The restoration of Dyke Marsh Preserve in a dynamic and changing world

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Overview

- Background and history
- Elevation and tidal channels
- Vegetation
- Sea level rise
- Restoration scenarios

Tidal freshwater marshes

- 820,000 ha in conterminous U.S.
  (Field et al. 1991)

- 164,000 ha along the Atlantic Coast
  (Odum et al. 1984)

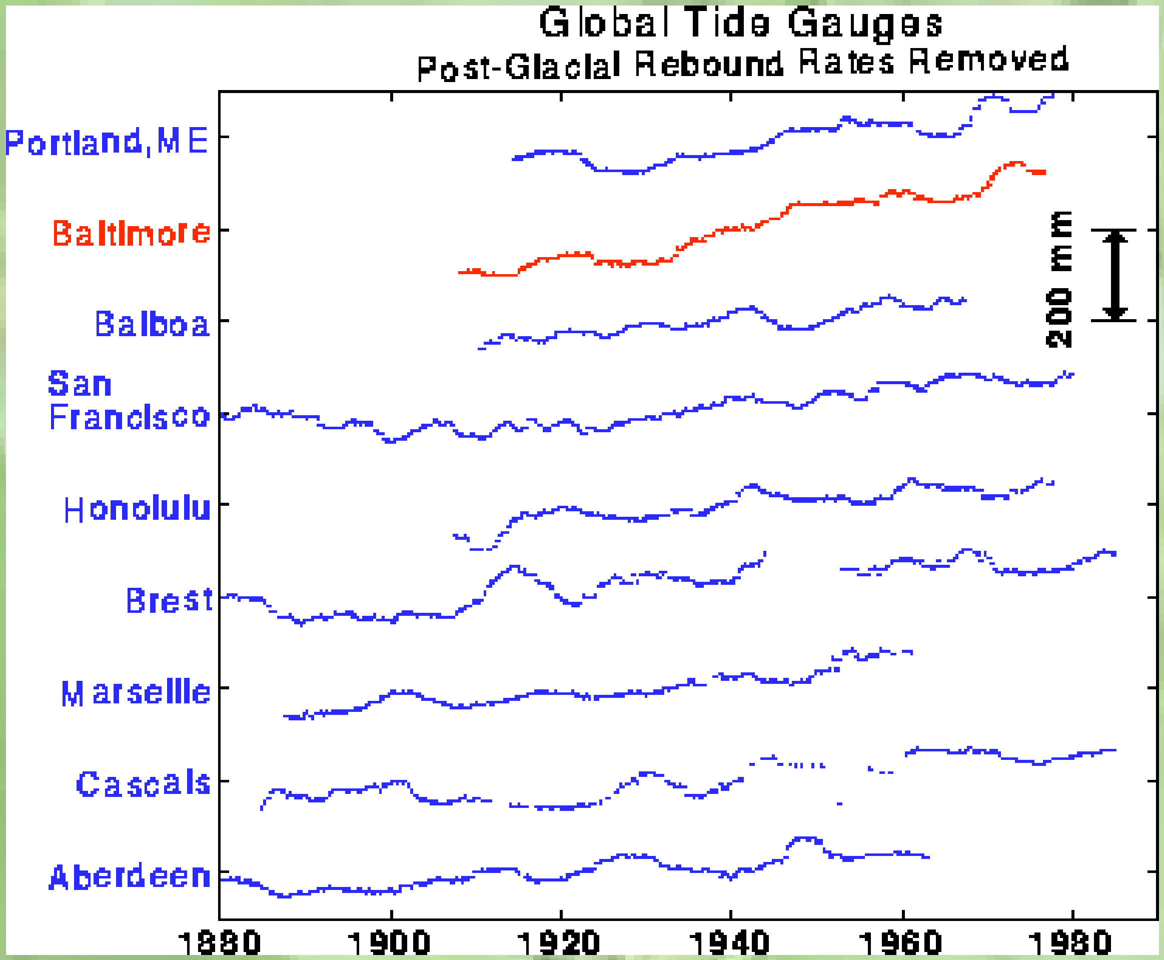
Loss of wetlands

- 53% of all wetlands in conterminous U.S. lost from 1780's to 1980's (Dahl 1990).
- Coastal wetlands lost at 8,100 ha/yr between 1922 and 1954 and 19,000 ha/yr between 1954 and 1970 (Gosselink and Baumann 1980).
- 1.7% of remaining coastal wetlands lost by 1990 (Dahl and Johnson 1991).
- Even today 0.1% / year is lost (Tiner 1998).

Causes

- Urbanization
  - 52% of U.S. population lives within 80 miles of the U.S. coast (Southworth 1989)
- Sea level rise
  - 3.1 mm/yr from 1993 to 2003.
  - Projected to rise between 0.18 to 0.59 m by end of century based on various emissions scenarios (IPCC 2007).
  - In Chesapeake Bay, sea level is rising at twice the global rate (Douglas 1991).

Background



NOAA

Consequences

- Unmitigated loss of wetlands
- Loss of diversity and ecosystem services

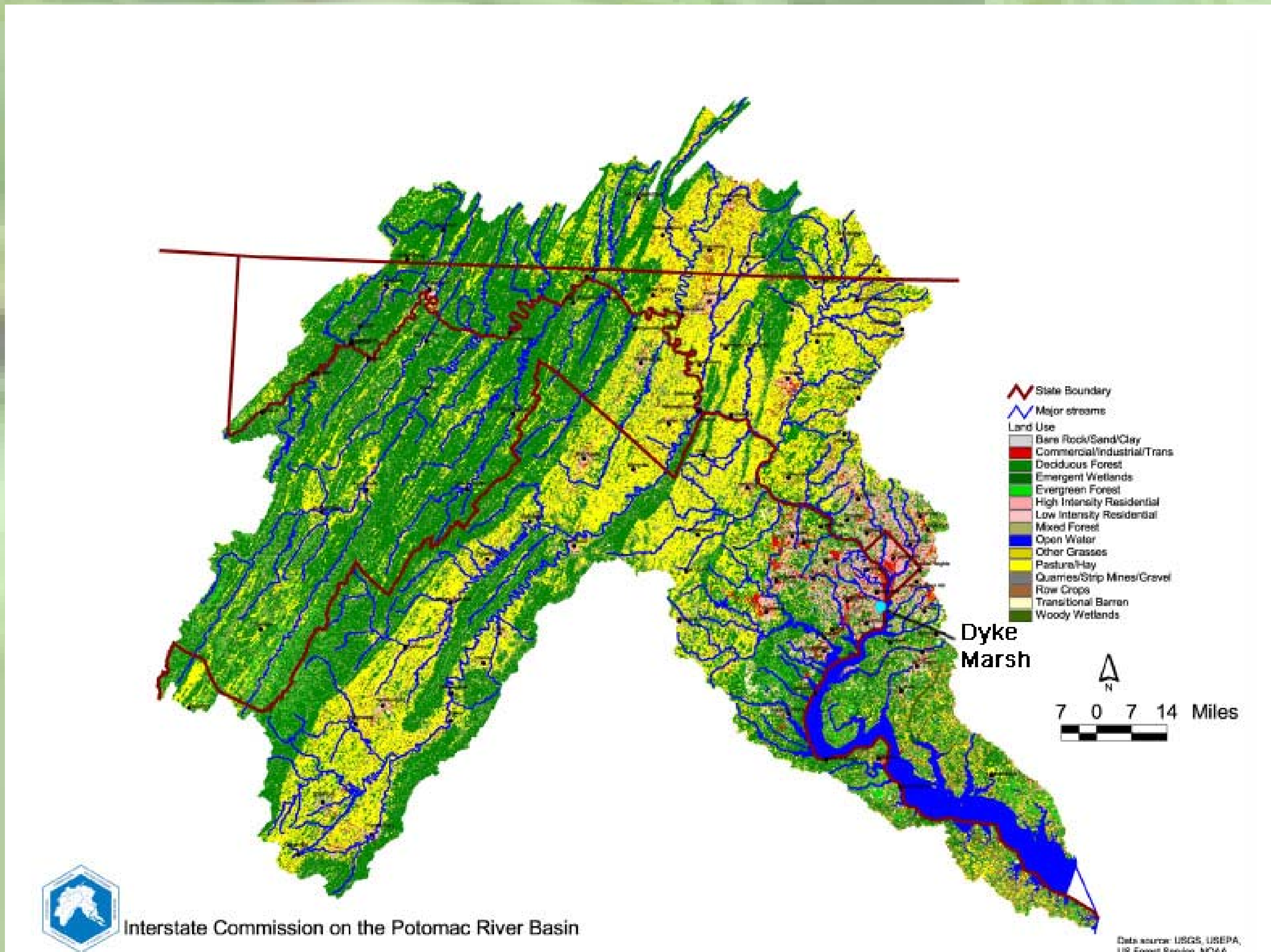
Grand challenge:

How can society protect remaining wetlands and restore wetlands that have been degraded or lost?

How can tidal freshwater marshes be protected and restored given their linkages to land and sea?

The case of Dyke Marsh Preserve, GWMP

Background



State Boundary
Major streams
Land Use
Bare Rock/Sand/Clay
Commercial/Industrial/Trans
Deciduous Forest
Emergent Wetlands
Evergreen Forest
High Intensity Residential
Low Intensity Residential
Mixed Forest
Open Water
Other Grasses
Pasture/Hay
Quarries/Strip Mines/Gravel
Row Crops
Transitional Barren
Woody Wetlands
Dyke Marsh
N
7 0 7 14 Miles
Interstate Commission on the Potomac River Basin
Data source: USGS, USEPA, US Forest Service, NOAA

