NSERC RESNET

CARBON STORAGE IN TIDAL MARSH SEDIMENTS IN THE BAY OF FUNDY

THE ROLES OF VEGETATION AND DEPTH

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BACKGROUND

Globally, tidal marshes have declined due to environmental damage in the form of dredging, dyking, drainage, invasive species and habitat conversion. Locally, these factors have already affected approximately 80% of the salt marshes in the Bay of Fundy and 50% of the salt marshes in Nova Scotia (NS). Tidal marshes have the ability to sequester and store atmospheric CO2 and thus contribute a valuable ecosystem service. The carbon stored in a coastal ecosystem's plant material and sediment is collectively referred to as 'blue carbon.' However, little is known about carbon storage differences between restored and natural marshes or the factors that influence carbon storage in these systems.

RESEARCH

This research compared below-ground carbon stocks in three tidal marshes: new restoration, old restoration, and natural reference. The new restoration occurred in 2018 when part of the Belcher dykeland, in New Minas, NS, was restored to tidal marshes. The old restoration site was along the Cogmagun River, NS, where tidal marsh was restored on former dykeland in 2009. The natural reference site was also found near Cogmagun.

This research expanded our knowledge of how carbon is stored across restored and natural tidal marshes over time to determine Smooth Cordgrass (*Spartina alterniflora*):

- if below-ground carbon stocks differed among vegetated and unvegetated areas;
- if organic carbon content varied by depth;
- if organic carbon content varied between restored and natural sites.

Carbon content was sampled using a Russian peat corer at three locations in *S. alterniflora* vegetation at each marsh. Two sediment cores were taken at each sampling location, one from an area with live plants and one from bare mud, and each core was subdivided into three depths: surface (<3cm), rhizosphere (3cm-30cm) and below-rhizosphere (<30cm). Statistical analysis showed that depth and vegetation did not significantly affect organic carbon density. There were some site differences: the Belcher Street site (new restoration site) had the lowest carbon density at an average of 0.020 g/cm3; the highest was Cogmagun (old restoration site) with 0.025 g/cm3 and the Cogmagun reference site in between at 0.023 g/cm3.

Figure 1. An example of a core taken in the field. All cores were photographed in the field before being wrapped for transportation back to the lab.

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RESULTS

Our study compared below-ground carbon stocks in three tidal marshes (new restoration, old restoration, natural reference) and found that the older restoration and natural sites contained more buried carbon per unit volume than the new restoration site. Vegetation and depth did not seemingly influence long-term carbon storage in tidal marshes. However, it should be pointed out that although unvegetated sampling areas had no plants aboveground, many of the sediment samples from those locations did contain roots, so further research is needed to determine the effect of plant roots on carbon content.

This study focused on the low marsh zone where vegetation can be sparse, and there is only one dominant species of plant (Smooth Cordgrass). The lack of effects of the depth at which sediment samples were taken on carbon content indicates that sediments above, in, and below the root zone generally have similar amounts of carbon. This may suggest that the carbon source at those sites in the low marsh zone is mainly sediment that has been deposited from tidal waters rather than carbon contributed by root growth and microorganisms. If this is the case, then it suggests that the primary determinant of carbon density in the low marsh zone may be the carbon content of the sediments in the water deposited. While plants are crucially important in reducing erosion and keeping sediments in place in the low marsh zone, it is possible that the plants that grow there do not add much to the overall carbon storage in this part of the marsh. Higher elevations contain different plant communities and are flooded less frequently. Hence, less sediment input from tidal water is likely a more critical role of plants in adding to the carbon stored in those zones. Ongoing studies examine variation in carbon density at a greater range of sites and across the vegetation zones found in tidal marshes.

Calculating carbon density is the first step toward measuring the amount of carbon currently stored in salt marshes (carbon stocks) and the storage rate (carbon accumulation rate). The amount of carbon stored in each wetland will depend on carbon density and the total volume of sediment. Our group is currently working on methods to calculate the depths of Bay of Fundy salt marshes so that we can calculate volumes and better estimate carbon storage.

APPLICATION & CONCLUSION

This research is vital in addressing one of the most recent 'pushes' within tidal marsh and coastal research: understanding blue carbon. Its finding on carbon sequestration will pair well with other research within ResNet in understanding carbon sequestration from a wider selection of sites, what it means within a tidal context, and what factors influence this process.

Further studies should explore the role of sedimentation and how climate change may influence or change carbon storage rates in these systems. Expansion of our methods to the other tidal marsh zones, in addition to increased samples, within future studies may be useful for a complete assessment of carbon stocks within a tidal marsh for comparison across other sites.

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