Spartina alterniflora marsh development on nutrient-rich dredged materials in a large-scale restoration project in mid-Chesapeake Bay: a case of silicon depletion?

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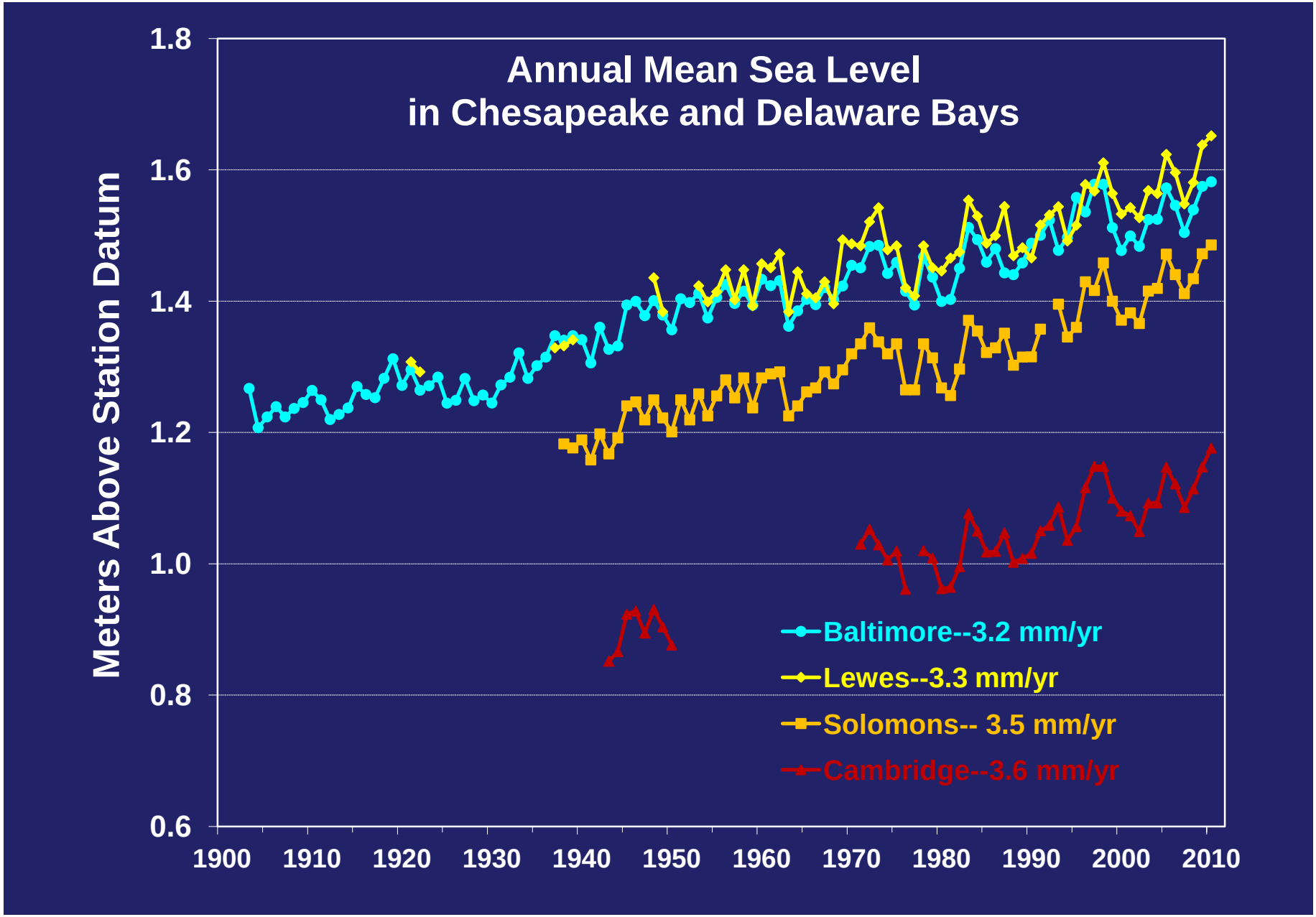
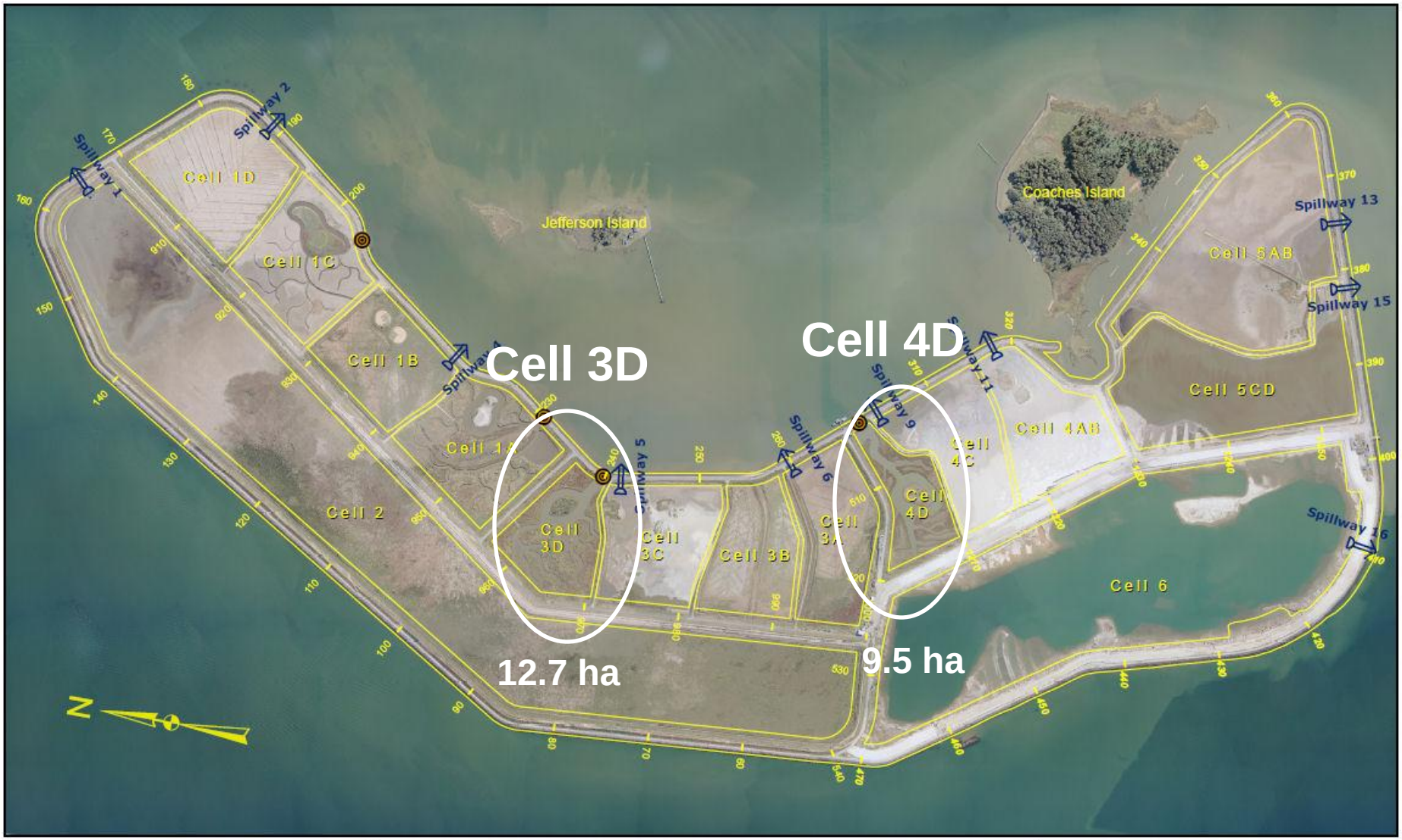
*** NOAA National Geodetic Survey, Silver Spring, MD**