Background

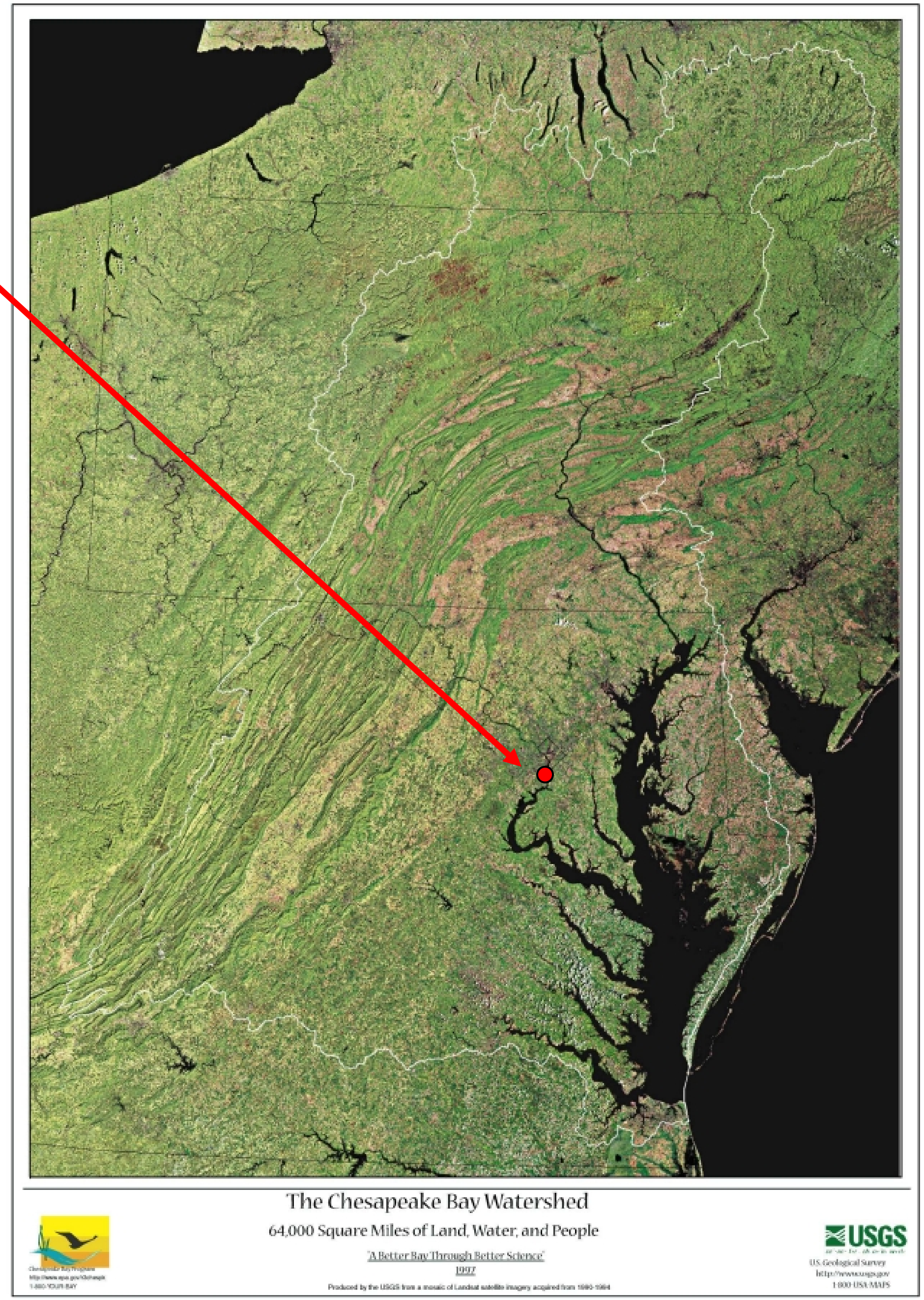
Dyke Marsh Preserve

GWMP

National Park Service

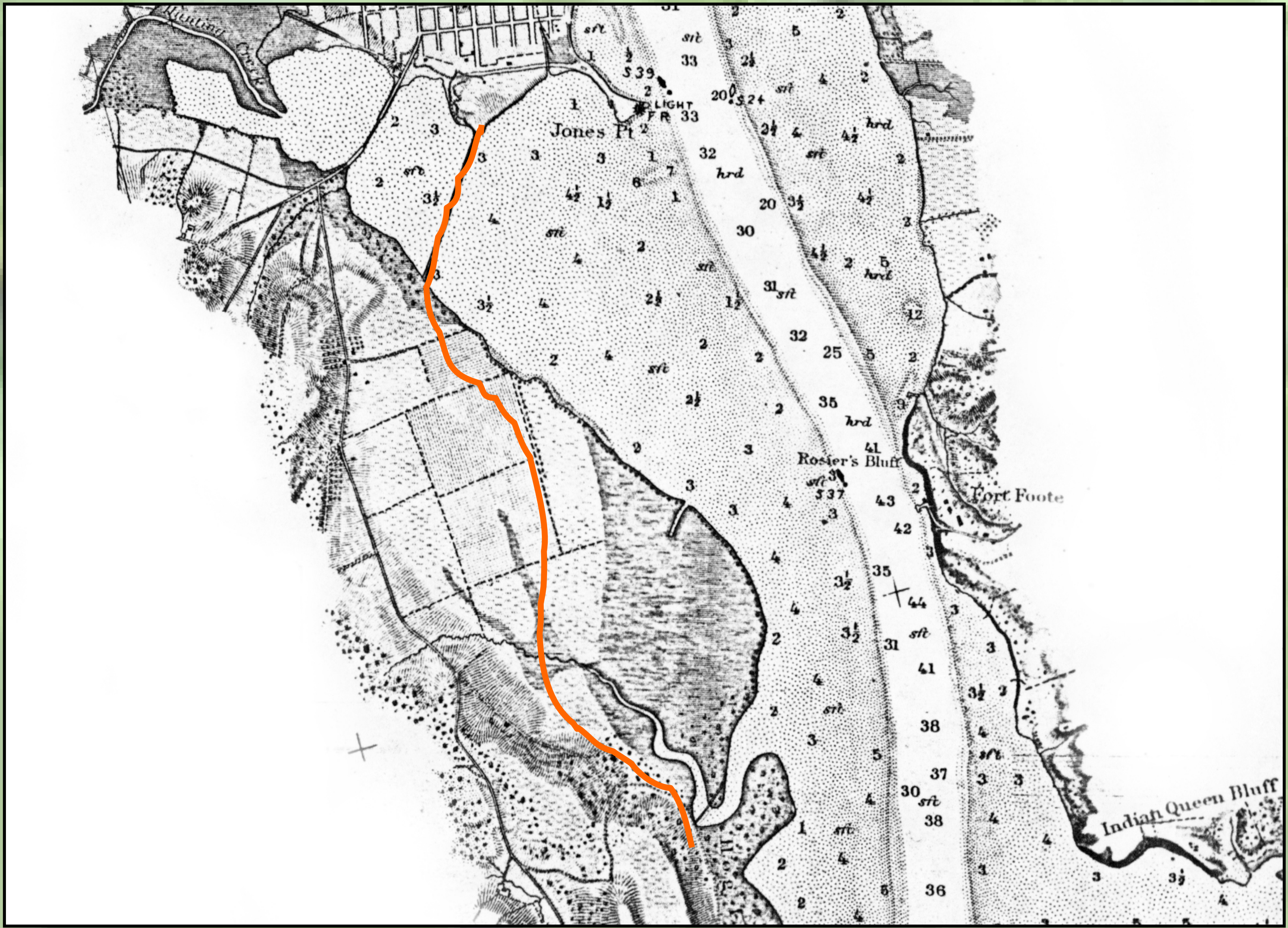
200 hectares

One of largest remaining tidal freshwater marshes in Potomac estuary.



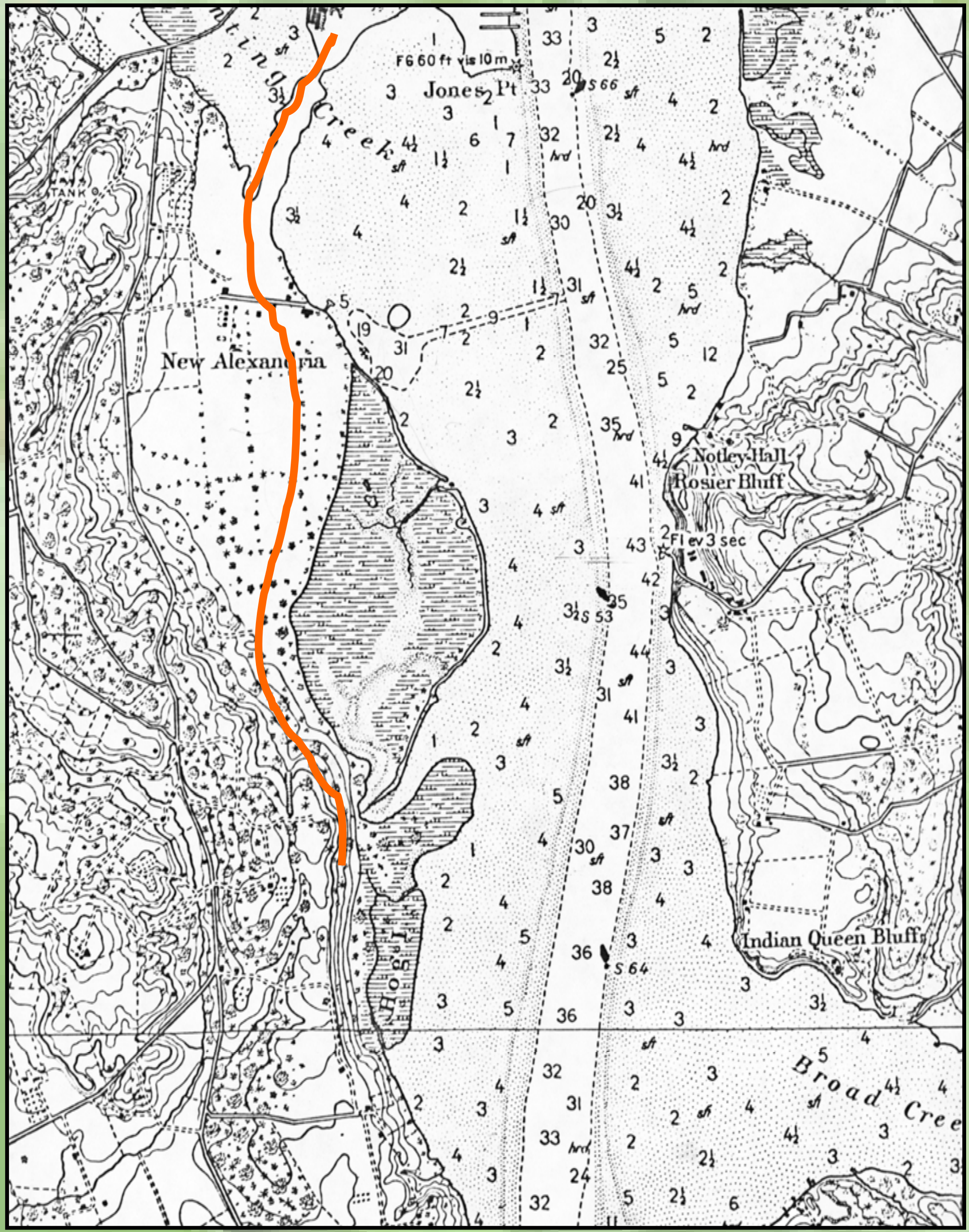
Background

1904



Background

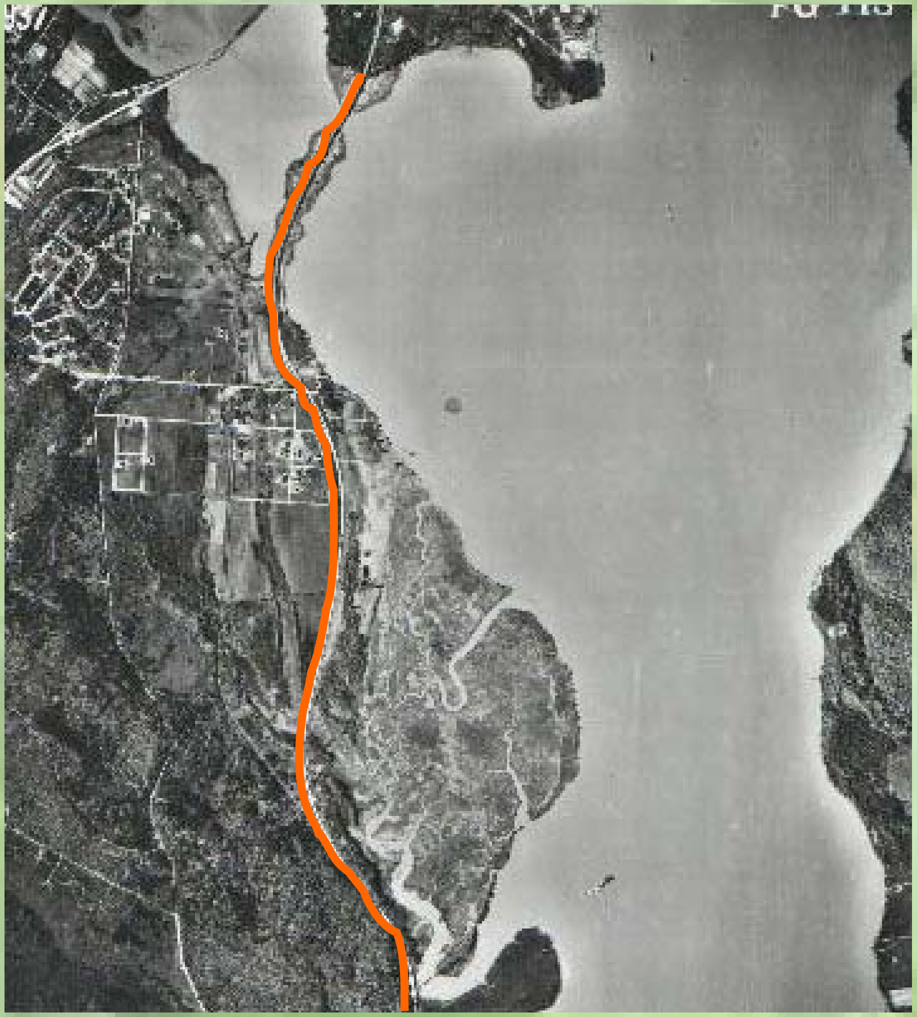
1931



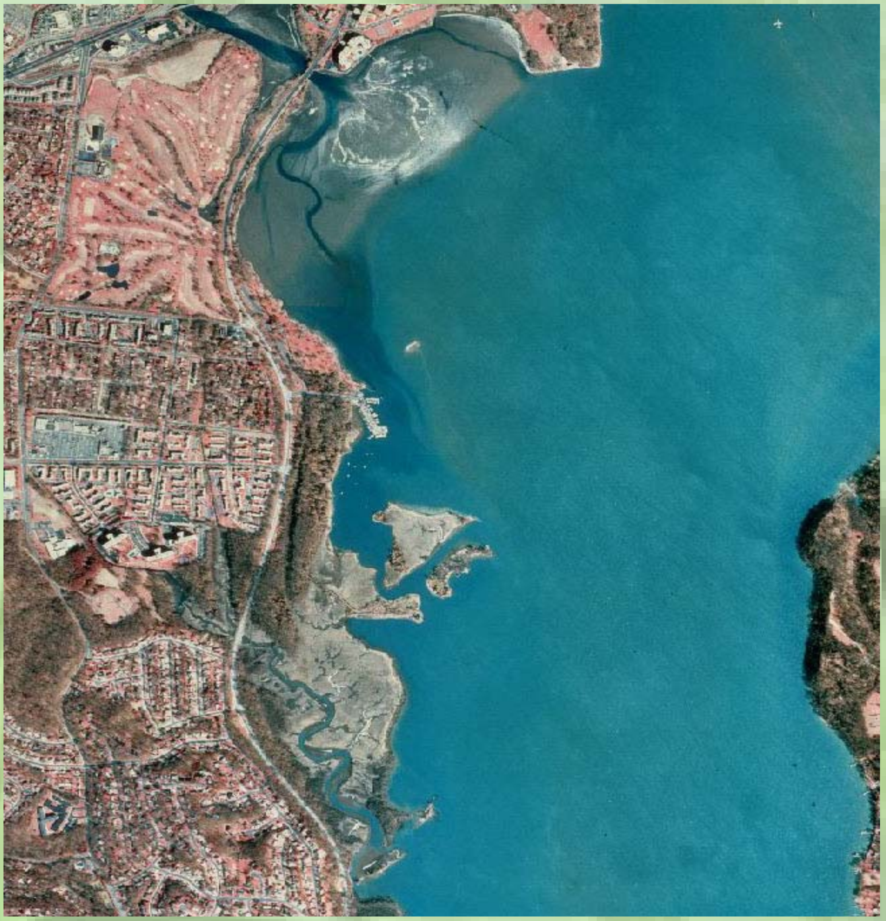
USGS
science for a changing world

Background

1937



Current



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Research Objectives

- To assess the current physical, biotic, and chemical conditions at Dyke Marsh Preserve.
    - Elevation
    - Tidal channels
    - Vegetation
    - Ecosystem functioning
- To forecast the impact of sea level rise on Dyke Marsh Preserve
- To begin to think about the ecosystem, which includes regional sediment transport processes.

