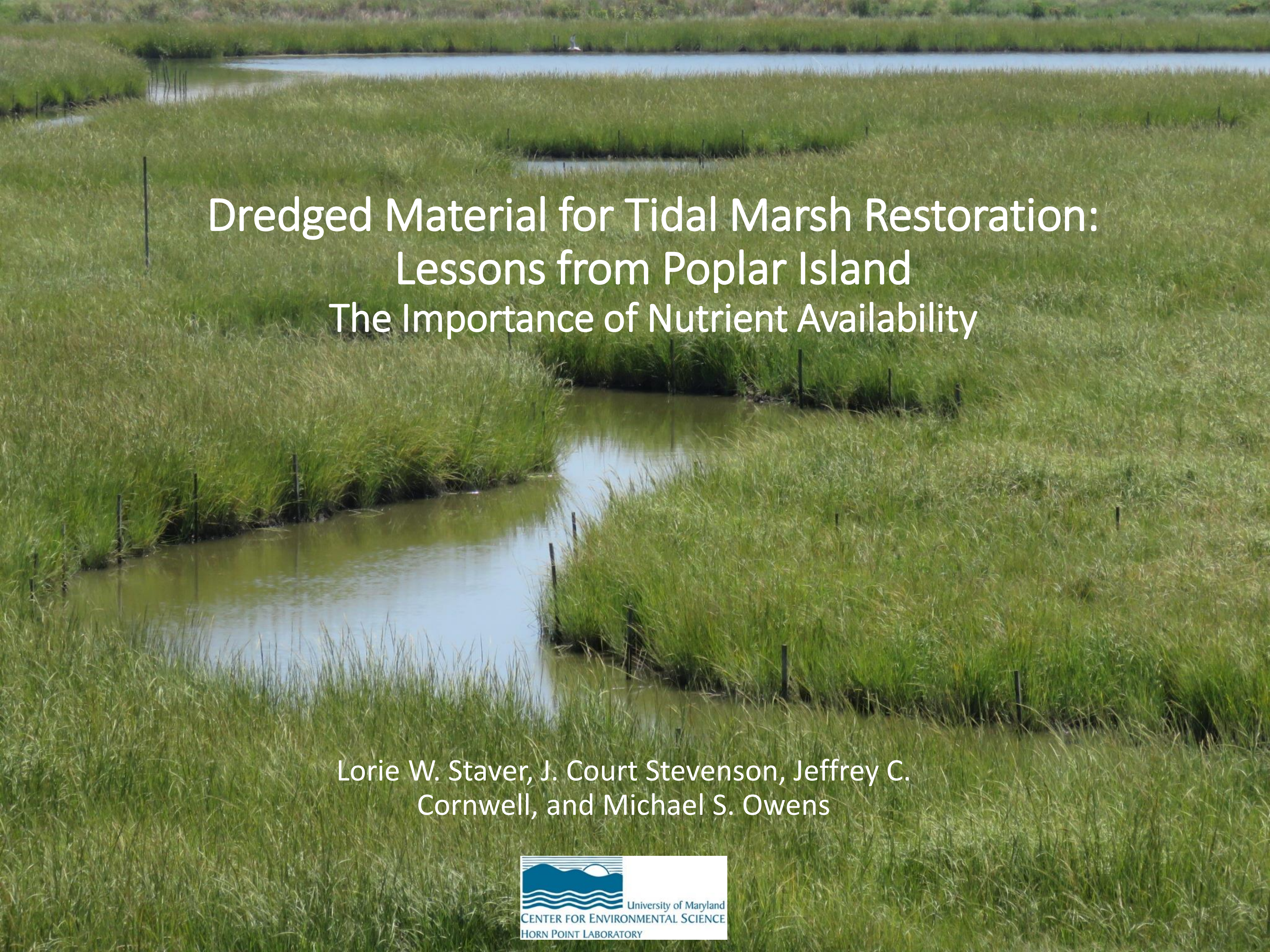

Dredged Material for Tidal Marsh Restoration: Lessons from Poplar Island

The Importance of Nutrient Availability

