Restoring a Historically Ditched Salt Marsh in a Mid-Atlantic Estuary: Application to Sea Level Rise and Coastal Resiliency

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Salt Marsh Ditching

- By 1930s - 90% of Atlantic coastal marshes ditched for mosquito control
  - 2/3 of Delaware’s 90,000 acres of salt marsh

- Remove standing water from marsh to eliminate mosquito breeding habitat

- Indiscriminately drained non-mosquito breeding habitat also

- Adverse impacts to marsh structure & function
Salt Marsh Self-Maintenance

- Requires tidal ebb and flow

- Above ground vegetation traps sediments transported on tidal flows

- Below ground vegetation contributes organic matter to sediments

- Marsh accretion must keep pace with sea level or self-maintenance breaks down leading to habitat loss (Morris et al. 2002)
Self-Maintenance – Created Ditch

- Habitat initially drained by ditches has subsided over time reducing the depth to water table and creating wetter conditions than in natural creek habitat.

- Elevations and hydrologic regime supports vegetation growth but water retention in the rooting zone alters community composition (forbs), sediment trapping, and soil organic content.

- Self-maintenance has been functioning for the past 70 years, but questions remain:
  - Will accretion keep pace with sea level rise?
  - Will further subsidence occur and limit self-maintenance?

- Impacts from ditching may be greater in more extensively ditched marshes with overlapping hydrologic regimes.
Delaware’s Inland Bays are a “mesocosm” for studying the effects of sea-level rise

Indian River Inlet has experienced significant scouring since first stabilized in 1938-40

Increase in inlet cross-sectional area has increased tidal prism

Tidal range has increased 1-2 ft. within Indian River Bay between 1948 & 1988

USACOE, 1994
Self-Maintenance: Ditch-plug Pools

- Poor drainage results in surface and pore-water retention that promotes edaphic stress and vegetation die back.

- Low organic and mineral inputs, low sediment strength, and collapse of the root zone has led to habitat instability and marsh subsidence with lower elevations.

- This hydrologic restriction leads to a decoupling of the self-maintenance process with a transition from vegetated to open water habitat, and the potential for additional loss of salt marsh habitat with continued sea level rise.
- 24-acre project site within nature preserve near Ocean View, DE
- 135-acre marsh complex
- Mostly *S. alterniflora* low marsh
- Managed by Delaware Center for the Inland Bays
- Owned by Sussex County
Project Goals & Objectives

- Compensatory mitigation for a natural resource damage assessment
- Address habitat alteration from ditching
- Enhance habitat value for salt marsh resources
  - Restore more natural hydrologic patterns
  - Increase micro-habitat diversity & interspersion
  - Expand foraging opportunities for fish, birds & invertebrates
  - Stimulate plant growth in poorly drained areas
Design Features

- Replace linear ditches with meandering tidal creeks
- Increase permanent open water on marsh surface at low tide
- Improve drainage in water-logged areas with stunted vegetation
- Completely backfill mosquito ditches with excavated spoil
Channel Design

- Empirical basis for channel plan-form & cross-sectional design

- Morphometric analysis
  - Bifurcation ratios
  - Sinuosity
  - Drainage density

- Target values developed from Delaware Bay reference marshes

- Empirical tidal prism model

- Site-specific relationships developed from on-site mosquito ditches
Monitoring

- **Pre-Construction (2005 - 2007)**
- **Post-Construction (2009 - 2013)**

### Biological Parameters
- ✓ Vegetation
- ✓ Nekton
- ✓ Birds
- ✓ Fiddler Crabs
- ✓ Ribbed Mussels

### Geophysical Parameters
- ✓ Pore Water Salinity
- ✓ Groundwater Elevation
- ✓ Tidal Hydrology
- ✓ Channel Morphology

### Photo-Monitoring
- ✓ 360° Panoramic
- ✓ Orthographic
- ✓ Oblique Aerial
Groundwater

Expectation

- Improved drainage would lower water table elevation & decrease pore water salinity

Methods

- 22 shallow piezometers
- 2x annually
- Low tide
Vegetation

Expectation

- Improved drainage would have a positive effect on vegetation
- No significant shift in species composition

Methods

- 36 fixed 1m² plots
- 1x per year (end of growing season)
Key Findings - Vegetation

- Construction resulted in short-term collateral impacts to marsh vegetation; most recovered in 1-2 years
- Percent cover exceeded pre-construction site-wide mean of 78% by Year 3
- Vegetation response strongest proximal to constructed tidal creeks esp. where soils previously water-logged
- Plant community composition remained largely unchanged
- Residual disturbance areas provide valuable foraging habitat for shorebirds
- Backfilled ditches quickly revegetated from marsh sod
- *Phragmites* did not expand into disturbed areas
In Summary

- Vegetation and hydrology are the primary indicators of self-maintenance.
- Ditching can disrupt self-maintenance under conditions of sea level rise.
- Ditch plugging alone does not restore the self-maintenance process.
- Restoration must address underlying factors linked to marsh decline.
- May be necessary for more involved effort, understanding funding constraints.
- Can be successful and should be considered as another tool to manage sea level rise.
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Natural Resource Trustees

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Cardno ENTRIX Project Team