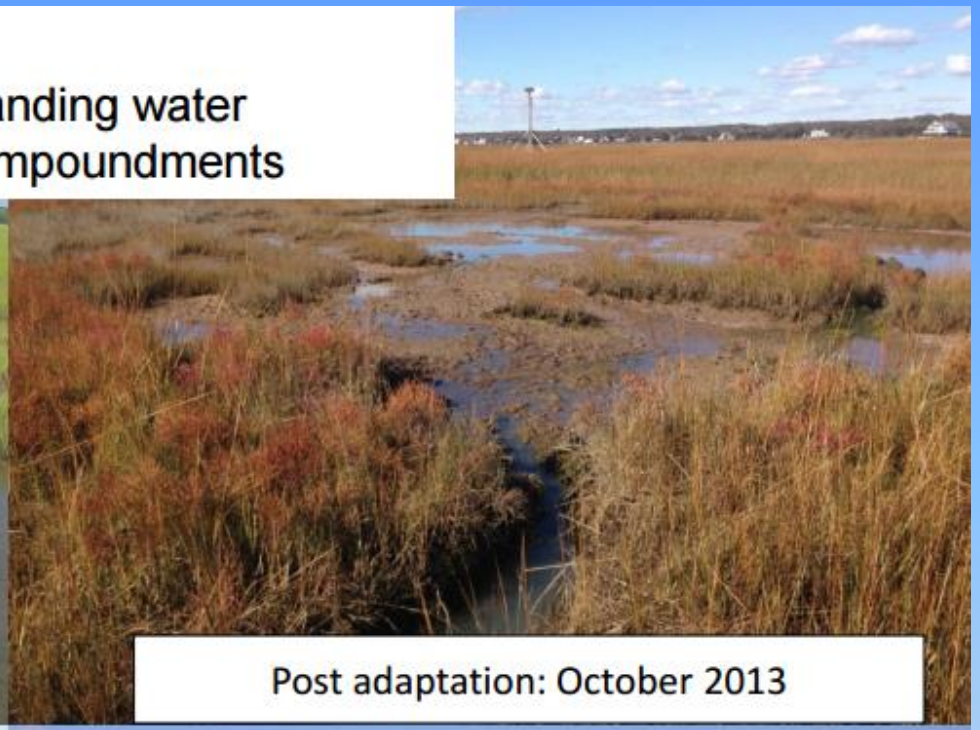
Winnapaug Marsh

- Recolonization of areas with shallow standing water
- Erosion along runnels draining deeper impoundments

August 2011



Post adaptation: October 2013

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Runnel and revegetation along edge of former ponded area 2014

2014

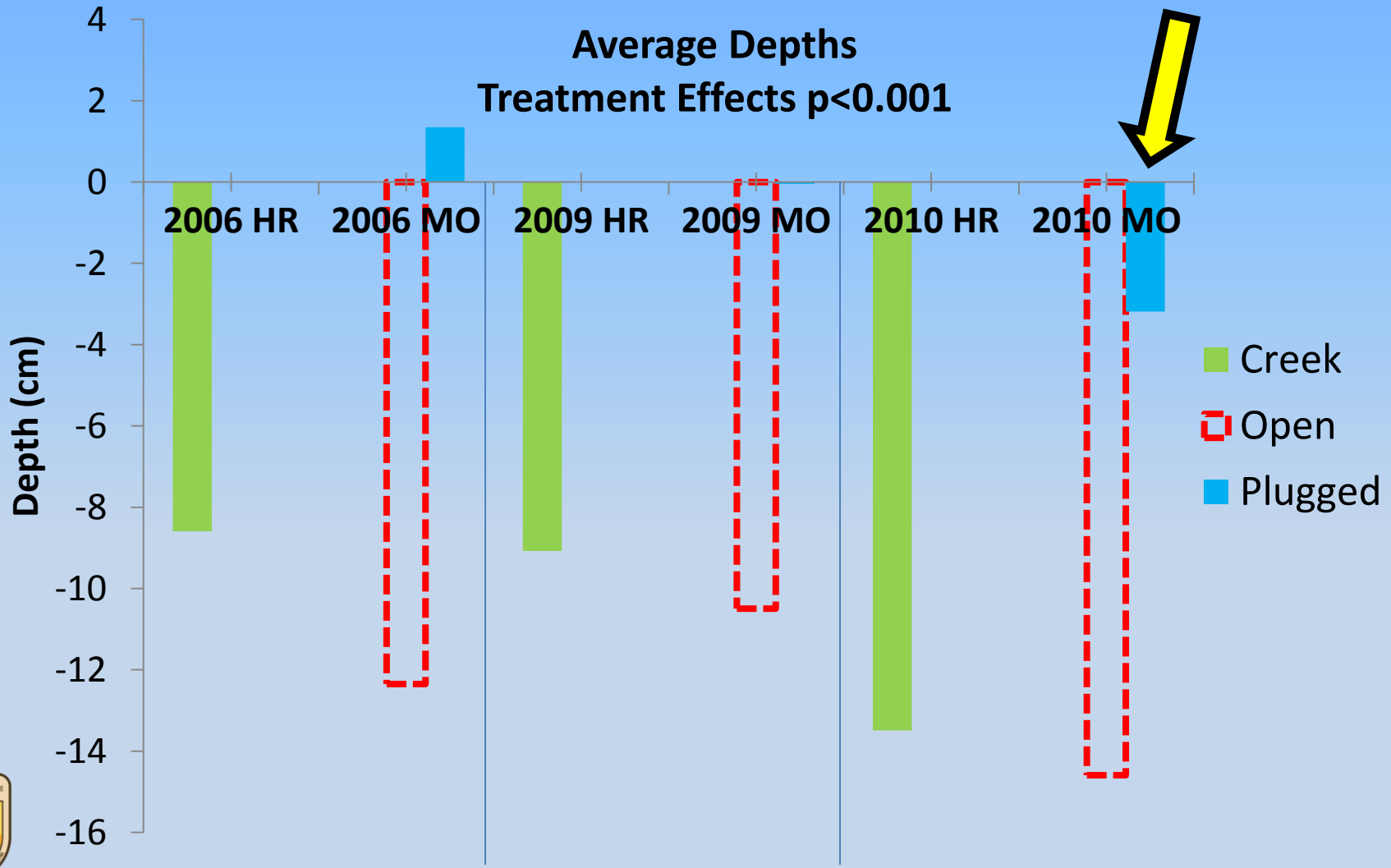
But what about other ditch effects?

