Evaluating the Evolution of Natural Tidal and Managed Wetlands in Delaware

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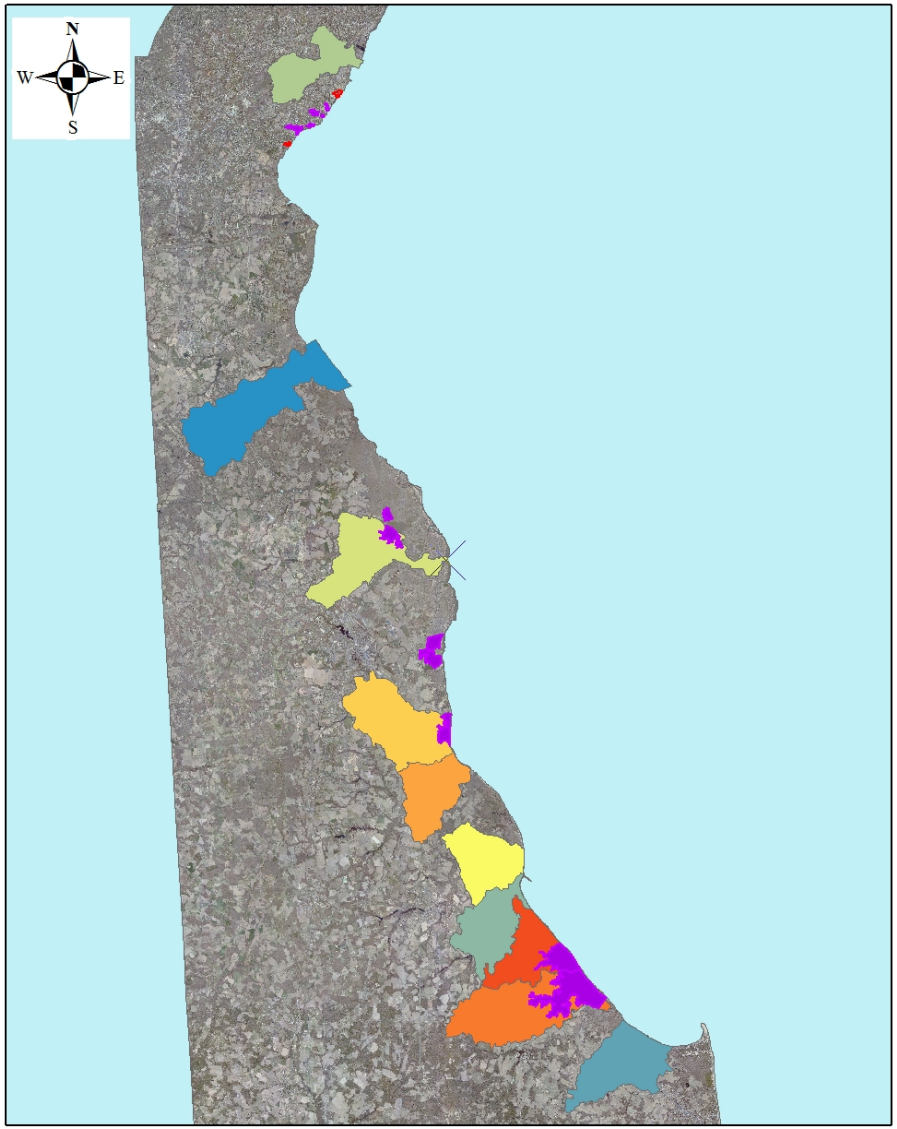
Project Objectives

- Quantify marsh accretion, marsh elevation, and organic/inorganic mass accumulation rates within coastal impoundments and in adjacent natural marsh.
- Determine the evolutionary trends in the managed and reference tidal wetlands.
- Integration of :
  - radionuclide analyses
  - RTK and RTN surveying
  - SET analysis, accretion marker layers
  - Determination of the preferred growth range for *Spartina alterniflora*



Research Areas

Legend

- Tidal Marsh Reference Areas
- Impoundments

Research Watersheds

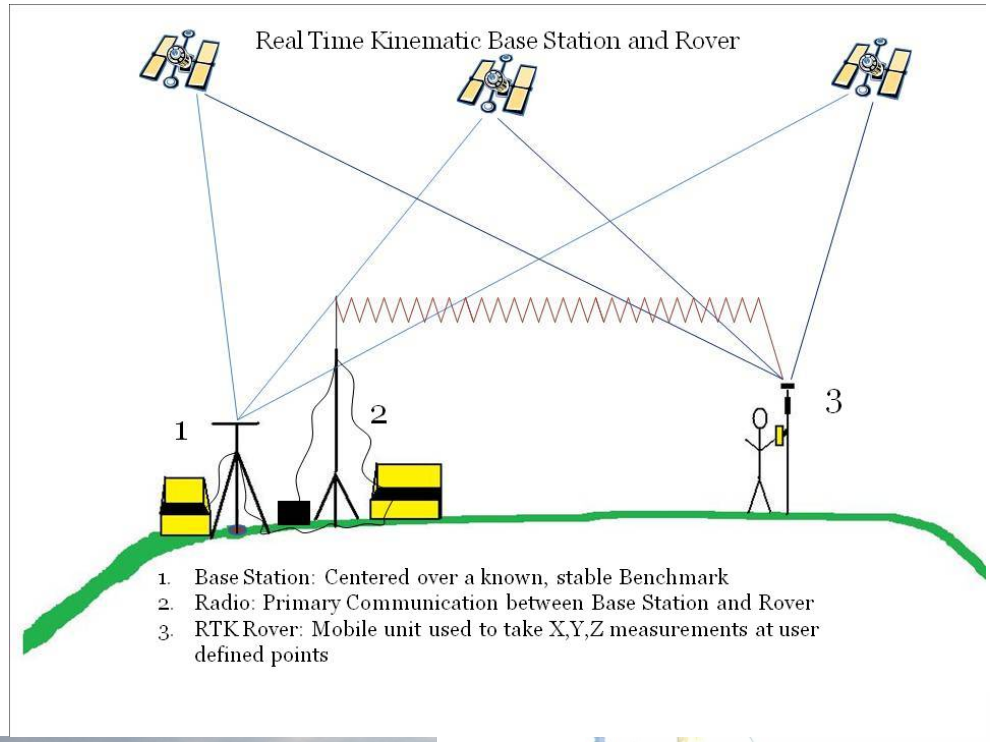
- Blackbird Creek
- Canary Creek-Broadkill River
- Lower Cedar Creek
- Lower Christina River
- Lower Lepsic River
- Lower Missipillion River
- Lower Saint Jones River
- Murderkill River-Town of South Bowers
- Primehook Creek
- Slaughter Creek

10 5 0 10 Miles

Delaware Coastal Programs DCMP

- **Impoundments**
  - **NC: Buttonwood, Broad Dyke, and Gambacorta**
  - **Kent: Bombay Hook NWR, Mahon, Little Creek, Logan Lane North, and Logan Lane South**
  - **Sussex: Primehook NWR Unit 2 and Unit 3**
- **Tidal Marshes**
  - **NC: Lukens, Rivers Edge, Blackbird Creek**
  - **Kent: Bombay Hook NWR, Pickering Beach, St. Jones, Murderkill**
  - **Sussex: Mispillion, Primehook NWR Unit 1 and Unit 4, and Broadkill River**

Real Time Kinematic (RTK) Surveying - Trimble 5700 RTK



^{210}Pb and ^{137}Cs Radioisotopic Dating: Sediment accumulation rate

Analysis Determines Sediment Accumulation Rates

- Porosity , Bulk Density, Organic Content

- Cesium-137 (t1/2=30 years):
  - Product of nuclear fission
  - First introduced into environment by nuclear weapons testing and reactor releases around 1954.
  - Atmospheric fallout ^{137}Cs peaked in 1963-64

- Lead-210 (t1/2=22.5 years):
  - natural radioisotope of the ^{238}U decay series
  - dissolved ^{210}Pb is scavenged by fine-grained particles and delivered to the seabed by sediment deposition
  - Excess ^{210}Pb activity eventually decays to background levels at a rate determined by the 22.3-yr half-life

City of New Castle Impoundment Studies

Historic Accretion Rates

Buttonwood and Lukens Marshes

Legend

- New Castle Pb and Cs Core Sites
- Impoundments
- Tidal Marsh Reference Areas

Determined by Cs 137 Content

	Post 1954 Accretion Rate: (cm/yr)
NCLM3	0.66
NCLM1	0.66
NCLM2	0.83
NCBW2	
NCBW1	0.28
NCBW3	0.32