Courtesy U. S. Army Corps of Engineers


Annual Mean Sea Level
in Chesapeake and Delaware Bays
Meters Above Station Datum
1.8
1.6
1.4
1.2
1.0
0.8
0.6
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Baltimore--3.2 mm/yr
Lewes--3.3 mm/yr
Solomons-- 3.5 mm/yr
Cambridge--3.6 mm/yr



Spillway

Tidal Connector

Cells and Boundaries

2010 Aerial Imagery - Poplar Island

US Army Corps of Engineers

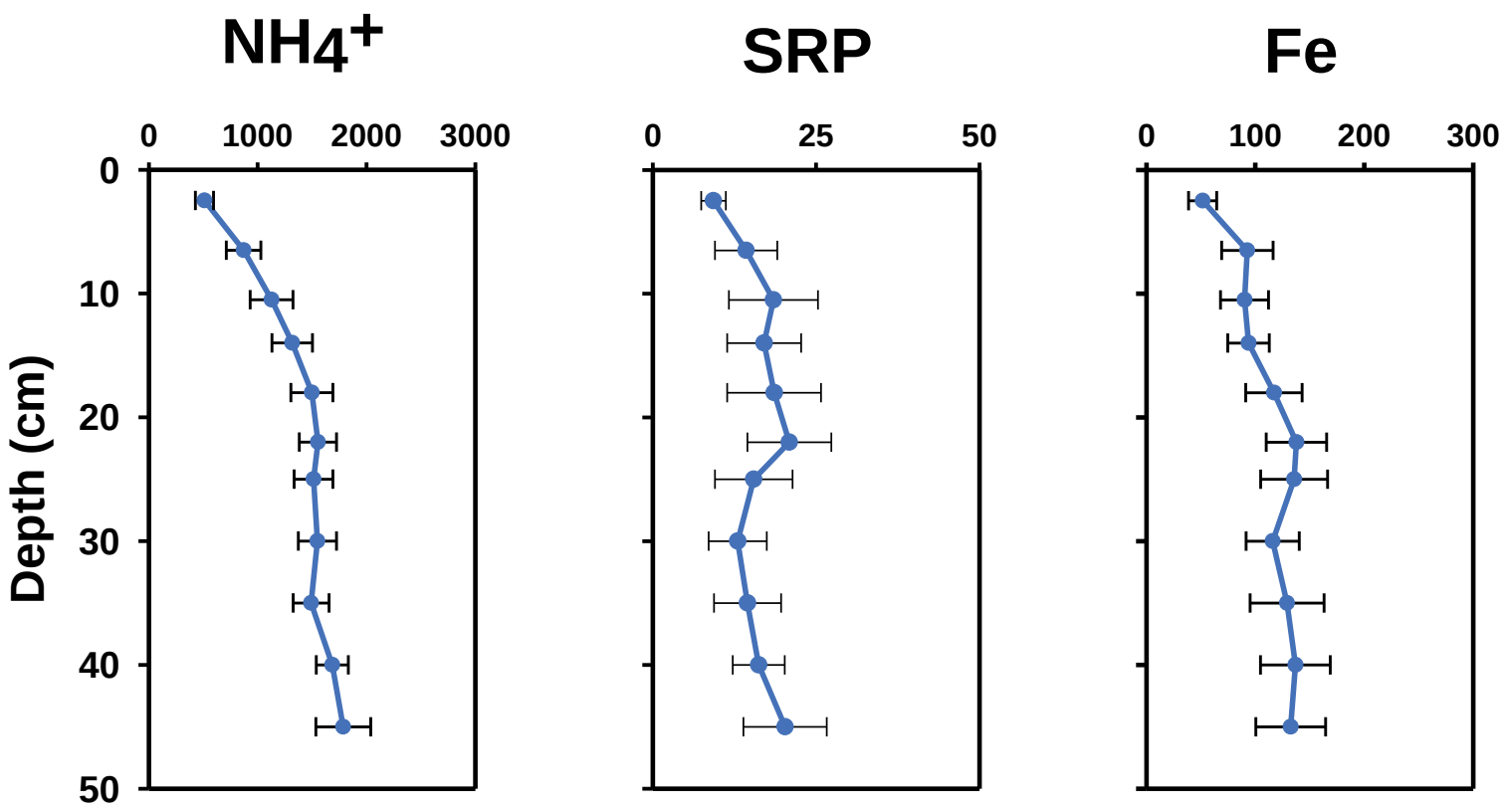
MARYLAND ENVIRONMENTAL SERVICE

0 1,000 2,000 3,000

Feet

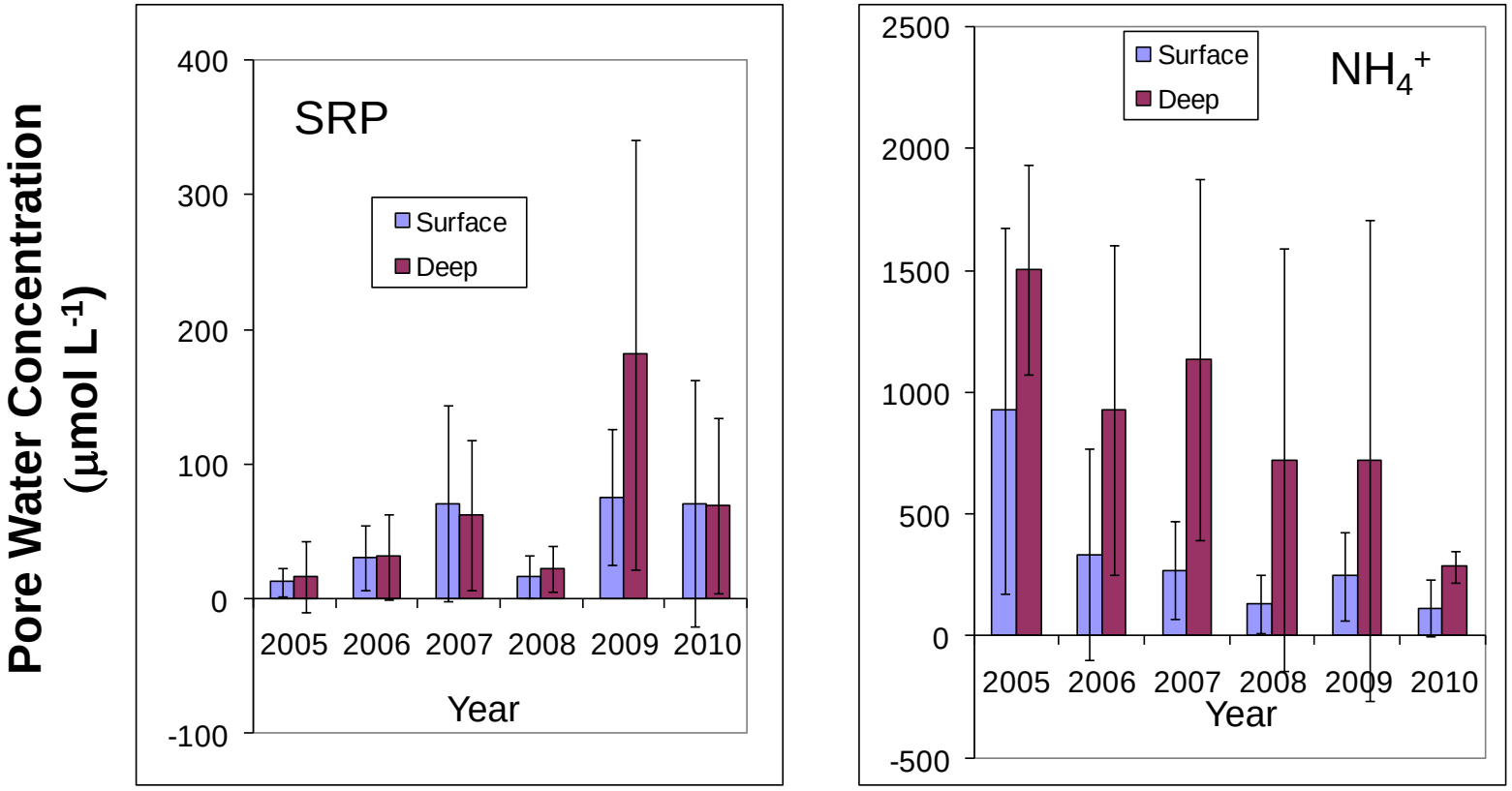
Projection: NAD 1983 State Plane Feet

