Spatial Variability in Coastal Saltmarsh Resilience to Sea-Level Rise Near Westport and Slocum Rivers, Massachusetts

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Introduction

- Wetlands, such as saltmarshes, provide storage for carbon; protection against flooding and wave action; and support a diverse array of ecological communities.
- Saltmarsh response to sea-level rise can be site specific and thus widely unconstrained.
- Saltmarshes can vertically accrete through sediment deposition and the addition of organic matter.

Driving Questions

- How are saltmarshes responding to sea-level rise?
- How can past marsh accretion rates guide future management strategies?

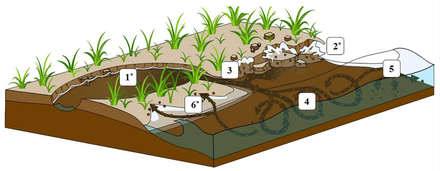

Figure 1. Diagram displaying sediment and wave transport influencing marsh stability. Pond and scarp erosion (boxes 1 and 2) contribute to the release of gases and overall erosion of the marsh. Boxes 3-6 indicate how sediment is transported to a marsh, adding vertical accretion to the wetland. From: McTigue et al., 2021, *Frontiers in Marine Science*

Methods

- Collected twelve, 25-cm diameter cores across four study sites near the mouth of the Westport River, MA
- Analyzed downcore activity of ^{137}Cs and ^{210}Pb, soil bulk density and loss-on-ignition (LOI)
- Calculated multi-decadal accretion rates using a constant flux with constant sedimentation (CFCS) model

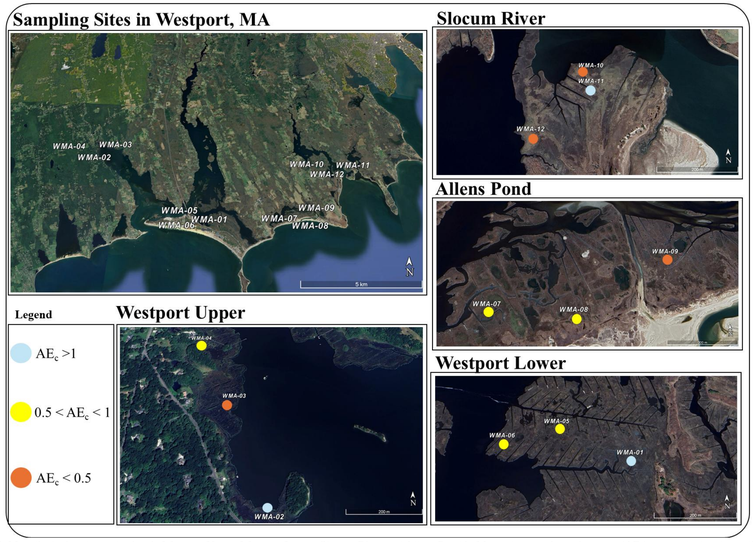

Figure 2. Map displaying the study sites in Westport Upper, Westport Lower, Slocum River and Allens Pond in Massachusetts. Accretion rates (AE_c) were calculated as a dimensionless assessment of the resilience of the marsh. An AE_c value greater than 1 suggests the marsh is accreting faster than sea-level rise. An AE_c value between 0.5 and 1 indicate the marsh is barely keeping up with sea-level rise or is slowly drowning. AE_c rates below 0.5 indicate that the marsh is drowning.

Key Takeaways

- Saltmarshes are barely keeping up with sea-level rise, and some rates are leading toward the marsh drowning, in Westport, Massachusetts.
- Accelerating sea-level rise is threatening these saltmarshes, leading to a loss of a crucial carbon storage system, flooding protection and a biodiverse habitat.
- Evidence of a sedimentation event likely associated with the New England Blizzard of 1978 indicates that significant sediment can be delivered to the marsh surface during storm events, illustrating how storms can aid in long-term marsh resiliency.