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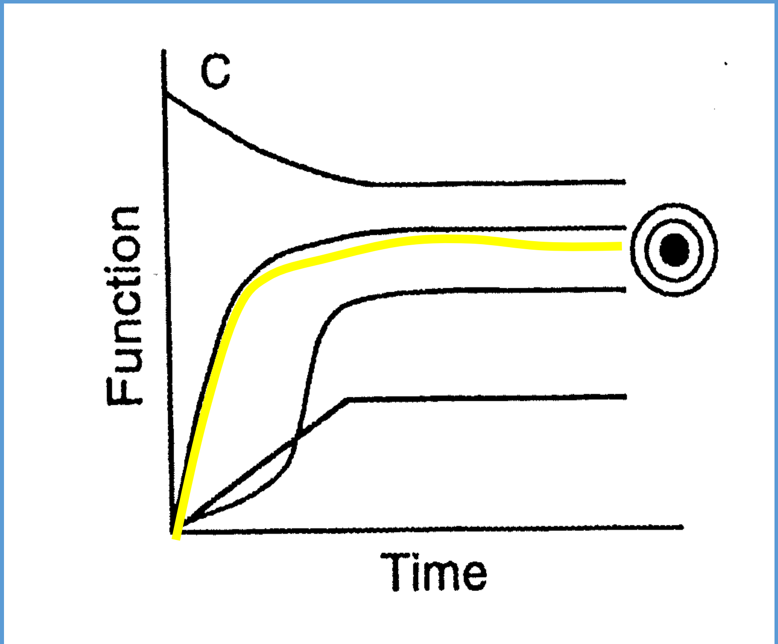
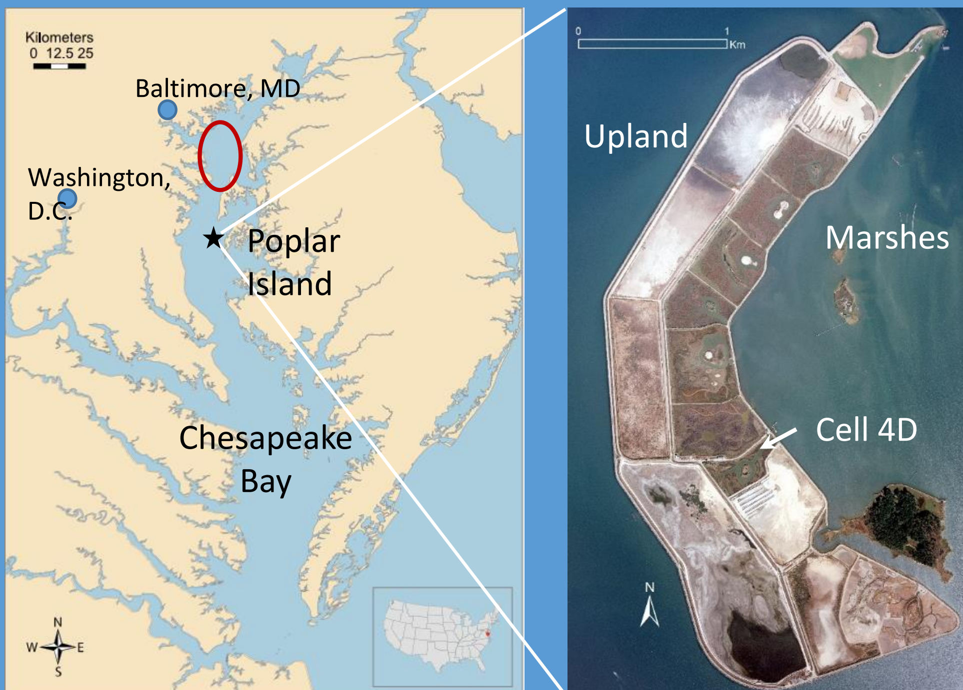
History of Tidal Marsh Restoration Using Dredged Material