Pore water concentrations (μmol L^{-1})



Fall 2005 Mean ± SE, n = 18

Changes in pore water NH_4^+ and SRP in Dredged Material



- SRP increasing in both surface (<12 cm) and deep (>20 cm)
- NH_4^+ decreasing in both surface and deep

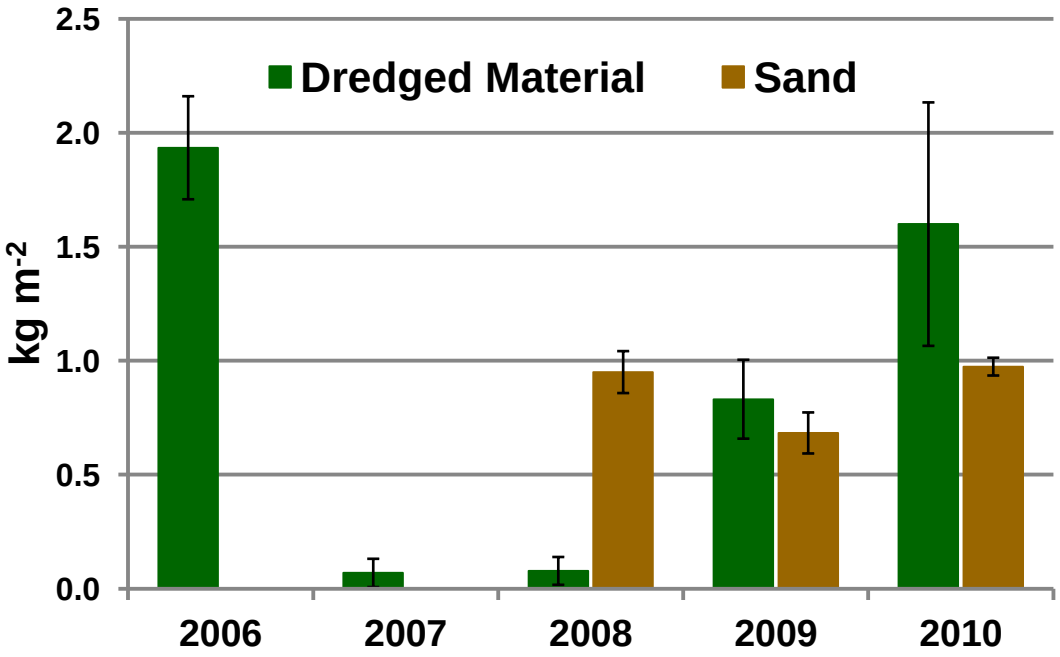
Planting

Lush growth

Re-colonization

Die-back

Substrate effect on *S. alterniflora* aboveground biomass production



- Fluctuating biomass on dredged material, more stable biomass on sand
- Initially almost double the biomass on dredged material as on sand