Ultimate goal

- To enhance the design and monitoring of a marsh restoration at Dyke Marsh Preserve.

Overview

- Background and history
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- Vegetation
- Sea level rise
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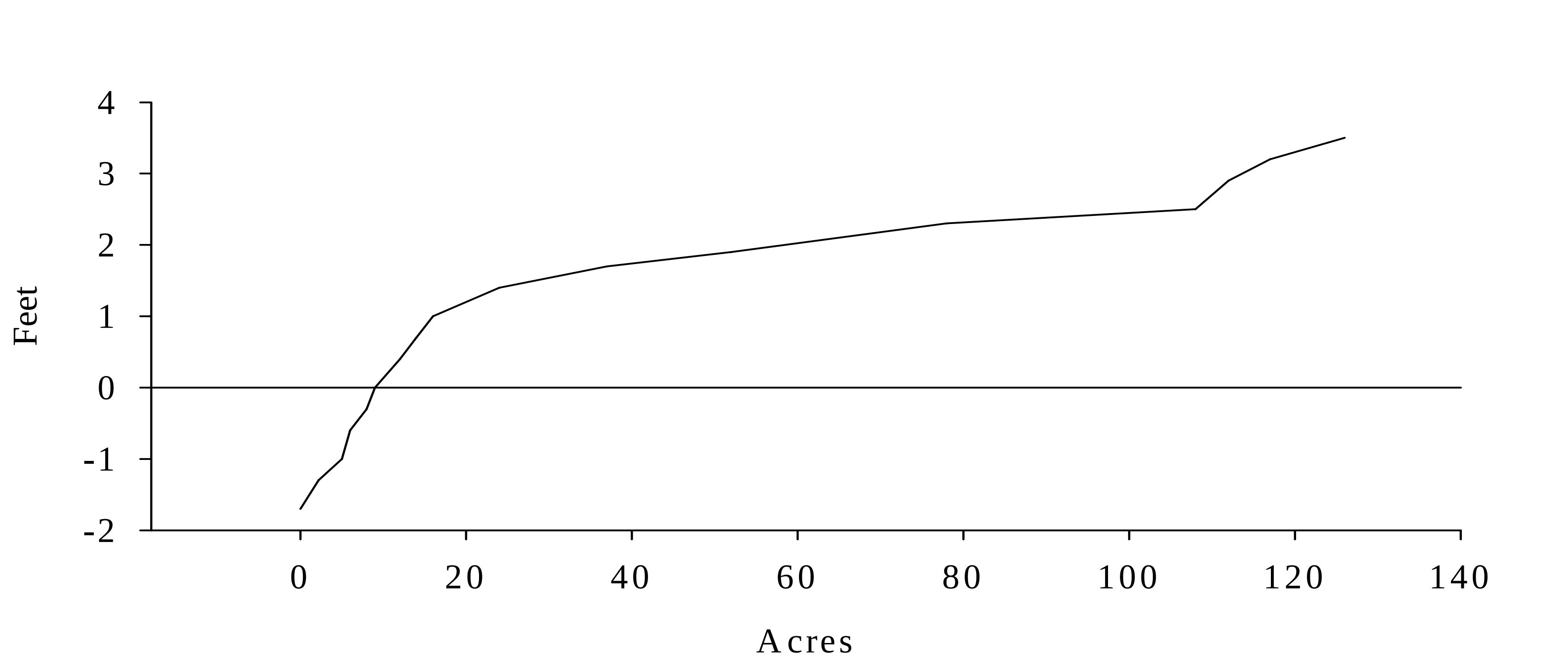
Elevations and tidal channels

- Tidal marshes are relatively flat (Myrick and Leopold 1963).

- Most elevations at Dyke Marsh range from 0.3 m to 0.8 m (Harper and Heliotis 1992).