- 40+ years of tidal marsh restoration using dredged material
- Methods, recommendations and expectations based largely on projects utilizing sandy substrate – low nutrient availability
- Differing trajectories or no trajectory in different marsh restoration projects
- Substrate type can influence outcomes



Hypothetical trajectories toward functional equivalency (Zedler and Calloway 1999)

Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island



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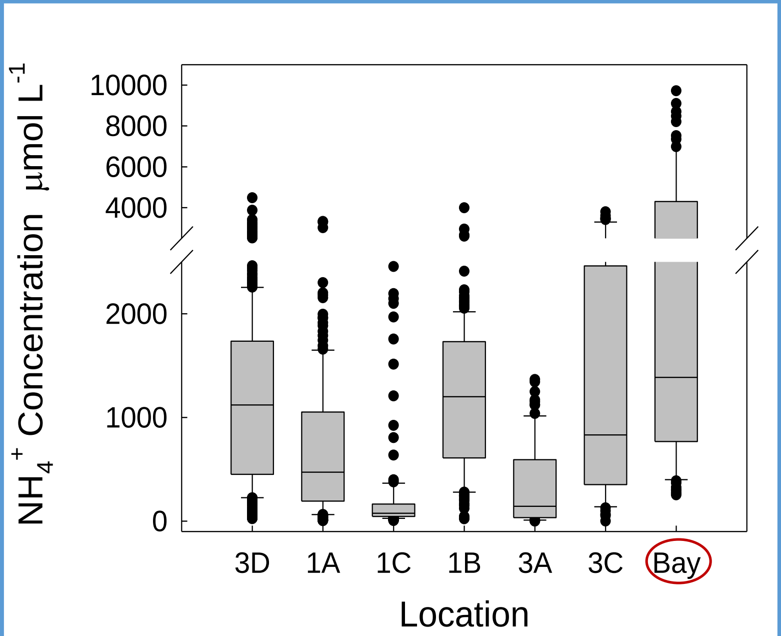
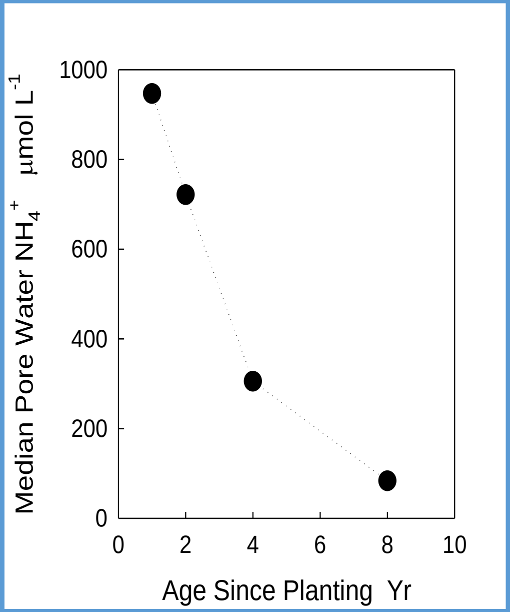
U.S. Army Corps of Engineers 2017

- Beneficial use – dredged material placement/remote island habitat restoration
- Substrate: upper Bay dredged material resulting from maintenance dredging of the approach channels…
- except Cell 4D, where sand was used to test designs and planting methods
- Total area = 694 ha (1715 acres), with approximately half tidal marsh and half upland habitat, subdivided into containment cells
- Tidal marshes are 80% low marsh, 20% high marsh
- Marshes developed sequentially as they are filled, creating an age range of 0 – 15 years
- Perimeter dike (2.7 m MSL)
- Various inlet structures