400 200 0 400 Meters

Delaware Coastal Programs DCMP

NOAA

Historic Accretion Rates

Gambacorta and Rivers Edge Marshes

Legend

- New Castle Pb and Cs Core Sites
- Impoundments
- Tidal Marsh Reference Areas

Determined by Cs 137 Content

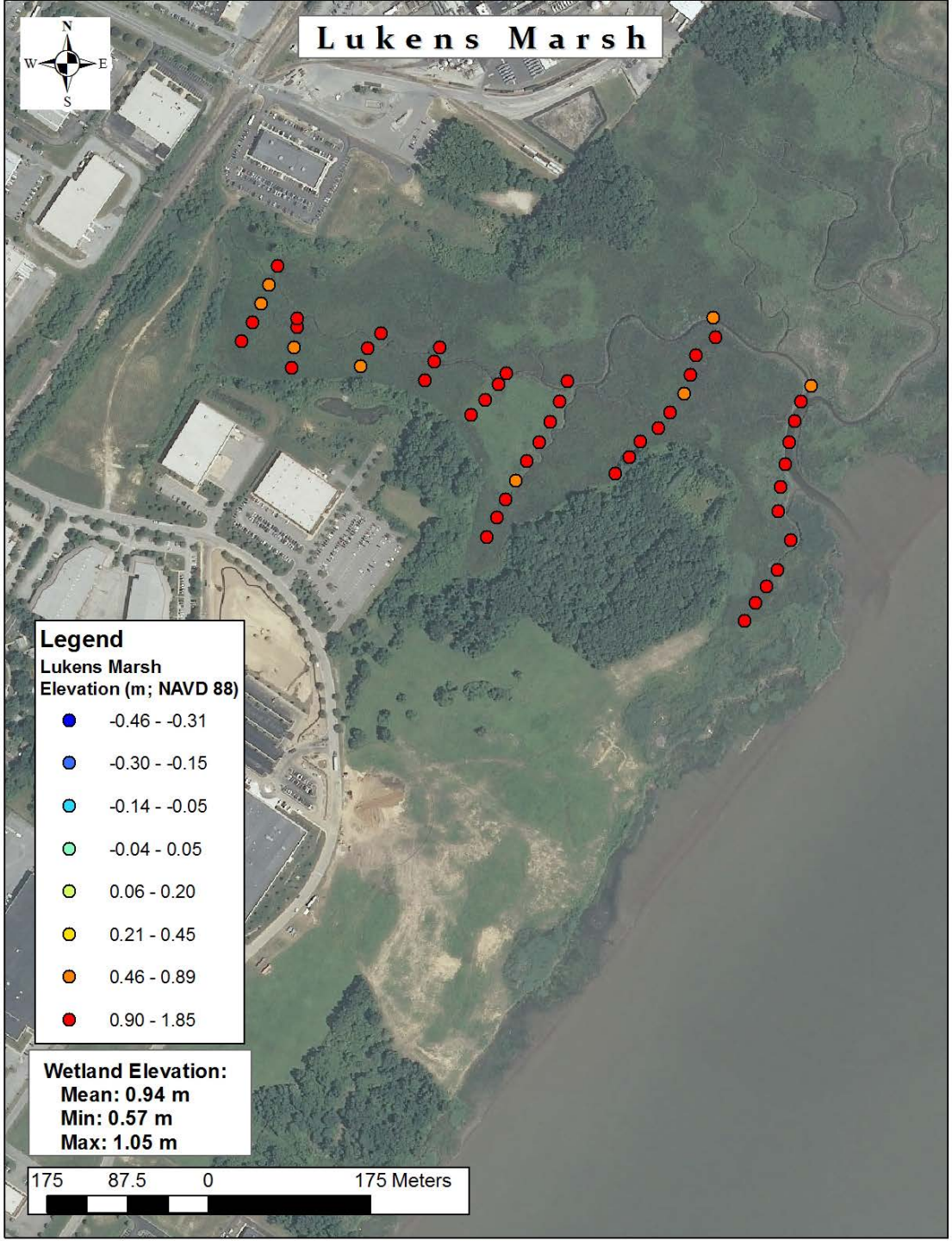
Post 1954 Accretion Rate: (cm/yr)

NCGB1	0.70
NCGB2	0.15
NCGB3	0.36
NCRE1	1.09
NCRE2	0.79
NCRE3	0.66

550 275 0 550 Meters

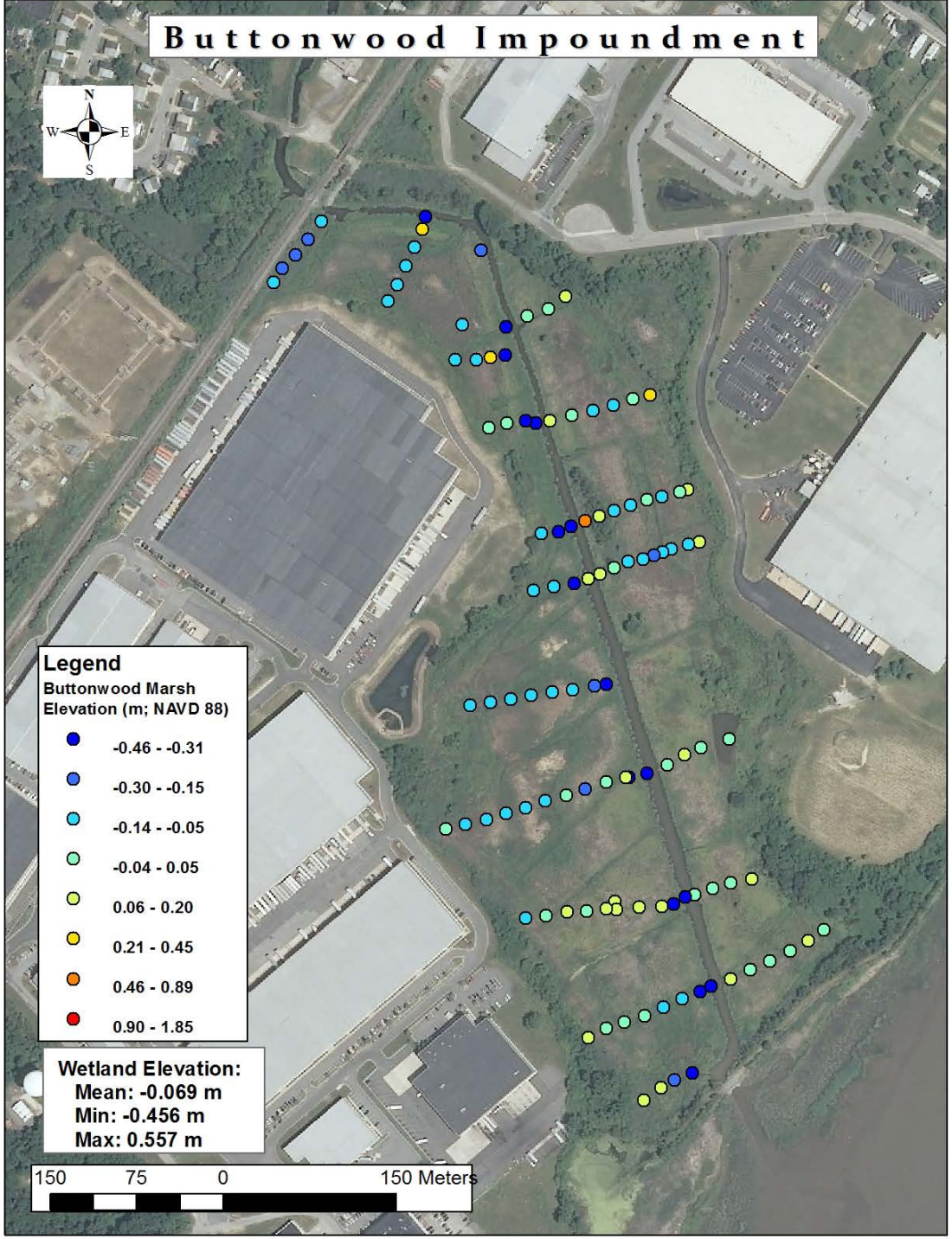
Delaware Coastal Programs DCMP

NOAA



Delaware River Tide Levels (m; NAVD 88)

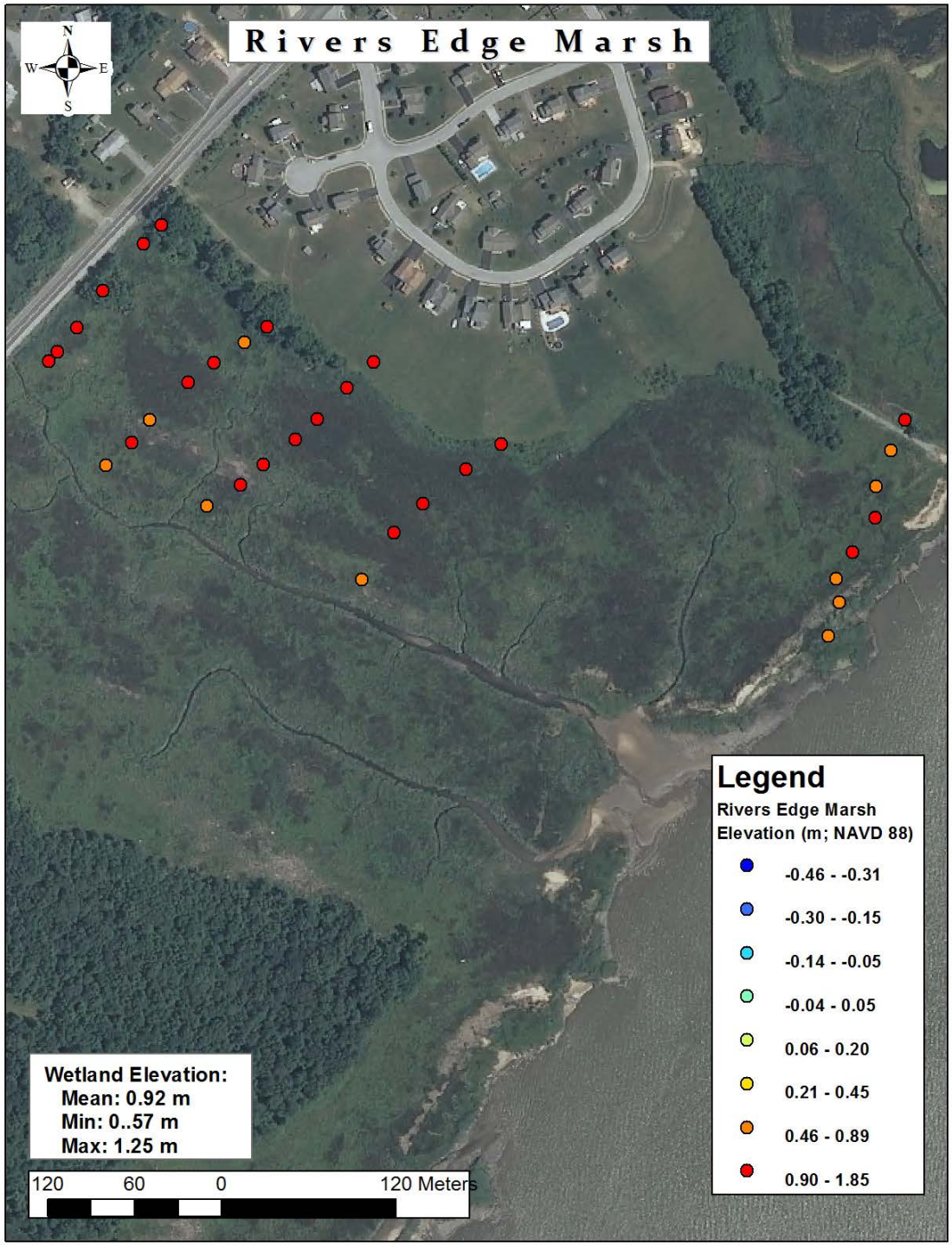
	Lukens Marsh
MHHW	0.95
MHW	0.83
MTL	0.02
MLW	-0.80
MLLW	-0.85



Delaware River Tide Levels (m; NAVD 88)

