# Vulnerability of Cape Cod National Seashore's salt marshes

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**Society of Wetland Scientists**
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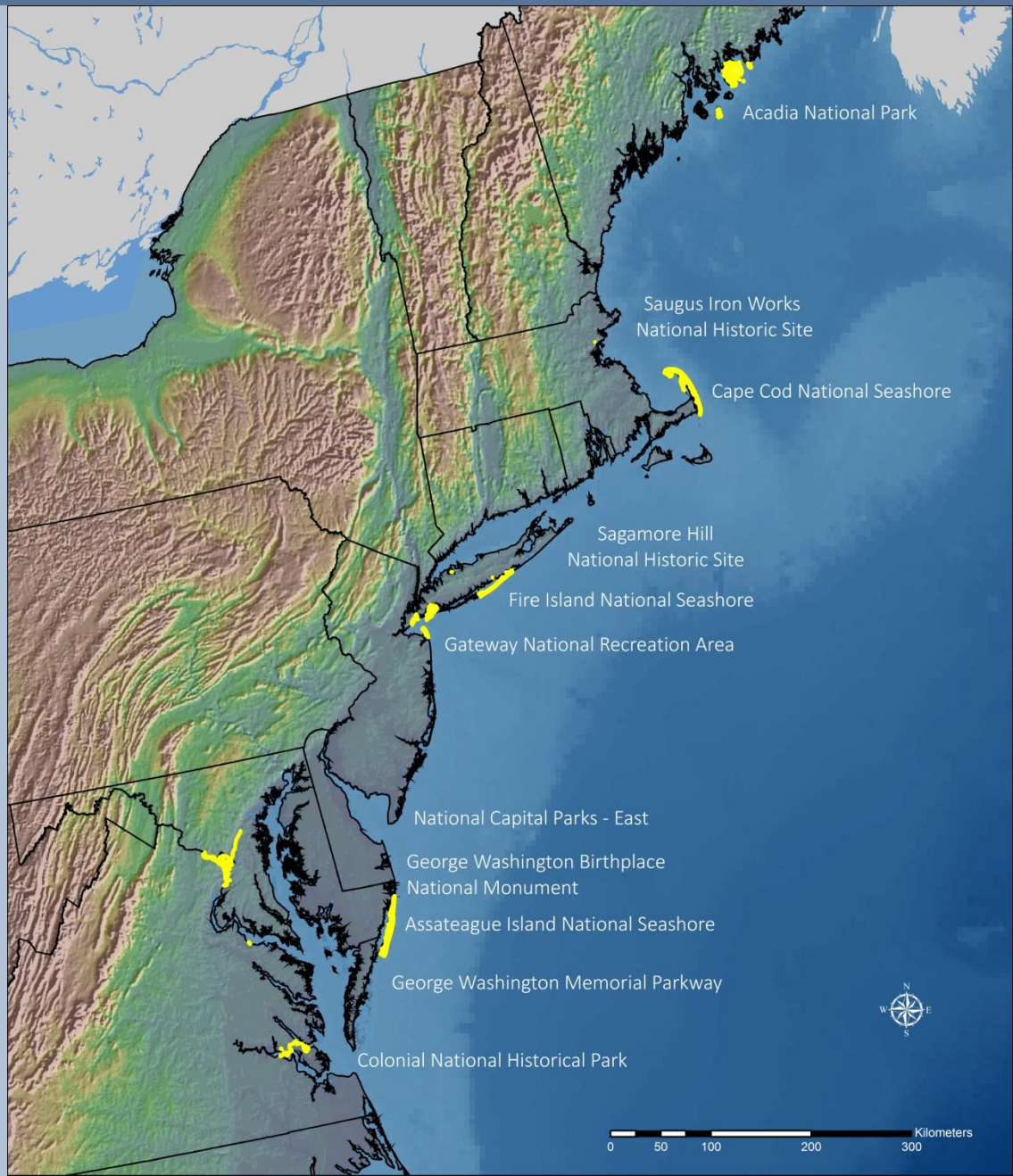
# Northeast Coastal and Barrier Network

## Sediment Elevation Monitoring

- 120 SETs across 12 parks
- Data collection 2 x/yr
- Co-located with other sampling

**Metrics:**

- Relative Elevation
- Sediment Accretion
- Shallow Subsidence



# Northeast Coastal and Barrier Network


- 38 marsh sites-across four parks (Cape Cod, Fire Island, Gateway, Assateague)
- RTK/Total Station Elevations collected on 20-m grid
- Vegetation-Braun Blanquet 1-$m^2$ plots on 20-m grid
- Water Level-10-20 Onset loggers/park deployed for 12 months
- Total Suspended Solids (TSS)
- Assuring permanent tide stations and calculated tidal datums for each park (NOAA and USGS partners)
- Marsh Equilibrium Modeling

# Coastal Wetland Vulnerability Overview

Funded for 2013-2015

Assess vulnerability of salt marshes and coastal wetlands to dieback, drowning, squeeze, habitat conversion

Include: elevation, vegetation types, accretion/erosion, barriers to migration, upland land use

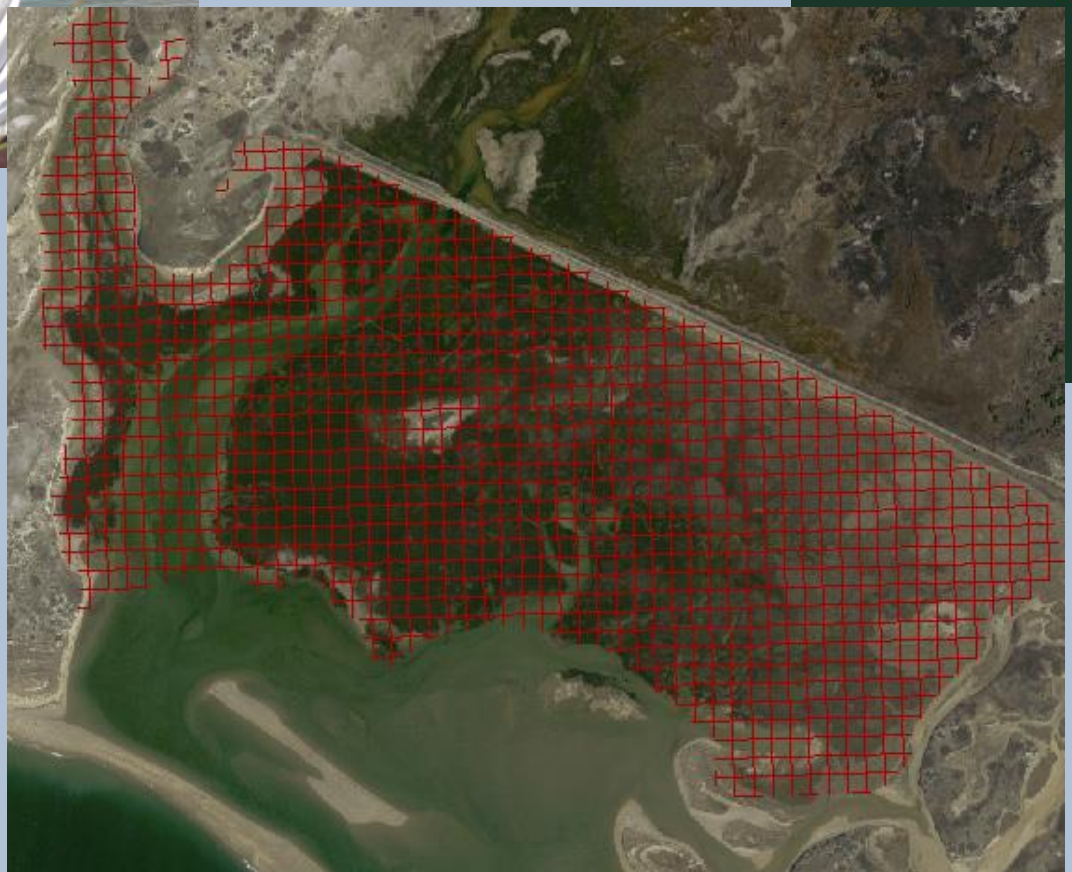
Visualize- vulnerable wetlands & infrastructure