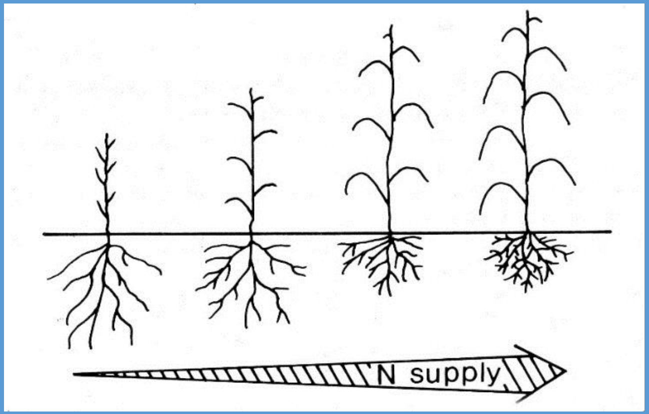
Fine-grained dredged material = high nutrient availability

- *Millimolar* concentrations of NH_4^+
- Wide range in initial concentrations, due to length of period prior to vegetation establishment
- N availability declines over time

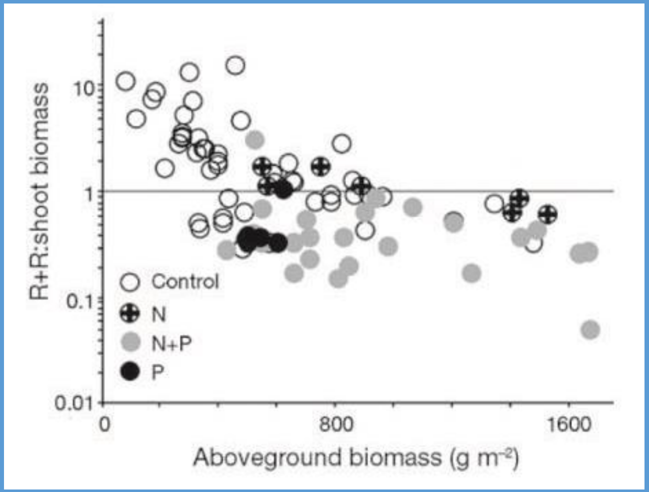




Morphological Effects of Nitrogen on Marsh Vegetation



Marschner 1995



Darby & Turner MEPS 2008

Poplar Island:

