Do retreating marshes create seagrass habitat?

The importance of sand, plant morphology, and hydrodynamics

E. Caroline Wicks¹ and Evamaria Koch²
November 7, 2007
Estuarine Research Federation Conference

¹ EcoCheck (NOAA-UMCES Partnership)
Cooperative Oxford Lab, Oxford, Maryland
² University of Maryland Center for Environmental Science
Horn Point Lab, Cambridge, Maryland
Outline of talk

- Introduction
- Characterizing the sediment
- Sediment organic content and sand layer depth laboratory experiments
- Conclusions
The ramifications of sea level rise

- 3-4 mm yr\(^{-1}\) in Maryland
- Shoreline erosion
  - 69% of Maryland’s coastline is eroding (USGS 2003)

- How will this affect seagrasses?
  - Increased salinity intrusion and depth limits
  - Sediment erosion, leading to seagrass loss
  - Whole beds will shift landward
Marsh retreat leads to potential new seagrass habitat

- Mill’s Island, Chincoteague Bay, Maryland
  - Retreating marsh shoreline with an eroding dune
  - Seagrass bed in subtidal area adjacent to retreating marsh
Field site characteristics

- Narrow band of *Zostera marina* along shoreline
- Marsh shoreline retreat
- Sand from eroding dune transported along shore
- A layered sediment environment for seagrasses
Site characteristics

• 80 cm depth contour through seagrass bed
• 15 points along transect
• Seagrass
  – Density
  – Biomass
  – Leaf and root length
• Sediment
  – Organic content
  – Sand layer depth
Possible threshold response

- Seagrass density decreased with increasing sediment organic content
Possible threshold response

- Seagrass density increased as sand layer depth increased

\[ y = -3.90x^2 + 93.66x + 44.99 \]

\[ r^2 = 0.88 \]
Laboratory experiment – organic content

• 5 treatments
• 3 replicates each
• Same water column
• 4 seedlings per compartment
• 8 weeks
• Quantify biomass and length

<table>
<thead>
<tr>
<th>Treatment (% organic content)</th>
<th>Sediment Source 1</th>
<th>Sediment Source 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 ± 0.0</td>
<td>Beach dune sand</td>
<td>—</td>
</tr>
<tr>
<td>0.5 ± 0.0</td>
<td>Marsh dune sand</td>
<td>Old marsh peat</td>
</tr>
<tr>
<td>1.2 ± 0.0</td>
<td>Marsh dune sand</td>
<td>Old marsh peat</td>
</tr>
<tr>
<td>4.4 ± 0.2</td>
<td>Old marsh peat</td>
<td>—</td>
</tr>
<tr>
<td>5.9 ± 0.0</td>
<td>Old marsh peat</td>
<td>Marsh sediment&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup> Marsh sediment obtained from Horn Point Marsh, Cambridge, Maryland. Sediment was a mixture of decomposed marsh vegetation and soil.
Seagrass biomass is significantly different between treatments

- One way ANOVA, \( p < 0.05 \)
- Pairwise comparison using Least Squares Method
Laboratory experiment – sand layer depth

- 5 treatments
- 3 replicates of each, 6 replicates of 0 SLD
- 3 seedlings per core
- 8 weeks
- Quantify biomass and length
Sand layer depth determines root length

- Average aboveground biomass
- Average belowground biomass

- Average leaf length
- Average root length

- Maximum root length

R² = 0.71

R² = 0.83
Piecing field and lab results together

- **Field**
  - Seagrasses decrease as organic content increases
  - Seagrasses increase with increasing SLD

- **Laboratory**
  - Seagrasses increase as organic content increase
  - Seagrass root length increases as SLD increases
Plant morphology may explain conflicting results

- Sediment organic content
  - Mesocosm experiment shows the sediment organic content adjacent to retreating marshes is not limiting seagrass distribution or growth parameters
  - Field results suggest the opposite trend
  - Is plant morphology a factor?
Plant morphology may explain conflicting results

- Sediment organic content
  - Mesocosm experiment shows the sediment organic content adjacent to retreating marshes is not limiting seagrass distribution or growth parameters
  - Field results suggest the opposite trend
  - Is plant morphology a factor?
Plant morphology may explain conflicting results

- Sediment organic content
  - Mesocosm experiment shows the sediment organic content adjacent to retreating marshes is not limiting seagrass distribution or growth parameters
  - Field results suggest the opposite trend
  - Is plant morphology a factor?

![Graph showing the relationship between sediment organic content and seagrass morphology](image)

$r^2 = 0.76$
BUT...does wave energy also play a role?
Retreating marshes create seagrass habitat, but local conditions determine distribution.

Sea level rise:

Local conditions may determine if seagrasses will migrate landward.
Thank you!

Committee
Dr. Evamaria Koch
Dr. Bill Dennison
Dr. Court Stevenson

Field and Lab Help
Bill Severn
Ralph Kimes
Gordy Dawson
Jack Seabrease