Products: planning tools (e.g. maps, visualizations, reports, predictions of land category change), workshop, interpretative exhibits

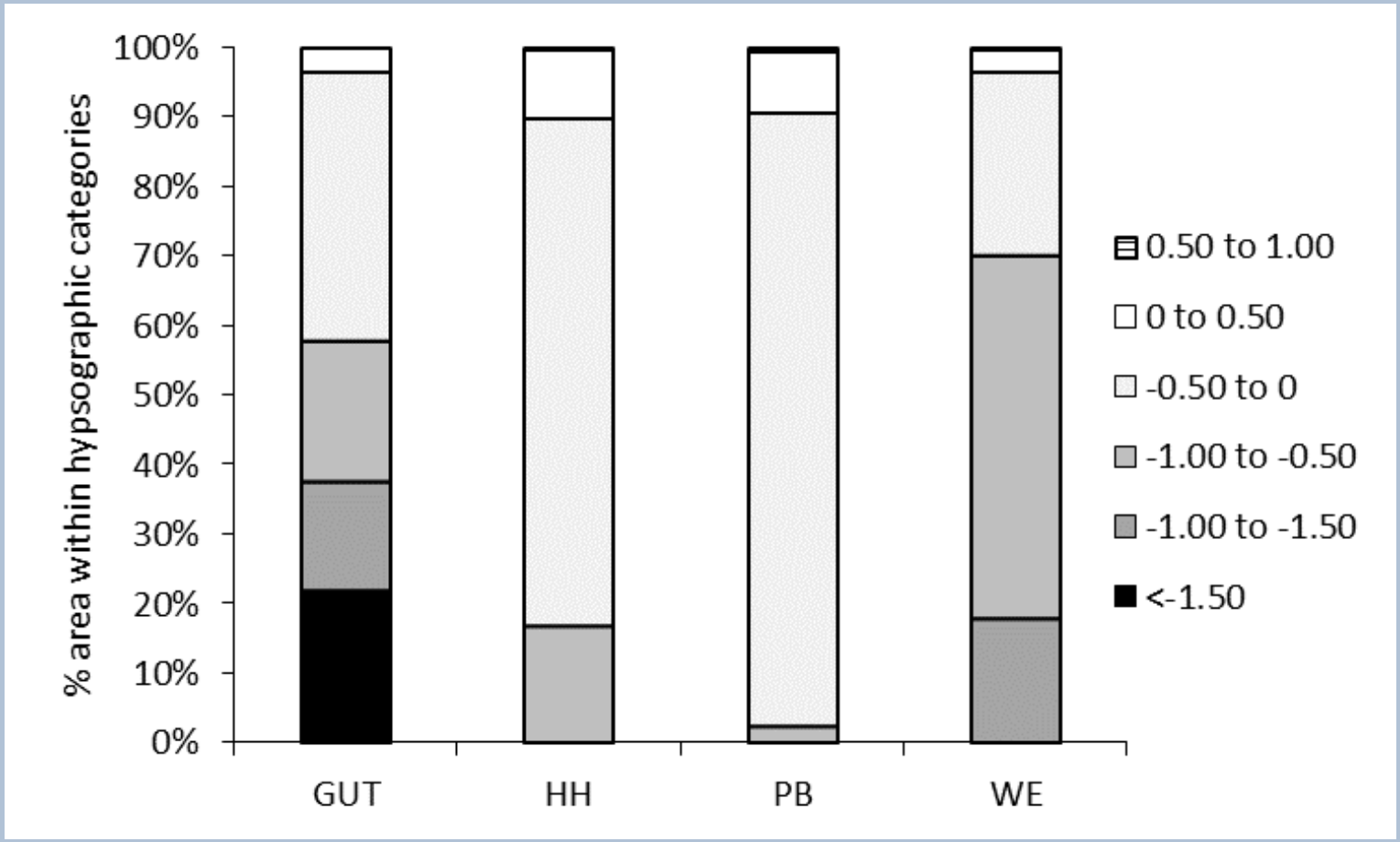
# RTK based salt marsh elevation monitoring

- 2-4 cm vertical accuracy
- Unrestricted marshes
- Within salt marsh veg
- Mask out- wide creeks, no SM veg

June-Sept 2013
~9,560 RTK points
20 m grid spacing
6 marshes

# Hypsometric distributions




More dark shading= larger relative proportion of area below mean high tide

# 2014 Delineation of seaward extent of vegetation

Green- lowest limit of *S. alterniflora, L*

Red- lowest limit of *S. patens, T*

Blue- upper limit of *S. patens, U*

# Geomorphic Context

| Site | | Lower limit *S. alterniflora* (m NAVD) | Lower limit *S. patens* (m NAVD) | |
|---|---|---|---|---|
| Hatches Harbor | | 0.155 | 1.12 | |
| West End | | -0.21 | 1.09 | |
| The Gut | | -0.58 | 1.24 | |
| Middle Meadow | | 0.035 | 1.4 | |
| Pleasant Bay | | -0.098 | 0.78 | |
| **Range** | | **0.74** | **0.62** | |