- Rapid plant establishment
- Robust growth
- Low RSR

Ecological Effects of Nitrogen on Marsh Vegetation

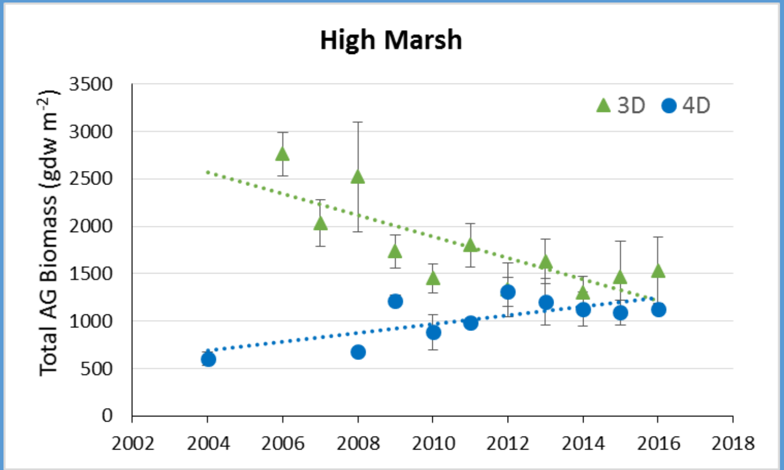
Increased rates of fungal infection

Increased grazing pressure

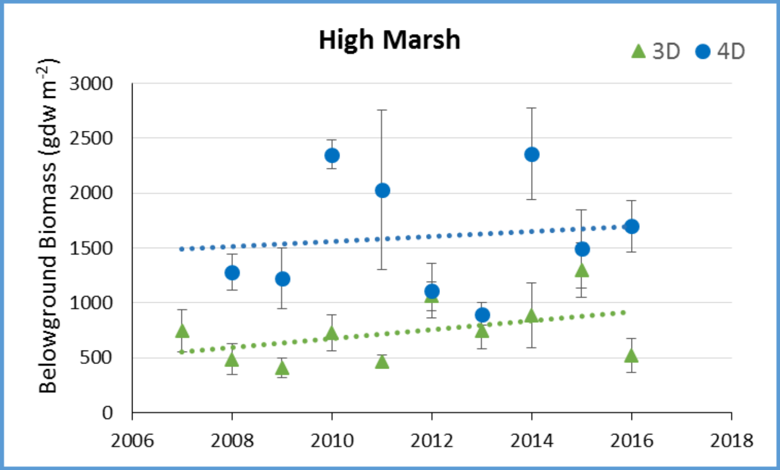
- Can limit biomass production (top-down control) and may contribute to dieback

Poplar Island Biomass Trajectories

Aboveground

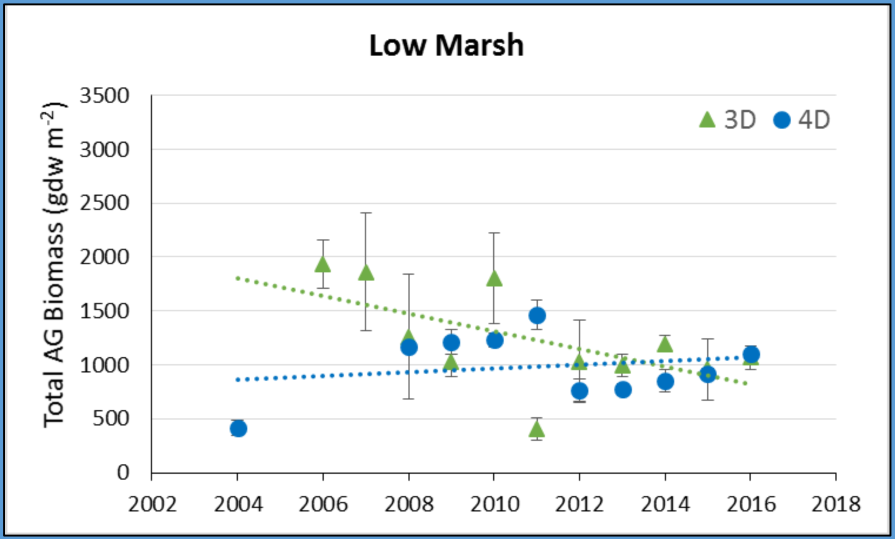


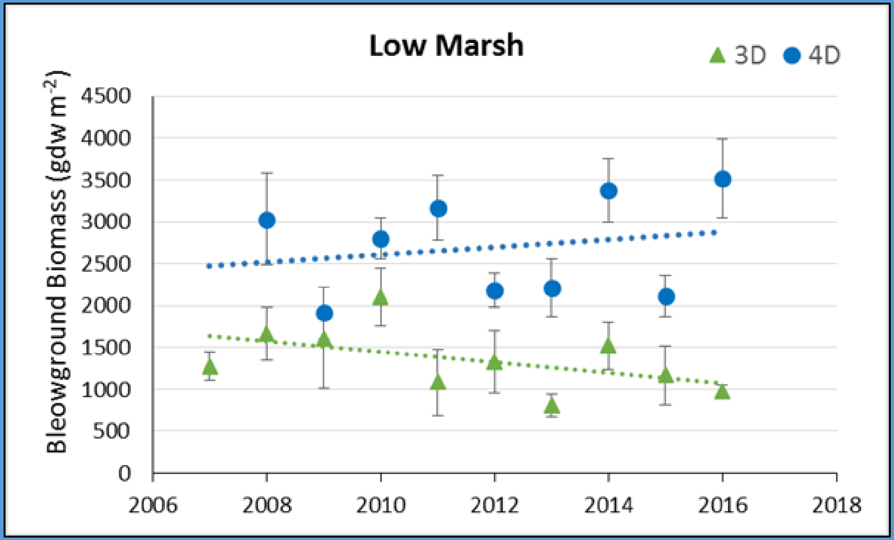
Belowground



- Expected trajectories due to changes in nutrient availability
- Little nutrient recharge from depth in dredged material due to compaction (diffusional transport) and drier conditions