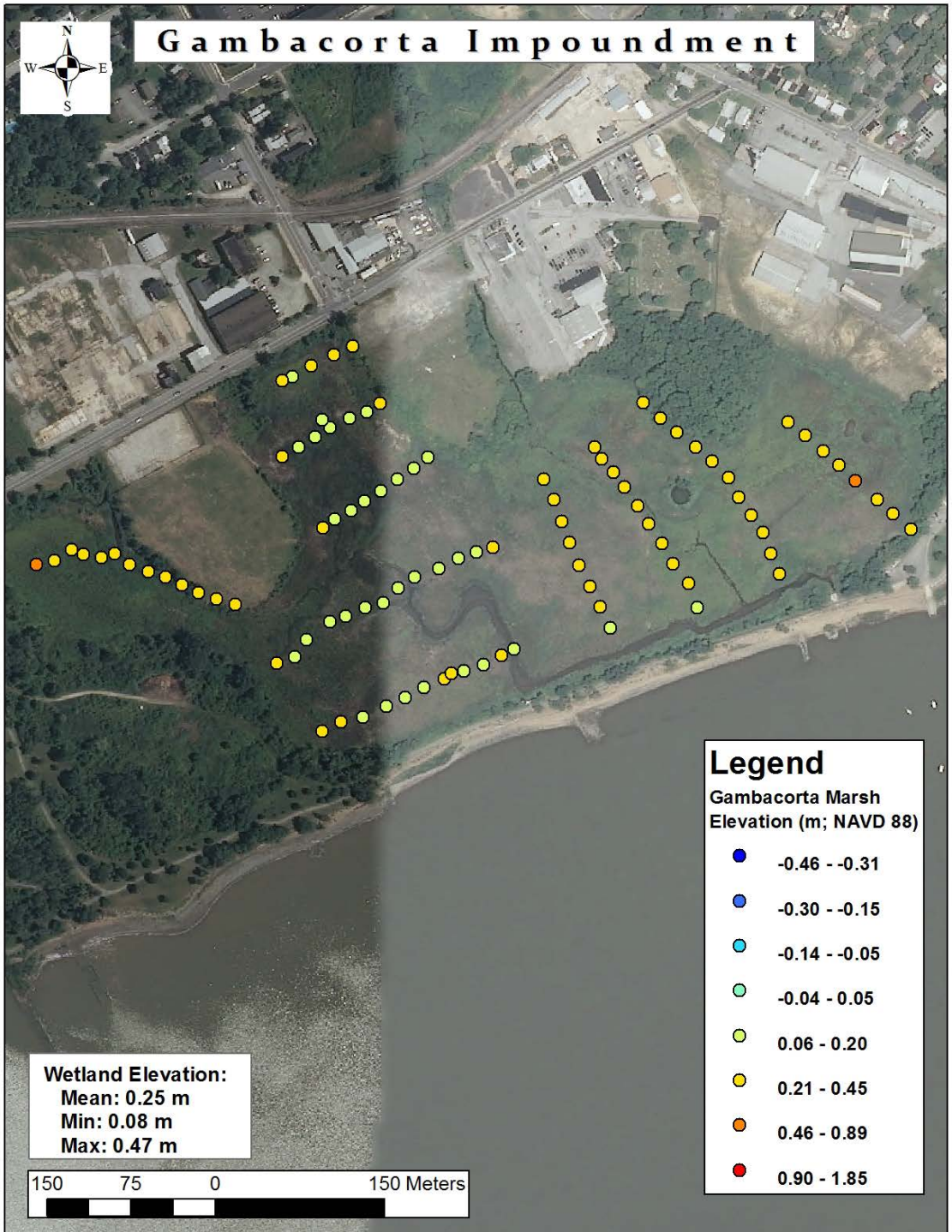
	Lukens Marsh
MHHW	0.95
MHW	0.83
MTL	0.02
MLW	-0.80
MLLW	-0.85

Wetland Elevation:
Mean: 0.94 m
Min: 0.57 m
Max: 1.05 m



Delaware River Tide Levels (m; NAVD 88)

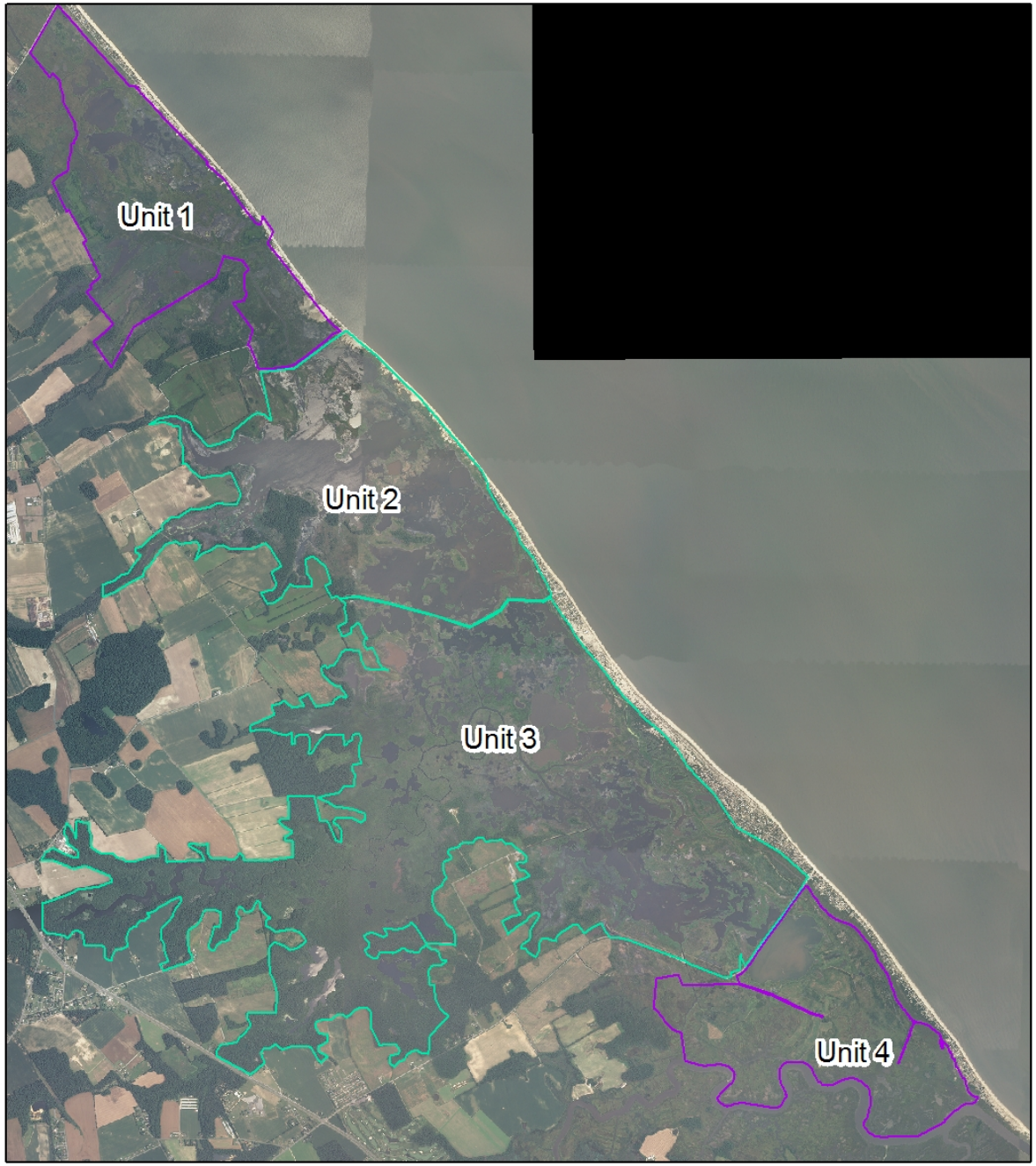
	Rivers Edge Marsh
MHHW	0.92
MHW	0.80
MTL	-0.01
MLW	-0.81
MLLW	-0.86



Delaware River Tide Levels (m; NAVD 88)

	Rivers Edge Marsh
MHHW	0.92
MHW	0.80
MTL	-0.01
MLW	-0.81
MLLW	-0.86

Wetland Elevation:
Mean: 0.92 m
Min: 0..57 m
Max: 1.25 m



Primehook National Wildlife Refuge

Legend

- Tidal Units
- Impounded Units

N
W E
S

1,500 750 0 1,500 Meters

Delaware Coastal Programs
DCMP

NOAA

Historic Accretion Rates

Primehook National Wildlife Refuge

Legend

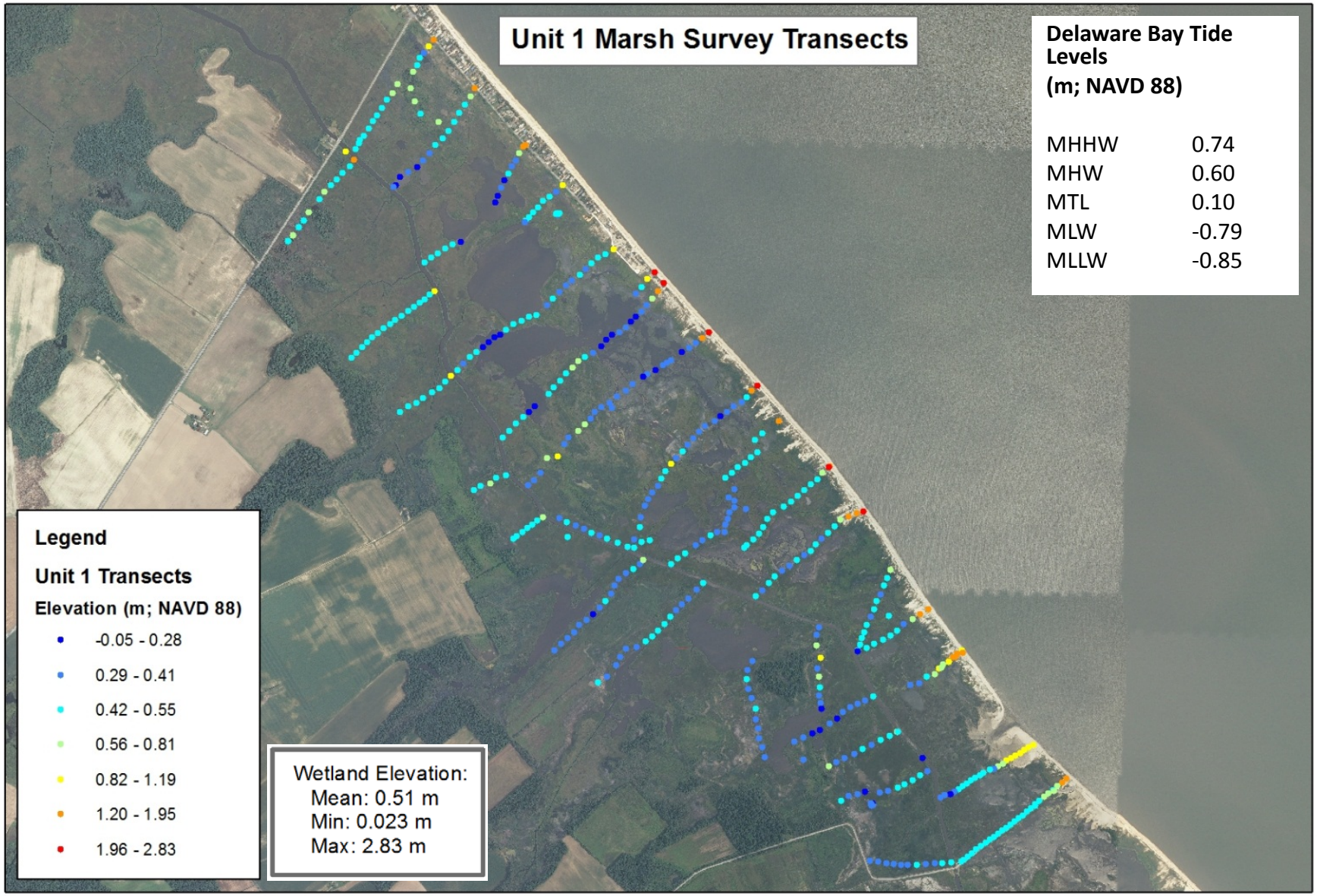
- Radiometric Core
- Future Core Location
- Tidal Units 1 and 4
- Impounded Unit 2 and 3