# Geomorphic Context

| Site | Mean High Tide (m NAVD) | Lower limit *S. alterniflora* (m NAVD) | Lower limit *S. patens* (m NAVD) | |
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| Hatches Harbor | 1.23 | 0.155 | 1.12 | |
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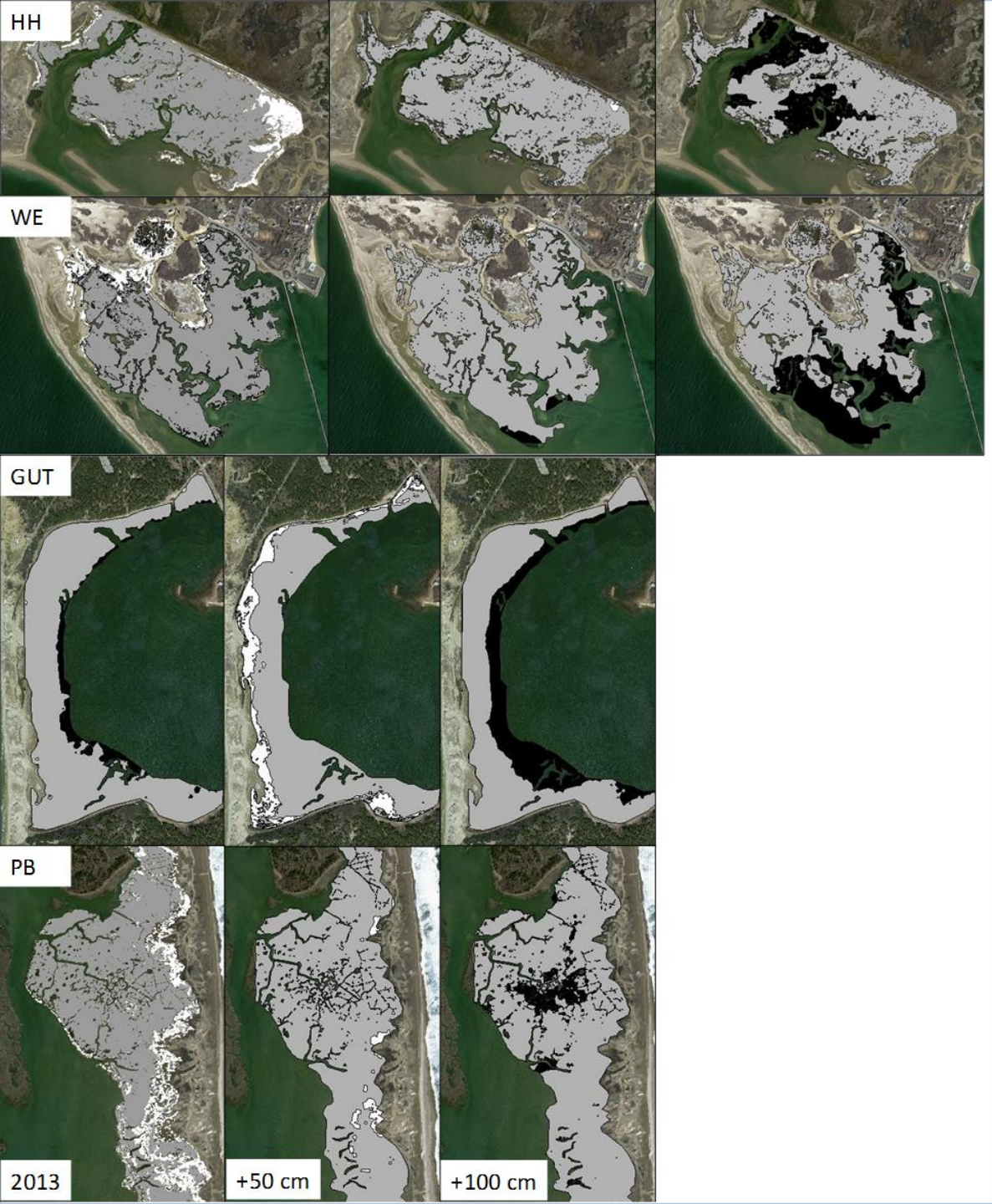
| The Gut | 1.61 | -0.58 | 1.24 | |
| Middle Meadow | ~1.61 | 0.035 | 1.4 | |
| Pleasant Bay | 0.92 | -0.098 | 0.78 | |
| **Range** | **0.69** | **0.74** | **0.62** | |

# Correlation between MHT and high marsh vegetation

**Yellow = elevations above current MHT**

**White = high marsh**

Smith et al., in prep




# Current and projected marsh cover types

Gray= low marsh (*S. alterniflora*)
White= high marsh (*S. patens*)
Black=unvegetated

