Briefing Note

North America's Blue Carbon

Salt marshes, tidal wetlands, seagrasses and mangroves are distributed around North America. They cover less than 0.05% of North America's coastal area but account for between 50% and 70% of all carbon stored in tidal and ocean sediments.[3]

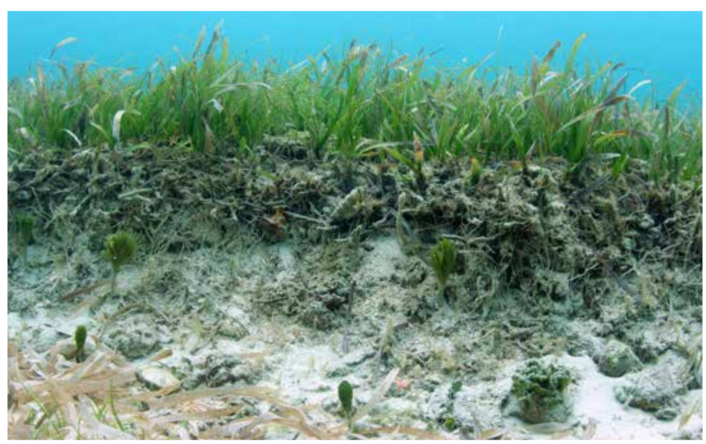
Over the past five years, scientists and policy-makers have increasingly focused on the impressive ability of coastal marine ecosystems to sequester, store and, when disturbed, even emit carbon.[1] In 2009, coastal ecosystem carbon—the carbon captured and stored in salt marshes, tidal wetlands, seagrasses and mangroves—was first grouped under the term "blue carbon" in a United Nations Environment Programme (UNEP) report.[2]

It is now recognized that these "blue carbon ecosystems" provide a great service in combatting climate change by capturing and storing carbon. The degradation and loss of these ecosystems, however, result in a double impact: not only is their capacity to capture carbon from the atmosphere lost, but their stored carbon is also released, contributing to increasing levels of greenhouse gases in the atmosphere and the acidification of coastal waters.

When these ecosystems are properly protected or restored, they play an important role in climate change mitigation and provide one of the Earth's few natural mechanisms for counteracting ocean acidification. Other key benefits of coastal protection and restoration include food security, buffering coastal zones from storms, and supporting fish and wildlife populations.

Carbon Accumulation

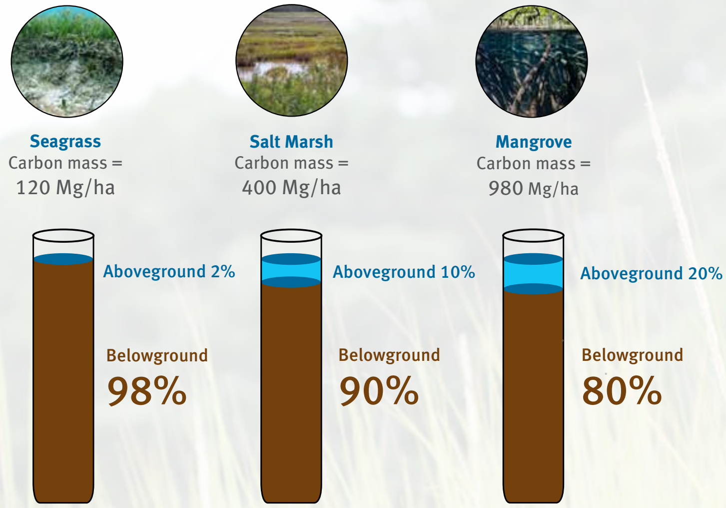
Blue carbon ecosystems accumulate carbon in multiple ways. First, carbon is sequestered and stored in plant biomass. This includes aboveground (branches and leaves), belowground (roots) and non-living (dead wood) biomass. The amount of carbon stored in biomass can range from relatively high in mangrove forests to relatively low in seagrass meadows.[4] Second, carbon is stored in the sediments (soil) underlying coastal ecosystems. For most blue carbon ecosystems, carbon storage in sediments far exceeds storage in biomass. In the case of salt marshes and tidal wetlands, carbon is stored in the sediments that continuously gather and settle as freshwater travels into marshes and wetlands and experiences a drop in velocity.[5] This allows marshes to trap carbon from large drainage areas and accrete in sediments vertically over time, keeping pace with sea-level rise up to a point. The anaerobic nature (lack of oxygen) of these sediments enables the burial of carbon for thousands of years (e.g., 3,000-8,000 years).[6] Lastly, seagrasses are a unique ecosystem in that they are a completely submerged community composed of underwater flowering plants. Seagrasses occur in coastal areas with low wave energy and they provide important habitat for a variety of marine species. Seagrass systems have low aboveground biomass and associated carbon when compared to other coastal ecosystems.