Determined by Cs 137 Content

	Post 1954 Accretion Rate: (cm/yr)	Mineral Mass Accumulation Rate: (g/cm²/yr)	Organic Mass Accumulation Rate: (g/cm²/yr)
PM2	0.31	0.09	0.04
PM7	0.45		
PM1	0.69	0.20	0.05
PM3	0.17	0.04	0.01
PM8	0.23		
PM4	0.17	0.01	0.02
PM9	0.16		
PM6	0.39	0.06	0.06
PM5	0.38	0.09	0.04

1,600 800 0 1,600 Meters

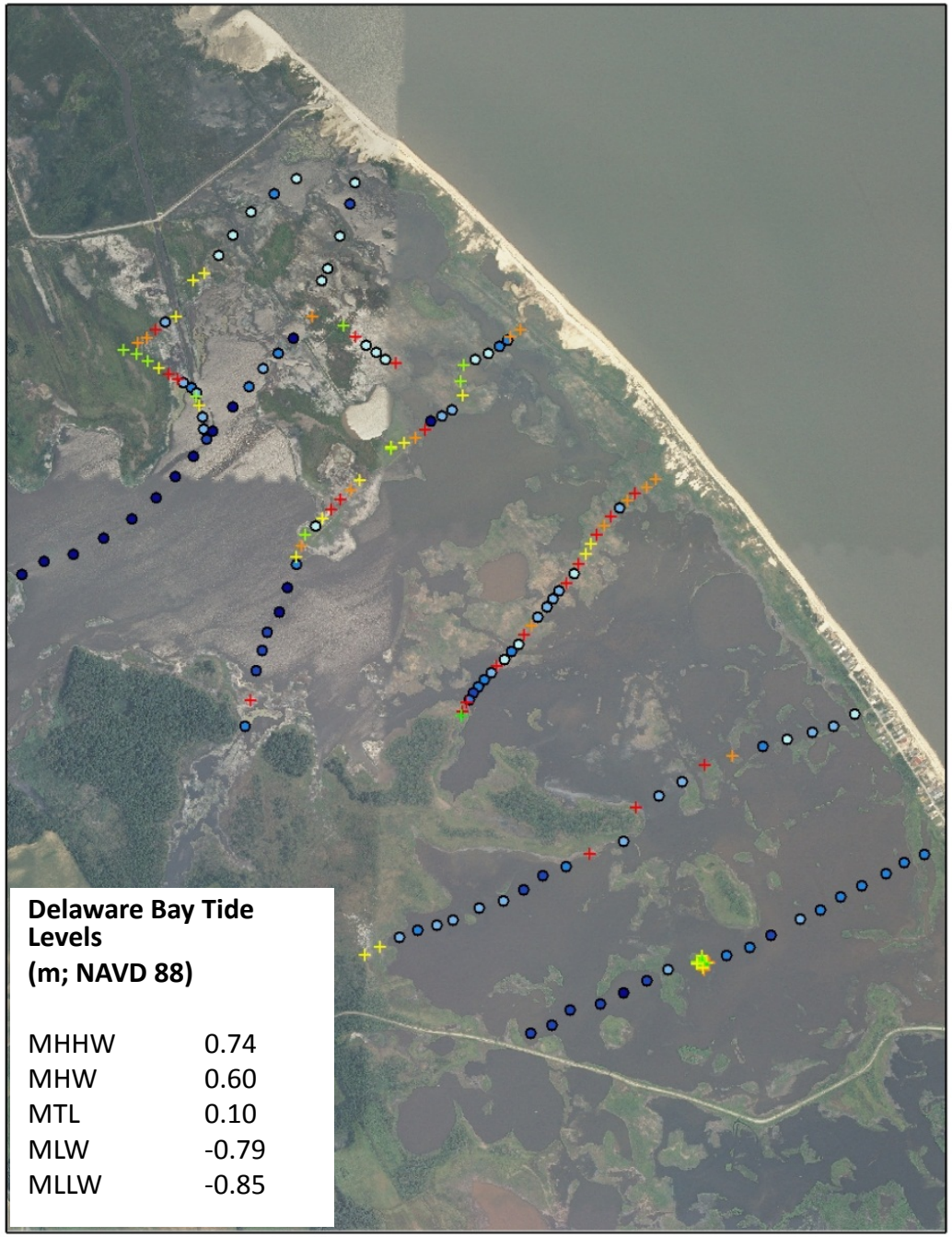
Delaware Coastal Programs DCMP



N
W E
S

750 375 0 750 Meters

DELAWARE COASTAL PROGRAMS
DCMP



Unit 2 Elevations

Primehook National Wildlife Refuge

Legend

Unit 2 Wetland Elevation (m NAVD 88)	Unit 2 Bottom Elevation (m NAVD 88)
0.250 - 0.349	-0.901 - -0.065
0.350 - 0.392	-0.064 - 0.089
0.393 - 0.441	0.090 - 0.176
0.442 - 0.503	0.177 - 0.277
0.504 - 0.556	0.278 - 0.418

Wetland Elevation:	Bottom Elevation:
Mean: 0.407 m	Mean: 0.140 m
Min: 0.250 m	Min: -0.901 m
Max: 0.556 m	Max: 0.418 m

Delaware Bay Tide Levels (m; NAVD 88)

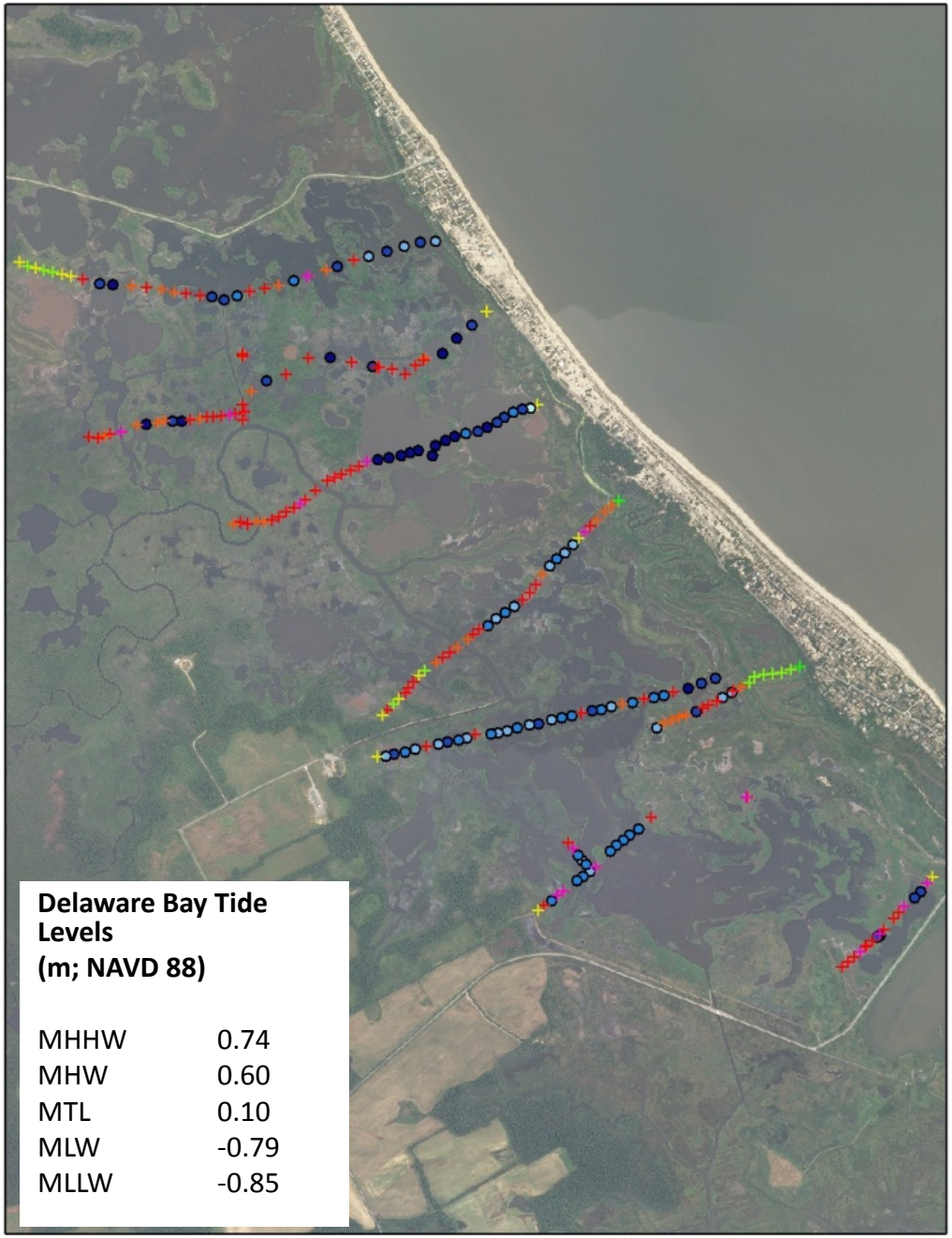
MHHW	0.74
MHW	0.60
MTL	0.10
MLW	-0.79
MLLW	-0.85