# Factors that affect marsh accretion:

Inundation & salinity

Above & belowground biomass

Total Suspended Solids/turbidity

Sediment deposition

*S. alterniflora* decomposition

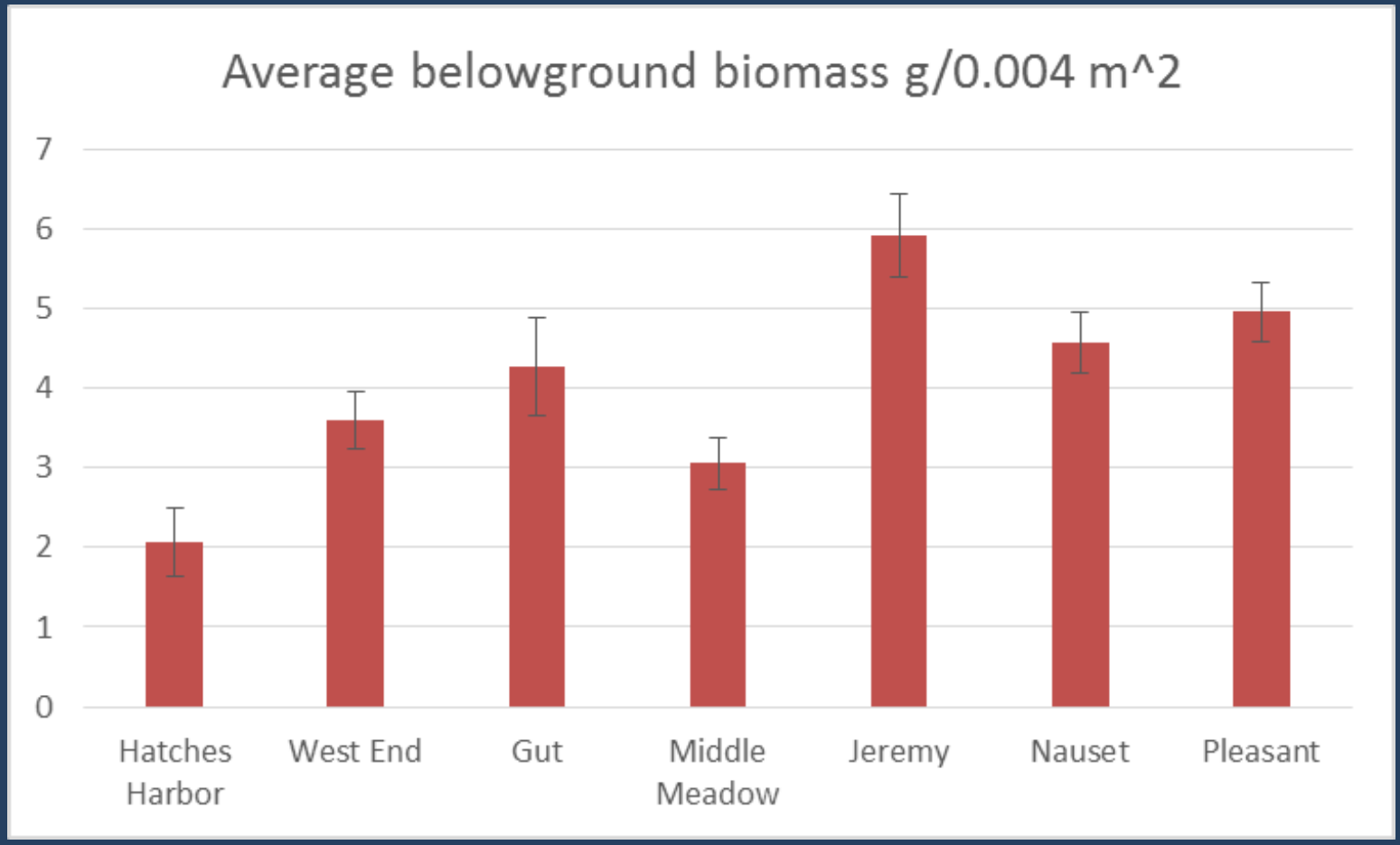
Sediment grain size, %OM

% cover, algae on marsh surface, soil compaction

# Geomorphic Context

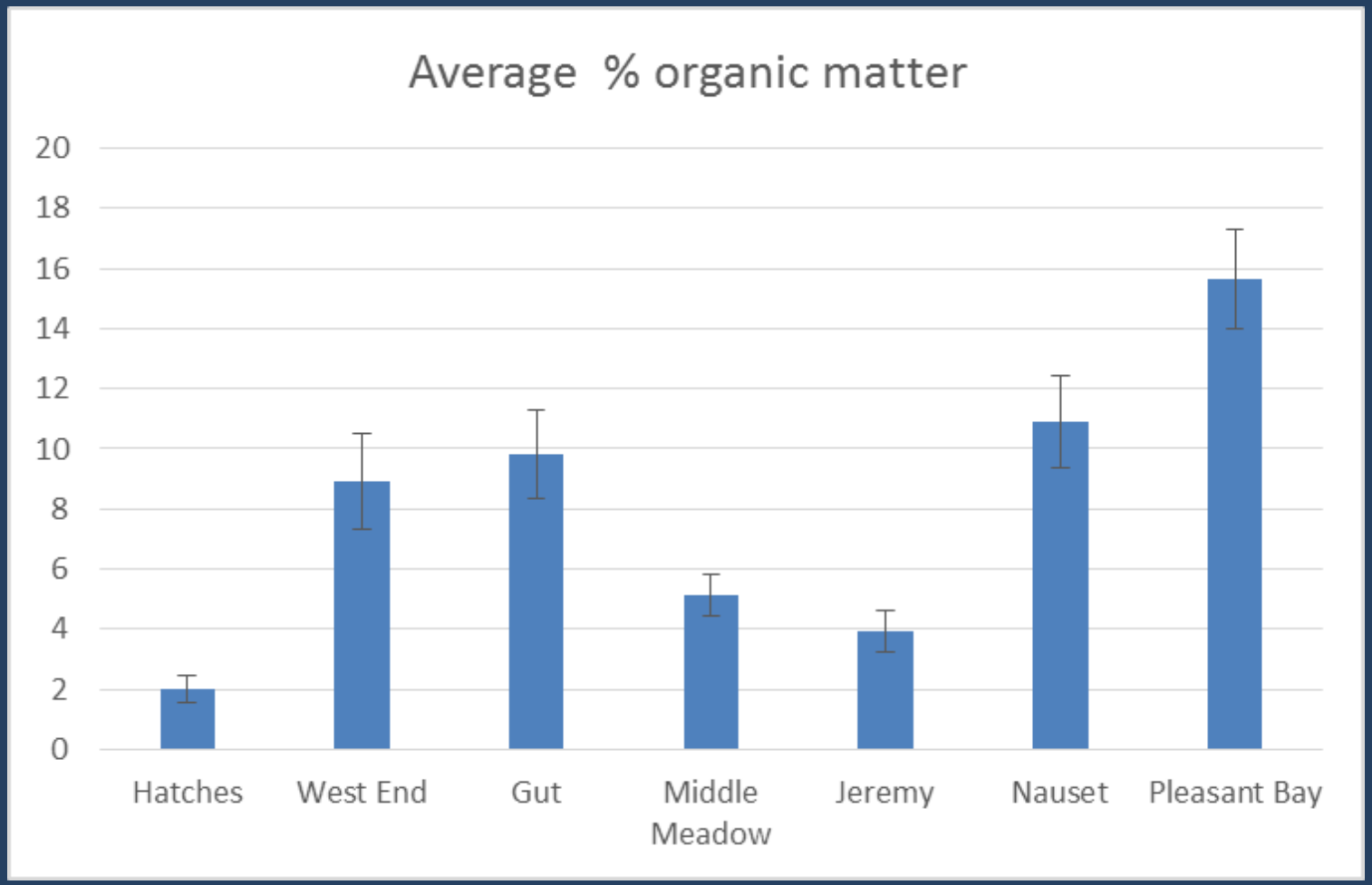
| Site | Mean High Tide (m NAVD) | Lower limit *S. alterniflora* (m NAVD) | Lower limit *S. patens* (m NAVD) | Average SET accretion rate (mm/yr) |
|---|---|---|---|---|
| Hatches Harbor | 1.23 | 0.155 | 1.12 | 0.95 |
| West End | 1.52 | -0.21 | 1.09 | ~1.48 |
| The Gut | 1.61 | -0.58 | 1.24 | 1.48 |
| Middle Meadow | ~1.61 | 0.035 | 1.4 | ~1.48 |
| Pleasant Bay | 0.92 | -0.098 | 0.78 | ~4.08* |
| **Range** | **0.69** | **0.74** | **0.62** | **3.13** |