- Ditch Plugging

Ditch Plug Removal

Plug removal → drawdown

Groundwater 2009: Creek, Ditch, Plugged Ditch

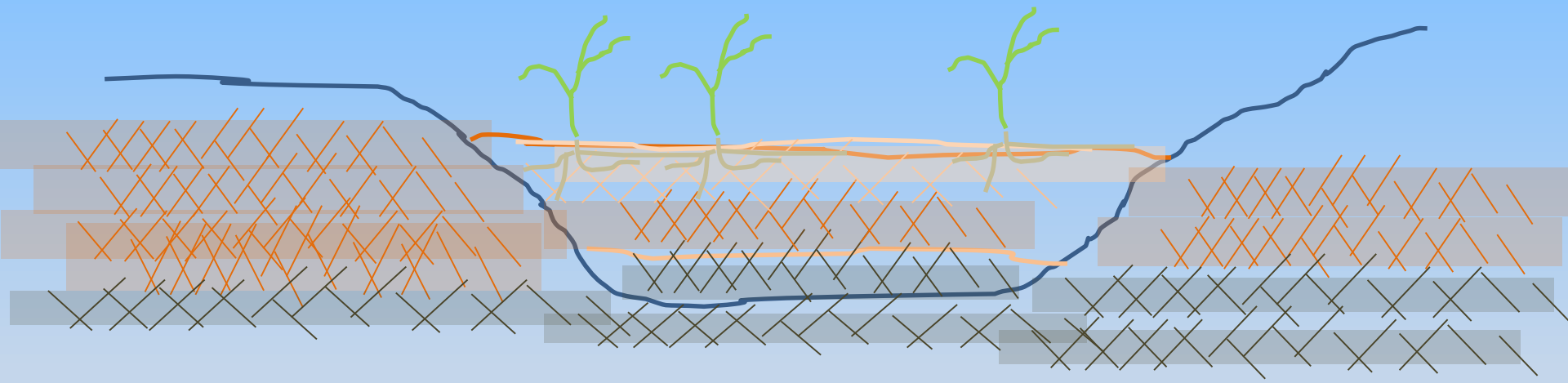


Over Ditching

How to choose the right ditches

- Not all ditches are remediated
  - MUST leave some to continue to convey surface water drainage
- Examine the entire site
  - Which ditches are already filling in naturally?
  - Which ditches are shallow enough to start with?
  - Is there enough high marsh vegetation (S. patens, Distichlis, Juncus) to withstand harvesting?
- Plan on returning to the site for “tweaking”