N
W E
S

410 205 0 410 Meters

DELAWARE COASTAL PROGRAMS DCMP

NOAA



Delaware Bay Tide Levels
(m; NAVD 88)

MHHW	0.74
MHW	0.60
MTL	0.10
MLW	-0.79
MLLW	-0.85

Unit 3 Elevations

Primehook National Wildlife Refuge

Legend

Unit 3 Wetlands Elevation (m NAVD 88)	Unit 3 Bottom Elevation (m NAVD 88)
-0.074 - 0.250	-0.901 - -0.065
0.251 - 0.349	-0.064 - 0.089
0.350 - 0.392	0.090 - 0.176
0.393 - 0.441	0.177 - 0.277
0.442 - 0.503	0.278 - 0.418
0.504 - 0.555	

Wetland Elevation:	Bottom Elevation:
Mean: 0.332 m	Mean: 0.102 m
Min: 0.155 m	Min: -0.307 m
Max: 0.555 m	Max: 0.257 m

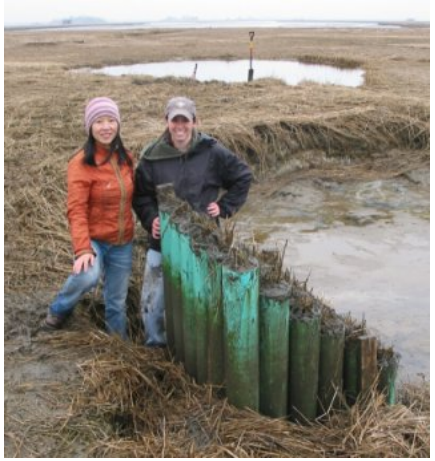
N
W E
S

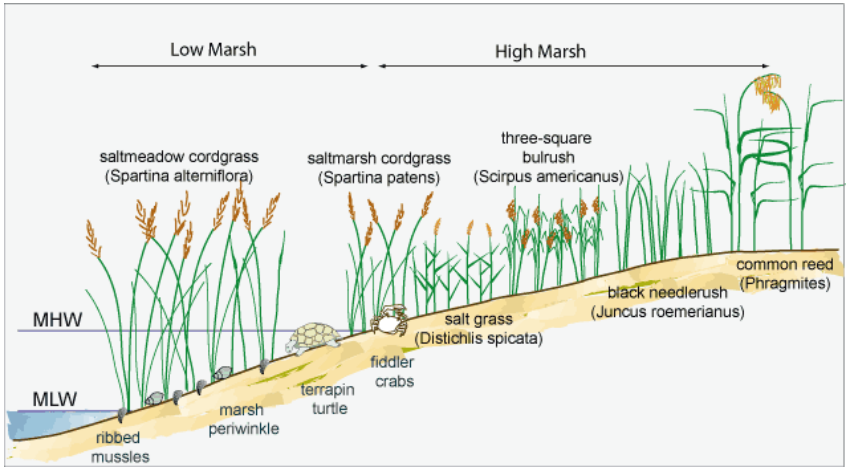
640 320 0 640 Meters

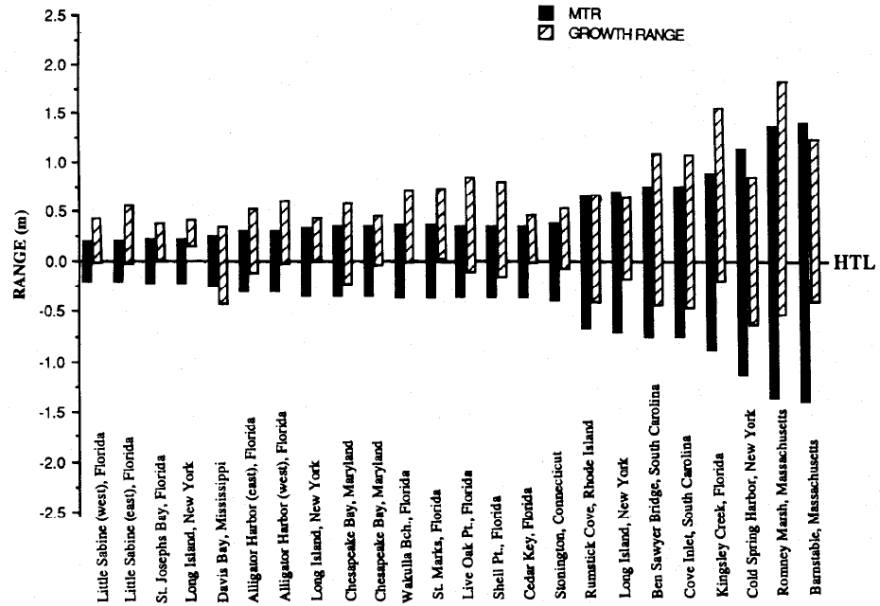
DELAWARE COASTAL PROGRAMS
DCMP

Marsh "Organs"

Smooth Cordgrass or Saltmarsh Cordgrass







niflora relative to mean tide range (MTR) at selected locations along the
dal amplitude). The half tide level (HTL) is the plane midway between

- "The Relationship of Smooth Cordgrass (*Spartina alterniflora*) to Tidal Datums: A Review" states that *S. alterniflora* tend to grow in relation to Mean High and Mean Low Water (McKee and Patrick, 1988)
  - Elevation of marsh platform within watersheds are dependant upon tidal datums

Purpose

- Develop vulnerability index for *Spartina alterniflora* salt marshes
  - Most common Halophyte in Delaware's marshes

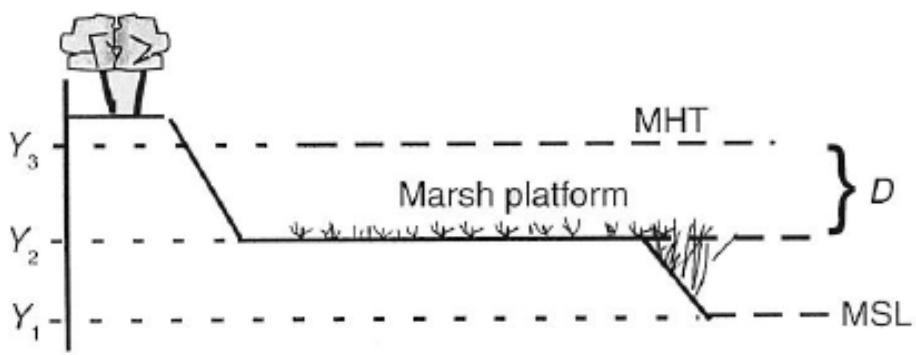
- Classify healthy, degrading, and severely degrading short-form *Spartina alterniflora* marsh regions based upon correlation
  - Degraded and severely degraded are known to have lower elevations

- Method to evaluate marsh vulnerability, determine relative timelines for collapse, setting priorities for potential restoration, and developing engineering criteria for restoration (i.e. restore marsh to this level).

Background Information

- For every marsh there is an optimum rate of RSLR, an optimum depth at which the marsh community is productive, and an equilibrium depth that can be greater or less than the optimum (Morris et al. 2002)

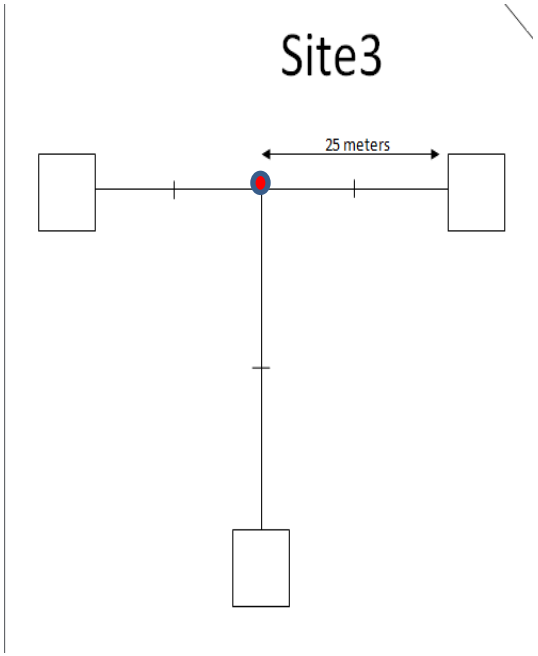
- The marsh surface and tidal surface elevation relationship is one of the ultimate controls in dictating wetland flooding frequency, length of inundation, available and potential suspended sediment concentrations, and type and density of vegetation cover (Morris et al., 2002).