Poplar Island Biomass Trajectories

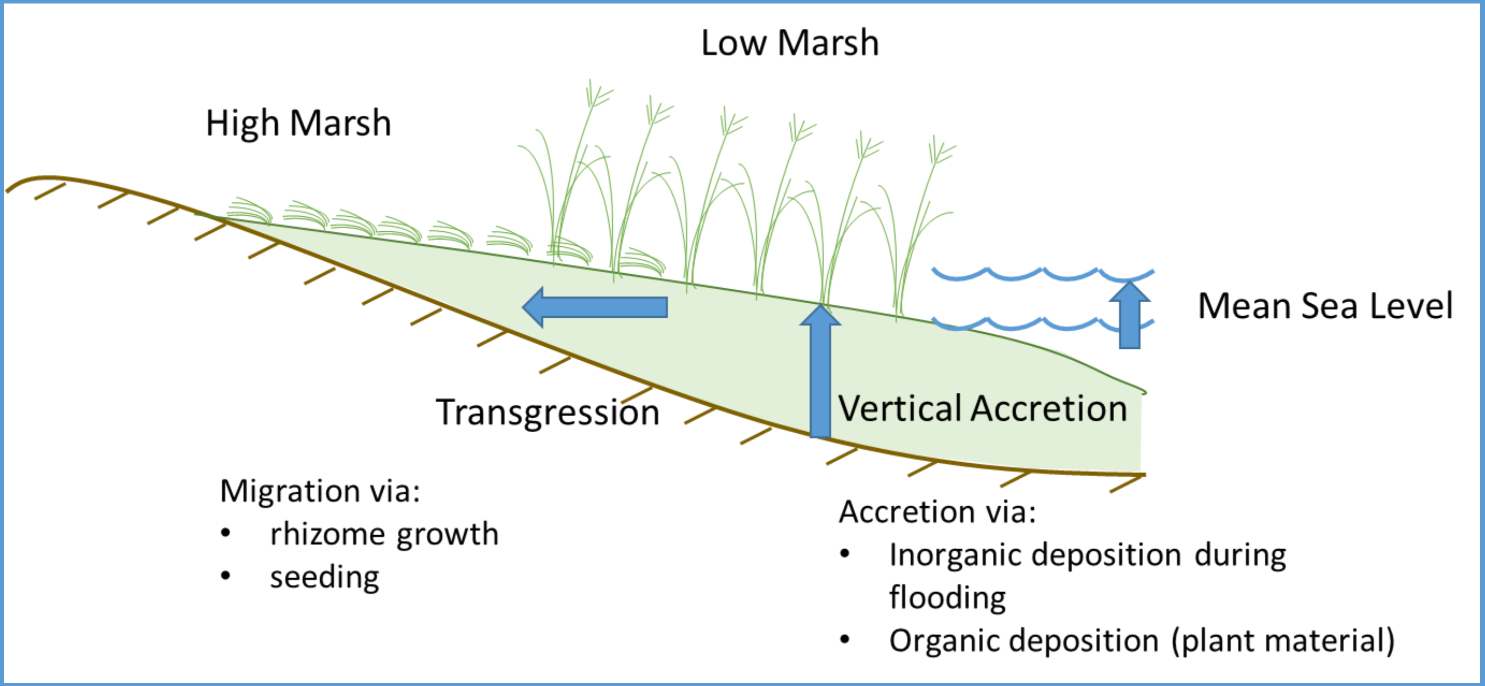




- Higher AG biomass in DM marsh (green)
- Higher BG biomass in sand marsh (blue)
- RSR initially <1 in DM marsh, >1 in sand marsh
- AG declining in DM marsh, but BG also declining, so likely due to top-down rather than bottom-up control

