COASTAL BLUE CARBON AND MAINE

MAINE BLUE CARBON NETWORK

What is blue carbon?

“Blue carbon” is the term for carbon captured by the world’s ocean and coastal ecosystems. “Coastal carbon” is a subset of blue carbon referring to only coastal ecosystems. Atmospheric carbon dioxide (CO2) is drawn into plants and buried in sediments in coastal ecosystems like salt marshes, kelp forests, and seagrass meadows and stored there, sometimes for thousands of years. Maine’s Biennial Report on Progress Toward Greenhouse Gas Reduction Goals includes carbon sequestration estimates for salt marshes, eelgrass, and farmed macroalgae.

Why is coastal blue carbon important to Maine?

Many coastal ecosystems excel at capturing and storing carbon, a critical tool in reaching the Maine state goal of net-zero greenhouse gas emissions by 2045. They also support heritage Maine industries, adaptive economies, resilient habitats, biodiversity, and access to nature.

Maine coastal wetlands are estimated to sequester 70,000 metric tons of CO2 annually, equivalent to the emissions of over 16,000 gas-powered cars[1].

Why should you care?

- **Emerging economies**: Carbon crediting for both farmed and naturally occurring coastal vegetation is becoming increasingly verifiable and presents an opportunity to diversify the blue economy in Maine.
- **Coastal resilience**: With increased frequency of coastal storms amplifying the effects of sea level rise, the coastal hazard buffering of blue carbon ecosystems becomes more critical.
- **Coastal identity**: Blue carbon habitats are integral to coastal Maine’s heritage, livelihoods, and economies.
- **Biodiversity**: Coastal carbon ecosystems are critical habitat for marine plants, fish, and wildlife that are the base of food chains and integral to commercial fisheries and other human values.
- **Climate mitigation**: Loss of coastal habitats can lead to not only the lost potential of carbon sequestration - their degradation and loss results in the release of carbon and methane to the environment and the atmosphere.

What can you do?

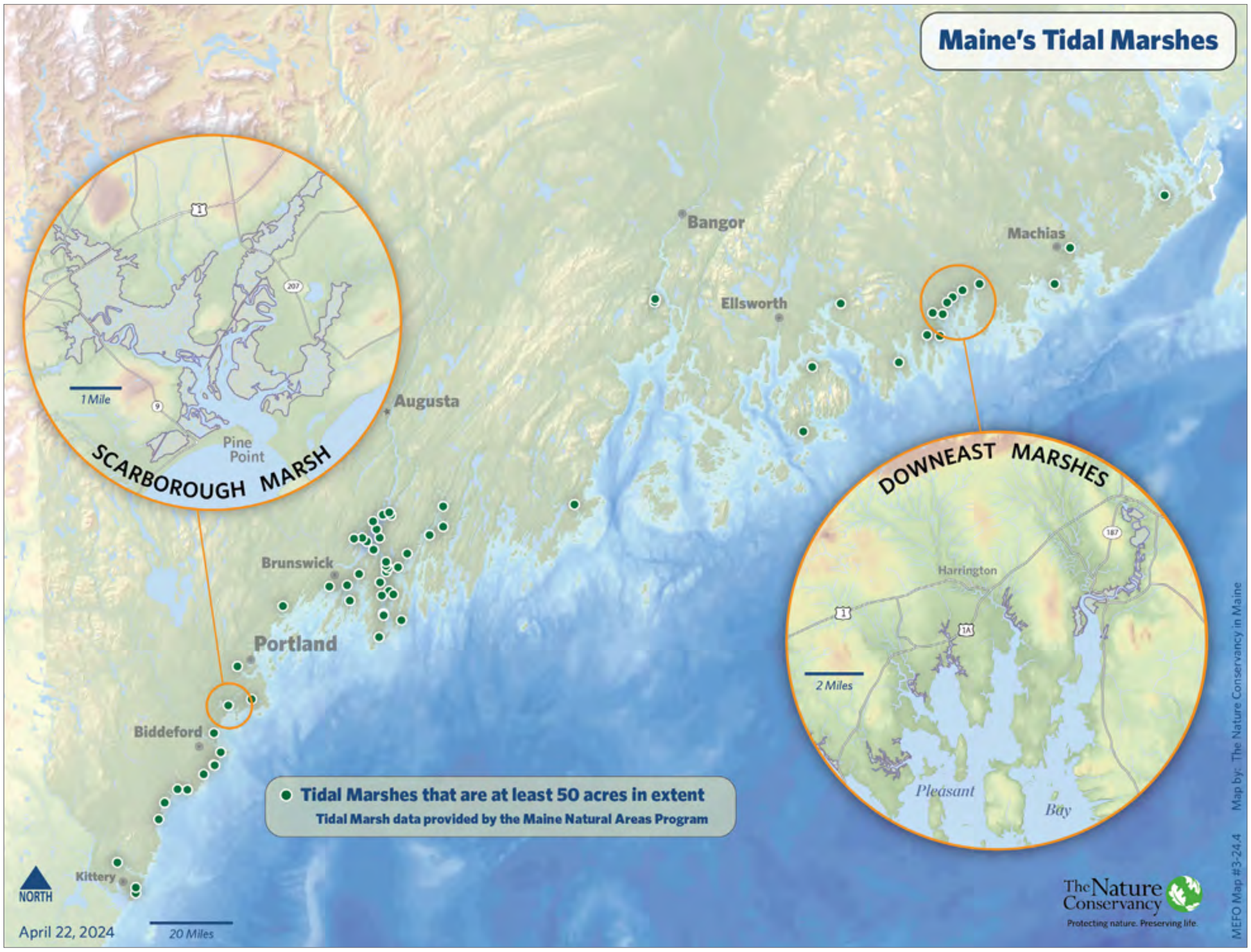
- **Legislators**: Consider how blue carbon impacts constituents in your district; introduce and/or support legislation that benefits communities through blue carbon. Key carry over bills for Fall 2025 session: LD 474, LD 475, LD 1026, LD 593, LD 646
- **Municipalities**: Upsize culverts that restrict tidal flow; maintain healthy blue carbon habitats and support restoration efforts; explore new ordinances like limiting fertilizer and pesticide use near coastal carbon habitats
- **Property owners**: Use nature-based solutions to coastal hazards like living shorelines and maintain natural buffers such as shrubs and trees along shorelines
- **Anyone**: Support habitat restoration efforts; help track and remove invasive species; reduce use of fertilizer; support Maine kelp farmers