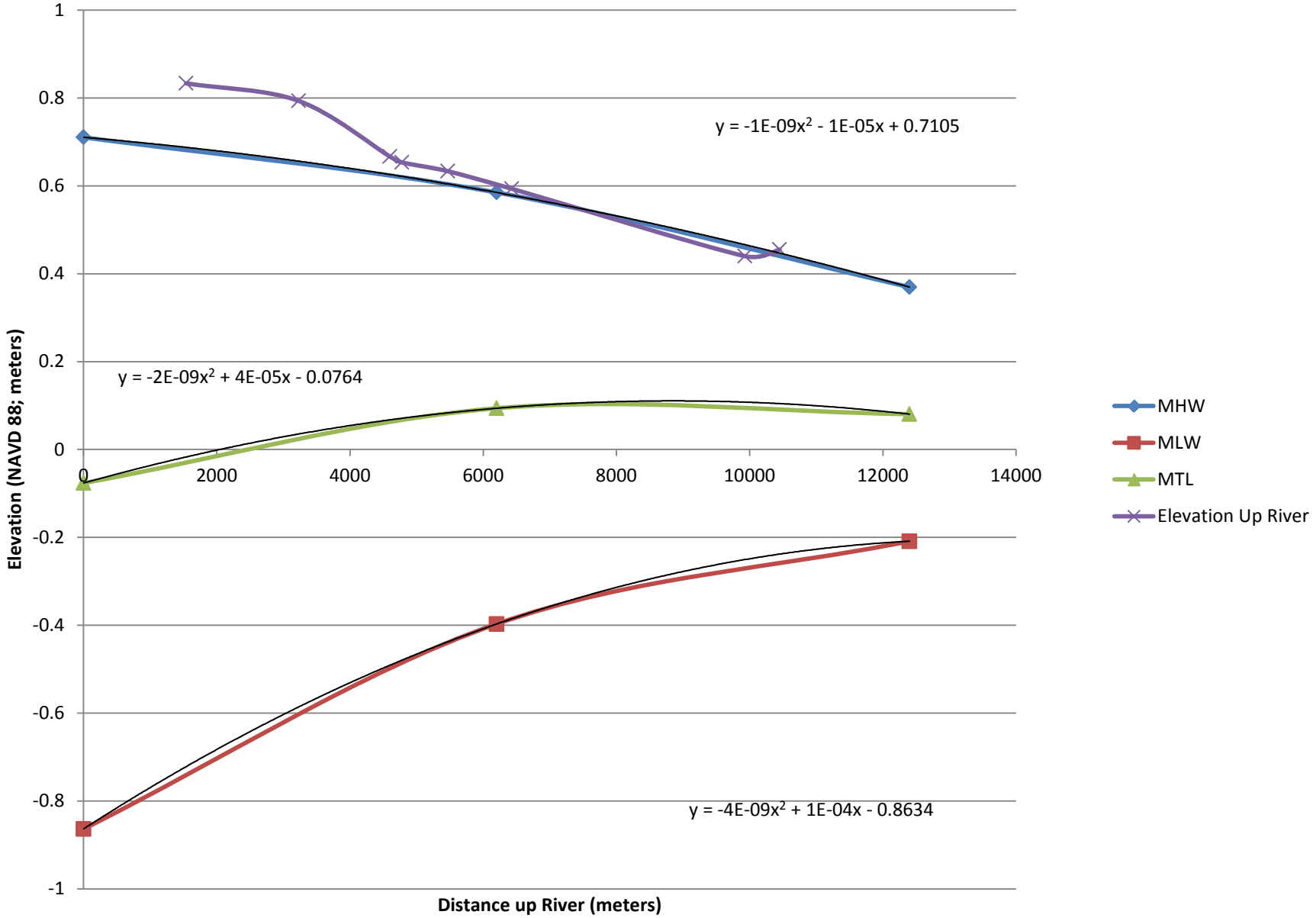
Morris et al. 2002

Methods

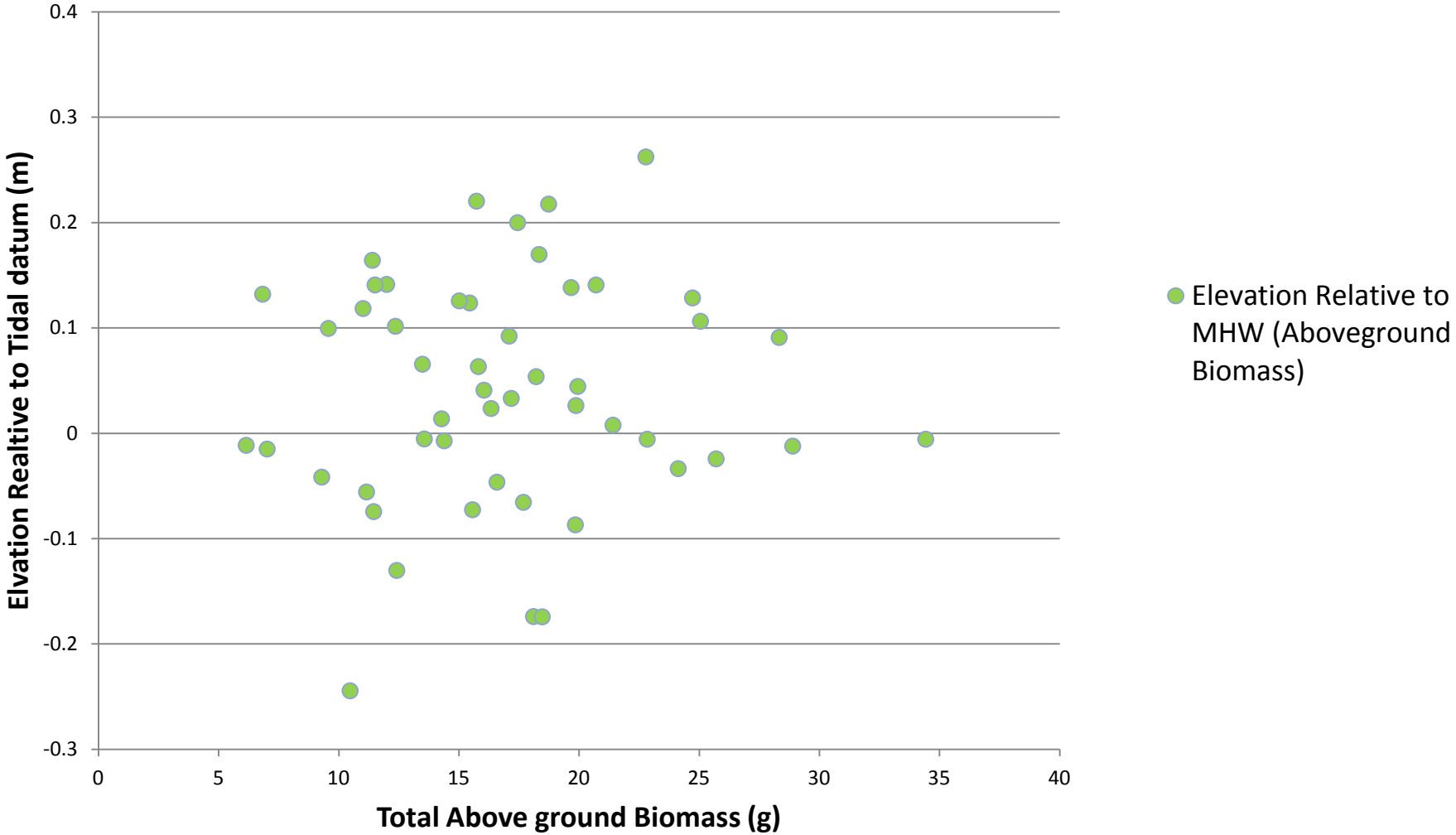
- Biomass Sampling
  - Three cores per site
  - Collect both above and below ground biomass samples
  - Sort and separate dead and alive plant matter
- Real-Time Kinematic (RTK) Survey
  - Provide elevation data for biomass sampling sites and additional *S. alterniflora* monotypic stands