Ditch Remediation Concept




10.20.2010

Parker River Ditch Remediation

Apr, 2011

Aug, 2011

Aug, 2012

Marsh Surface Elevations

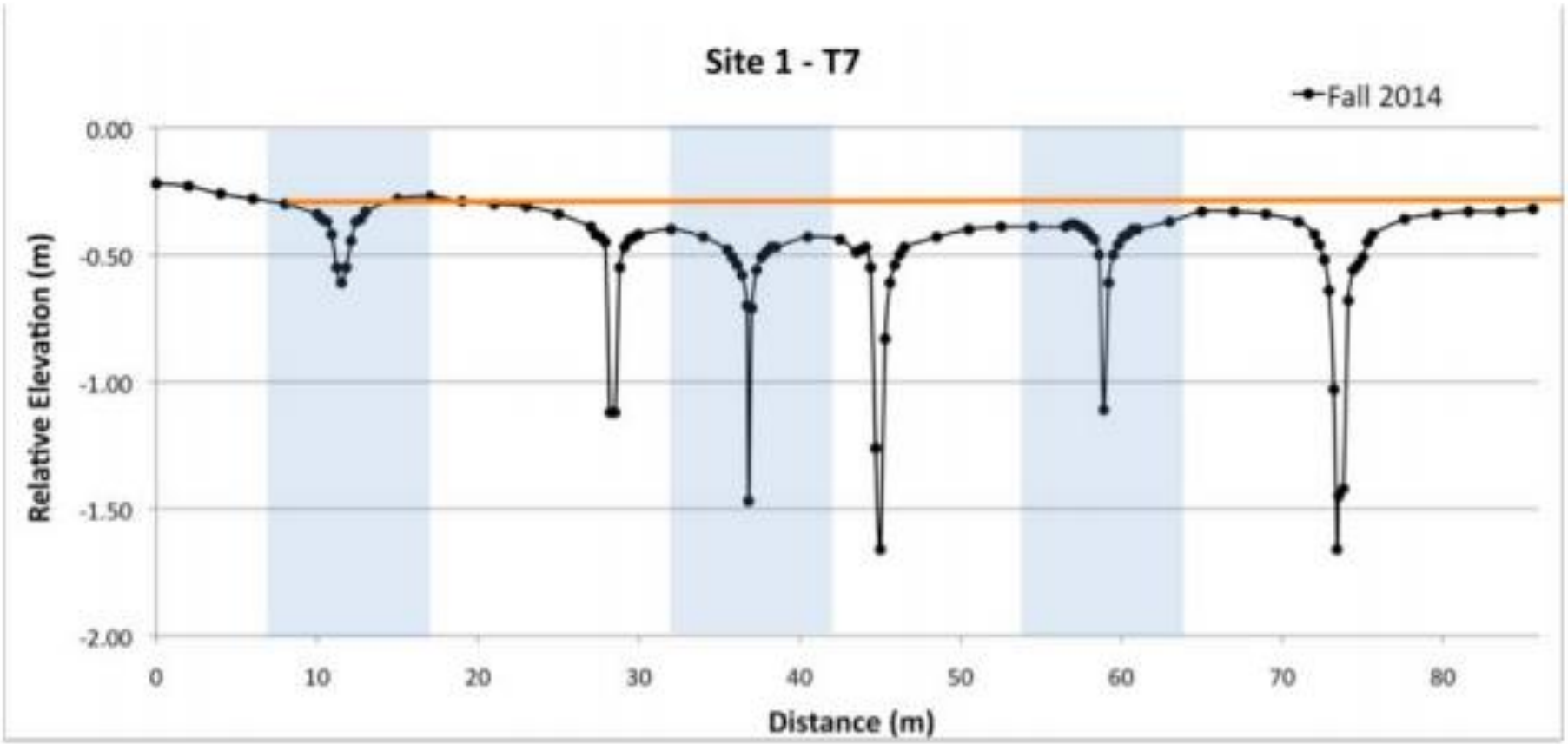


Fig 7. Elevation profile across densely ditched marsh prior to remediation. Note the shaded ditches are those that were chosen for remediation and the horizontal line draws attention to the loss in elevation of 10 to 15 cm associated with the closest ditches.

