BLUE CARBON

NATURAL CARBON SEQUESTRATION THROUGH COASTAL ECOSYSTEMS

Blue carbon is a climate mitigation solution that leverages the natural carbon capture and storage potential of coastal ecosystems, such as salt marshes, mangroves, and seagrass beds. These ecosystems serve as critical habitat for a wide range of coastal and marine organisms, including economically important commercial fisheries, and can help stabilize shorelines and protect coastal communities from storm damage. In addition to these vital ecosystem services and resiliency functions, blue carbon represents an important opportunity for carbon sequestration because these systems naturally capture carbon dioxide from the atmosphere and store it in underlying marine sediments. Processes within these systems can also release alkalinity into the ocean, which can capture and sequester atmospheric carbon dioxide for thousands of years, further enhancing the carbon removal potential of blue carbon.

BLUE CARBON ECOSYSTEMS UNDER THREAT

Despite the climate mitigation potential of blue carbon ecosystems, they are incredibly vulnerable to climate change itself – through rising sea levels and pollution – as well as human development along coastal areas. Nearly 67 percent of mangroves, 35 percent of tidal marshes, and 29 percent of seagrass meadows have already been destroyed, and it is estimated that upwards of 2.4 million acres of blue carbon ecosystems are lost each year – potentially releasing up to a billion tons of carbon dioxide into the atmosphere. Protecting, restoring, and enhancing these ecosystems represents a significant natural carbon sequestration solution, which can also provide substantial co-benefits, including enhanced productivity of fisheries, local mitigation of ocean acidification, pollutant removal, and storm protection.

YCNCC BLUE CARBON PROJECT

The Yale Center for Natural Carbon Capture (YCNCC) is working to advance the understanding of the carbon sequestration potential of blue carbon ecosystems, with the goal of supporting and informing efforts to protect, restore, and enhance these vital systems for their ecological value as well as their climate regulating impacts. YCNCC scientists are working across the globe to study a number of aspects of blue carbon ecosystems.

CARBON REMOVAL POTENTIAL

Despite the productivity of blue carbon ecosystems, research to date into actual carbon sequestration rates has been limited. YCNCC is creating a network of scientists to answer this crucial question. Scientists from around the world are sending peat core samples to be analyzed with a YCNCC-funded miniaturized mass spectrometer called a Mini Carbon Dating System (MICADAS). One of only a few dozen of its type globally, this room-sized instrument uses carbon dating to determine the rate of atmospheric carbon dioxide removal.

ECOSYSTEM CHANGES

YCNCC scientists are also working to understand how the internal dynamics of blue carbon ecosystems impact the capacity for carbon sequestration. In the Everglades, YCNCC scientists are measuring the net exchange of carbon between the atmosphere and the plants, soil, water, and other properties that makeup the ecosystem, focusing on how disturbances, water levels, and salinity impact ecosystem productivity and species composition.

BLUE CARBON MRV

While blue carbon ecosystems can be incredibly productive carbon sinks, they also naturally release other greenhouse gasses (GHGs), a process that may be further exacerbated by pollution and climate change. Understanding this process is critical to developing monitoring, reporting, and verification (MRV) protocols that fully assess the carbon removal potential of blue carbon strategies. In the Everglades and Long Island Sound, YCNCC scientists are partnering with the National Aeronautics and Space Administration (NASA) to study the release of methane gas from blue carbon ecosystems. The goal is to create a framework that can be used to develop full ecosystem carbon budgets for blue carbon, which can support and inform efforts to accurately quantify carbon sequestration claimed from blue carbon restoration and protection strategies.

OCEAN ALKALINITY ENHANCEMENT AND BLUE CARBON

In addition to direct capture of carbon dioxide through photosynthesis, blue carbon ecosystems can also generate alkalinity, which offers additional carbon removal potential. In these systems, microbial reaction in the underlying marine sediments creates alkalinity that is then released into the ocean. Once in the ocean, this alkalinity can lead to the drawdown of additional carbon dioxide from the atmosphere, as well as mitigate ocean acidification near the point of release. This process within blue carbon ecosystems is not well understood, and YNCCC scientists have developed a novel instrument to measure alkalinity fluxes in the field. A provisional patent has been filed for this instrument, and testing is underway at the mouth of the Connecticut River.

WHAT'S NEXT?

By advancing our understanding of blue carbon, its carbon removal potential, and associated co-benefits, YCNCC scientists are helping to inform restoration and protection efforts for these vital ecosystems that can make a meaningful contribution to mitigating the effects of climate change.

ADDITIONAL READING

- National Oceanic and Atmospheric Administration: Coastal Blue Carbon (https://oceanservice.noaa.gov/ecosystems/coastal-blue-carbon/)
- Conservation International: Our Blue Carbon Initiative (https://www.conservation.org/projects/our-blue-carbon-program)
- Nature: Ocean alkalinity enhancement through restoration of blue carbon ecosystems (https://www.nature.com/articles/s41893-023-01128-2)