Optimizing Resilience in Tidal Marshes Created with Fine-grained Material in Chesapeake Bay

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Restore America’s Estuaries 2016 Summit
Poplar Island

Tidal marsh “cells”

Dredged Material

Sand

Cell 4D

Cell 3D

Cell 1A

Upland “cells”

2003

2005

2009

2011

2012

2015

2016

2018

Sand
Vegetation - Development

Planting

Lush growth
Vegetation - Development

- Planting
- Lush growth
- Die-back
- Re-colonization
Dieback intensity was heterogeneous, with the western area (arrows) of the marsh hit hardest.
Vegetation – Responses to excessive N

- Fungal Infection
- Lodging
- Muskrat activity
- Stem boring insects
- Leaf spotting
- Reference
- Dredged Material
• Downward trend in Cell 3D -- dredged material

• Upward trend in Cell 4D -- sand, with a setback in the low marsh in 2012.

• Overall, higher AG biomass production in Cell 3D, except during dieback events.
Belowground Biomass

- High level of inter-annual variability in both marshes.
- No strong trends in either marsh over time.
- Overall, higher BG biomass production in Cell 4D, the sand marsh.
Questions:

1. Does high N affect elevation change & do vegetation diebacks reduce long term marsh resilience?

2. What are the major contributors to elevation gain in the Poplar Island marshes?
   - Inorganic deposition
     - Does distance from inlets matter in terms of sediment?
   - Organic deposition
     - Biomass production – above or belowground
     - What strategies can we use to optimize resilience, especially bin view of long term sea-level rise?
Vertical Accretion – SETs, Marker Horizons

SET design (Cahoon et al., USGS)

SET installation, Poplar Island

Feldspar Marker Horizon
Elevation Change – SETs

SET locations:

- Green = dredged material
- Yellow = sand
Elevation Change

- Historical Chesapeake Bay SLR: **3-4 mm y\(^{-1}\)** (Baltimore and Solomon’s)
- 2008 – 2013 SLR: **11 – 14 mm y\(^{-1}\)** (Baltimore and Solomon’s)
- Dredged material marshes not significantly different from sand
- Rate slowing in all cells
- Marker horizons (Cell 3D)
  - \(6.0 \pm 1.20\) mm y\(^{-1}\) (2007)
  - \(6.2 \pm 0.77\) mm y\(^{-1}\) (2011)
  - \(5.4 \pm 1.13\) mm y\(^{-1}\) (2015)
Elevation Change: Effect of Dieback

- Blue = low dieback
- Red = high dieback
Elevation Change: Effect of Dieback

Blue = low dieback
Red = high dieback
Elevation Change: Organic vs. Inorganic

- Rate vs. AG biomass significant
- \((P = 0.001)\)
  - Dieback is likely to have a negative effect on the sustainability of the marshes.

- Rate vs. distance from the inlet was not significant \((P = 0.51)\)
  - Microtidal system, TSS <30 mg L\(^{-1}\)
CONCLUSIONS & LESSONS LEARNED

1. Good News: elevation gain is well above historical rates of SLR in most low marshes at Poplar Island, but *Spartina alterniflora* has begun creeping into high marsh zones as sea-level increases. We need to engineer effective transition zones into the uplands.

2. Periodic dieback is likely associated with water logging in low marsh and possibly increased abundance of stem boring insects, both of which lower rates of accretion. We need slightly higher marsh elevations in both high and low marsh zones -- with improved water drainage networks.

3. Another possibility we are now investigating is that since these marshes now depend on above-ground organic deposition, knocking down overwintering insect grazers periodically, using winter burns might be feasible!
What are the tradeoffs?