Burdick, Moore, Peter, Wilson

Marsh Elevations 1 yr later

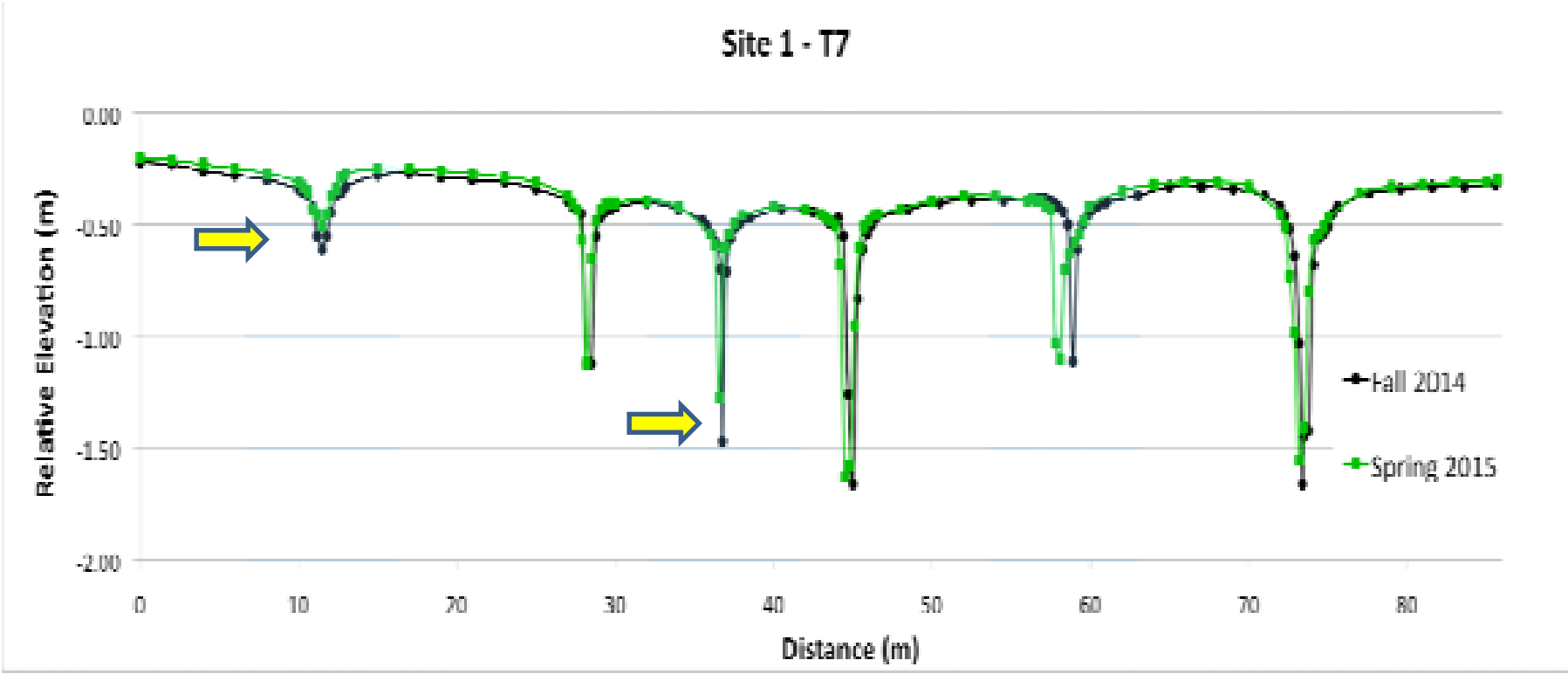


Fig 8. Elevation profile across densely ditched marsh prior to and following the first year of remediation (shaded ditches only). Note two of the three ditches (first and third, from left to right) are beginning to fill with sediment.

Burdick, Moore, Peter, Wilson

“The saltmarsh sparrow is the polar bear of the salt marsh.”

Wenley Ferguson

Acknowledgements

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Hunt Durey

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

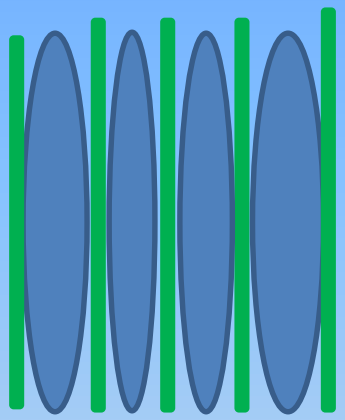
UNIVERSITY of NEW HAMPSHIRE

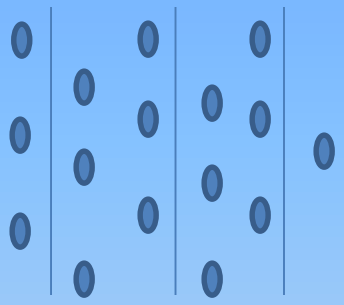
Northeast Wetland Restoration

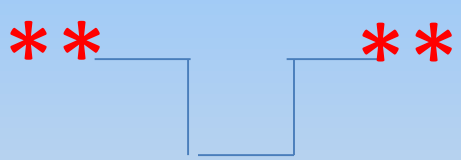
Added Slides

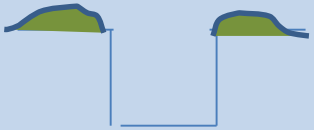
Hazard Rd, Newport, RI. Bing Maps. Birds Eye View

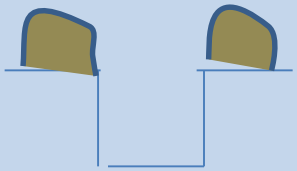
Diagnostics











Patterned Wetlands