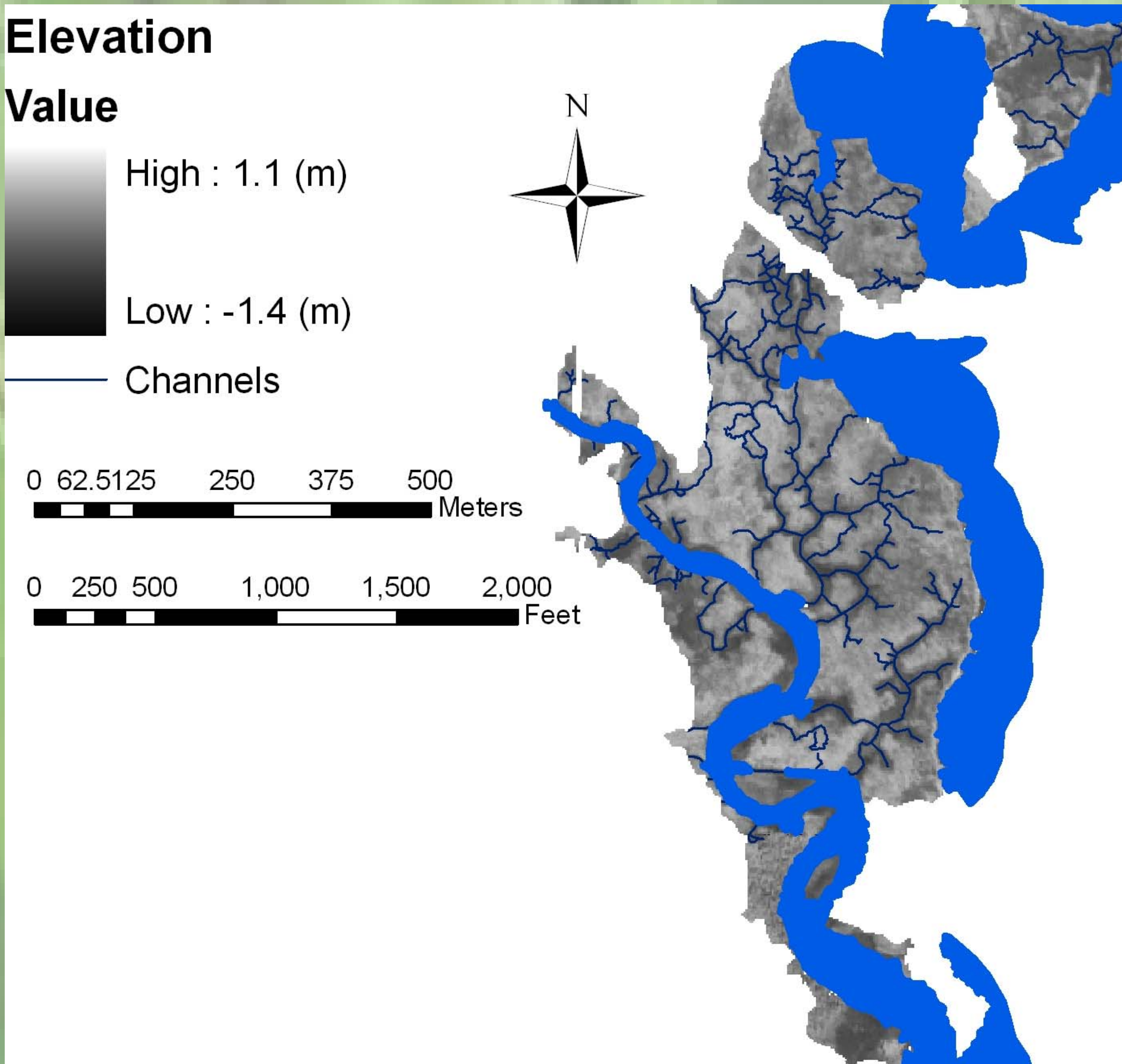
Elevations

QuickBird satellite image of Dyke Marsh Preserve on September 30 2005

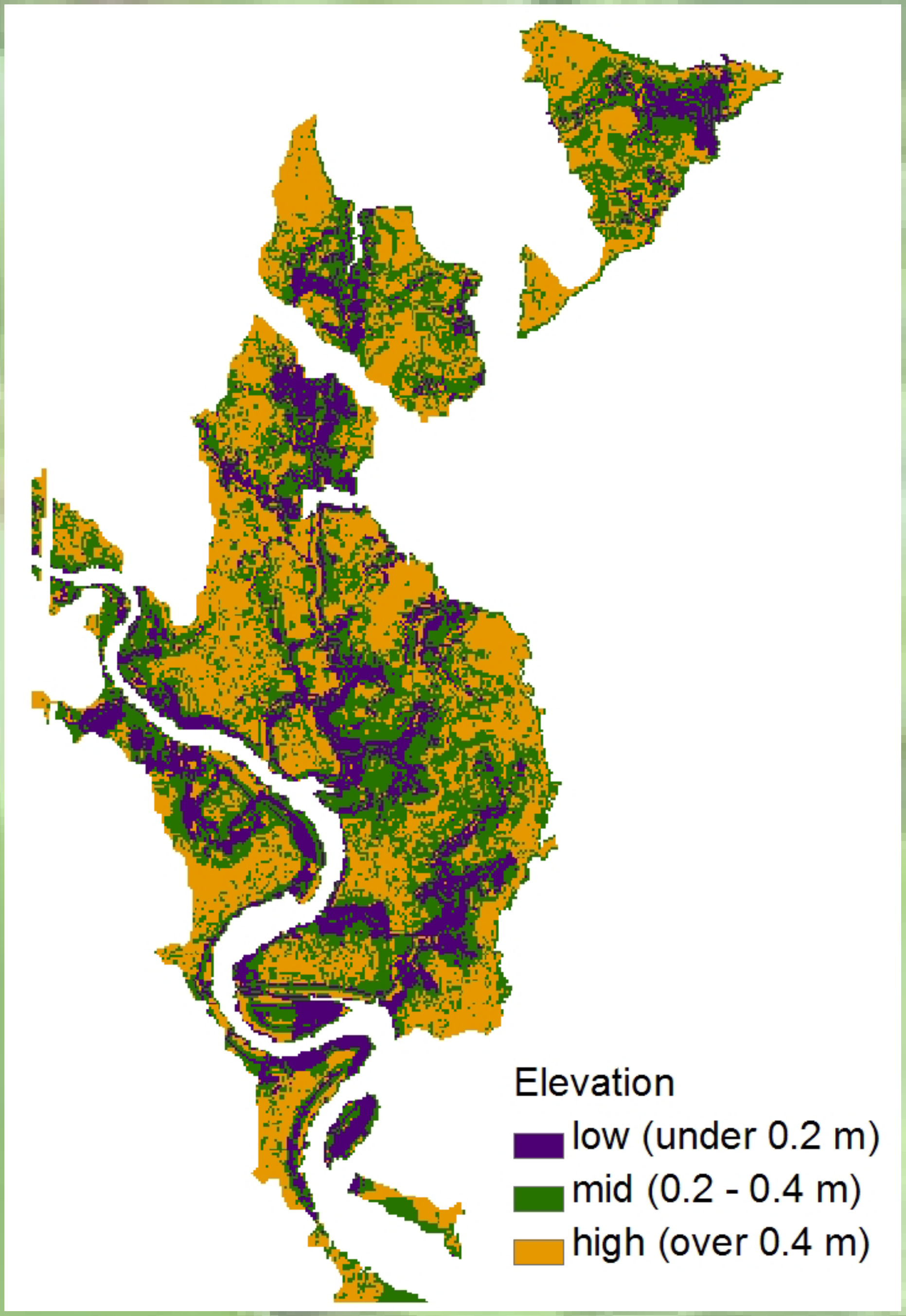
Image created by Andrew Elmore

Elevations

Elevations measurements

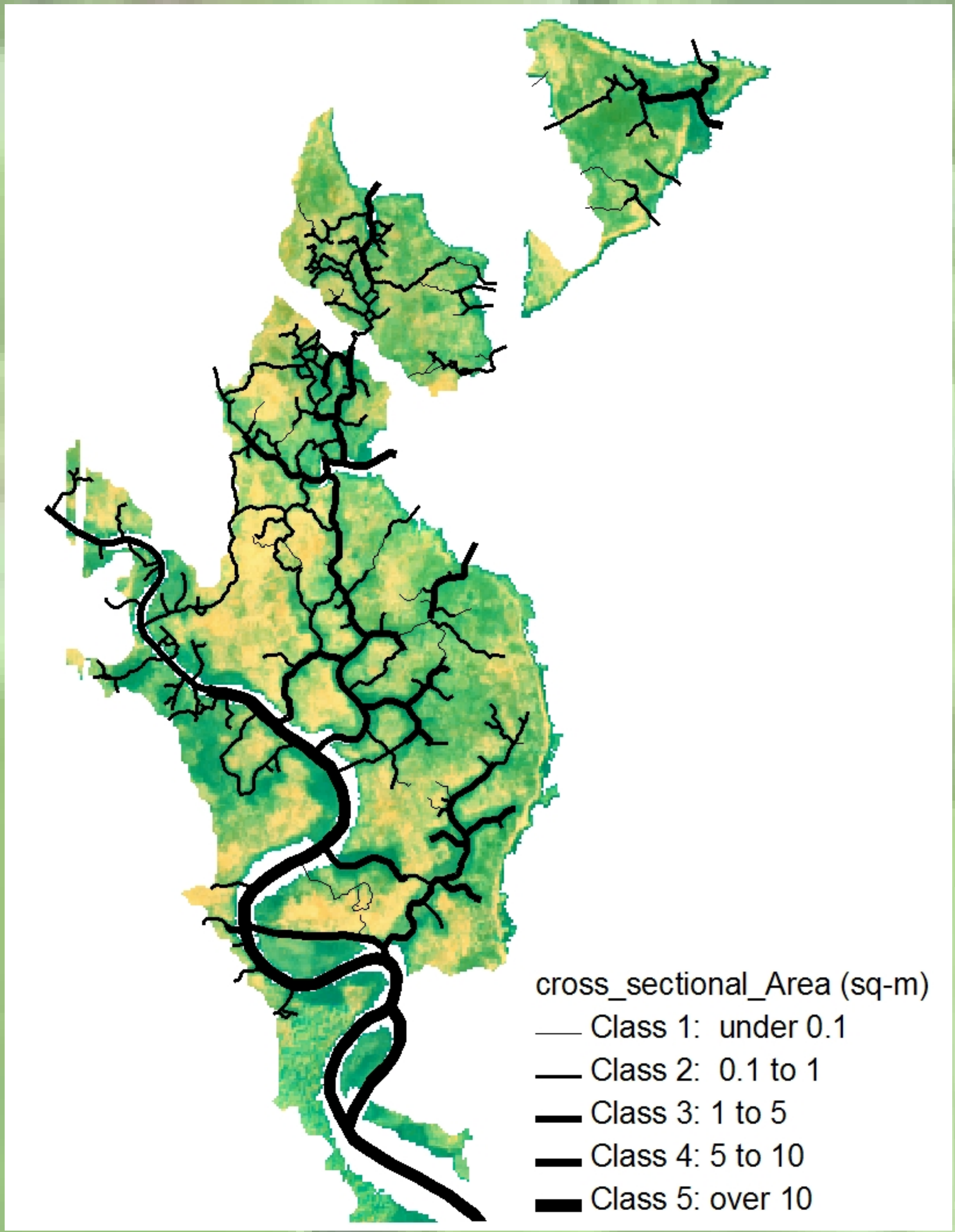

Elevation
Value
High : 1.1 (m)
Low : -1.4 (m)
Channels
N
0 62.5125 250 375 500
Meters
0 250 500 1,000 1,500 2,000
Feet

Elevations



Created by:
Annie Elmore

Elevations



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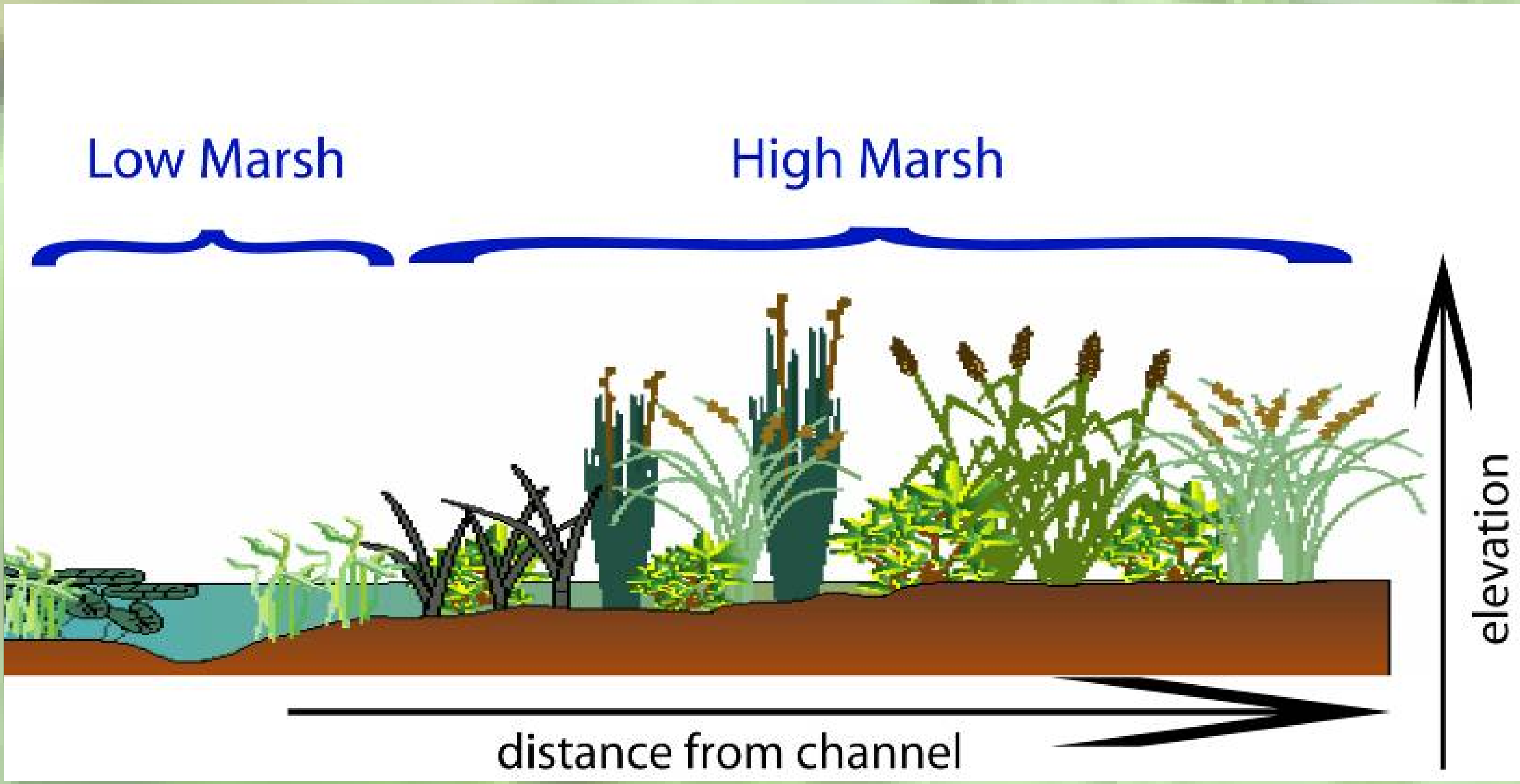
Annie Elmore

Conclusion:

- Vegetated marsh elevations range from –50cm to +65cm
- The marsh is not flat – elevations are variable even at small distances.
- Elevation increases with distance to tidal channels.
- Tidal channel orders are hard to define owing to feedbacks among channels.

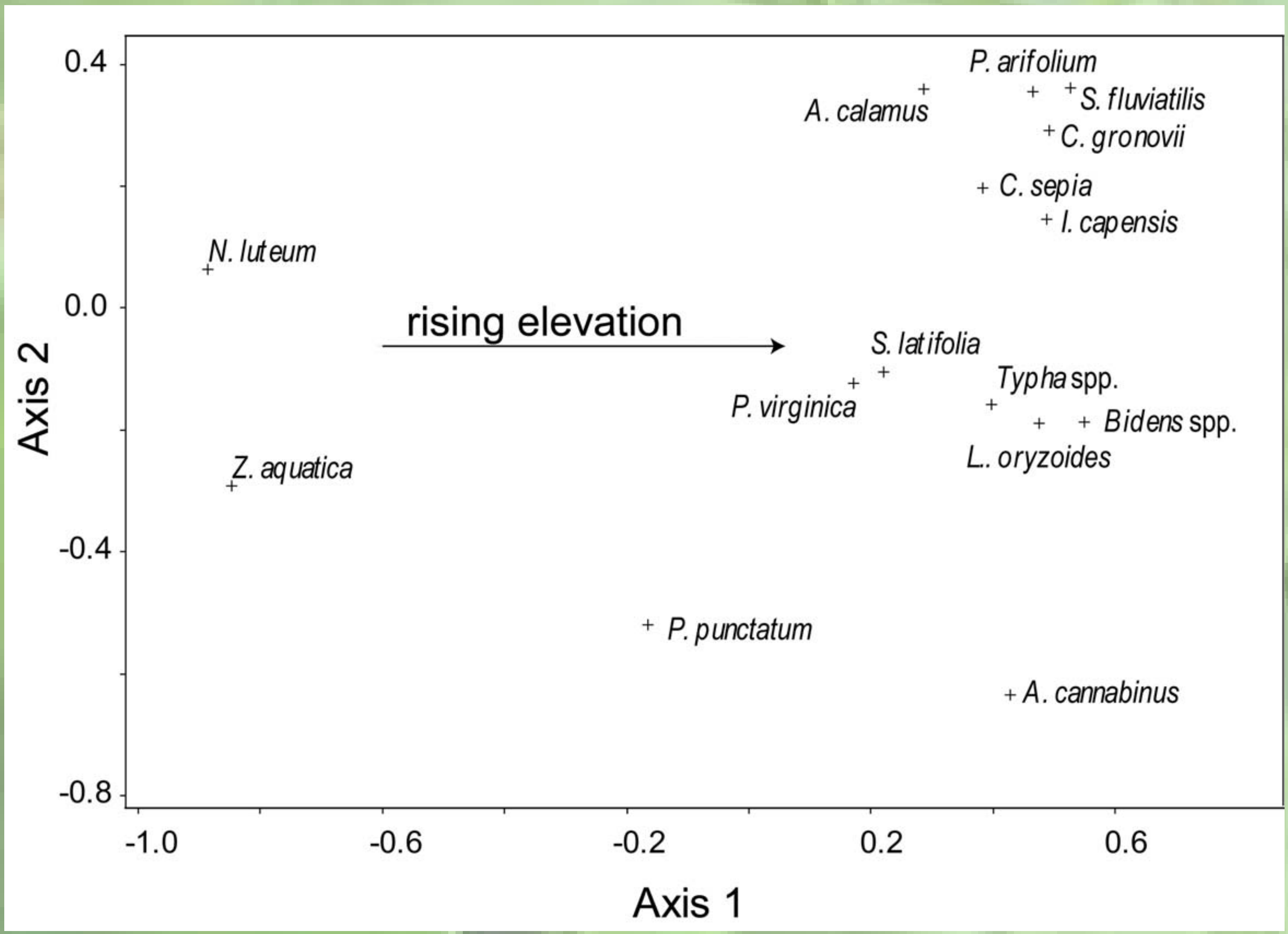
Vegetation

Marsh vegetation occurs in zones that are an imprint of marsh surface elevation and distance to channels.