Marsh characteristics associated with high fertility sediments:

- Lodging
- Low root:shoot ratio
- Fungal infection
- Leaf speckling
- Muskrat grazing

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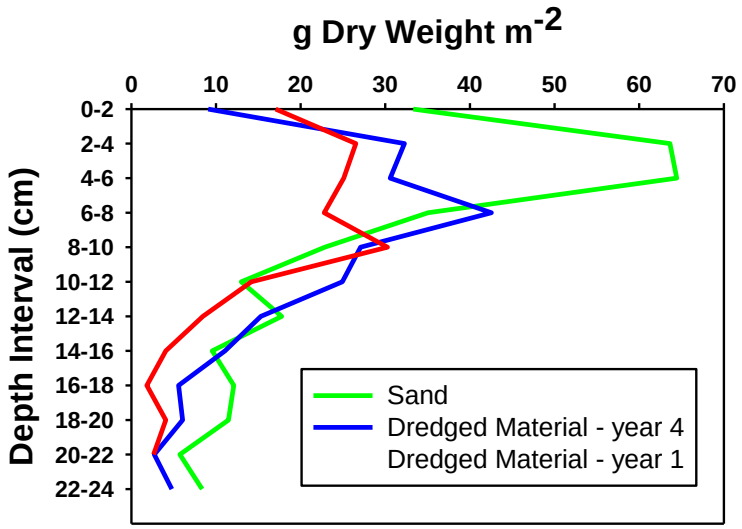

Poplar Island Biomass 2010

Substrate	AG (gdw m^{-2})	BG (gdw m^{-2})	RSR
Dredged Material	1599	210	0.13
Sand	974	280	0.29

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Fusarium infections on *S. alterniflora* stems (left) and *S. patens* inflorescence (right).

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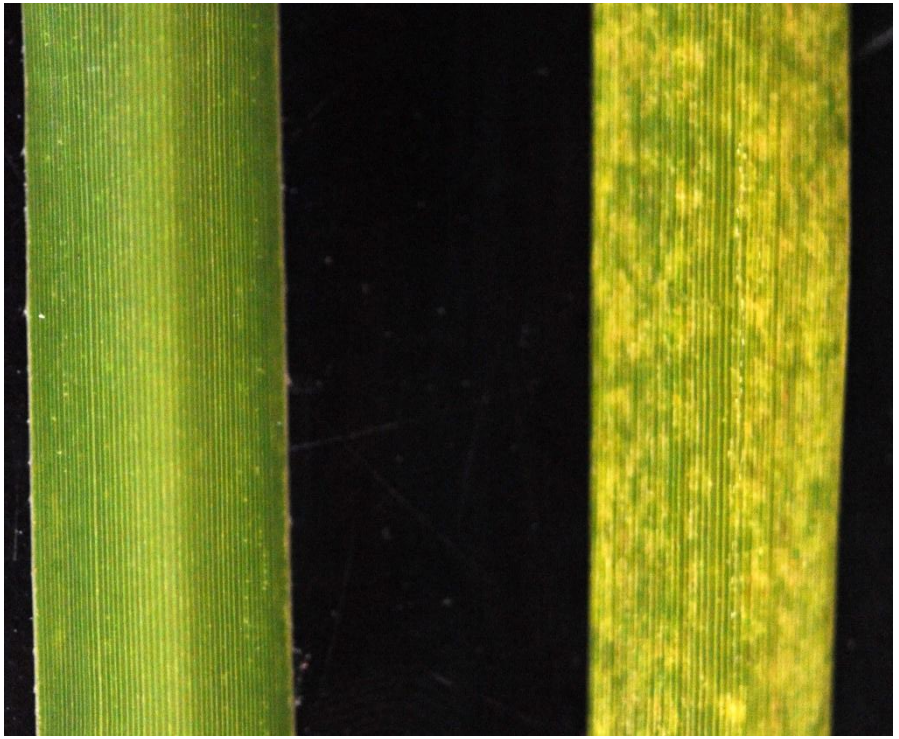