Belowground, however, seagrasses have immense root structures that accrete carbon vertically as sediments build up around them: thus the roots and sediment that develop beneath seagrass meadows can store large quantities of sequestered carbon.[7] Seagrasses also promote sedimentation by slowing water currents and stabilizing the seabed through the growth of their roots and rhizomes.

1. Laffoley and Grimsditch 2009; Nellemann *et al.* 2009
2. UNEP 2009
3. CEC 2013
4. CEC 2013; Fourqurean *et al.* 2012
5. CEC 2013
6. Duarte *et al.* 2005
7. CEC 2013

- Blue carbon is the carbon captured and stored in salt marshes, tidal wetlands, seagrasses and mangroves.
- Compared with mature tropical forests, current studies suggest that blue carbon ecosystems annually sequester carbon at a rate two to four times greater than mature tropical forests and store three to five times more carbon per equivalent area.
- When degraded or lost, these ecosystems not only lose their ability to capture and store carbon, but also release their stored carbon—sometimes up to 8,000 years' worth—back into the atmosphere.



Blue Carbon Ecosystems versus Forest Ecosystems

Current studies suggest that blue carbon ecosystems annually sequester carbon at a rate two to four times greater than mature tropical forests and store three to five times more carbon per equivalent area. Furthermore, blue carbon ecosystems, on average, store carbon for thousands of years, compared with forests that only store carbon for up to hundreds of years.[8]

Threats

Key drivers of blue carbon ecosystem loss include coastal development, pollution, oil spills, erosion, extreme weather events, and conversion to aquaculture (e.g., fish and shellfish farms).[9] If these ecosystems are degraded or converted to another use—i.e., if mangroves are deforested, salt marshes are drained, or seagrass beds are dredged—the carbon stored in the sediments can be oxidized and released, causing large emissions to the atmosphere of carbon dioxide and other greenhouse gases, as well as loss of biodiversity and other services.[10] We know that the greenhouse gas emissions due to the removal or conversion of mangroves are very high, accounting for nearly one-fifth of emissions from global deforestation.[11]

Roads and other coastal infrastructure can create another problem. When salt marshes and tidal wetlands accrete vertically to account for sea-level change, they sometimes expand inward, away from the shoreline, effectively enlarging the coastline. Building roads and other developments within these ecosystems can cause a "coastal squeeze"—limiting the inward expansion of these ecosystems.

New Directions for Blue Carbon

There are now hundreds of blue carbon projects underway across North America. These are advancing our understanding and management of blue carbon ecosystems and encouraging us to include these ecosystems in the protocols for national and regional carbon accounting. Reporting standards have already been developed by the Intergovernmental Panel on Climate Change (IPCC) for some blue carbon ecosystems in the 2013 Supplement to the 2006 *IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands*.[12] A new, comprehensive set of methods to assess and measure blue carbon emission factors has also been developed by the Blue Carbon Initiative.[13]

Carbon markets globally are beginning to incorporate blue carbon projects into carbon credit schemes. The Verified Carbon Standard (VCS), the world's leading voluntary greenhouse gas program, included its first Wetlands Restoration and Conservation project for carbon credits in 2013.[14] More projects like this will hopefully follow.

The CEC and Blue Carbon

The Commission for Environmental Cooperation (CEC) began a two-year project in 2013, *North America's Blue Carbon: Assessing the Role of Coastal Habitats in the Continent's Carbon Budget*, to improve blue carbon data, mapping, and approaches to reduce emissions and protect current blue carbon sequestration and storage across the continent. The project is also facilitating a North American community of practice through workshops, meetings and the exchange of information. Project activities include compiling and developing coastal blue carbon maps; establishing criteria for a greenhouse gas offset methodology for tidal wetland conservation; and supporting five research projects in the three countries that will improve estimates of carbon storage, sequestration and flux/emissions, including impacts of natural and human-caused disturbances and restoration of carbon processes.

8. G. Chmura pers. comm.; Chmura *et al.* 2003
9. UNEP 2014; CEC 2013
10. CEC 2013
11. Howard *et al.* 2014
12. IPCC 2013
13. IPCC 2013; Howard *et al.* 2014
14. VCS 2012

To date, work done under the CEC project includes these initiatives:

1. ***Community of Practice***: The first North American blue carbon experts' workshop held to develop guidance on the status and needs for North American blue carbon science, policy and mapping work.