# Similarities in *S. alterniflora* biomass

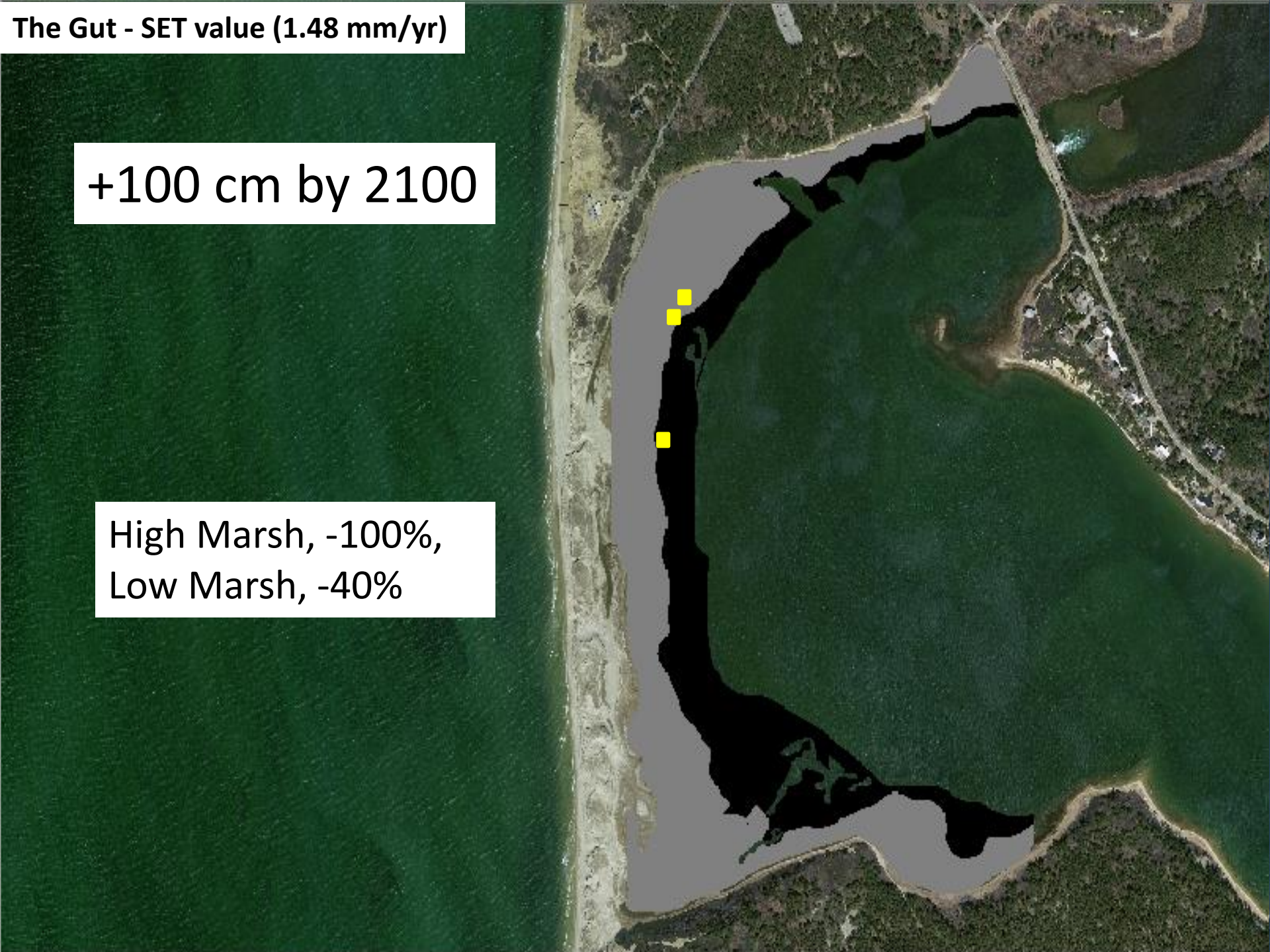



West End similar to the Gut, Nauset similar to Pleasant Bay

# Similarities in sediment organic matter




West End very similar to the Gut, Nauset lower, but similar to Pleasant Bay

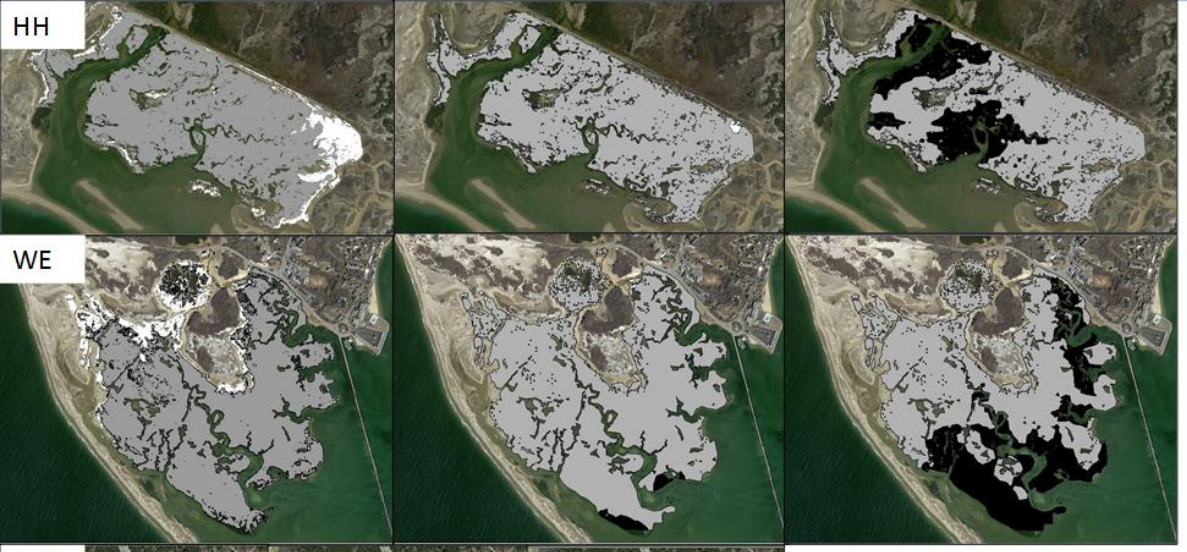

The Gut - SET value (1.48 mm/yr)
+100 cm by 2100
High Marsh, -100%,
Low Marsh, -40%