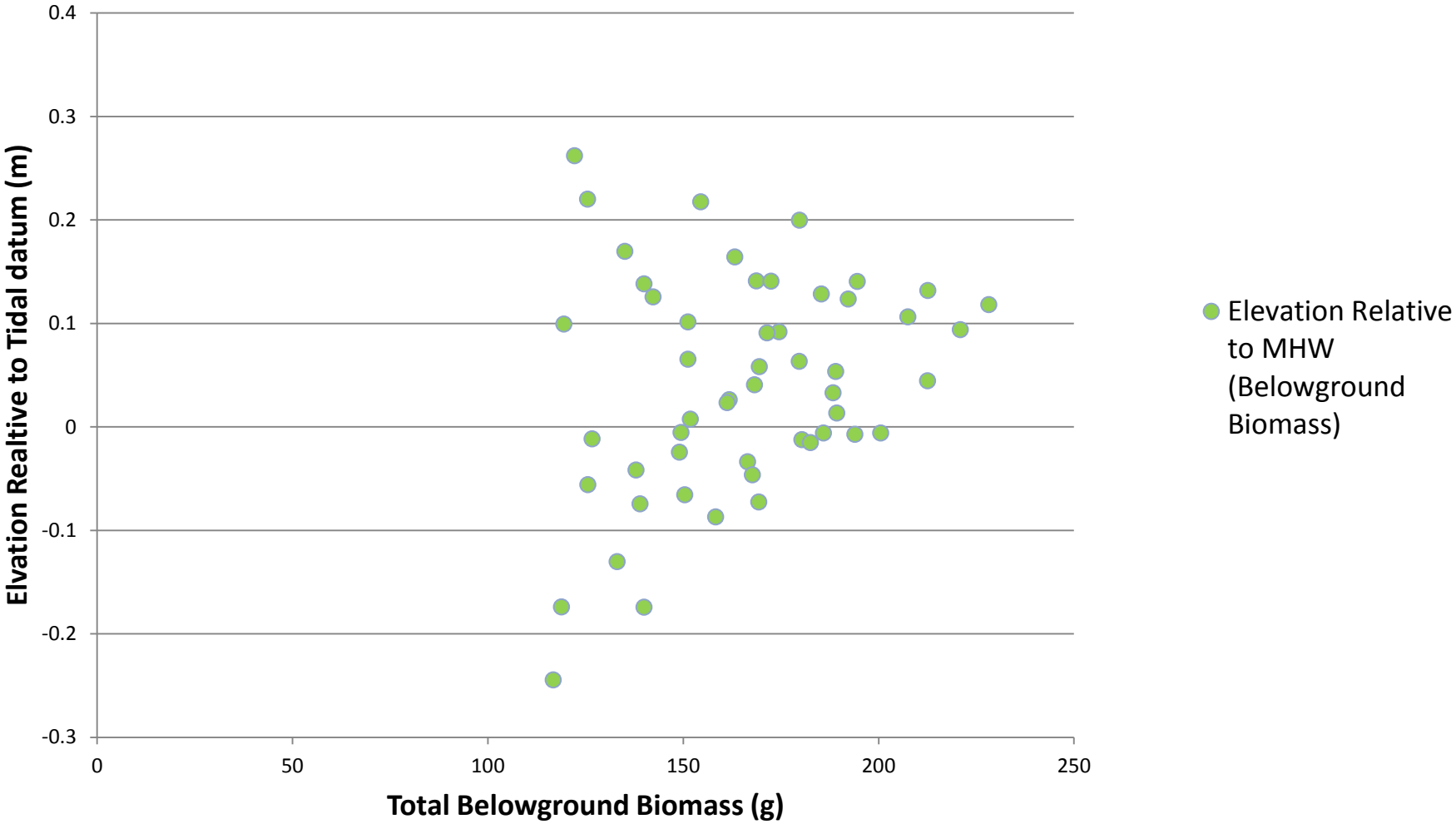
St Jones River Tidal Datum's



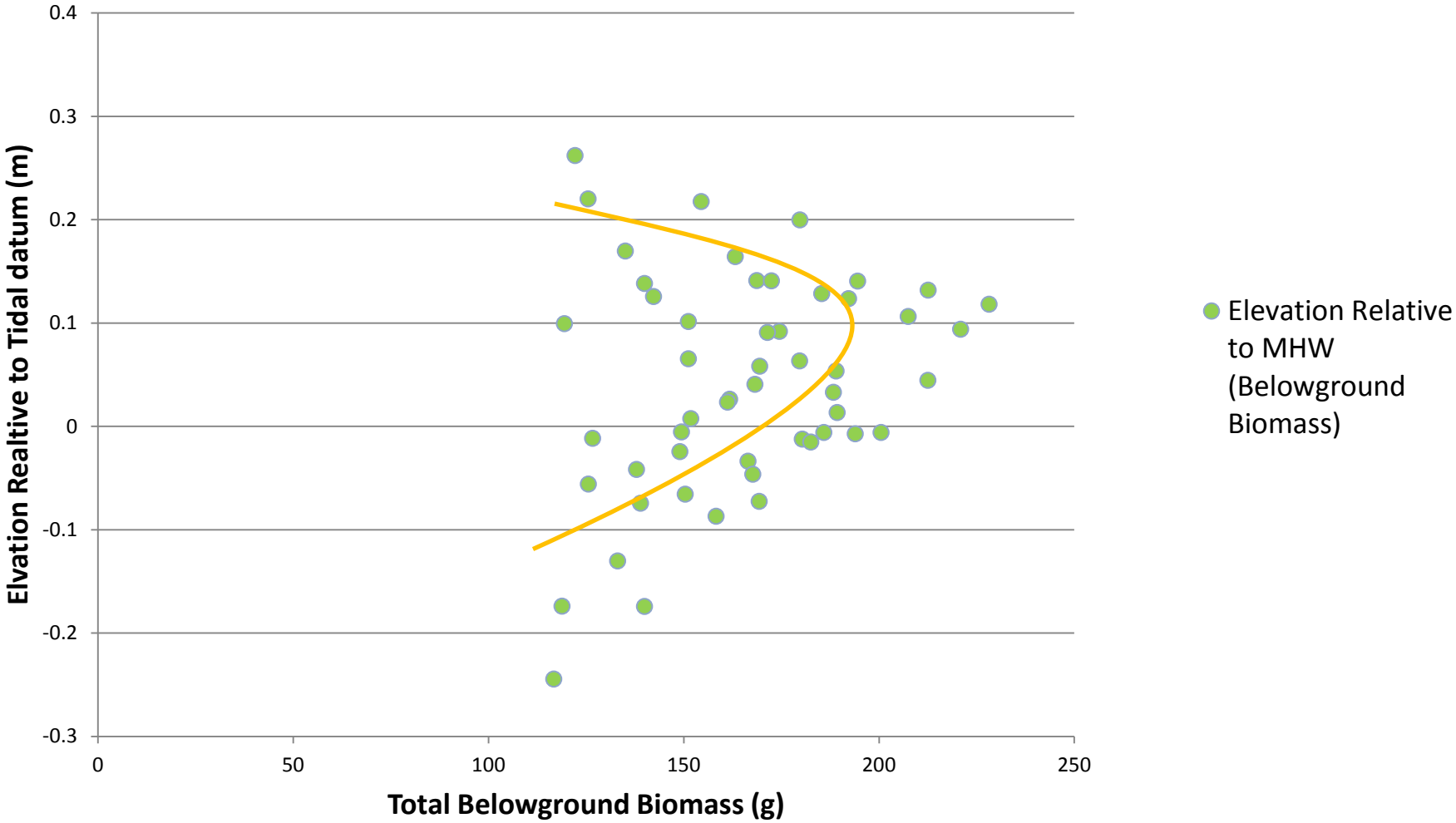
Elevation Relative to MHW vs Total Above Ground Biomass



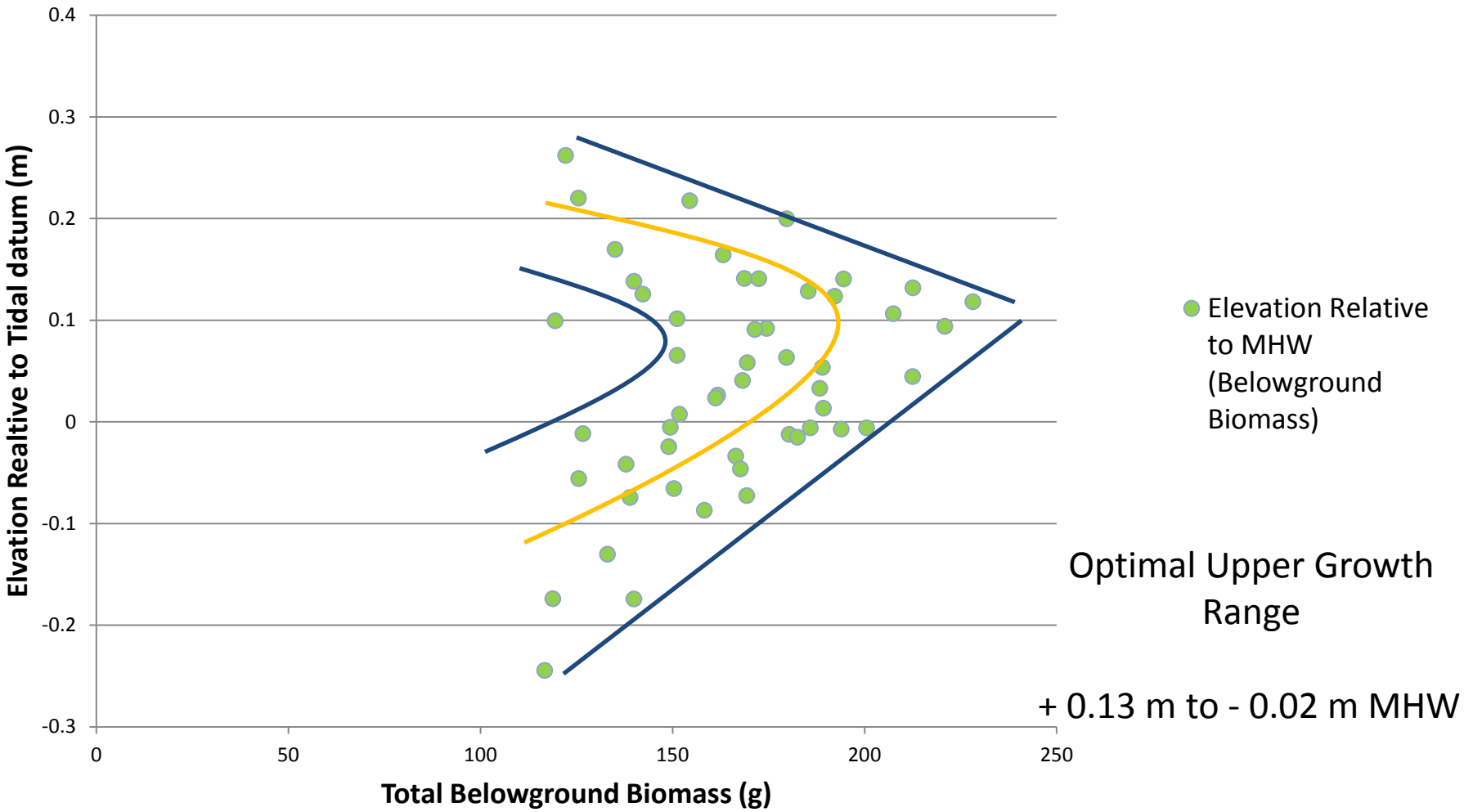
Elevation Relative to MHW vs Total Below Ground Biomass

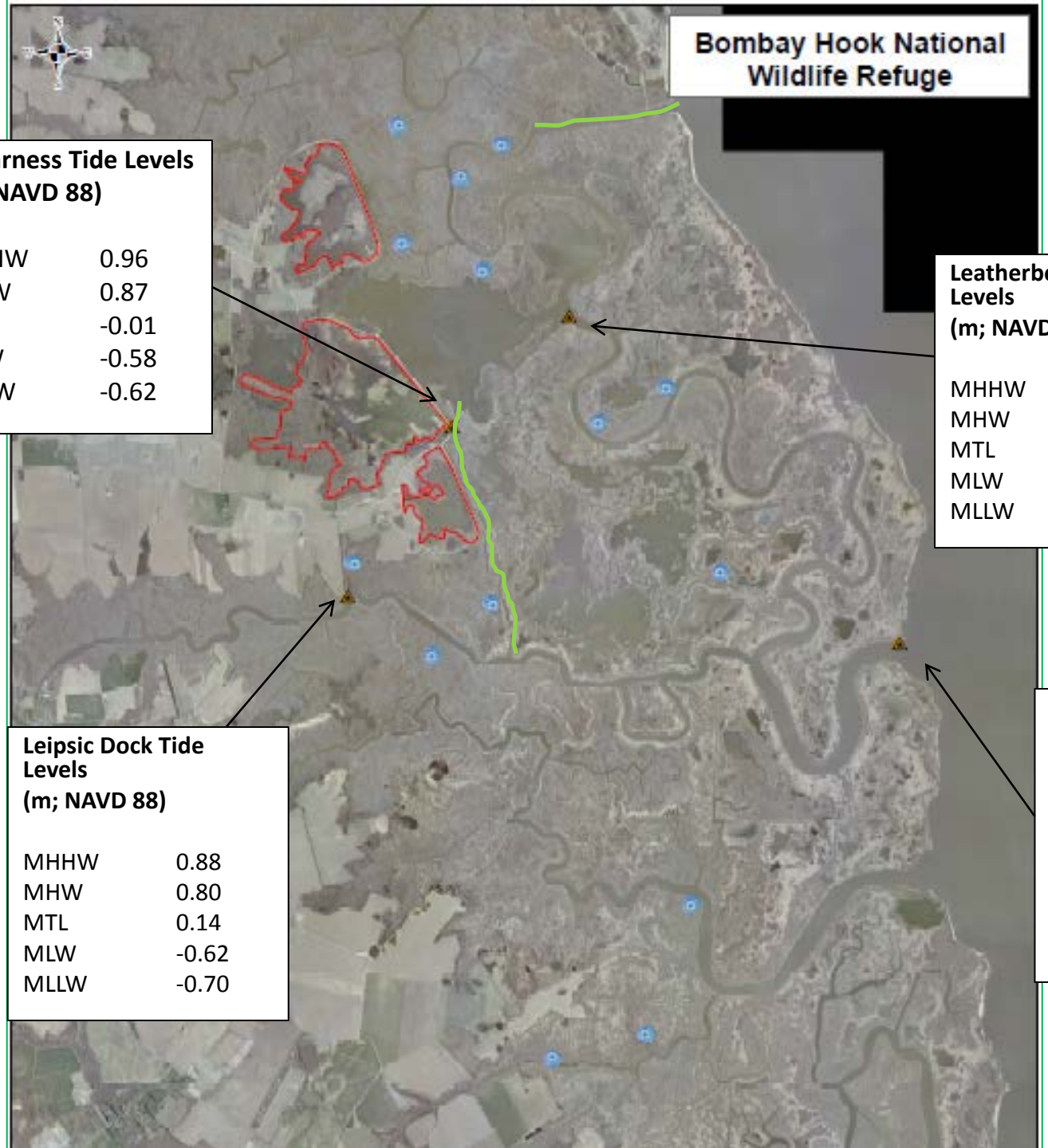


Elevation Relative to MHW vs Total Below Ground Biomass



Elevation Relative to MHW vs Total Below Ground Biomass





Shearness Tide Levels (m; NAVD 88)