What is the Maine Blue Carbon Network?

A group of partners from science, government, and nonprofit organizations working together to advance understanding and sustainable management of Maine's coastal blue carbon ecosystems and create opportunities to leverage their potential.

Tidal Marshes

Tidal marshes are an important habitat along Maine's coast with historical, cultural, and ecological significance. With **over 20,000 acres of tidal marsh along Maine's coastline**[2], tidal marshes serve as vital habitats for a diverse array of plant and animal species. Human communities also have close relationships with tidal marshes. Wabanaki have harvested sweetgrass in marshes for generations, forming reciprocal relationships "between the grass and the people[3]." Early European settlers in Maine also recognized the fertility of saltmarsh soils, modifying their hydrology through complex ditching and draining systems to increase the yield of salt hay[4]. Today, many communities and individuals have strong ties to marshes as they provide a sense of place and connection with the coast.



Coastal wetlands store three to five times more carbon per unit area than tropical rainforests[5].

Sample research in the Northeast:

- Marsh restoration efforts throughout Maine include right-sizing tidal restrictions, altering marsh hydrology, and adding sediment.
- Research led by Bates College, with partners at MNAP and GMRI, is investigating the impact of tidal restrictions on the carbon sequestration potential of marshes, specifically how restrictions may lead to higher methane emissions. These partners are also working to understand how environmental conditions impact carbon stocks across the state.

Key benefits of tidal marshes:

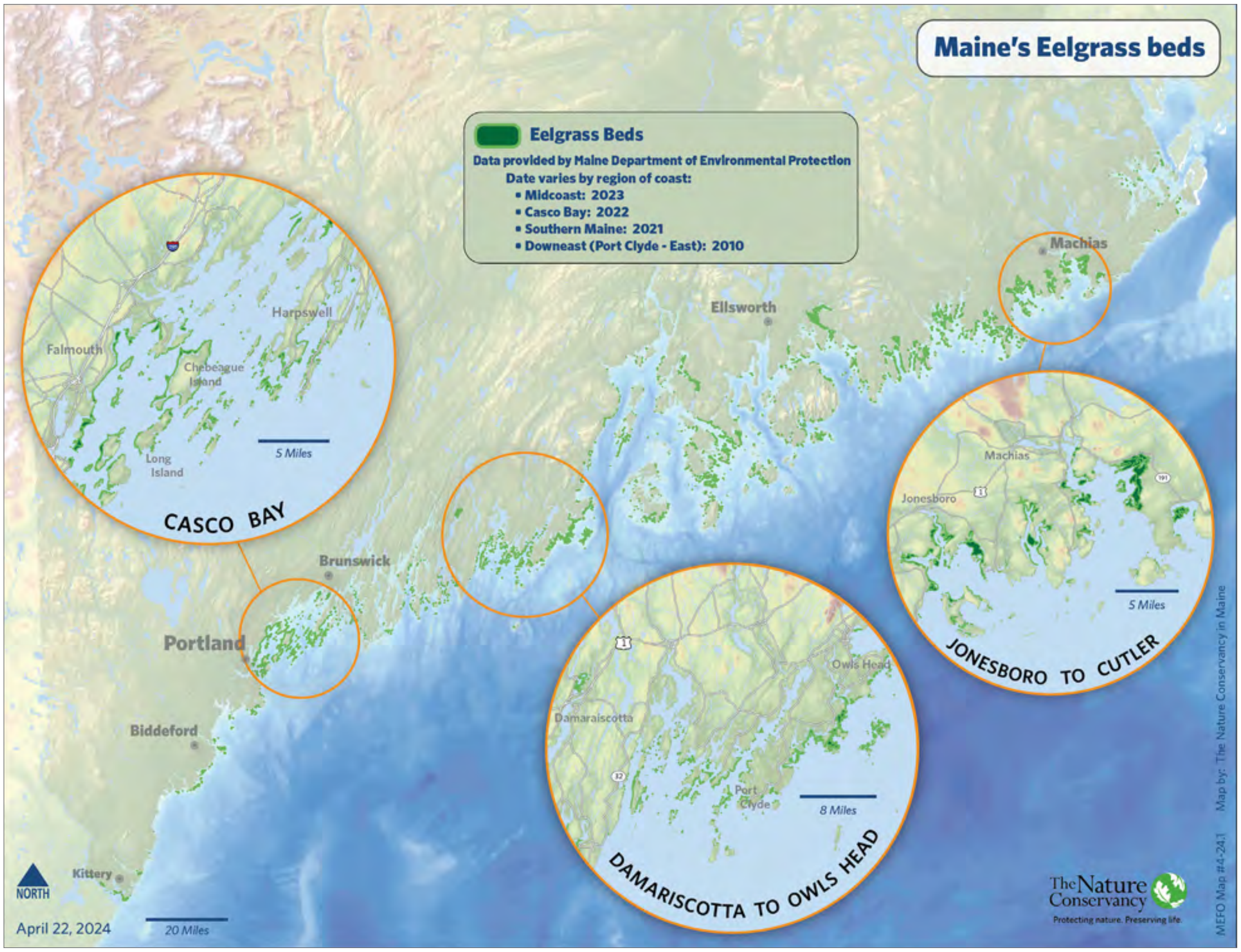
- Support commercial fisheries, providing nursery and feeding grounds for fish and shellfish
- Buffer coastal erosion and storm surge, protecting inland areas and infrastructure
- Sequester carbon dioxide through accumulated organic matter in soils
- Support uniquely adapted plant and animal diversity and rare species

Threats to tidal marshes:

- Undersized tidal culverts and dams prevent natural tidal flow and sediment supply
- Armored shoreline stabilizations cut off tidal marshes from coastal sediment supply
- Historic ditches and embankments from salt hay farming prevent marshes from draining properly
- Sea level rise erodes marsh edges
- Built infrastructure prevents tidal marshes from naturally migrating landward as sea level rises
- Increased intensity and frequency of coastal storms erode marsh edges
- Excess nutrients from development, sewage, agriculture, aquaculture, etc.

Eelgrass

Eelgrass (*Zostera marina*) is one of the foundational species in coastal ecosystems, forming extensive underwater meadows that provide critical habitat for a diverse array of marine organisms. In 2021, **Maine had an estimated 21,666 acres of eelgrass meadows**[2], more than any other state in the northeast. However, the DEP Marine Vegetation Mapping Program (est. 2021) has documented eelgrass decline in some portions of Maine, with a 54% loss documented in Casco Bay between 2018-2022[6] and a 60% loss documented in the entire Midcoast Region between 2005-2023[7].



Globally, seagrass beds cover 0.2% of the ocean floor, yet they sequester approximately 10% of marine carbon[8].

Sample research in the Northeast:

- In 2023, the EPA published “Blue Carbon Reservoirs from Maine to Long Island, NY” documenting the significant carbon sequestration potential of eelgrass meadows and marshes in the region.
- Eelgrass restoration partners in Casco Bay are piloting new restoration methods in Maine.
- Maine DEP and GMRI are partnering to understand how environmental changes impact eelgrass persistence.
- In 2021, the Marine Vegetation Mapping Program (MVMP) was established by P.L. 2021, ch. 424, an Act to Restore Eelgrass Mapping and Enhance Salt Marsh Vegetation Mapping in the State.