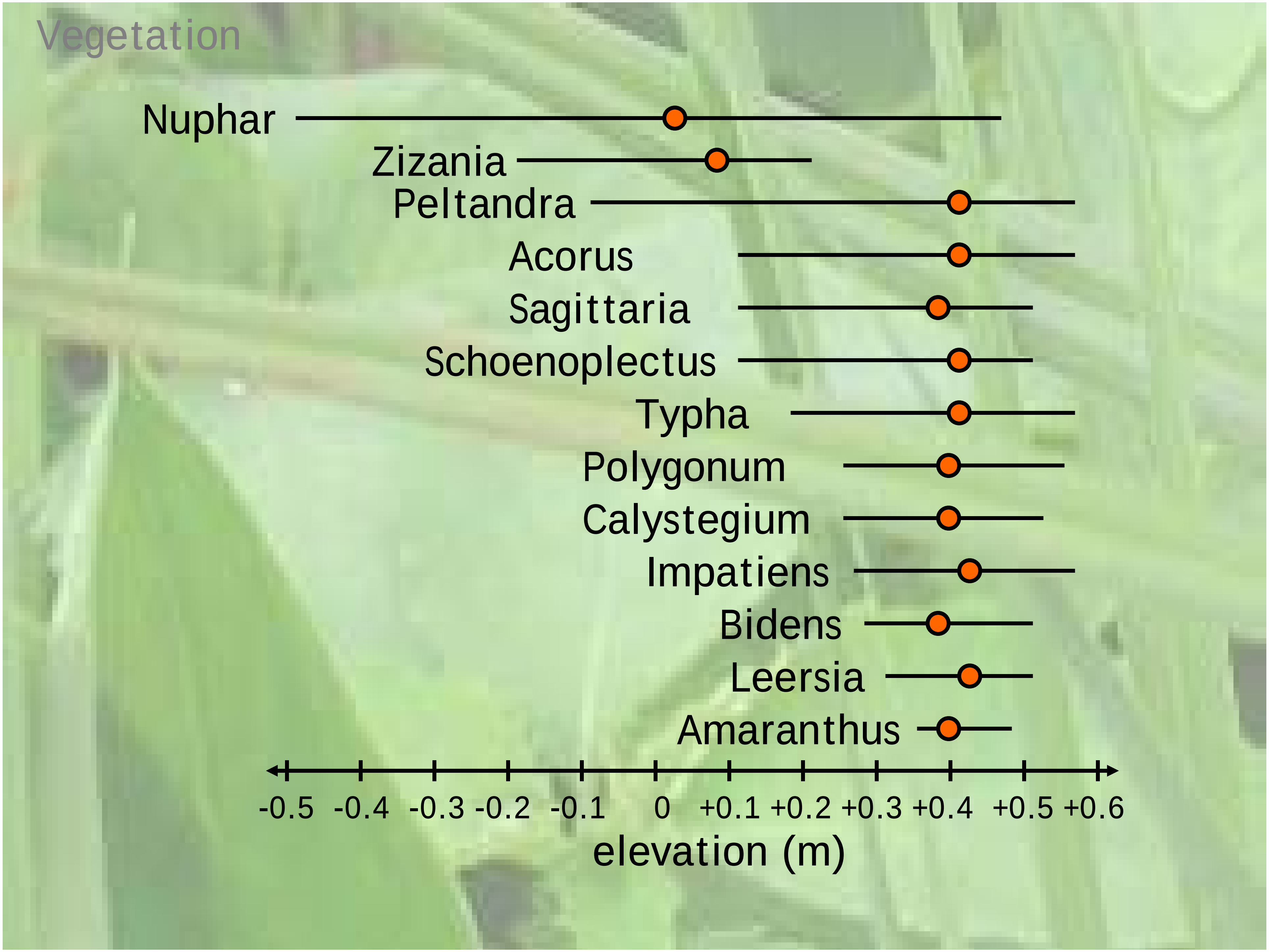


Vegetation

Vegetation



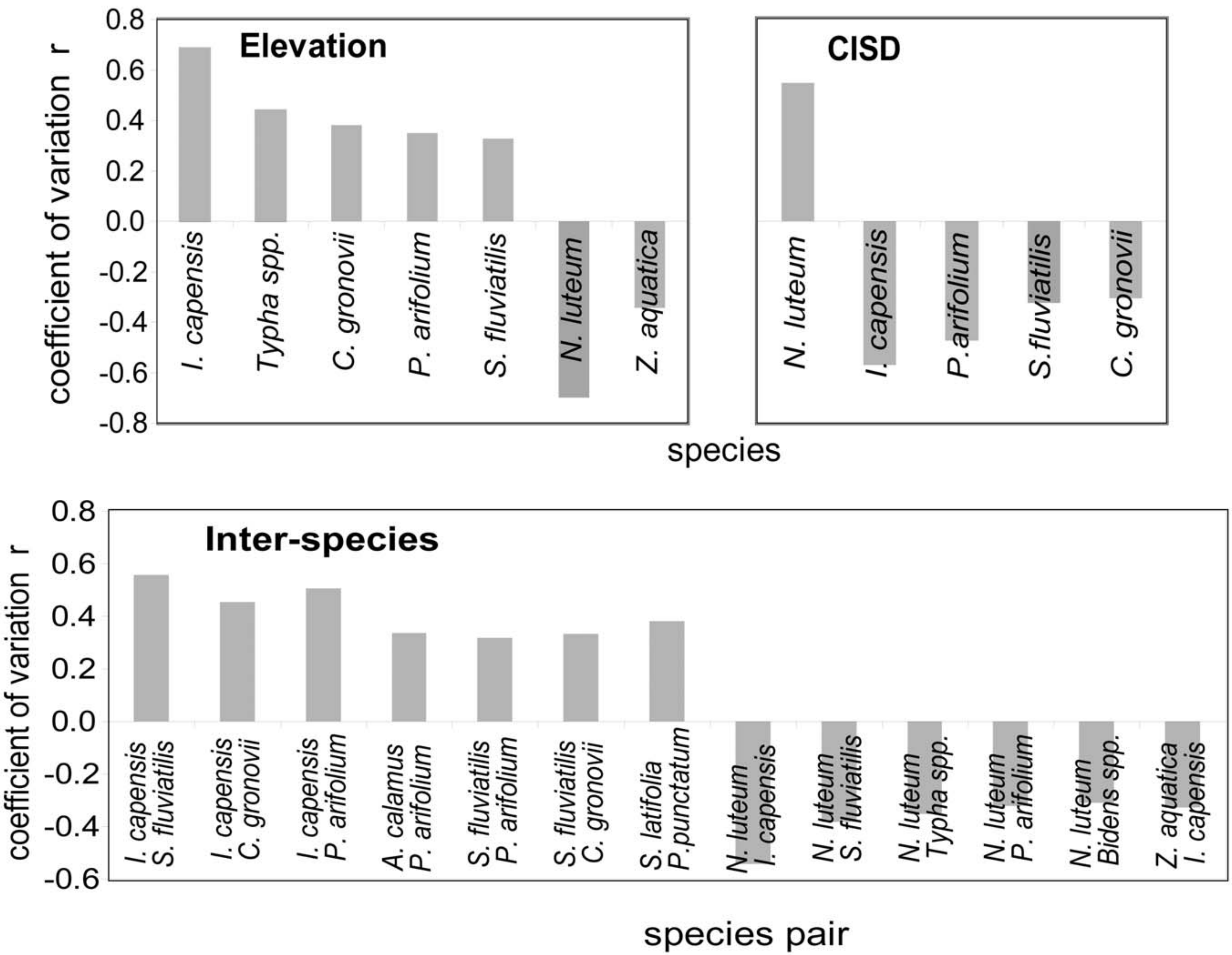
0.4
0.0
-0.4
-0.8
-1.0
-0.6
-0.2
0.2
0.6
Axis 1
Axis 2
rising elevation
P. arifolium
A. calamus
S. fluviatilis
C. gronovii
C. sepia
I. capensis
N. luteum
S. latifolia
Typha spp.
P. virginica
Bidens spp.
L. oryzoides
Z. aquatica
P. punctatum
A. cannabinus



Vegetation
Nuphar
Zizania
Peltandra
Acorus
Sagittaria
Schoenoplectus
Typha
Polygonum
Calystegium
Impatiens
Bidens
Leersia
Amaranthus
-0.5 -0.4 -0.3 -0.2 -0.1 0 +0.1 +0.2 +0.3 +0.4 +0.5 +0.6
elevation (m)

Vegetation

Vegetation



Elevation
CISD
coefficient of variation r
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
I. capensis
Typha spp.
C. gronovii
P. arifolium
S. fluviatilis
N. luteum
Z. aquatica
N. luteum
I. capensis
P. arifolium
S. fluviatilis
C. gronovii
species
Inter-species
coefficient of variation r
I. capensis S. fluviatilis
I. capensis C. gronovii
I. capensis P. arifolium
A. calamus P. arifolium
S. fluviatilis P. arifolium
S. fluviatilis C. gronovii
S. latifolia P.punctatum
N. luteum I. capensis
N. luteum S. fluviatilis
N. luteum Typha spp.
N. luteum P. arifolium
N. luteum Bidens spp.
Z. aquatica I. capensis
species pair

Conclusion:

- Species richness increases with elevation.
- While abundance of some species is associated with elevation and distance to tidal channels, many species are not.
- Species are well mixed but…
- Species associations exist and annual and perennial species often occur together.

Overview

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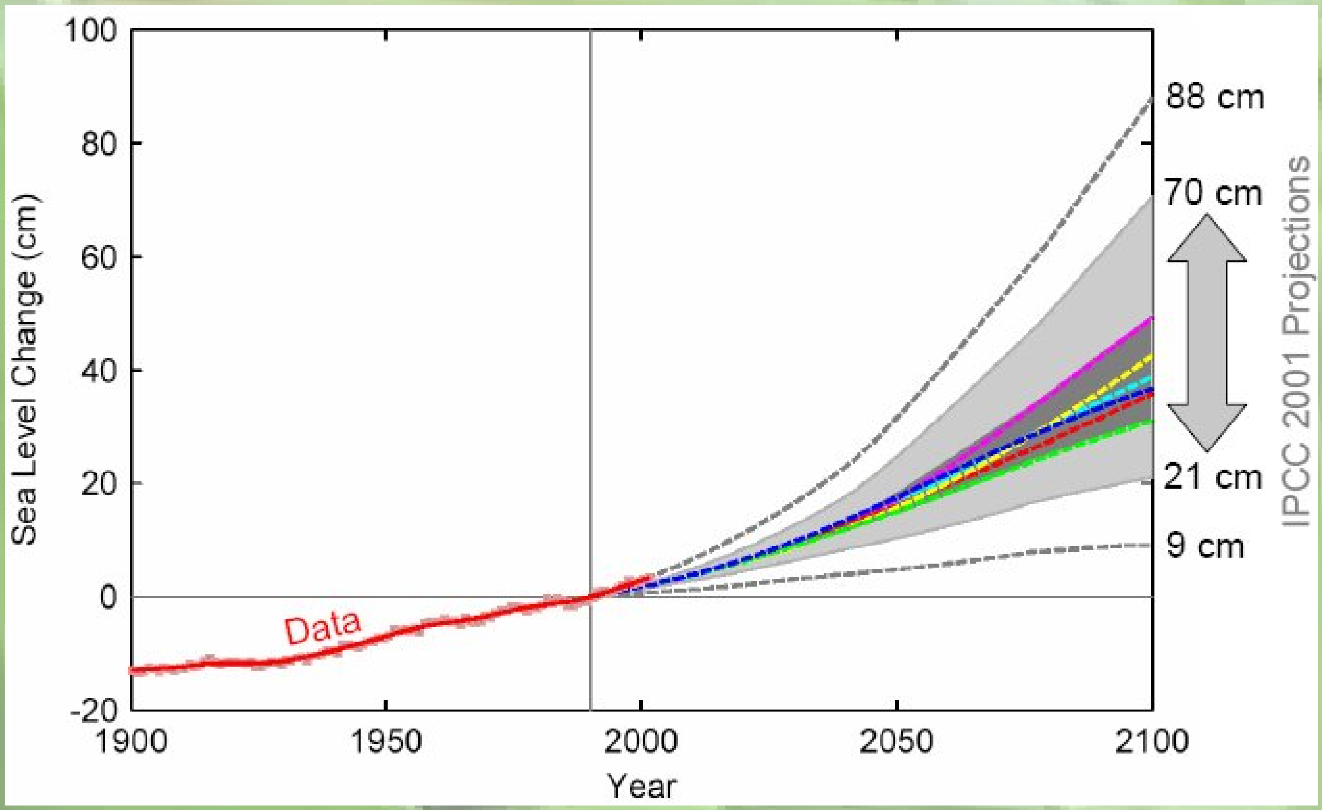
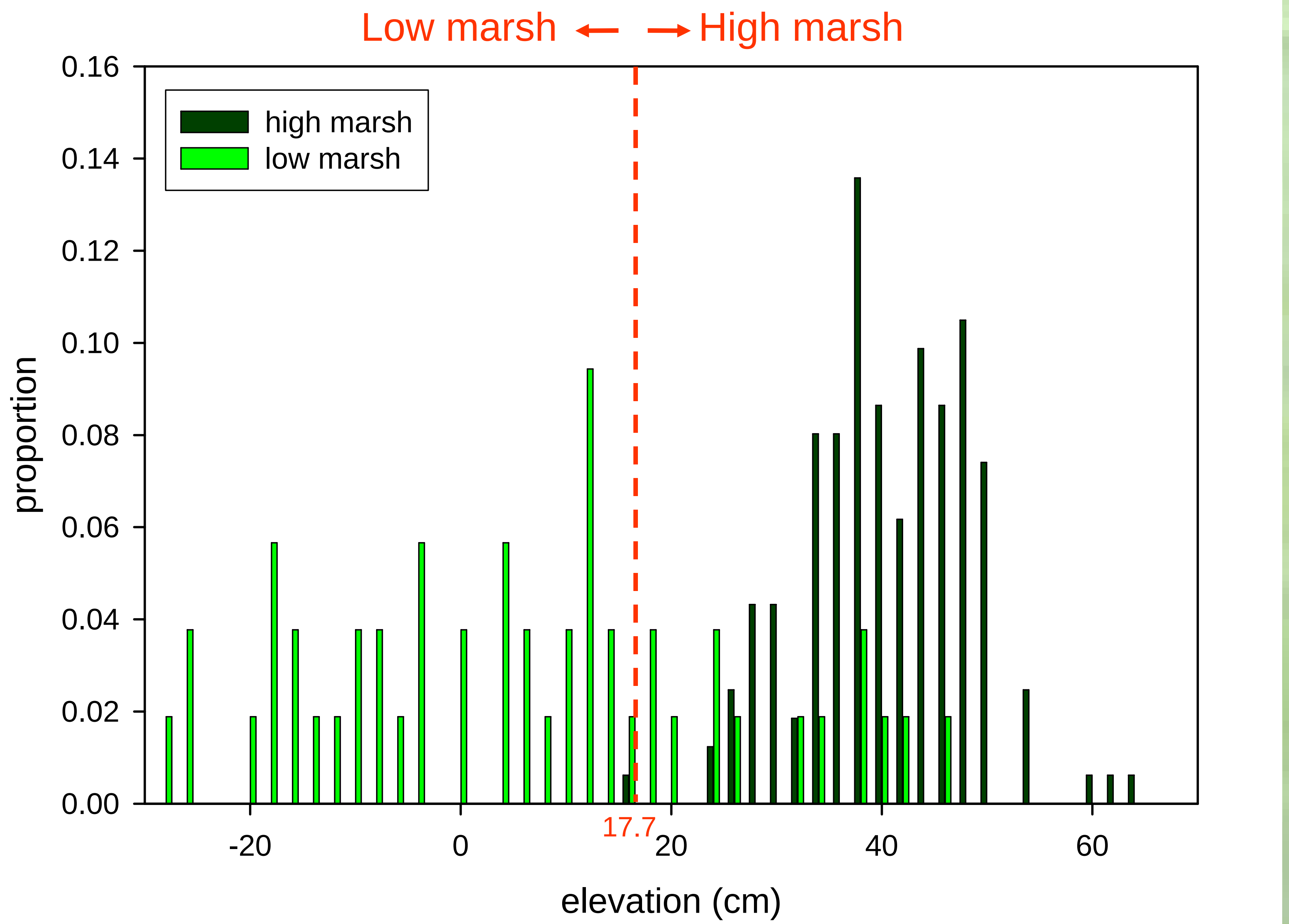
Sea level rise