Reference Marsh Dredged Material

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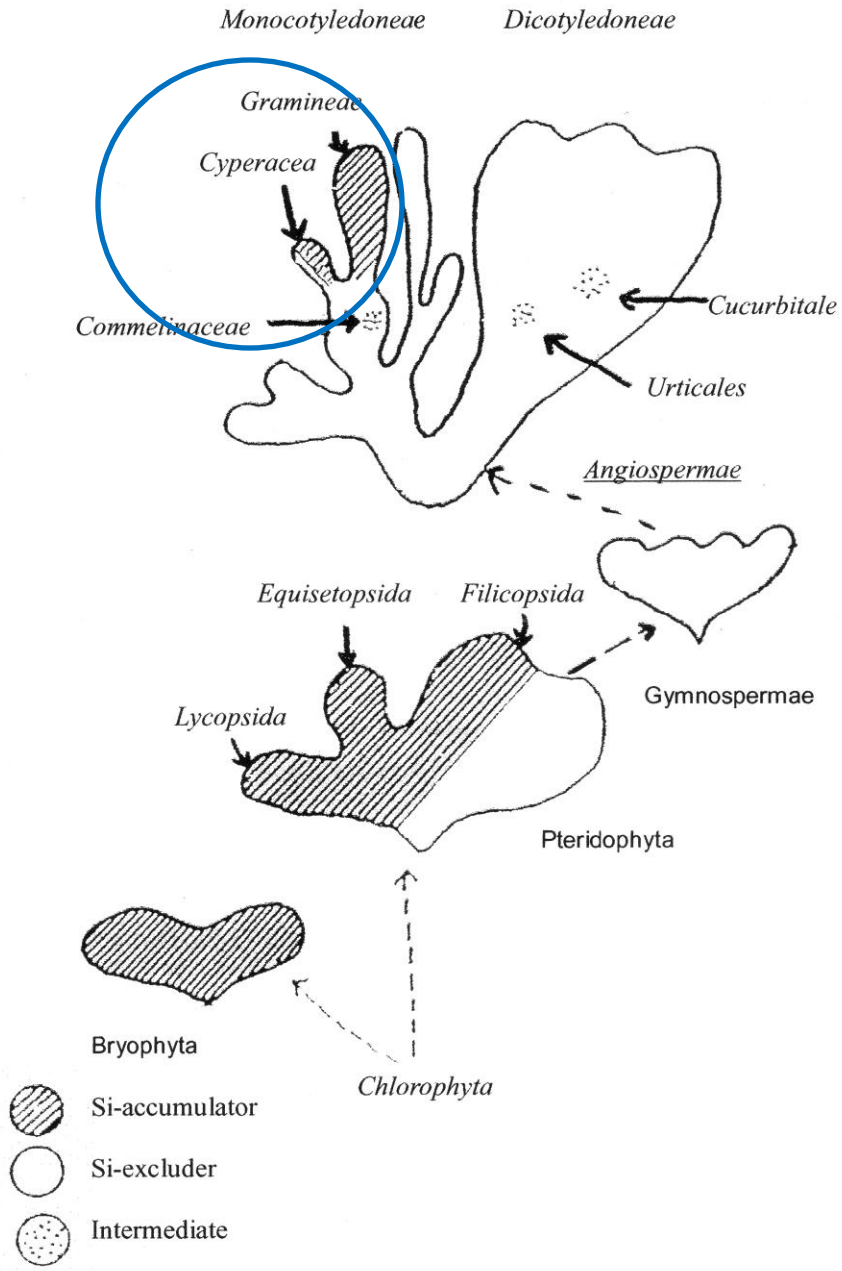
USFWS Muskrat Capture (level of effort)

Location	Sept. 2008	2007-2009
Dredge	50 (0.04)	192
Sand	4 (0.06)	19

Pers. Com., Chris Guy and Pete McGowan, USFWS

Causes???

- Low root:shoot ratio
- Fungal infection
- Lodging
- Leaf speckling
- Muskrat grazing