MHHW	0.96
MHW	0.87
MTL	-0.01
MLW	-0.58
MLLW	-0.62

Leatherberry Tide Levels (m; NAVD 88)

MHHW	1.35
MHW	1.24
MTL	0.34
MLW	-0.63
MLLW	-0.70

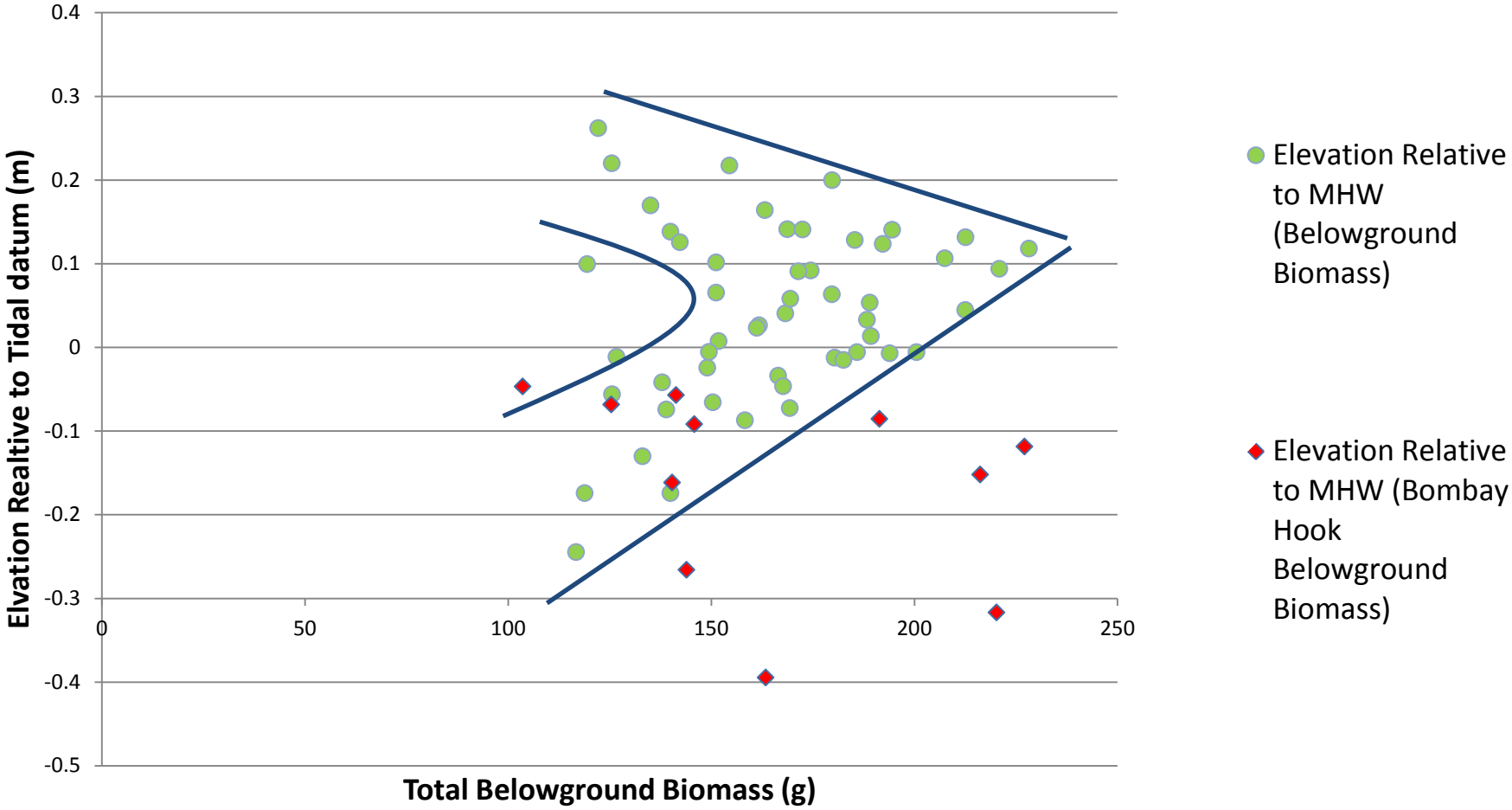
Leipsic Dock Tide Levels (m; NAVD 88)

MHHW	0.88
MHW	0.80
MTL	0.14
MLW	-0.62
MLLW	-0.70

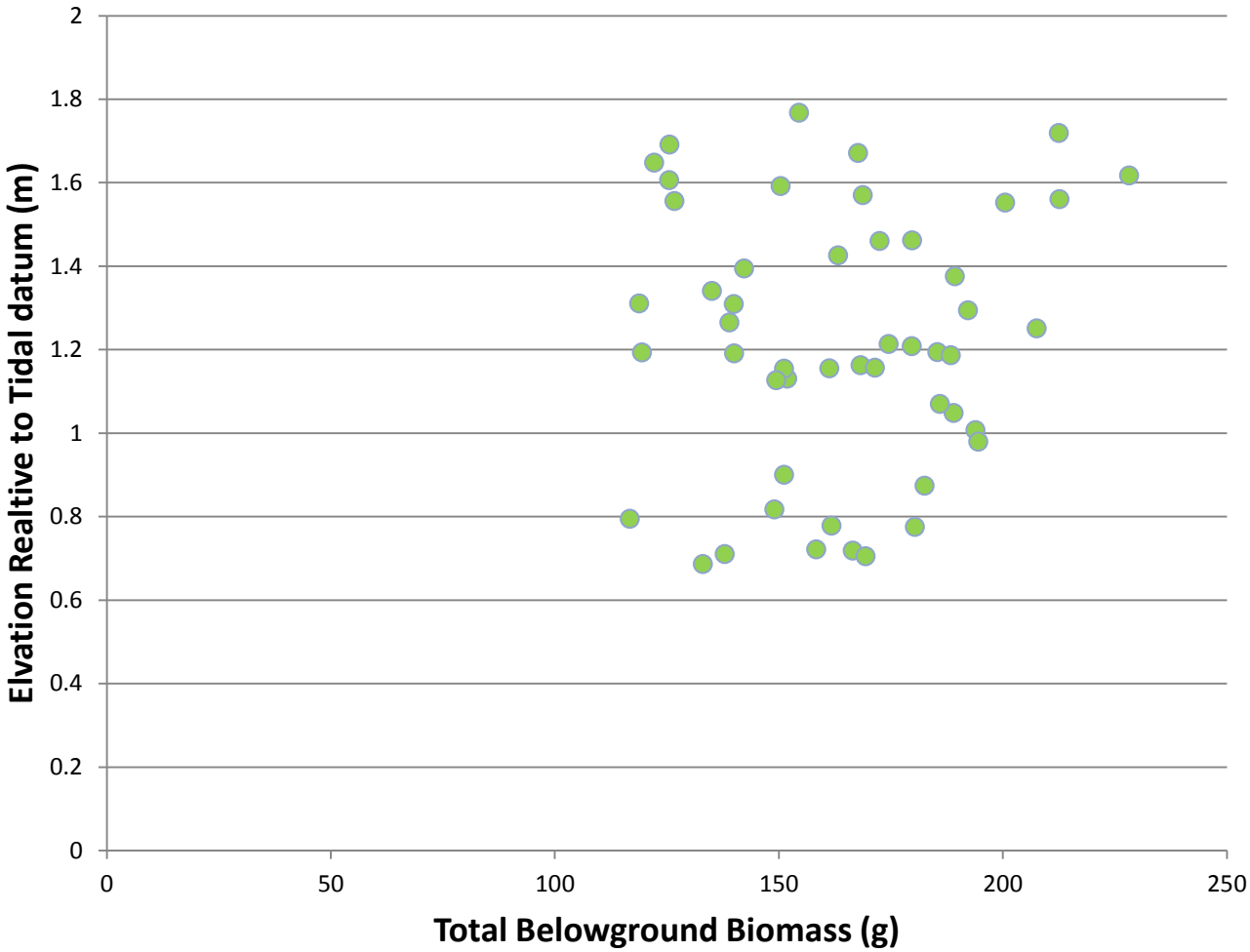
Nav Light Tide Levels (m; NAVD 88)

MHHW	1.02
MHW	0.90
MTL	0.09
MLW	-0.77
MLLW	-0.82

Elevation Relative to MHW vs Total Below Ground Biomass



Elevation Relative to MLW



Lower Growth Range

~ + 0.68 m above MLW

Upcoming Research

- Continue ongoing monitoring
- Evaluate spatial distribution of sediment accumulation.
- Evaluate constituents of sediment deposited
- Correlate MVI and Below ground biomass results with sediment accumulation and elevation change.
- Correlate elevation change and sediment accumulation to tidal elevations.

- Acknowledgements
  - Michael Stroeh and Susan Guiteras, Bombay and Prime Hook NWR
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  - Chris Bason, Center for Inland Bays
  - Don Cahoon, USGS Patuxent Wildlife Research Center