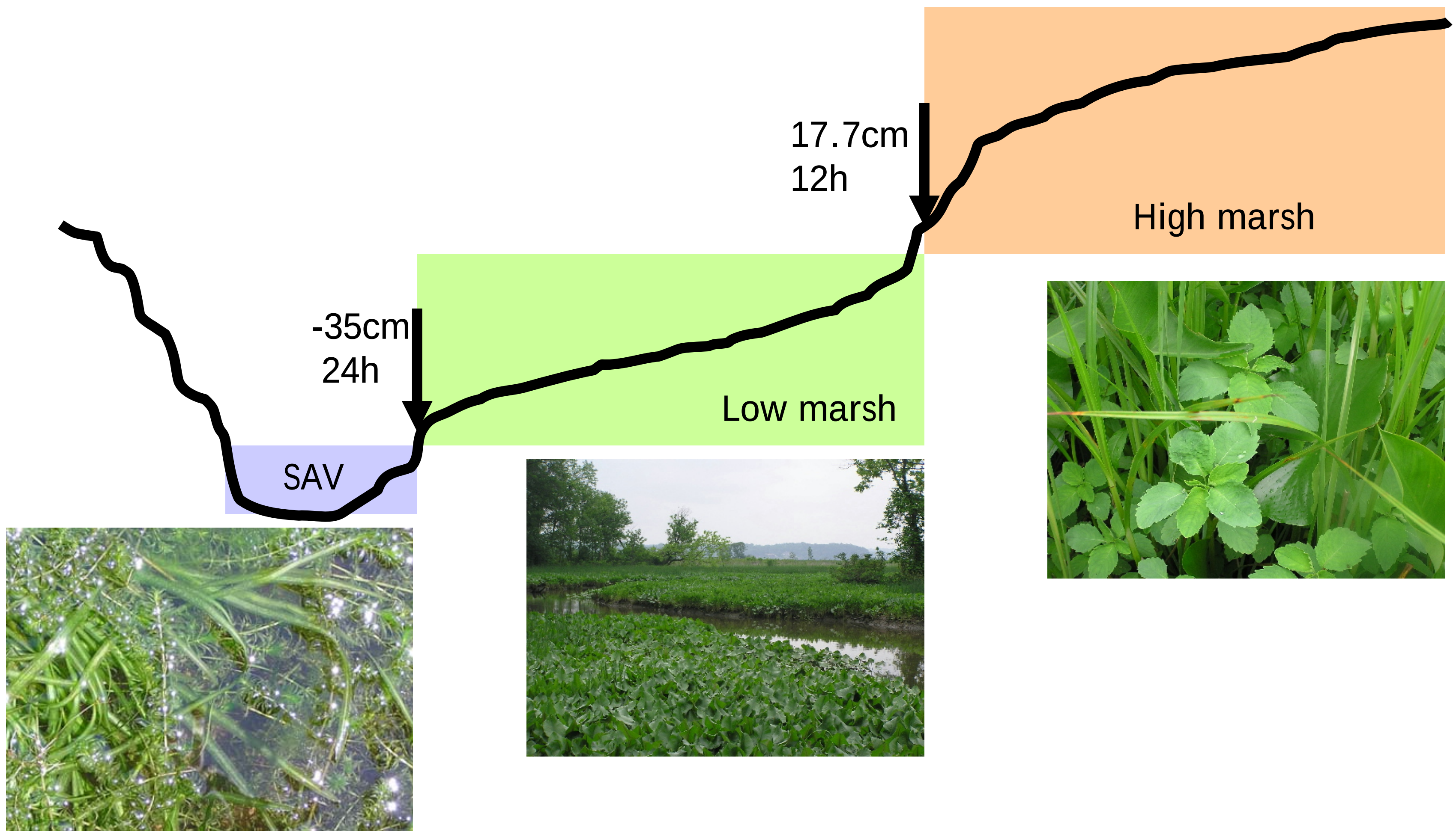
Marsh area may be lost if marsh accretion cannot keep pace with sea level rise and ground subsidence.