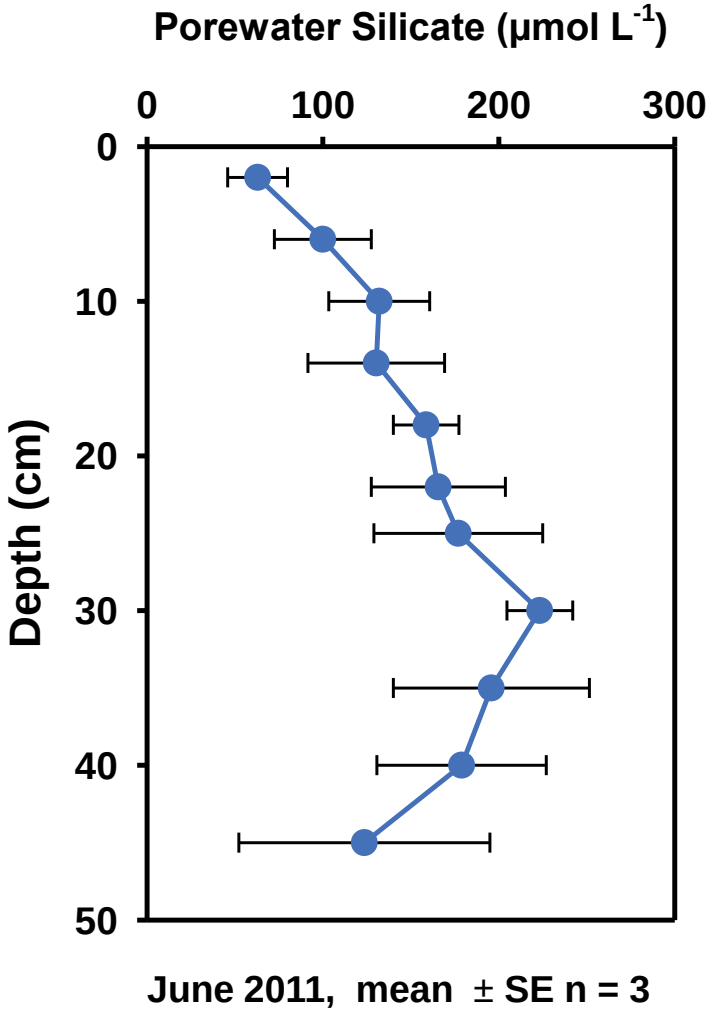


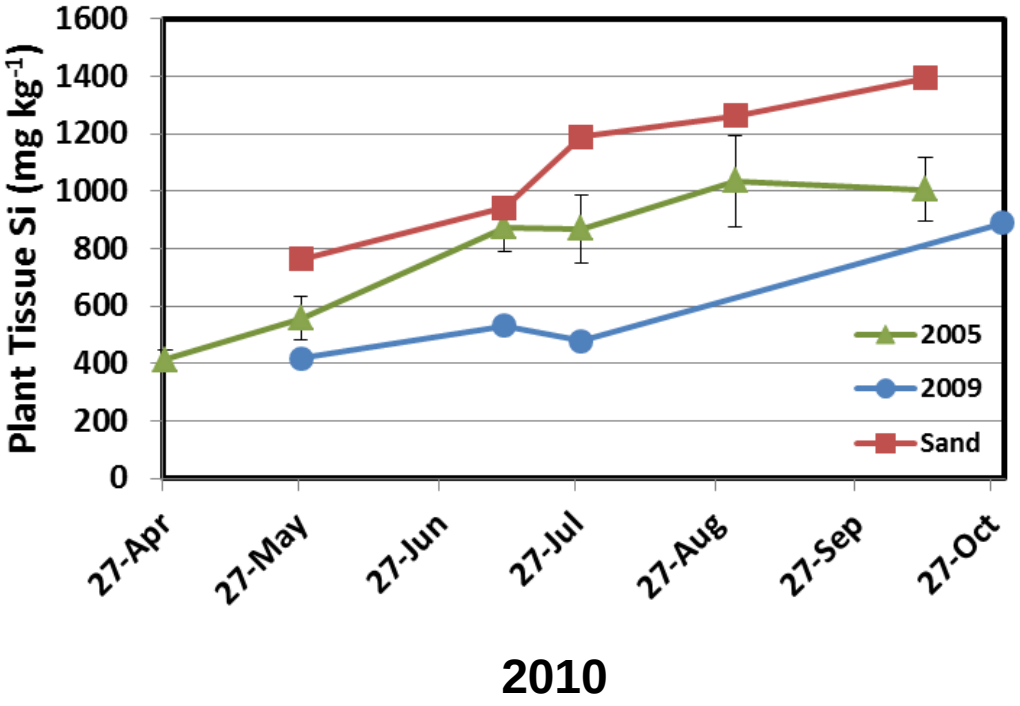
Role of silicon in higher plants:

- Essentiality: diatoms, horsetails, scouring rushes
- Enhancement of growth and yield
- Promotion of upright stature and resistance to lodging
- Favorable exposure of leaves to light
- Surface properties
- Resistance to disease organisms
- Resistance to herbivores
- Resistance to salinity stress
- Reduction of drought stress
- Protection against temperature extremes
- Effects on enzyme activities
- Effects on mineral composition