➢ Significance: BG plant material more likely to be retained and contribute to elevation gain

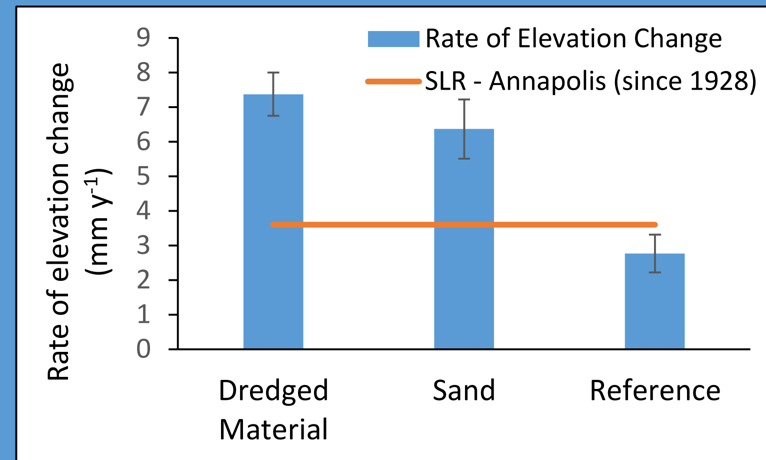
Adjustment to SLR in Poplar Island Marshes



- ➢ Transgression very limited at Poplar Island due to dikes, and inorganic sediment inputs are low
- ➢ Organic matter production dominant contributor to elevation gain
- ➢ Implications for elevation change?

Elevation Monitoring at Poplar Island

Surface elevation table (SET)
- 36 on-site
- 3 in reference marsh



- Rate of elevation change in dredged material marshes not significantly different from sand marsh (Cell 4D), despite lower RSR
- Poplar Island marshes >2x natural reference marsh
- Poplar Island marshes > SLR at Annapolis > reference marsh

Lessons Learned for Marsh Restoration with Fine-grained, Nutrient Rich Dredged Material

Dike - 2.7 m MSL

Tidal Inlet

- Reduce exposure to waves, ice scour, biomass export

- Plant establishment – take advantage of rapid growth (grid configuration)
- Elevation gain – use inlet and protective structures that promote biomass retention
- Management - controlled burns to reduce grazing and pathogen pressure
- Grading – slopes to prevent ponding
- Thin layer placement – consider nutrient amendment

➢ **Substrate characteristics have significant ecological consequences that should be considered in order to design and manage for maximum resilience.**

Ongoing Work

- Closer examination of drivers of marsh elevation change, including both field measurements and modelling
- Fire as a management tool to suppress grazing and disease in the marshes
- Effect of dieback on *S. alterniflora* genetics
- Geomorphology and channel design (Nardin)



Questions?








Photo credits USFWS, MES, UMCES

PORT OF BALTIMORE 1706 Helen Delich Bentley

US Army Corps of Engineers® Baltimore District

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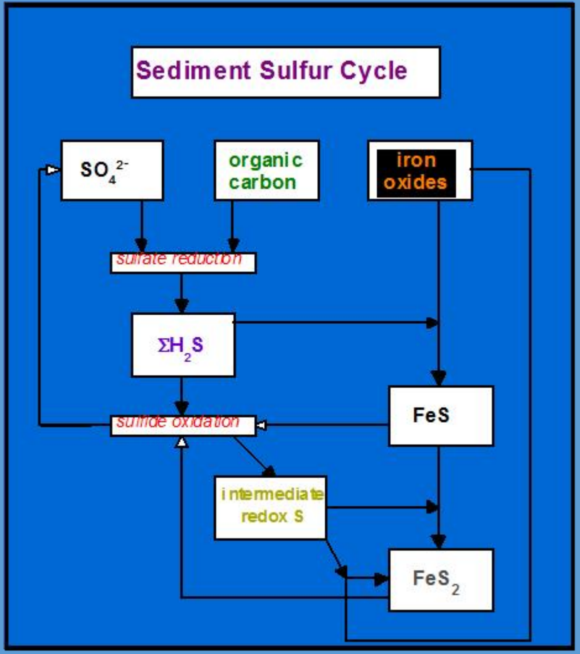
U.S. FISH & WILDLIFE SERVICE DEPARTMENT OF THE INTERIOR