Results

- Accretion rates range from 1.21 to 3.54 mm yr^{-1} with corresponding AE_c values: 0.41-1.20.
- Average ^{210}Pb accretion rate: 2.12 mm yr^{-1}.
- Median full downcore soil bulk density: 0.27 g cm^{-3} and median full downcore LOI: 38.8%.
- Pattern (circled in Fig. 3) of low LOI and peak bulk density ~2cm section is indicative of a mineral-rich layer that is observed in almost all cores. This suggests a regional-scale deposition event, possibly associated with the New England Blizzard of 1978.
- Marsh resilience does not appear to be related to elevation as indicated by R^2=0.056 (Fig. 4). Lack of correlation may be attributed to the small range of elevation across the sampled marshes.

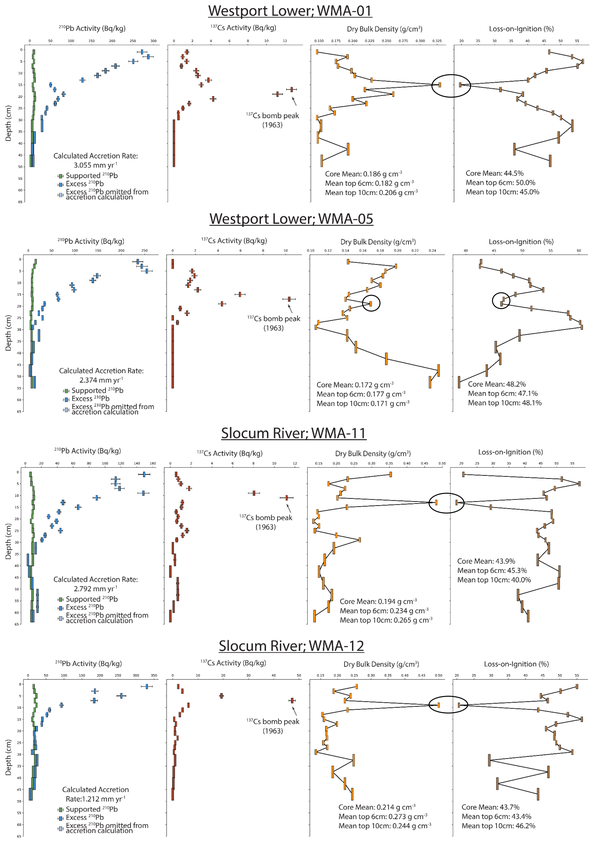

Figure 3. Example downcore analysis of ^{210}Pb activity, ^{137}Cs activity, loss-on-ignition (LOI) and dry bulk density on each core taken at the lower sections of the Westport River and the Slocum River. Accretion rates were calculated based on a CFCS model.

Discussion

- High LOI data contrasted with low bulk density values suggest these marshes primarily grow vertically through organic-matter production.
- 75% of the cores have AE_c values lower than 1, suggesting that most of the marshes are barely keeping up with sea-level rise.

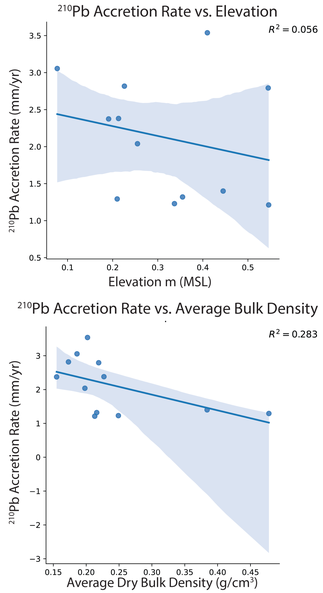

Figure 4. Linear regressions of ^{210}Pb accretion rate with elevation (top) and average bulk density (bottom). Average bulk density was calculated using the depths included for the accretion rate. Elevation of the sampled marshes does not significantly impact the respective accretion rate. There is a weak but not significant correlation between accretion rate and average bulk density.

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