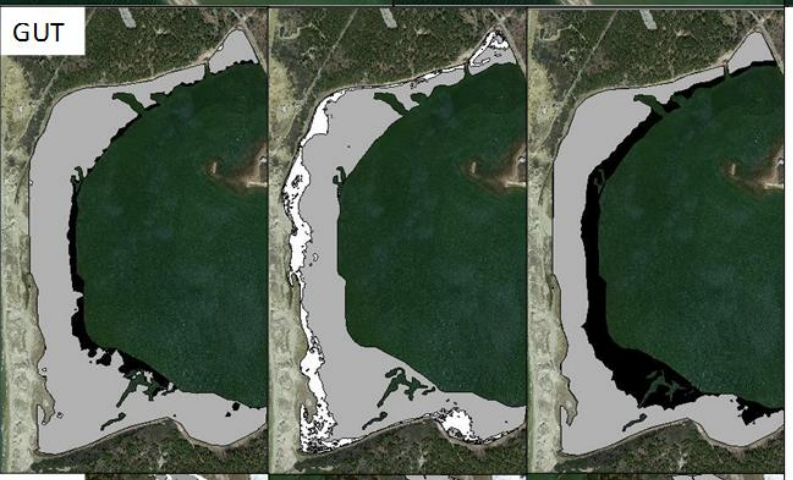

## Middle Meadow

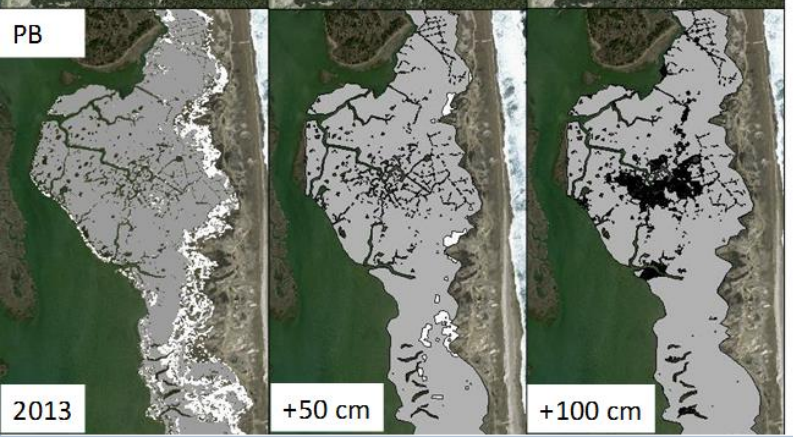
high marsh 1984

high marsh 2013

Smith 2014



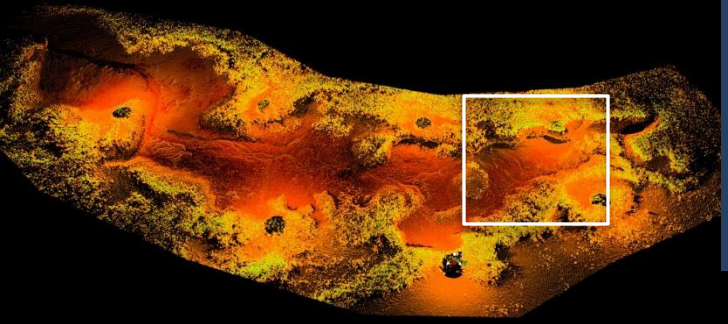

# Relative vulnerabilities of marsh cover types

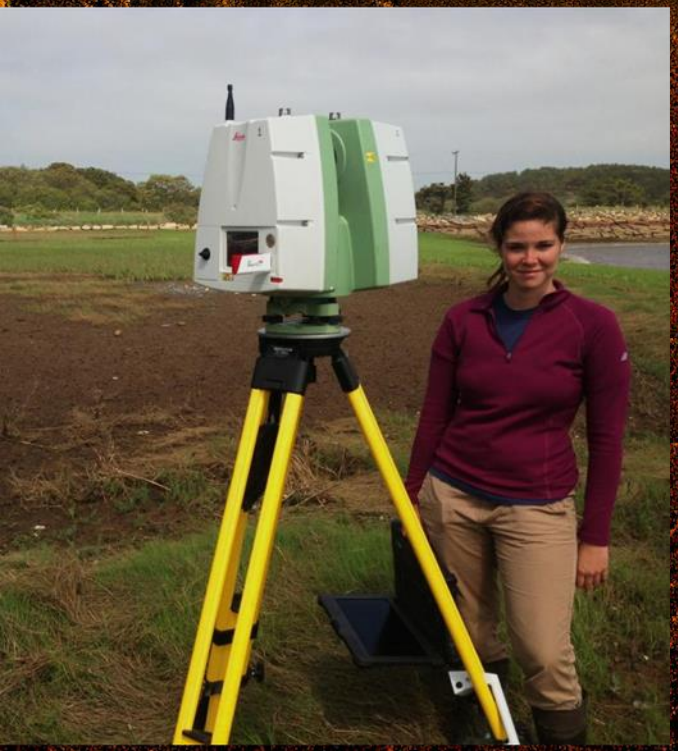
Gray= low marsh (*S. alterniflora*)
White= high marsh (*S. patens*)
Black=unvegetated

| | 50 cm | 100 cm |
|---|---|---|
| High marsh | GUT>HH>WE>PB | HH=WE=GUT≥PB |
| Low marsh | all sites gain LM (net) | WE>HH>GUT>PB |
| No marsh | GUT>WE (HH & PB gain LM) | WE>GUT>HH>PB |

21 % loss of marsh veg over all sites

# Detailed view of tidal channel bank (point cloud)





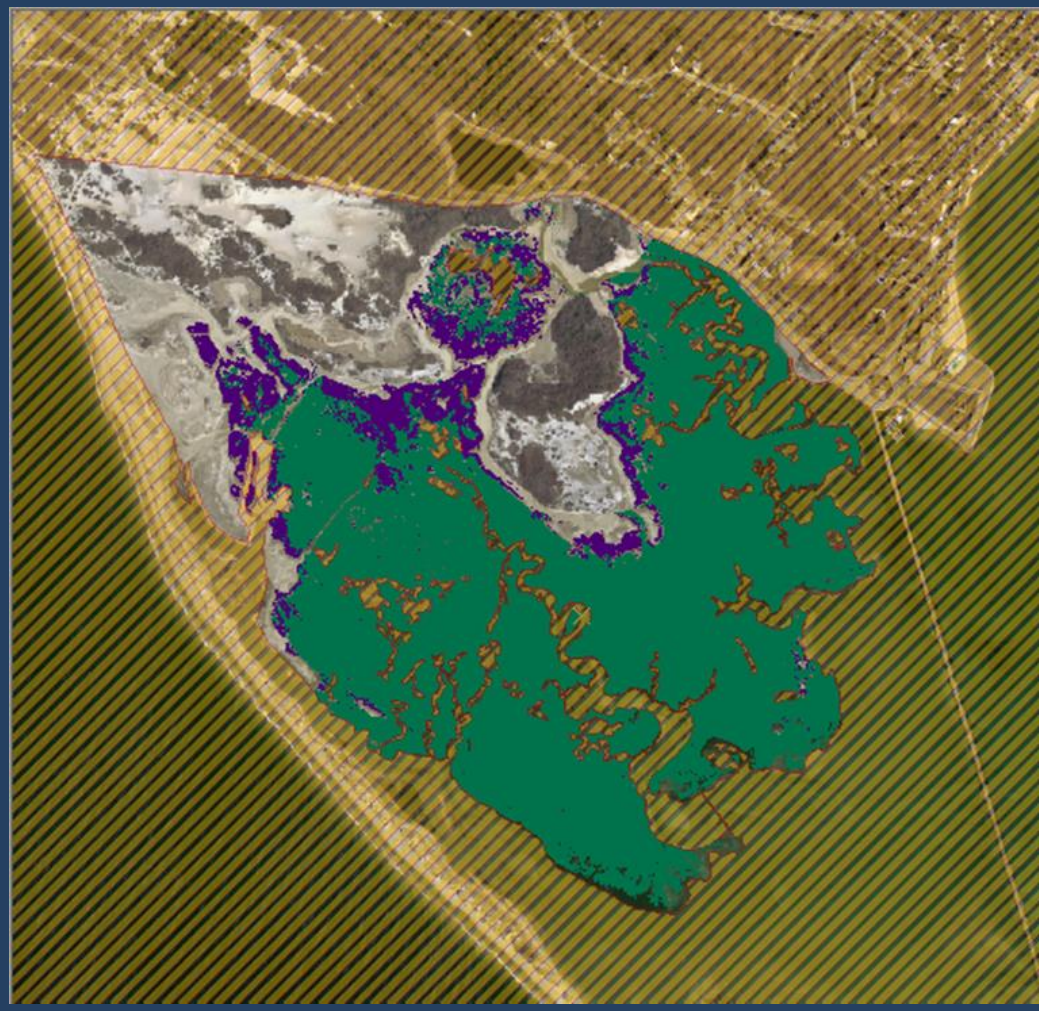
Elev -1.344 m

Elev -1.962 m

1.744 m

# Elevation change detection

- Continue to use SETs
- Laser scans limited areas
- Delineation of hi/low marsh
- LIDAR
- Repeat ground-based surveys



# Many claws make light work


Staff from: Cape Cod National Seashore, NE Coastal Barrier Network, East Carolina University, Geological Society of America, North Atlantic Landscape Conservation Cooperative