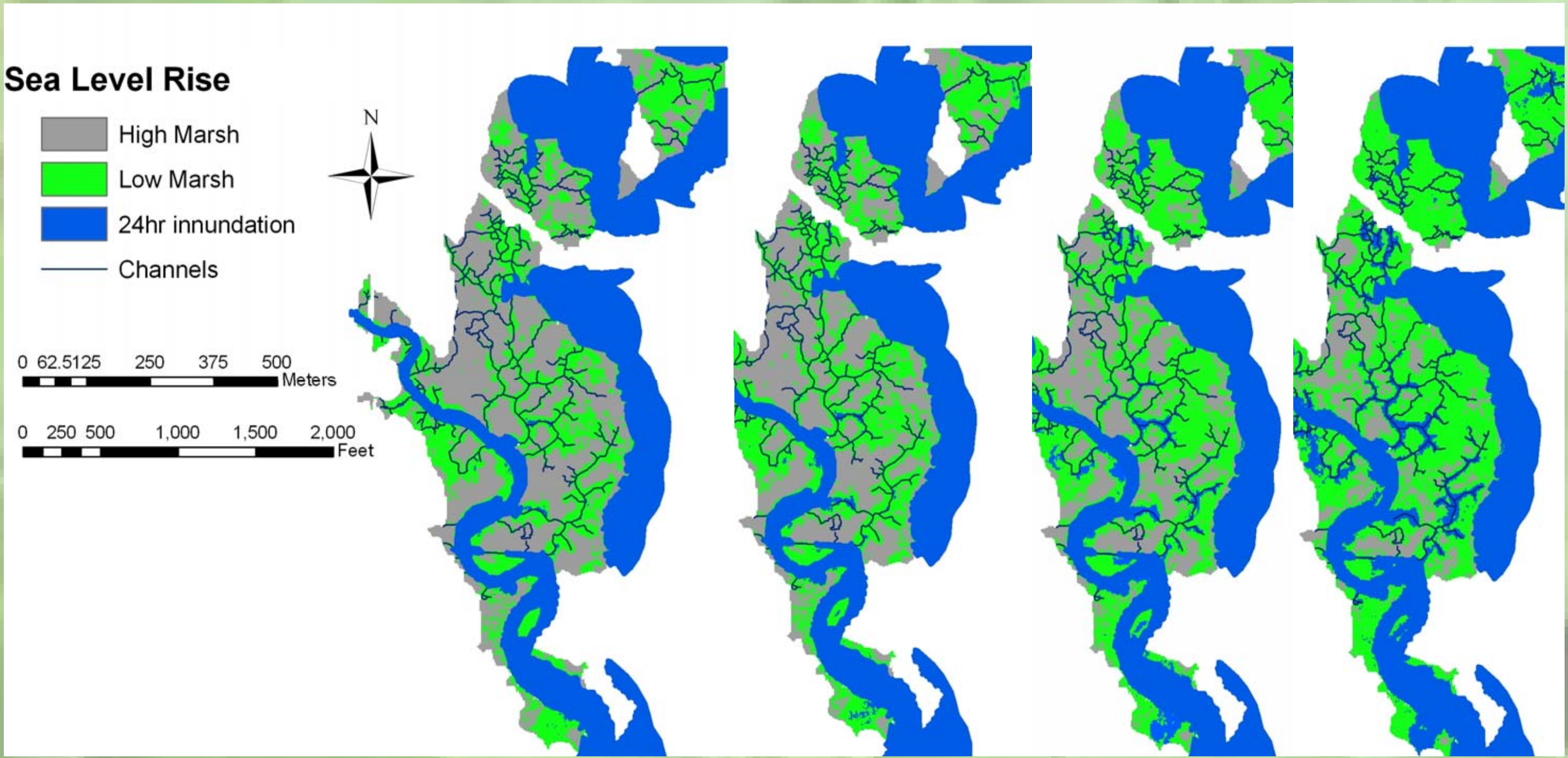
Sea level rise



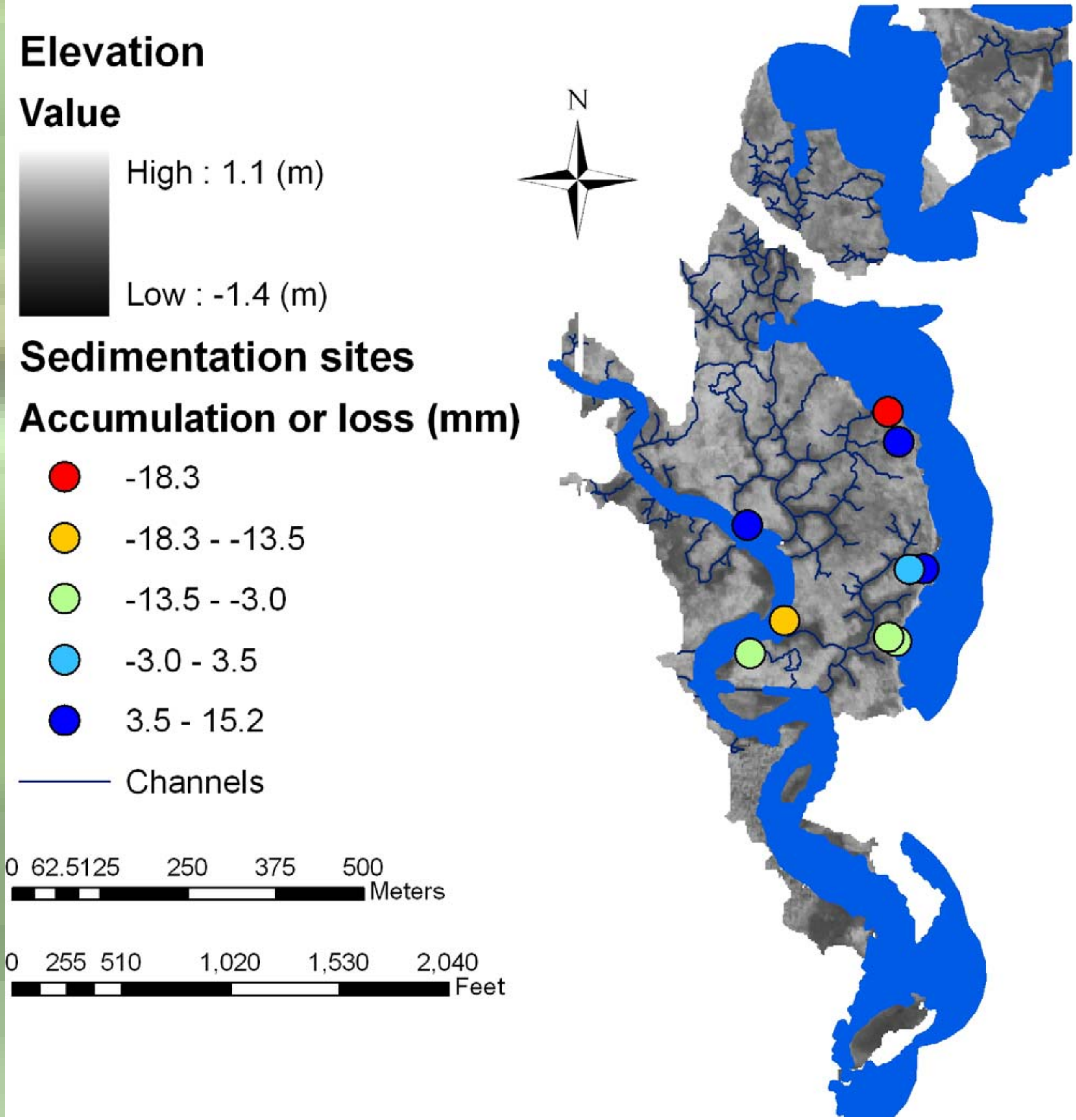
Sea level rise



Sea level rise without accretion



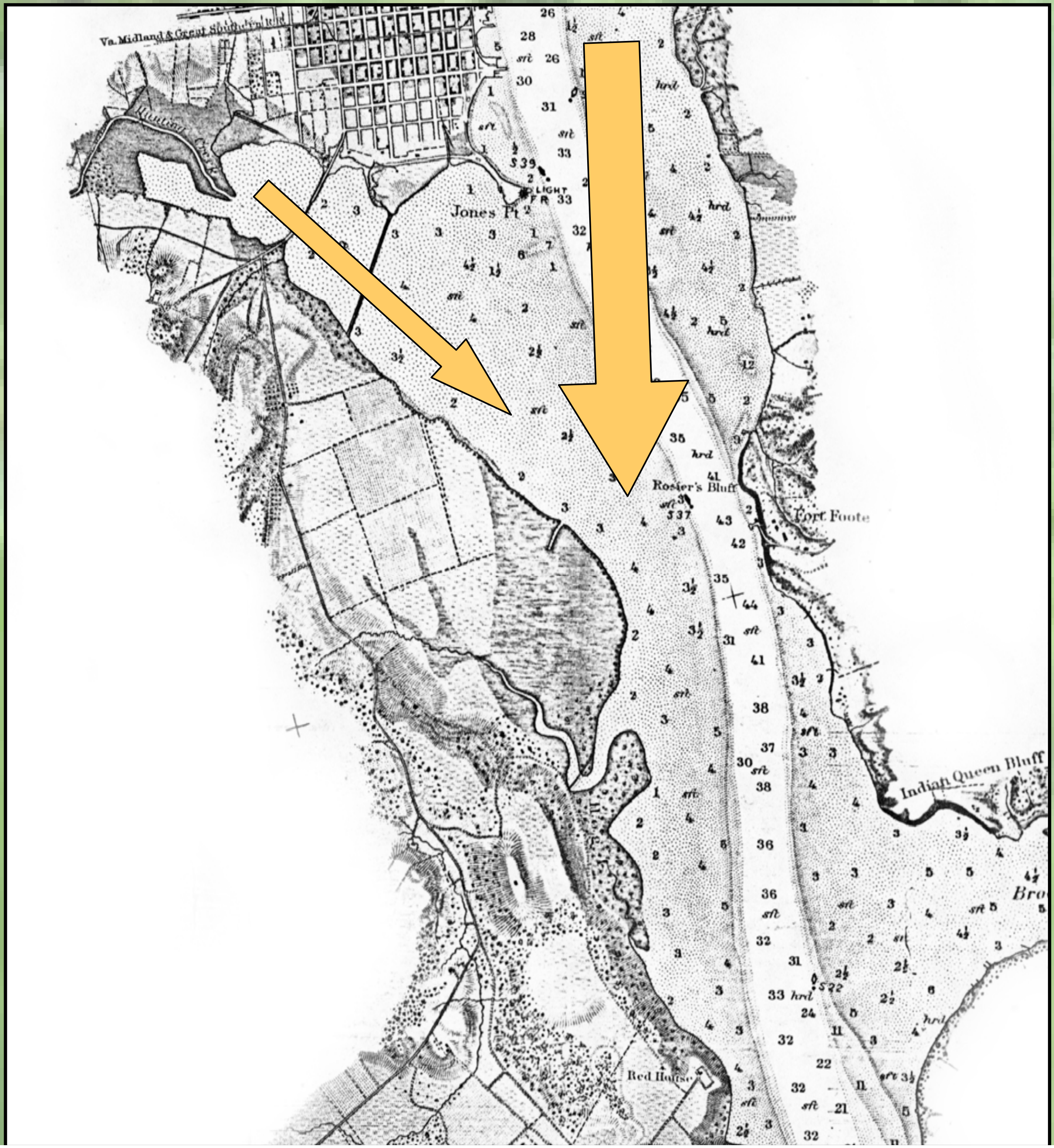
Current Year 2020 2060 2100

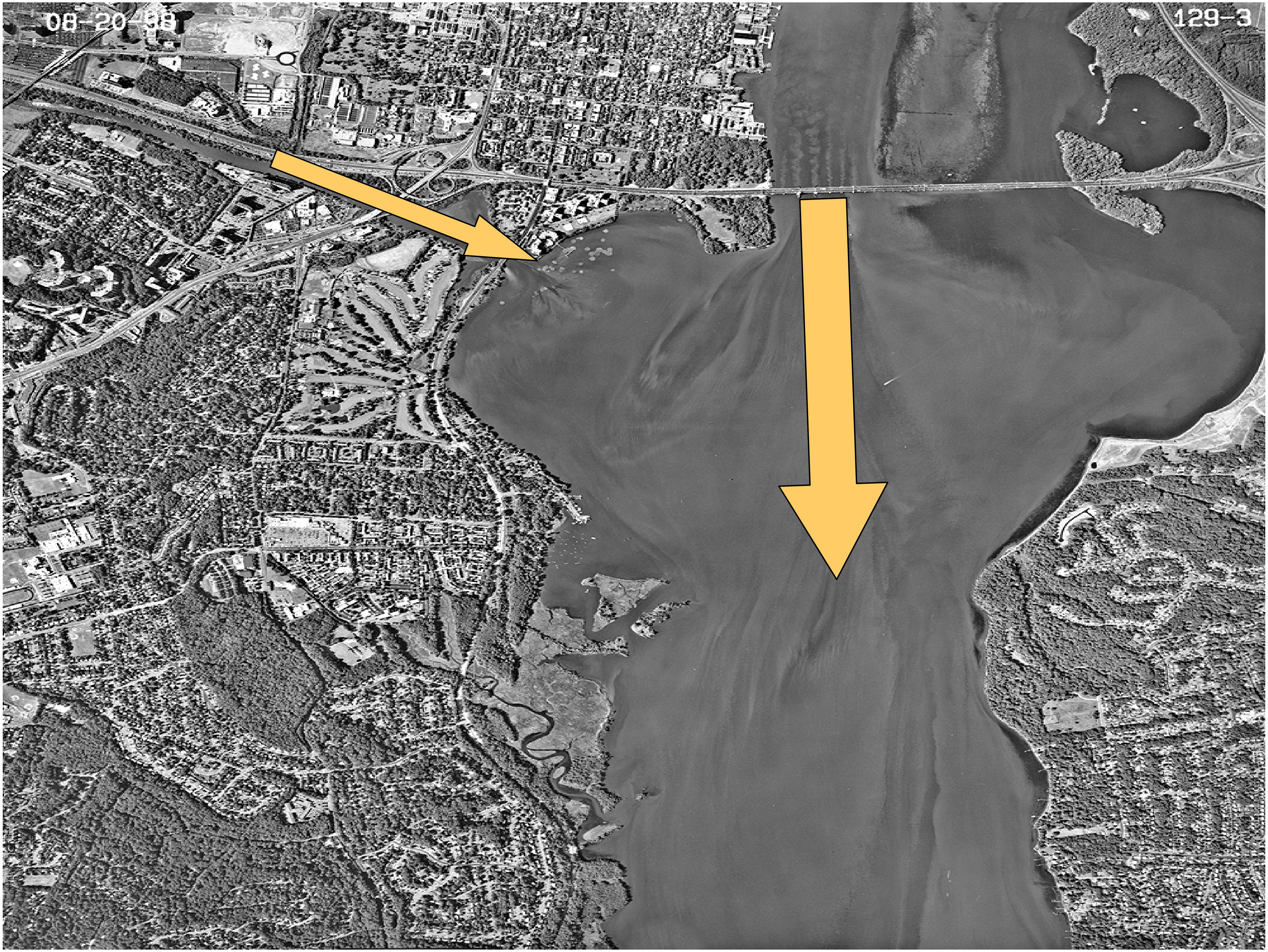

Elevation
Value
High : 1.1 (m)
Low : -1.4 (m)
Sedimentation sites
Accumulation or loss (mm)
-18.3
-18.3 - -13.5
-13.5 - -3.0
-3.0 - 3.5
3.5 - 15.2
Channels
0 62.5125 250 375 500
Meters
0 255 510 1,020 1,530 2,040
Feet
N

Future challenges

- Need to understand the feedbacks between geomorphology and local physical and biological conditions.

1904


Va. Midland & Great Southern R.R.
Jones Pt
LIGHT F R
Rosier's Bluff
Fort Foote
Indian Queen Bluff
Red House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Whole Marsh Restoration – Scenario 1

Goal: Entire marsh

Activities:

- Fill all dredged areas
- Repair eroded shoreline areas
- Create submerged and emergent marsh footprint to pre-dredged size

Feasibility:

- Availability of dredge material
- Construction and long-term stability
- Effects on ecosystem; negative and positive

Partial restoration – Scenario 2

Goal: Specific areas of the marsh

Activities:

• Fill shallow areas that are bounded by existing sand bars

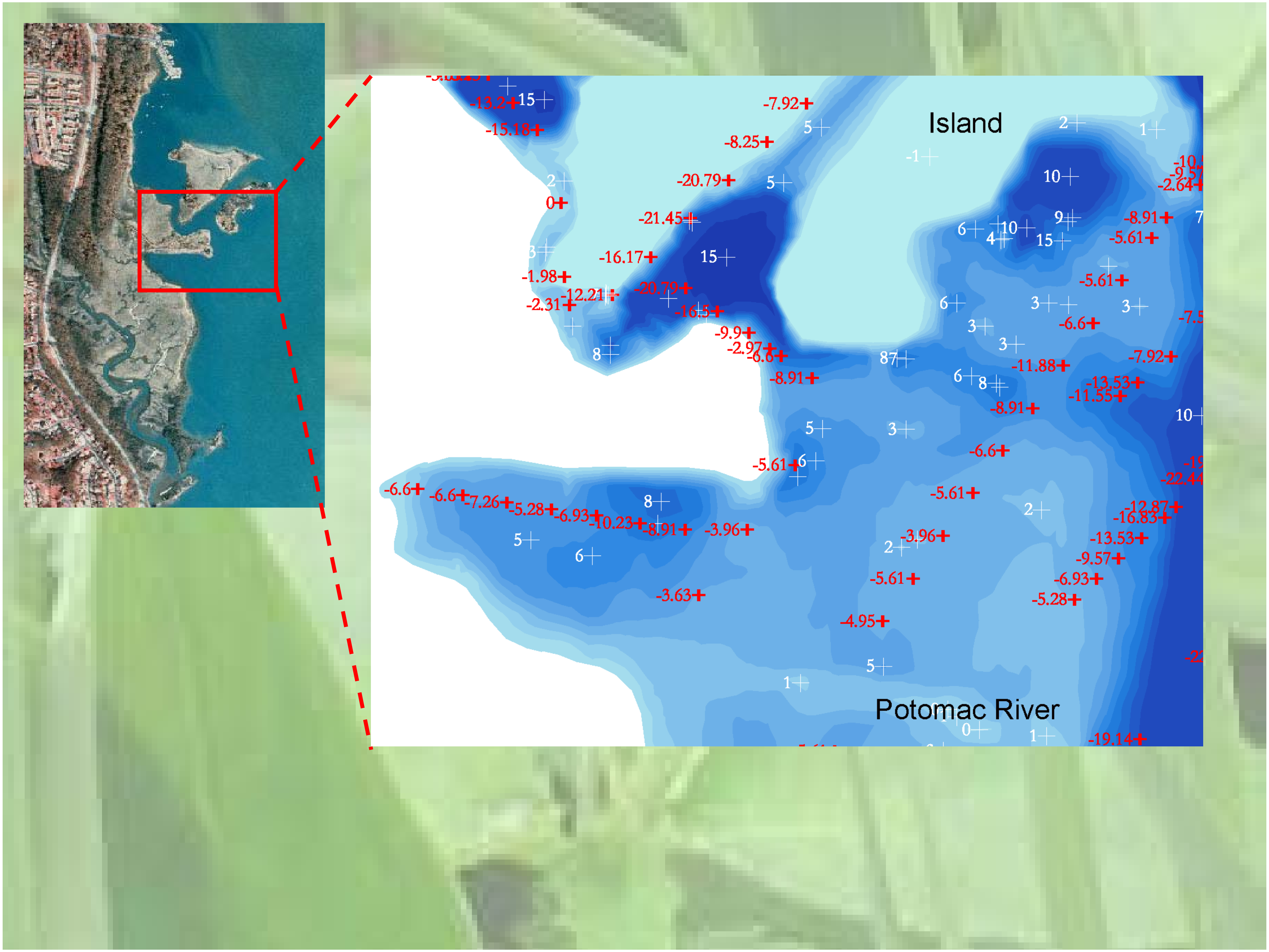
• Restore pieces with the potential goal to restore the footprint of the entire marsh

Feasibility:

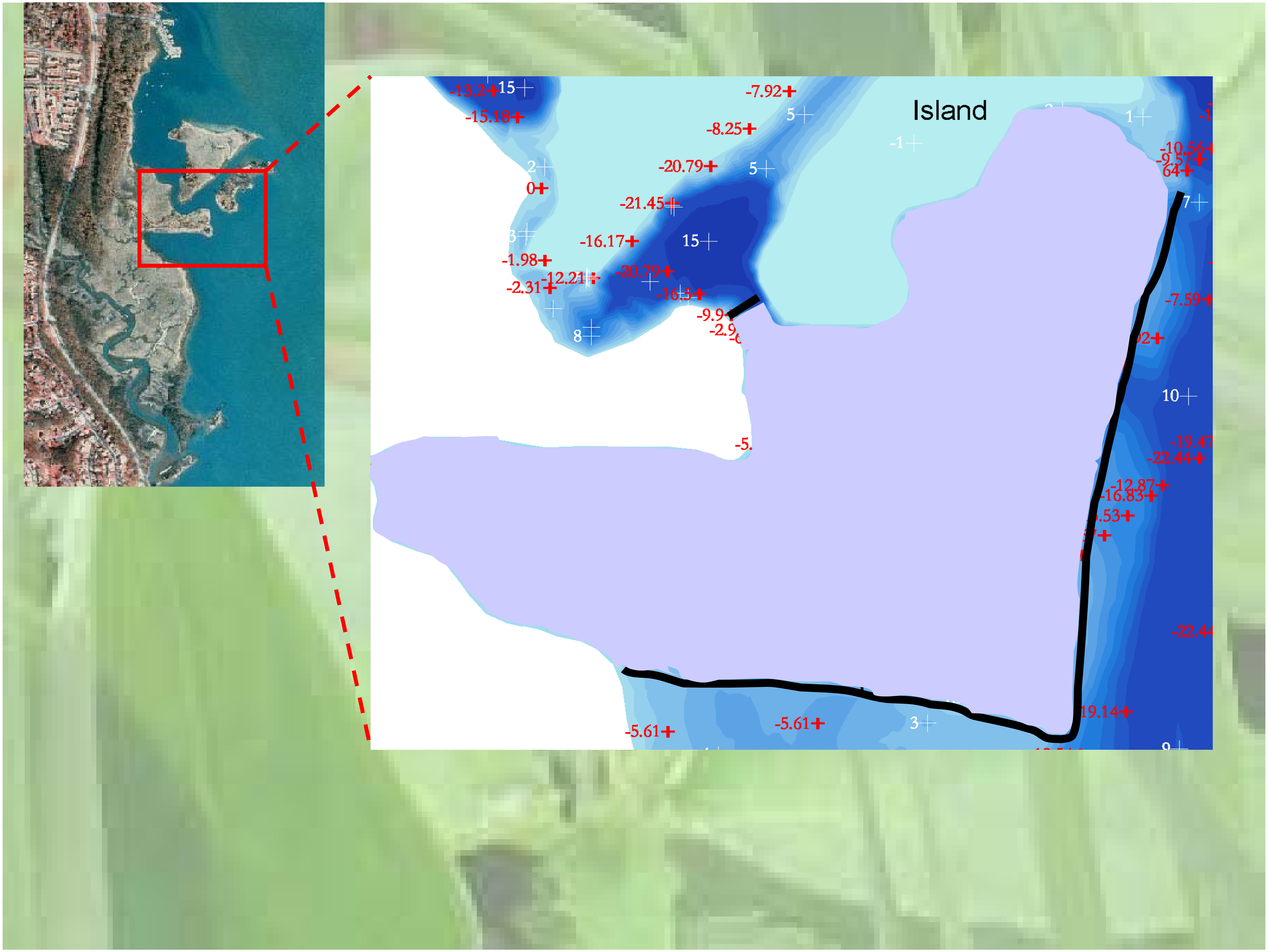
• Availability of “clean” dredge. Long-term site for dredge spoil

