Learning how salt marsh plants may signal carbon capture capacity

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Aiden Barry '19 (CAHNR), lead author of the study, in a drowning salt marsh on the Connecticut coast. Credit: University of Connecticut

Coastal wetlands like seagrass meadows, mangroves, and salt marshes play vital roles along the shoreline, from providing a buffer against storm surges, to providing critical habitat for animals, to capturing atmospheric carbon.

We are still just beginning to comprehend the intricate workings of these highly productive ecosystems and their role in mitigating the climate crisis, but UConn researchers are one step closer to understanding how salt marsh vegetation, their bacterial communities, and vegetation can help predict a marsh's potential to be a blue carbon reservoir. The research was recently published in the journal *Estuaries and Coasts*.

"Coastal marshes are increasingly recognized as important ecosystems because they sequester and store a lot of carbon. There is increasing interest in understanding these blue carbon ecosystems because of our current climate crisis," says Beth Lawrence, co-author and College of Agriculture, Health, and Natural Resources Assistant Professor of Wetland and Plant Ecology in the Department of Natural Resources and the Environment and Center for Environmental Science and Engineering.

Lawrence explains how salt marshes serve as focal ecosystems in conservation and restoration. They are habitat for a wide range of species, including endangered species like the salt marsh sparrow. Located at the interface between land and sea, these ecosystems buffer storm energy and perform other important functions, like the removal of excess nitrogen from water making its way to estuaries where it may otherwise lead to algal blooms and oxygen-deprived "dead zones."

Development leads to changes in the movement of water (see side bar) and Lawrence says that, often, tide-restricted salt marshes become less salty and wet, leading to shifts in what plants grow there. Plants that thrive in these brackish conditions can be invasive, like Phragmites australis, which has become the bane of coastal managers, Lawrence says.

Tidal restoration aims to reconnect marshes cut off from the ocean to improve habitat. Increasing the size of culverts underneath roads, railroads or bridges or removing tide gates can restore tidal flow and the organisms that rely on it.

To observe how tidal restoration may alter carbon cycling and soil microbes, the researchers sampled from several marsh locations in Connecticut, including less-disturbed "reference" marshes, and formerly restricted marshes that have since undergone restoration.

"Tidally restored and the unrestored references differed in carbon density and how much carbon is in the soil. Highly restricted sites presumably had dried out to some degree and lost some carbon," says Lawrence.

This makes sense, Lawrence says, because in wetter soils, microbes do not break down carbon-rich plant material as efficiently as in dry soil, therefore the material and the carbon within it remains. When microbes can feast away on the plant matter in drier, more oxygenated conditions, the carbon is lost to the atmosphere in the form of carbon gas, in a process called mineralization.

Other measurements between tidally restored and undisturbed marshes were the same across the suite of parameters used in the researchers' measurements, including soil chemistry, plant biomass, and microbial communities. However, there were large differences across vegetation zones.

"The key difference we saw were across plant communities," Lawrence says. "We saw differences in microbial respiration as well as the microbial communities living in the soils in different vegetation zones. These findings suggest that both plants and microbes are responding to differences in environmental conditions."

With the knowledge of which plants thrive where, the researchers can get a glimpse into the biological processes at play within the marsh by noting which plants are present.

"I think one of the key takeaways from our study is that these bands of vegetation are good indicators of what's going on hydrologically and biogeochemically," says Lawrence. "For example, if we see native Spartina alterniflora growing, we know the environment is saltier than where Phragmites is growing. These soils are likely to have different bacterial community composition and process carbon and nitrogen differently than in a higher, drier community."

Considering the importance of salt marshes and the need for further restoration work, Lawrence says managers could use satellite imagery or drones to look at the vegetation at greater spatial scales to get an indication of growing conditions as well as a system's carbon capture capacity. This could help in focusing restoration efforts and monitoring.

"Managers are really interested in scaling up," Lawrence says. "Quantifying carbon and nutrient cycling is very time-consuming and detailed so an important implication of this work is that the dominant vegetation in salt marshes can be used as a proxy for some biogeochemical processes. We have to carefully consider how we're spending our limited conservation dollars."

The Cost of Not Going with the Flow

With efforts in the early part of the 20th century to eradicate salt marshes following fears of mosquito-borne diseases, restoration efforts have been underway in the past several decades to re-establish these vital communities. Lawrence points out that here in Connecticut, high-density development disrupts the landscape right up to the coast, including salt marshes.

"We have lots of people living near coasts with roads, bridges, and railroads that often transect our salt marshes. When that happens, you're changing the hydrology because oftentimes, what they do is they'll put a little pipe underneath the road or railroad so that water can go underneath but that restricts the tide. We go from a big stream that conveys water down to a little pipe underneath the road that changes the frequency of inundation and dampens the tidal range."

More information: A. Barry et al, Vegetation Zonation Predicts Soil Carbon Mineralization and Microbial Communities in Southern New England Salt Marshes, *Estuaries and Coasts* (2021). DOI: 10.1007/s12237-021-00943-0

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