Source: Datnoff et al. 2001, Silicon in Agriculture

Silicon in pore water and plant tissue





Silicon amendment pilot study

Silicon amendment field trial

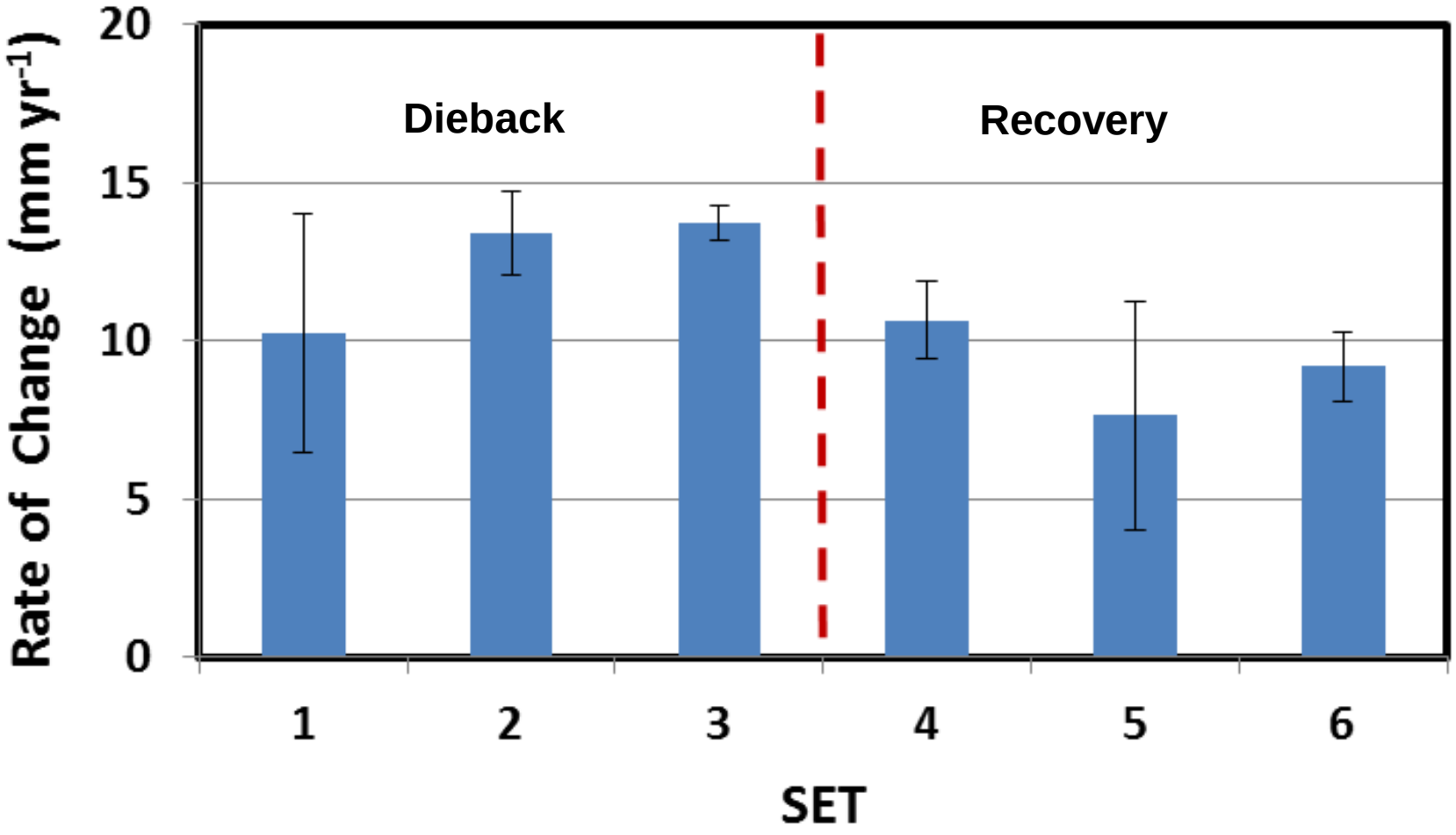
May 2012

Elevation monitoring

Installing SETs, Nov. 2008

Feldspar marker horizon

Elevation change 2009-2012



Conclusions

- Restoration using high fertility dredged material has resulted in oscillating productivity of *S. alterniflora* during the first 6 years after planting.
- Elevated pore water NH_4^+ concentrations are persistent and SRP concentrations have increased, suggesting that the effects of this nutrient rich substrate will be long-term.
- Soil silicon amendments may help alleviate the problems associated with high fertility in a marsh restoration, as in rice cultivation.
- Implications for natural marshes: there may be a limit to the ability of natural marshes to adjust to increasingly hyper-trophic conditions and keep abreast of sea-level rise.

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