Key benefits of eelgrass meadows:

- Provide nursery habitat for important fish and shellfish species, including lobster
- Stabilize sediment and mitigating coastal erosion
- Cycle nutrients and maintain water quality
- Sequester carbon dioxide and buffer ocean acidification by reducing carbonic acid in seawater

Threats to eelgrass meadows:

- Interactive stressors like low light, warming seawater, and invasive species
- Excess nutrients from development, sewage, agriculture, aquaculture, etc.
- Sea level rise and increased intensity of coastal storms

Macroalgae

Macroalgae takes many forms in Maine, including sugar kelp grown on longlines in underwater farms, in rockweed meadows growing on rocky shorelines, and in colorful seafloor communities swathed in brown, green, and red seaweed species. Certain species of macroalgae (kelp) grow incredibly fast, making them exceptional at carbon absorption. That said, the amount of carbon sequestered by these ecosystems can vary widely. About 43% of macroalgal carbon is exported out of the ecosystem, and some of that is likely sequestered in sediments or the deep sea[9]. Maine has the longest history in the U.S. of kelp farming and the most farmed seaweed landed in the U.S[10].

Globally, kelp forests are estimated to sequester 173 million metric tons of carbon annually or the equivalent of 142 million passenger vehicles[11].

Sample research in the Northeast:

- Bigelow Laboratory for Ocean Sciences has a "Kelp Blue Carbon Group" that recently developed an eDNA tool for tracking kelp particles around aquaculture farms.
- In 2022, researchers at Darling Marine Center were able to model reductions in the cost of carbon sequestration through kelp aquaculture from $17,048 per ton of carbon dioxide equivalent to $1,257. An updated model evaluation is underway.
- The Island Institute released greenhouse gas assessments for aquaculture products, including farmed kelp.

Key benefits of macroalgae:

- Provide crucial habitat to marine organisms including submerged forests that offer protection for commercially important fisheries species and intertidal mats that reduce heat stress to invertebrates
- Sequester carbon dioxide in marine sediments
- Buffer ocean acidification by reducing carbonic acid in seawater
- Limit shoreline erosion by reducing wave energy
- Support Maine's blue economy through aquaculture and carbon crediting
- Capture nutrients that cleans coastal waters from runoff and pollution

Threats to macroalgae:

- Lack of knowledge on the per species biomass, connectivity between subpopulations, and the trajectory of populations in a changing ocean
- Prohibitively high cost (in terms of labor and reporting) for entering carbon markets for single farms
- Increased frequency and severity of coastal storms and marine heat wave events
- Invasive algae species like Asian red algae (*D. japonica*) or turf algae outcompeting native species for light and space, or prohibiting native species from 'recruiting' the next generation

Tidal Flats

Tidal flats (aka mudflats) are large, flat areas of coastline made of fine-grained sediments. They are unvegetated, yet tidal flats are rich habitats for large populations of shellfish, marine worms, and other invertebrates and feeding grounds for birds like sandpipers, herons, egrets, and ducks. **Maine has an estimated 160,000 acres of tidal flats**[12]. Carbon sequestration of tidal flats is generally lower than that of vegetated tidal marshes[13], but they sequester carbon effectively due to their large expanse. For example, in China, **tidal flats contain an estimated 80% of the intertidal carbon stock nationwide**[14]. Some of the carbon stock in tidal flat soil originates in the flat itself through benthic macroalgae[15], but carbon sequestered in tidal flats also can be transported from other terrestrial or marine sources[16]. More research needs to be done on the origin of carbon in tidal flat soil to understand the role of tidal flat ecosystems in coastal carbon cycles.

In 2024, Maine's soft-shell clam harvest was valued at $15.46 million but has been steadily declining since the 1980s.

Sample research in the Northeast:

- Gulf of Maine Research Institute, University of Massachusetts Amherst, Manomet Conservation Sciences, and Maine Maritime Academy are measuring carbon densities in tidal flats throughout the Gulf of Maine (Ipswich to Sipayik). The group is aiming to develop spectral indices that would enable estimation of carbon density in tidal flats from satellite imagery.

Key benefits of mud flats:

- Support the blue economy in Maine and preserve legacy livelihoods for Mainers
- Provide significant habitat for recreationally, commercially, and culturally important species
- Play an important role in marine nutrient cycling, maintaining larger food webs

Threats to mud flats

- Ocean acidification, warming seawater temperatures
- Sea level rise and limited space for mudflats to migrate upland
- Invasive species, such as green crabs
- Poor water quality and excess nutrients from development, sewage, agriculture, etc.
- Reduction in access to mud flats as the coastal Maine real estate market expands
- Armored shoreline stabilizations that cut off mud flats from coastal sediment supply

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