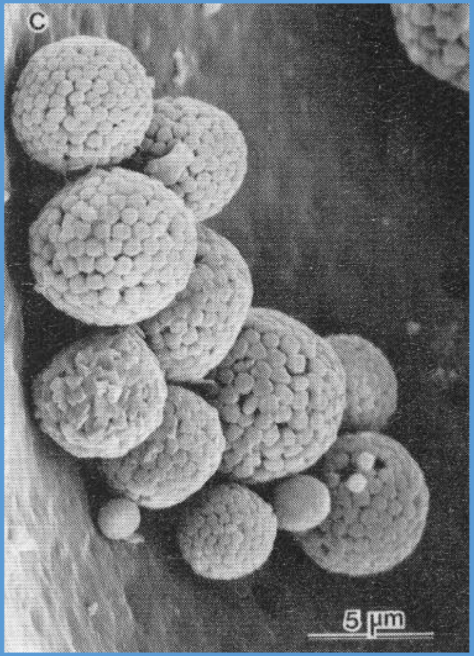
Why would pH be a Problem?

Iron sulfides, including pyrite, form in Chesapeake Bay sediments when sulfide produced by sulfate-reducing bacteria interacts with iron oxide minerals which are abundant in the bay.

Cornwell and Sampou 1995



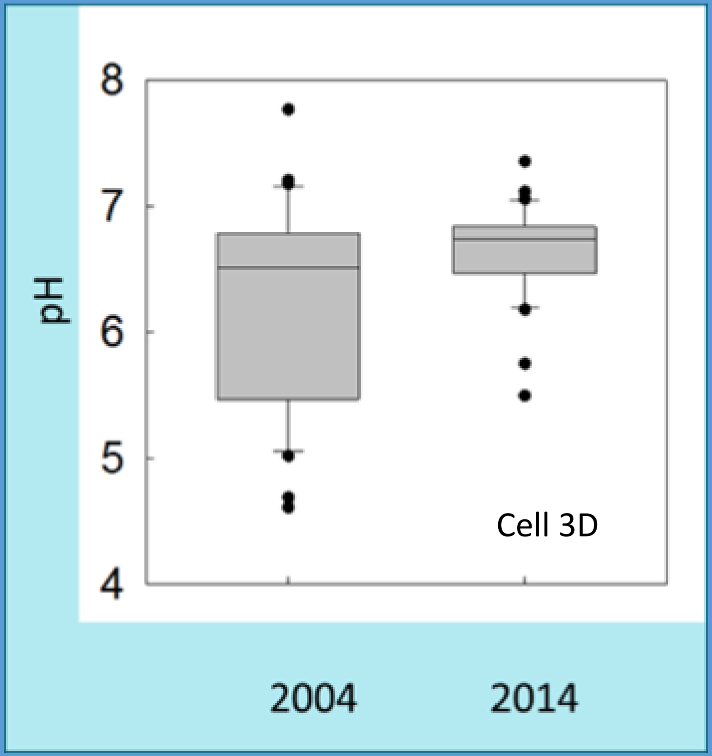
Morse and Cornwell 1987



Upon exposure to oxygen during drying and "crust management", low pH arises because of pyrite oxidation :

$$4FeS_2 + 15O_2 + 8H_2O \rightarrow 2Fe_2O_3 + 8\ H_2SO_4$$

Upper Chesapeake Bay Dredged Material



- Concerns for tidal marsh: pH …