Salt marsh vegetation losses on Cape Cod

Stephen Smith, PhD
Cape Cod National Seashore
stephen_m_smith@nps.gov
Non-herbivory-related (bottom-up) salt marsh vegetation losses on Cape Cod

Middle Meadow (Wellfleet)

-20 acres, -48%

This is the effect of SLR (MHW rose 11 cm during this period)
Low marsh losses at seaward edges
Hatches Harbor

Predictions

HM, - 96%,
LM, 13%
NM, 0%

HM, - 100%,
LM, -12%
NM, 23%

2013  +50 cm  +100 cm

West End

HM, - 93%,
LM, 8%
NM, 2%

HM, - 100%,
LM, -22%
NM, 30%

2013  +50 cm  +100 cm
Top-down salt marsh vegetation losses on Cape Cod

- first reported in 2002 along Cape Cod’s south shore and in 2003 in Cape Cod National Seashore
- initially termed “sudden wetland dieback” – thought to have happened recently (2002) and more or less “all at once”
- subject of 3 conferences (2005-2007) and a great deal of media attention
Low marsh (*Spartina alterniflora*) dieback

Photo by E. Lilley (Harwich)
The culprit: *Sesarma reticulatum* (purple marsh crab/squareback crab/wharf crab)

- native; nocturnal, herbivorous
- previously thought to be relatively rare in Southern New England
Vegetation losses in the low marsh:

- frequently along creekbanks but can be throughout extent of low zone; patchy
- no standing dead phase (i.e., no brownmarsh)
- shredded, tattered leaves and stems
- severed stems in wrack lines
Experiments: Christine Holdredge & Mark Bertness (Brown University)
Bertness et al.: crab densities are very high on Cape Cod – WHY?

Cape Cod (dieback)

~95% survivorship

Rhode Island (no dieback)

~10-30% survivorship

* crabs not getting preyed upon in Cape Cod
Conceptual Model of *Sesarma*-driven dieoff:

- *Sesarma* populations have greatly increased over the last several decades due to the loss of a predator(s) and/or expansion of *Sesarma* range northward faster than predators (e.g., blue crabs)
Herbivory occurs in the high as well (*S. patens*) - *Sesarma* grazing exacerbates stress due to sea level rise.
Herbivory occurs in the high as well (*S. patens*)

Symptoms of herbivory
- *Sesarma* grazing exacerbates stress due to sea level rise.

Plant demise is consistently along the seaward edge, suggesting a link with hydrology (sea level).
Interaction between hydrology and grazing?

- naturally growing *S. patens* along dieback edges and in the healthy high marsh was clipped (to simulate grazing) and then caged; 10 reps per treatment per site

% plots with re-sprouts on Sep 11 (all sites)

- seaward edge: 37%
- upslope from edge: 100%

- plants along the seaward “dieback” edge have a reduced ability to re-sprout if grazed

Consequences of vegetation losses......
- Subsidence, erosion, carbon loss and release
Major topographic changes following herbivory-driven dieoff
The Gut (Wellfleet) – effects of sea level rise + herbivory
Cascading effects of vegetation losses
Colonization/utilization of dieoff areas by fiddler crabs (*Uca pugnax*).

**SSH**=simulated Sesarma herbivory (clipped)

**VR**=vegetation and topsoil removed, replaced with DB soil

**DB**=dieback area (no veg)

**V**=vegetated

Effects of fiddler crabs on the germination of halophyte seeds (bioturbation effects)

### Table

<table>
<thead>
<tr>
<th>Seed germination</th>
<th>Uca</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. alterniflora</em> (initial no. seedlings = 0)</td>
<td>1.8 (±1.3)</td>
<td>7.0 (±1)</td>
</tr>
<tr>
<td><em>Suaeda</em> (initial no. seedlings = 0)</td>
<td>2.3 (±1.2)</td>
<td>26.0 (±1.5)</td>
</tr>
<tr>
<td>Pre-established seedlings</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>S. alterniflora</em> (initial no. seedlings = 6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Suaeda</em> (mean initial no. seedlings = 7, ranging between 4 and 13)</td>
<td>-94.4% (±5.6%)</td>
<td>0% (±0%)</td>
</tr>
<tr>
<td></td>
<td>-78.7% (±13.9%)</td>
<td>37.6% (±40.1%)</td>
</tr>
</tbody>
</table>

**Smith, S.M.** and M.C. Tyrrell. 2012. Effects of mud fiddler crabs (*Uca pugnax*) on the recruitment of halophyte seedlings in salt marsh dieback areas of Cape Cod (Massachusetts, USA). Ecological Research 27: 233–237

Effects of fiddler crabs on sediment erosion and elevation loss

Soil elevation loss from cages with fiddler crabs vs. controls (no crabs)

Provides more “creekbank” habitat for *Sesarma* than what would otherwise be available.
Species composition changes are NOT really recovery

- Cessation of herbivory mostly caused by decline in suitable substrate (and food)


- Population of blue crabs (predator of Sesarma) a factor as well

- Being at the northern extent of their range, populations likely go through substantial fluctuations depending on winter conditions (?)
Thank you!