2. ***Mapping***: The compilation of over 50 blue carbon-related maps. Preliminary distribution data indicate that there are more than 79,606 km^2 of blue carbon habitat in North America, with the largest portion in the US: more than 49,630 km^2. In all three countries, seagrass area is the largest proportion.

3. ***Voluntary Carbon Markets***: The development of a Greenhouse Gas Offset Methodology Criteria for Tidal Wetland Conservation aimed at a Verified Carbon Standard-compliant set of procedures for a greenhouse gas offset methodology for tidal wetland conservation for North America and other coastal countries.

4. ***Sea-level Rise:*** A study to look at the response of marsh and coastal forest carbon accumulation rates to sea-level rise on the Atlantic and Pacific coasts of Canada and the United States. Preliminary results from a meta-analysis of 112 marshes suggest that carbon accumulation rates in marshes are not strongly limited by sea-level rise, but increased sequestration and storage of carbon by marshes as a result of rising sea levels should not necessarily be expected either.

5. ***Northern Salt Marshes***: Research to estimate carbon sequestration levels in northern salt marshes and the carbon stocks in undisturbed, drained and restored salt marshes. Data from six salt marshes at various stages of disturbance, including degraded (drained), restored and unimpacted, are being analyzed to calibrate two models to estimate marsh-wide carbon stocks. These estimates are providing new data on regional carbon stocks and are improving the understanding of carbon dynamics in degraded, restored and pristine salt marshes.

6. ***Mangroves and salt marshes***: Support for research on the carbon stocks of mangroves and salt marshes in the Pantanos de Centla of southeastern Mexico. In addition to assessing carbon stocks in these ecosystems, this work looks at the differences in carbon storage between coastal fringe and estuarine mangroves. It also looks at the carbon stocks of cattle pastures that were formed on sites previously occupied by mangrove forests, including the potential emissions that could arise from conversion of mangroves to cattle pastures. Preliminary results indicate that these mangrove carbon stocks are exceedingly high compared to the upland forests of Mexico and that significant emissions result from the conversion of mangrove forests to cattle pastures.

7. ***Seagrass***: A study to quantify seagrass carbon stocks across a range of environmental conditions and seagrass bed types to determine the amount of carbon deposited across the Gulf of Mexico. This work compares always-barren sites, polluted-barren sites, naturally-occurring seagrass beds, and restored seagrass beds to determine differences in carbon sequestration rates. It also looks at different seagrass responses in carbon sequestration after the impact of different pollution events (i.e., release of hot effluent, dredging and fill, sewage dumping, oil spills). Initial results show that restored seagrass sites are comparable to natural seagrass beds in the amounts of carbon sequestered, and that organic matter accretion occurs rapidly within two years' time after site recovery or restoration.

8. ***Salt Marshes***: Research on the spatial variability of carbon storage within and across marshes of the National Estuarine Research Reserve System (NERRS) across the United States. This research is quantifying the percent of soil organic matter, carbon content, and soil bulk density at a subset of eight NERRS sites (in Maine, Delaware, South Carolina, Florida, Mississippi, California, Wisconsin, and Ohio) to fill critical research gaps in estimates of the current carbon storage in the upper 20 cm of the soil across a range of marsh types that differ in geomorphic setting, dominant vegetation, and salinity. Preliminary results are due in late 2014.

Results from the above work are improving our understanding of the current and future role of coastal ecosystems in the North American carbon cycle. They are also stimulating improved management of these systems by identifying the best available approaches to reduce emissions and/or protect current carbon storage and sequestration to achieve climate change mitigation objectives in all three countries.

For more information about the CEC's project, please contact:

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About the CEC

The Commission for Environmental Cooperation (CEC) is an intergovernmental organization that supports the cooperative environmental agenda of Canada, Mexico and the United States to green North America's economy, address climate change by promoting a low-carbon economy, and protect its environment and the health of its citizens. The CEC is composed of three bodies: a Council, representing the governments of the three member countries, a Joint Public Advisory Committee (JPAC) that advises the Council and serves as a liaison with the public, and a Secretariat that supports the Council and JPAC and prepares independent reports. The CEC brings together governments, civil society, and businesses to develop innovative North American solutions to global environmental challenges. Find out more at: www.cec.org.

CEC initiatives are undertaken with the financial support of the Government of Canada, through the federal Department of the Environment, the Government of the United States of America, through the Environmental Protection Agency, and the Government of the United States of Mexico, through the Secretaría de Medio Ambiente y Recursos Naturales.