Carbon capture and storage in seagrass meadows

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Blue Carbon: carbon captured and sequestered in coastal wetlands - mangroves, salt marshes, seagrass meadows

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Mcleod et al. 2011
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Table 1 | Summary of collected data on seagrass biomass and soil properties from the global data set.

| Soil C<sub>org</sub> (percentage of dry weight) | 2.535 | 0-48.2 | 1.8 | 2.5 ± 0.1 |

Fourquarean et al. 2012
What influences carbon stocks and accumulation rates in seagrass meadows?

- Plant species (\textit{Z. marina} dominant in U.S. waters, \textit{T. testudina} along Gulf coast)
- Plant density and morphology
- Nutrient availability
- Meadow size, patchiness
- Wave exposure (daily and seasonal/annual patterns)
- Substrate type (grain size)
- Other factors?
Methods

- 10 sites, range of exposure and N supply

- Sediment cores in eelgrass and reference areas (30 cm deep, n=3). C, N, stable isotopes, grain size, bulk density, core age ($^{210}$Pb)

- Eelgrass morphology, shoot density, and growth rates, C, N, stable isotopes
Results: 1. Eelgrass sediments store more carbon than reference sediments
   2. High variability in storage amount (order of magnitude across all sites)
How much carbon is that?

- Using 1990s estimates of eelgrass acreage in Massachusetts
- Average bulk density and %C data from our cores (only 30cm deep)

- 14,000+ hectares storing 276,703,000 Kg C
- Equates to the C produced from burning 128,697,554 gallons of gas
- 6,434,877,693 Prius miles (drive to Pluto)
- $12,200,486 (social cost of carbon of $40/ton)

New Horizons image courtesy NASA
**Results:** Stable isotopes suggest much of sediment carbon is from non-eelgrass sources.
Results: Different sites have very different sediment and carbon accumulation rates ($^{210}$Pb dating)

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<tr>
<th>Site</th>
<th>Sediment Accumulation Rate (g/cm²·yr⁻¹)</th>
<th>Carbon Accumulation Rate (g/m²·yr⁻¹)</th>
<th>Core age (yrs)</th>
</tr>
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<tr>
<td>Great Bay</td>
<td>1.0</td>
<td>198</td>
<td>20</td>
</tr>
<tr>
<td>Gloucester</td>
<td>0.12</td>
<td>16.5</td>
<td>100+</td>
</tr>
<tr>
<td>Cohasset</td>
<td>0.2</td>
<td>12</td>
<td>100</td>
</tr>
<tr>
<td>Orleans</td>
<td>0.3/0.16*</td>
<td>10.8/3.2*</td>
<td>80</td>
</tr>
<tr>
<td>Ninigret Pond</td>
<td>0.35</td>
<td>120</td>
<td>40</td>
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*something happened in the late 1960s and the sedimentation rate apparently doubled in Pleasant Bay.*
Other studies have measured spatial variation within meadows (e.g., Oreska et al. 2017) -

**Results:**

1. Carbon storage increases with distance from edge of a large meadow

2. Restored meadows accumulate similar stocks of organic carbon in sediments

Oreska et al. 2017, PLoS ONE
Seagrass carbon: current understanding

- Seagrass meadows are very effective at capturing and storing carbon
- Much of the stored carbon originates from sources other than the plants themselves (marine or terrestrial)
- Restored meadows are also effective at storing carbon
- Carbon accumulation rates vary within and between meadows
- Larger or more contiguous meadows probably store more C than small, patchy ones
Seagrass carbon: data gaps and information needs

Current status:
• Extent of habitat – less than 60% of seagrass meadows in U.S. waters are mapped
• Fate of seagrass production – if sediment carbon is from external sources, where is the grass going (wrack line or transport to deep sea = long term storage?)
• Carbon emissions from meadows (CH₄, CO₂) – very little known

Future changes:
• Changes in water quality, physical disturbance, land use change
• Climate change – range shifts with warming waters?
• Ocean acidification may stimulate seagrass growth
• Sea level rise – opportunities for migration
MANY, MANY THANKS TO:

- Fred Short, Eric Nelson, Dan Arsenault, Jean Brochi, Chuck Protzmann, Tim Bridges, Holly Plaisted, Agnes Mittermayr, Jill Carr, Kate Ostrikas, Tay Evans, Jack Buckley, Dani Ewart, Dave Grunden, Hanna Mogensen, Juliette Williams, Lindsay Peter, Mark Rousseau, Mike Sacarny, Audrey Michniak, Regina Lyons, Molly Sullivan, Ivy Mlsna, Kathryn Baltes, Bill Osbahr, Don Cobb, John Deane, Briana McDowell, Scott Nesbit