• Construction and long-term stability

• Effects on ecosystem; negative and positive



Island
Potomac River


Island
-13.2
15
-15.18
-7.92
5
-8.25
-20.79
5
-1
1
-10.56
-9.57
2
0
-21.45
-16.17
15
-1.98
-12.21
-20.79
-2.31
-16.5
-9.9
8
-7.59
10
-19.47
-22.44
-12.87
-16.83
-22.44
19.14
-5.61
-5.61
3

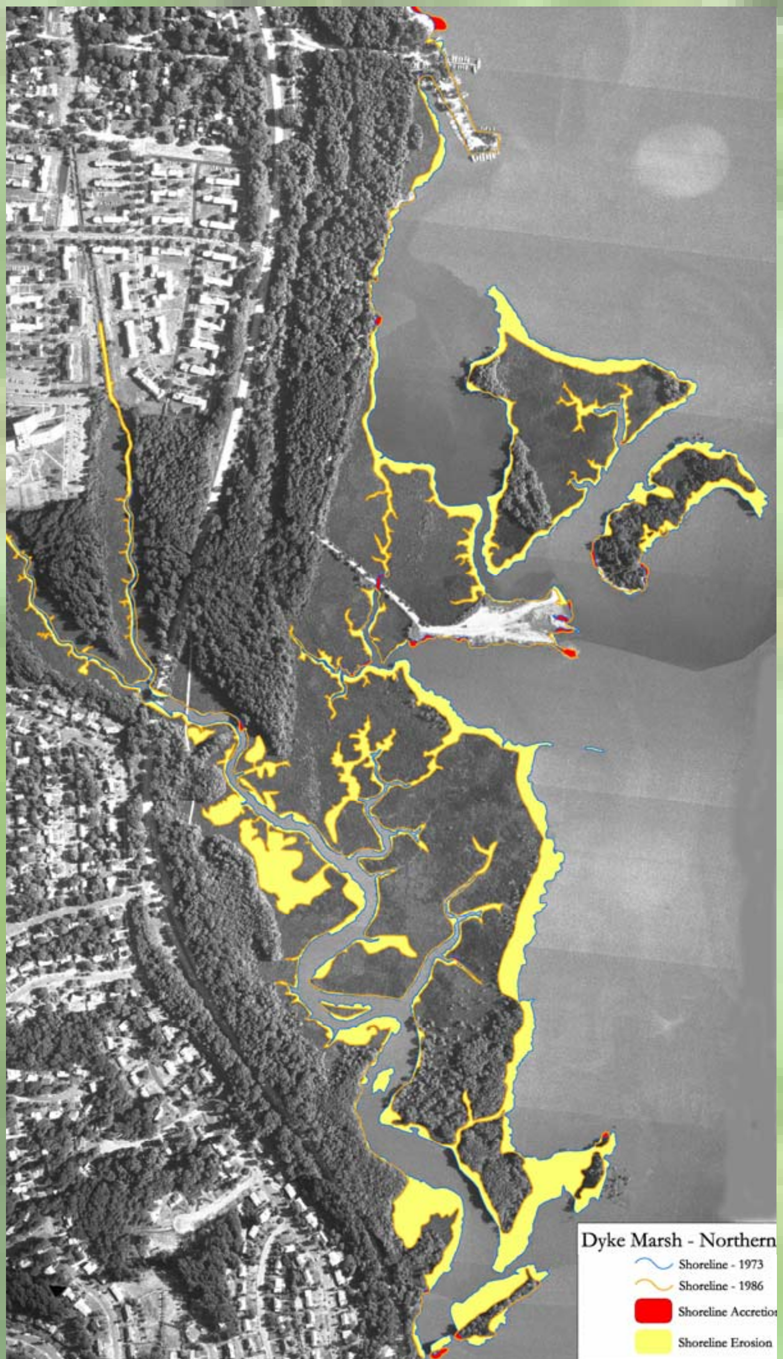
Belle Haven
Marina
island
George Washington
Memorial Parkway
Haul Road
demonstration area
Potomac River
Hog Island Gut
N
100 0 100 200 Meters

Shoreline Erosion Control – Scenario 3

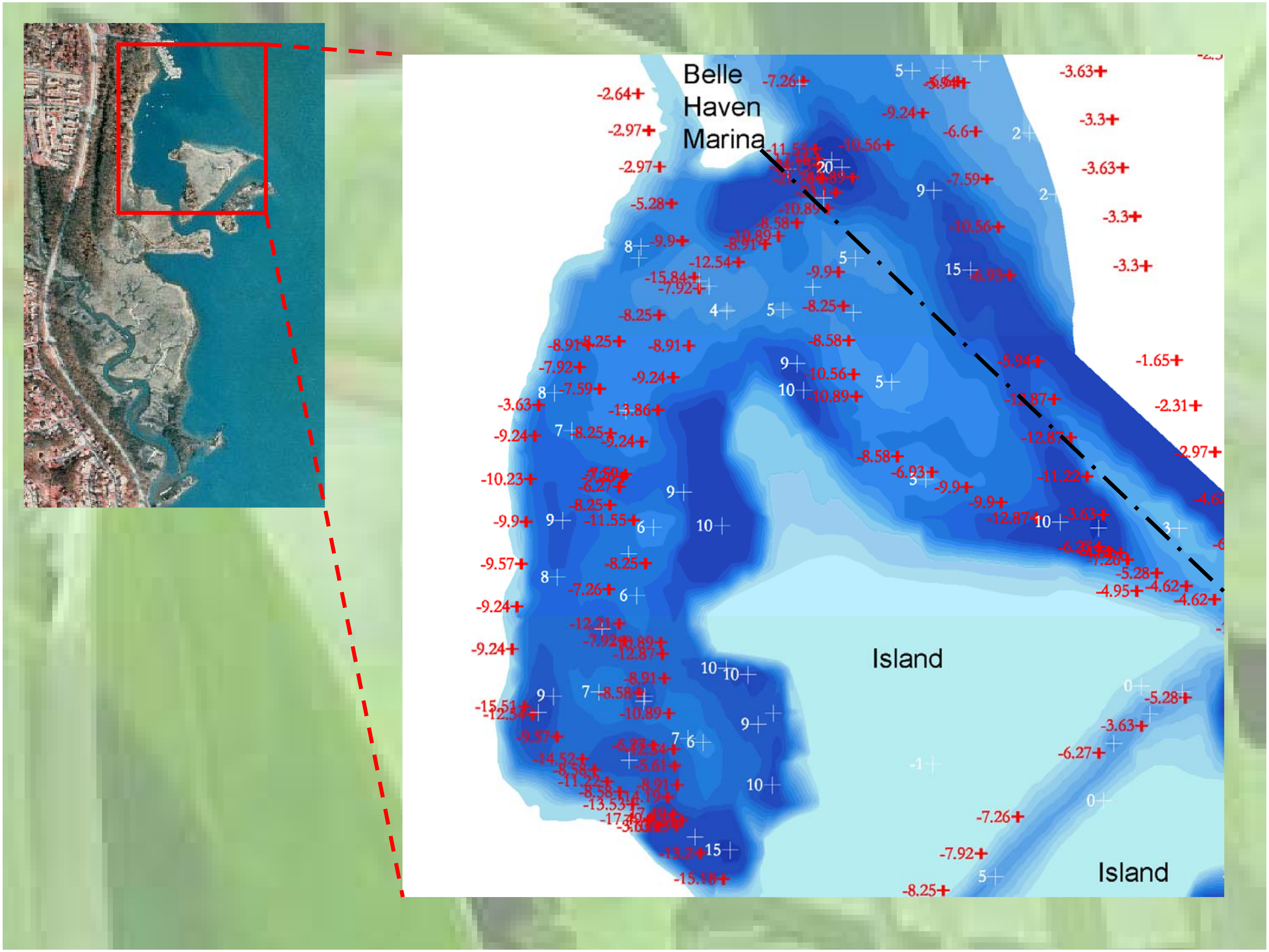
Goal: Selected shoreline areas with severe erosion or have potential for severe erosion

Activities:

- Stabilize shorelines through biological and physical techniques



Tammy Stidham, NPS



Belle
Haven
Marina
Island
Island

Fringe wetlands, Anacostia

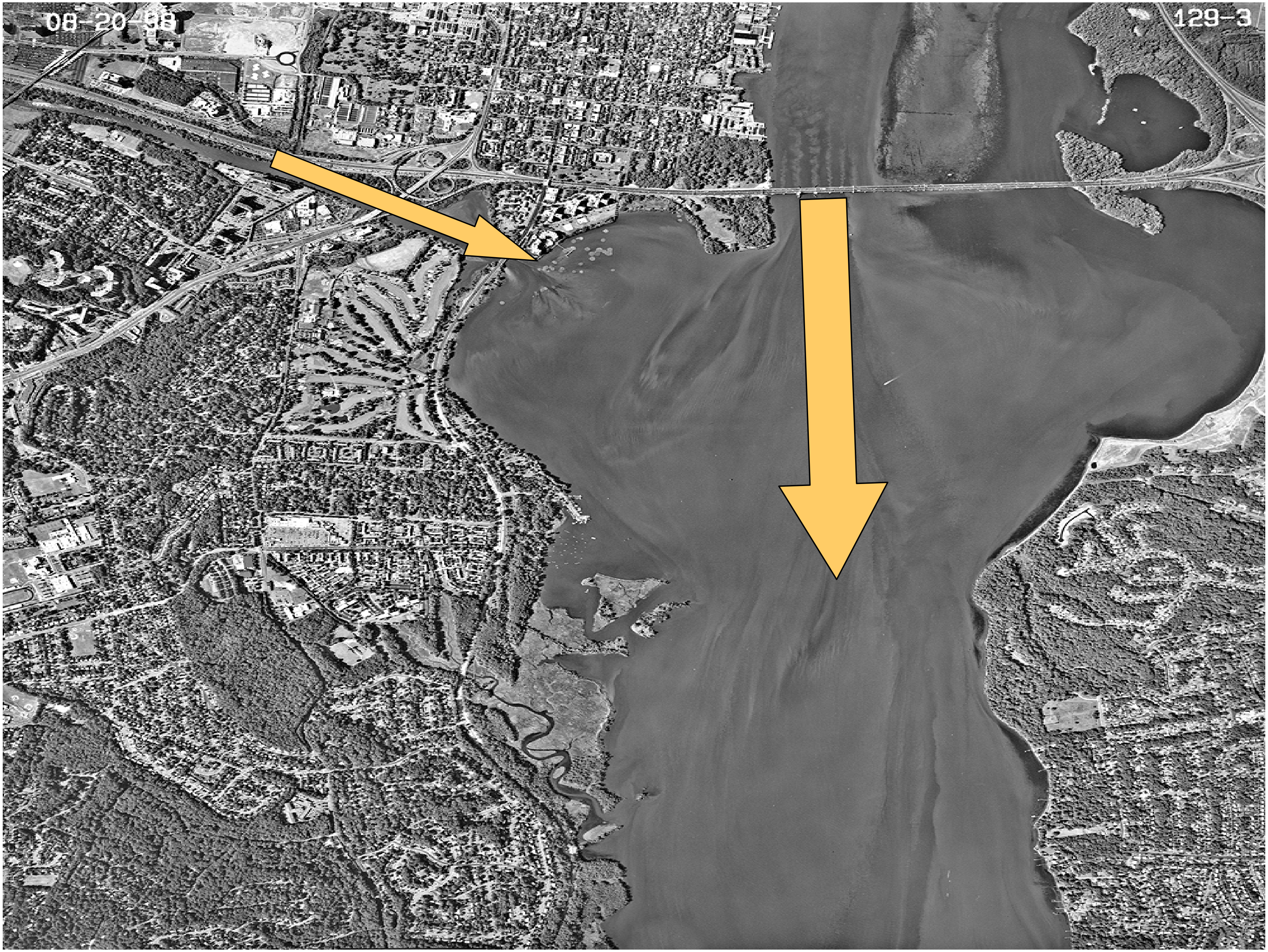
Kingman marsh, Anacostia River

Kenilworth marsh, Anacostia River

Kenilworth marsh, Anacostia River

Conclusions

- Tidal freshwater marshes are complex ecosystems that are the result of interactions between both land and sea.
- To get it right, restoration will need to recreate the highly variable elevation landscape of the existing marsh and ensure that sediment accretion can keep up with sea level rise.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Thanks to:

- Andrew Elmore, Steve Seagle, Todd Lookingbill, Sujay Kaushal
- Annie Elmore, Kristy Hopfensperger
- National Park Service through the Chesapeake Watershed CESU
- Friends of Dyke Marsh