# Geomorphic Context

| Site | Type | Significant Wave Height (Hammar-Klose et al. 2002) | Mean High Tide (m NAVD) | Lower limit *S. alterniflora* (m NAVD) | Lower limit *S. patens* (m NAVD) | Average SET accretion rate (mm/yr) |
|---|---|---|---|---|---|---|
| Hatches Harbor | Back barrier | High | 1.23 | 0.155 | 1.12 | 0.1 |
| West End | Back barrier | Moderate | 1.52 | -0.21 | 1.09 | ~0.1 |
| The Gut | Riverine | Moderate | 1.61 | -0.58 | 1.24 | 0.15 |
| Middle Meadow | Back barrier | Moderate | ~1.61 | 0.035 | 1.4 | ~0.15 |
| Pleasant Bay | Back barrier | Very high | 0.92 | -0.098 | 0.78 | ~0.41 |
| **Range** | | | **0.69** | **0.74** | **0.62** | **0.3** |

# Geomorphic Context

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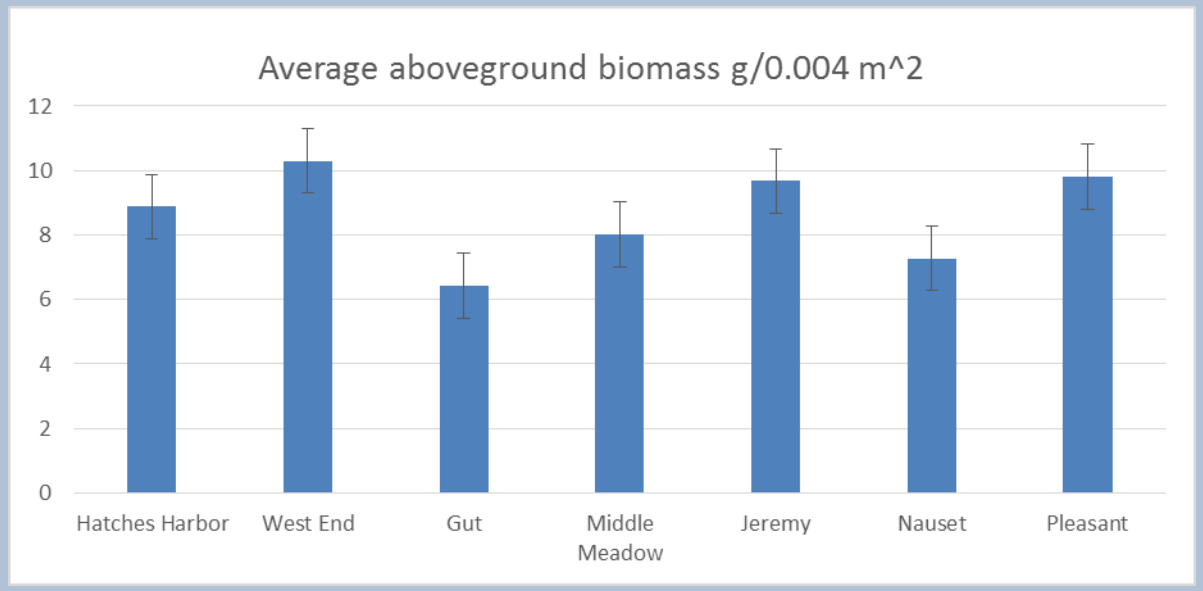
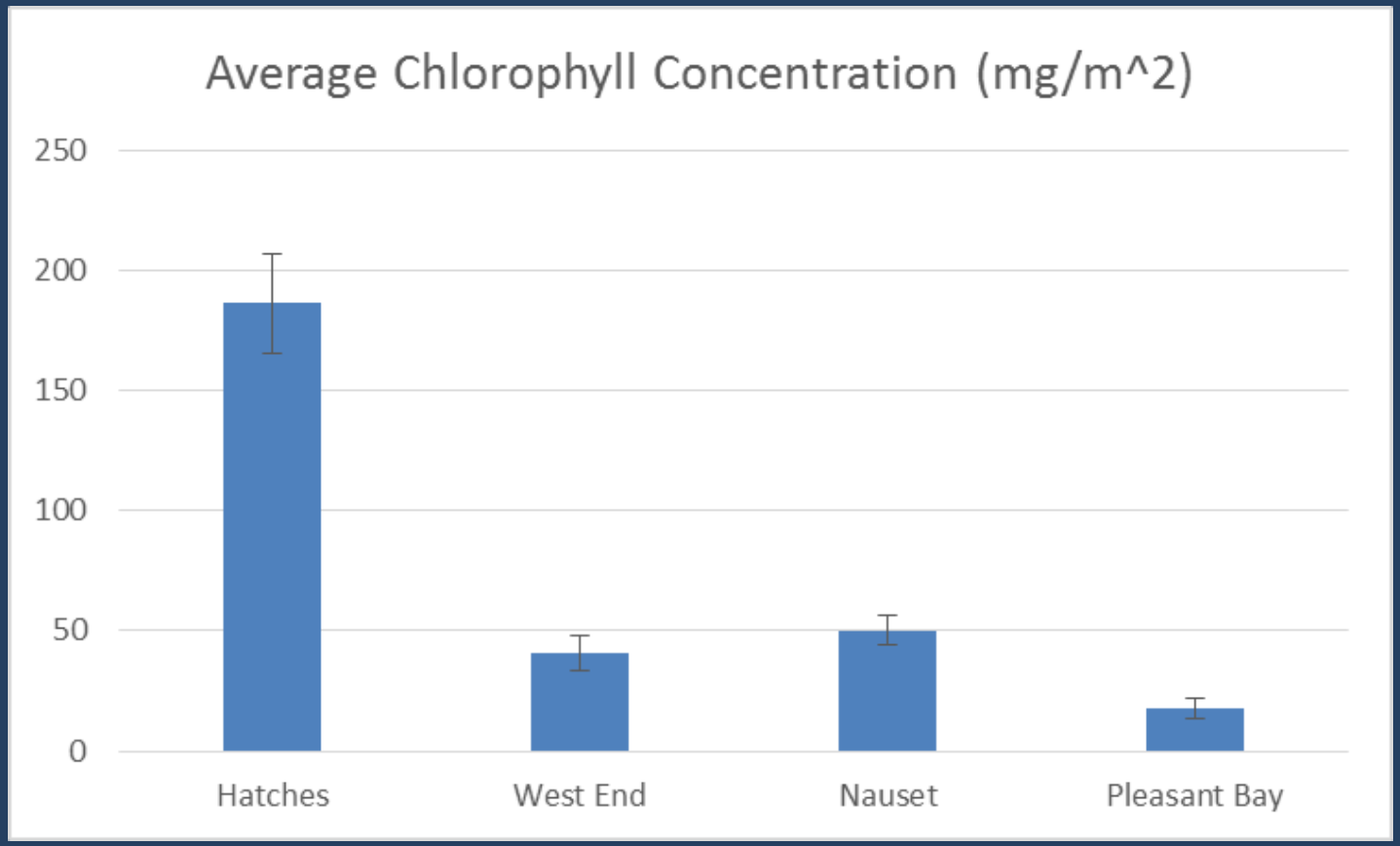
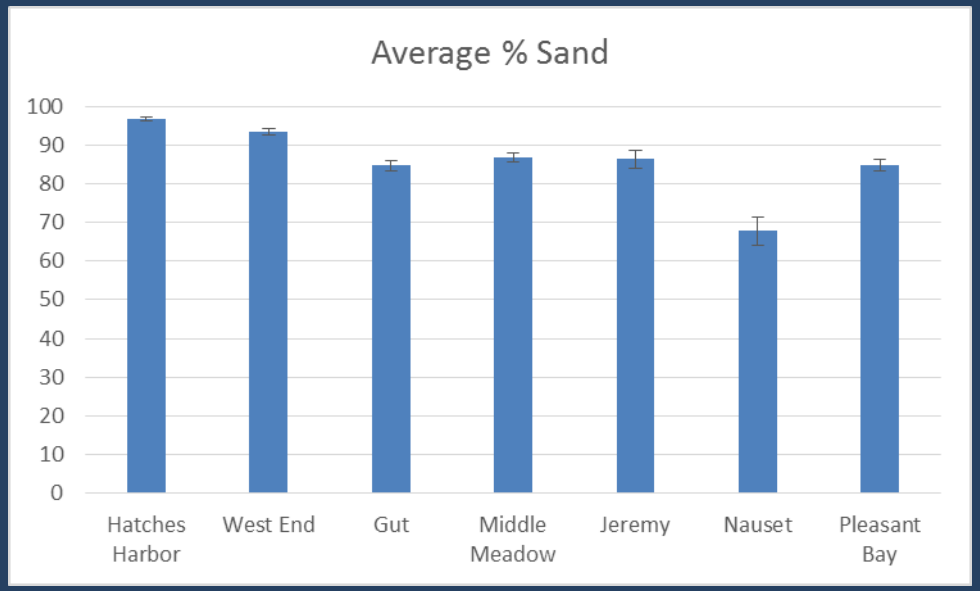
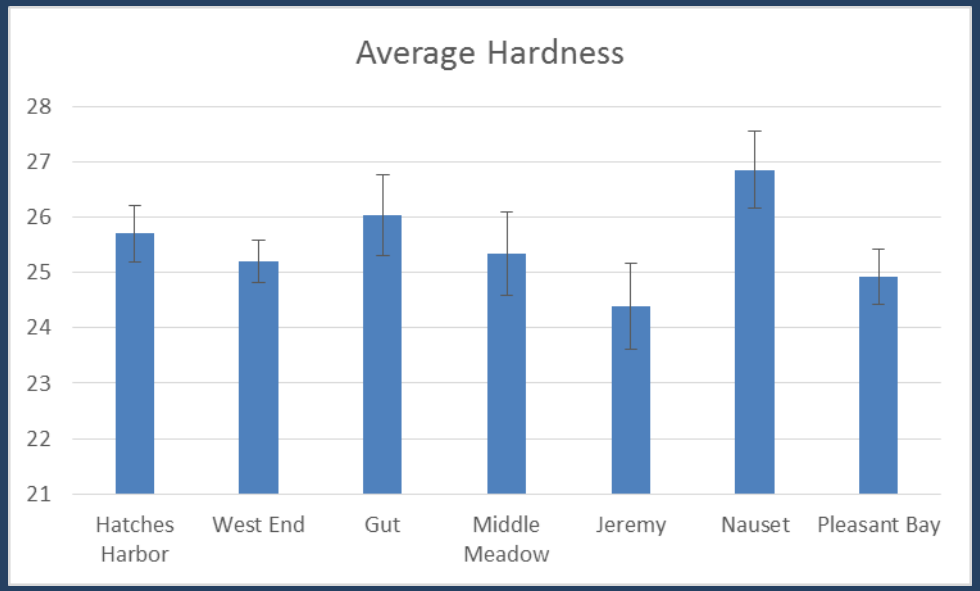
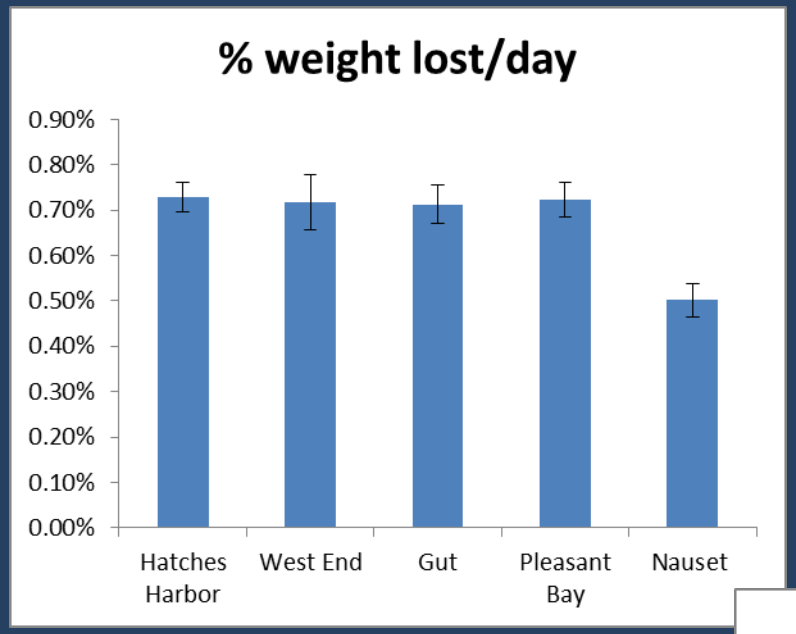

Average aboveground biomass g/0.004 m^2
12
10
8
6
4
2
0
Hatches Harbor
West End
Gut
Middle Meadow
Jeremy
Nauset
Pleasant

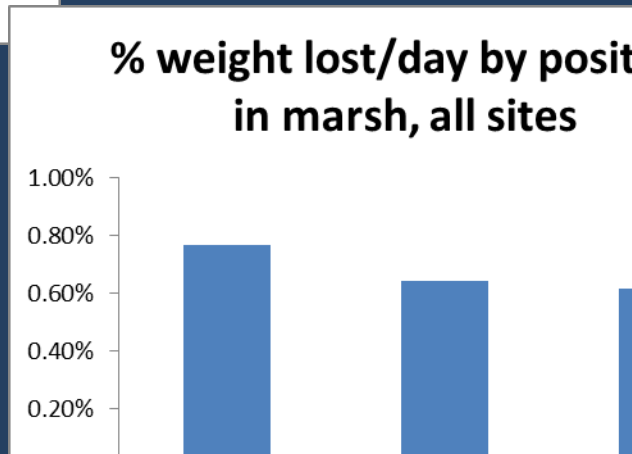

Average Chlorophyll Concentration (mg/m^2)
250
200
150
100
50
0
Hatches
West End
Nauset
Pleasant Bay


Average % Sand
100
90
80
70
60
50
40
30
20
10
0
Hatches Harbor
West End
Gut
Middle Meadow
Jeremy
Nauset
Pleasant Bay

# Within a site, presence of fiddlers crabs lowers sediment penetration resistance




% weight lost/day
0.90%
0.80%
0.70%
0.60%
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
Hatches Harbor
West End
Gut
Pleasant Bay
Nauset


% weight lost/day by posit
in marsh, all sites
1.00%
0.80%
0.60%
0.40%
0.20%