San Diego Bay EELGRASS BLUE CARBON STUDY 2021-2023

What Is Blue Carbon?

Blue carbon refers to carbon captured by the world's oceans and coastal ecosystems. All blue carbon ecosystems, such as seagrass beds, tidal salt marshes, and mangroves, are **carbon sinks**, meaning they can **sequester** and **store** large amounts of carbon in their plants and soils. Seagrasses, like the native eelgrass beds found in San Diego Bay, can store twice as much carbon as forests on land.

How the Blue Carbon Cycle Works: Step by Step

Like plants on land, plants in coastal wetland ecosystems breathe in carbon dioxide (CO_2) **(1)**, and through photosynthesis use that carbon to grow leaves, stems, and roots **(2)**. When land plants die, **aerobic** bacteria take oxygen from the air and turn the dead plant's carbon back into CO_2.

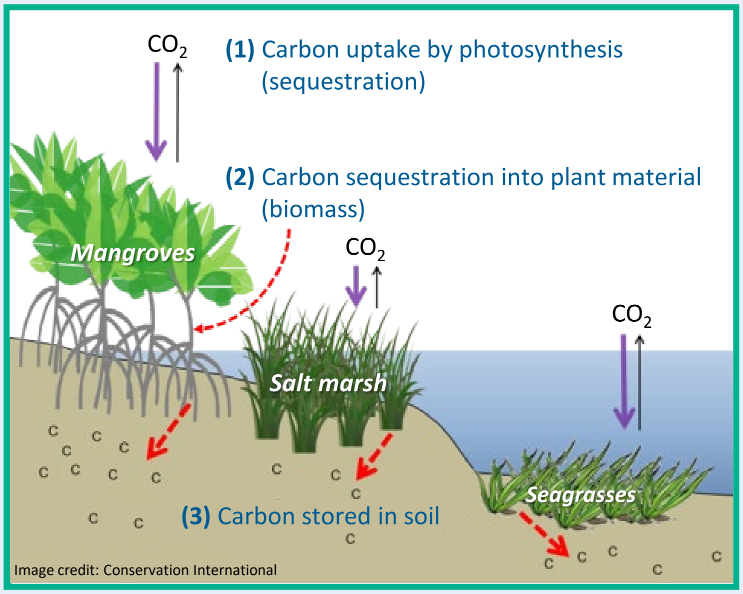


Image credit: Conservation International

Unlike land plants, coastal wetland ecosystems are often submerged in water. Water contains much less oxygen than air, which prevents aerobic bacteria from performing the CO_2 conversion process. Instead, **anaerobic** bacteria, which do not use oxygen, break down the plant material into carbon-rich organic matter.

Some of this organic matter is trapped and buried below ground in sediments **(3)**. As this carbon builds up over time, it can remain sequestered in wetland soils for hundreds to thousands of years.

Why Blue Carbon Ecosystems Are Important

In addition to storing carbon, blue carbon ecosystems provide multiple **co-benefits**. They improve water quality, are important foraging and nesting areas for birds, and provide nursery habitat for juvenile fish. They also help dissipate wave energy and accommodate sea level rise, which protects shorelines from erosion and flooding. (Photo credit: Port of San Diego)

San Diego Bay Eelgrass Blue Carbon Study

In 2021, the Port partnered with the **U.S. Maritime Administration** and received funding through the **Maritime Environmental & Technical Assistance Program** on the first-ever assessment of carbon storage in San Diego Bay's eelgrass beds. This study built a baseline for understanding carbon storage in the bay and informs potential opportunities to mitigate greenhouse gas emissions. (Photo credit: Merkel & Associates, Inc.)

Key Findings: Carbon Storage in the Bay

San Diego Bay has lots of eelgrass

- The bay has nearly 2,600 acres of eelgrass. That's 50% of all the eelgrass in Southern California and about 17% of all eelgrass in the state.

Eelgrass store tons of carbon (literally!)

- The bay's eelgrass beds are estimated to currently contain **170,600 metric tons of CO_2 equivalent** (Mt CO_2e). That's the same amount of CO_2 that **37,000 cars** emit annually.

South Bay is a carbon storage hot spot

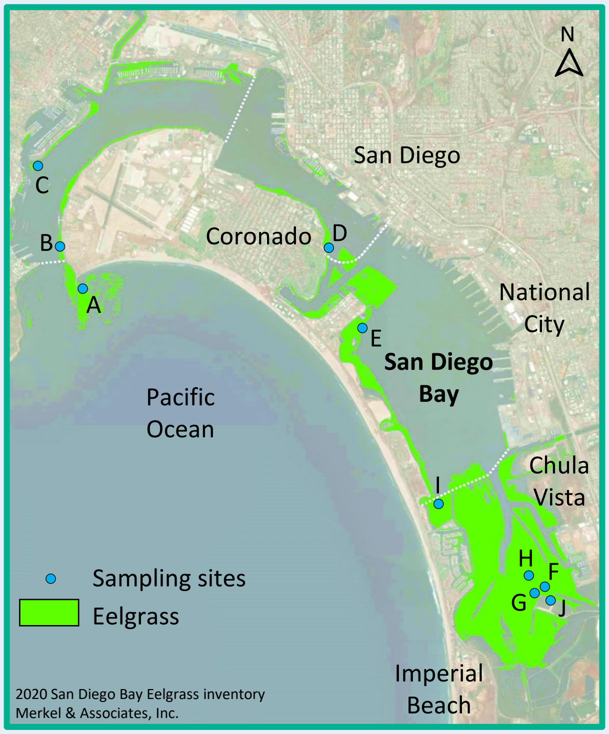
- Most of the bay's carbon, as much as 73%, is stored in South Bay. The calm waters and fine-grain muddy sea floor sediments of South Bay appear to be ideal conditions for storing carbon.

Older eelgrass beds store more carbon

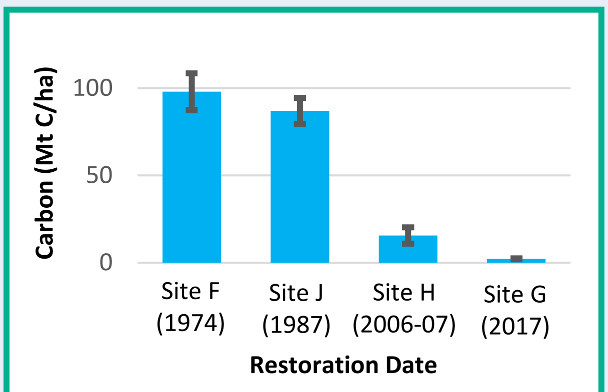
- There appears to be a strong link between the age of an eelgrass bed and how much carbon it contains. Older eelgrass beds (decades old) contain roughly 9 times more carbon than new beds.
- The graph to the right shows four eelgrass beds in the South Bay. Sites F and J are at least several decades old and contain significantly more carbon, upwards of 100 Mt of carbon per hectare, than newer beds at sites H and G, which were recently restored.

Restoring eelgrass could aid in more carbon storage

- Planting more eelgrass could sequester more carbon, especially in the first few decades of restoration.



2020 San Diego Bay Eelgrass inventory
Merkel & Associates, Inc.



2022 San Diego Bay Eelgrass Blue Carbon Study
Environmental Science Associates

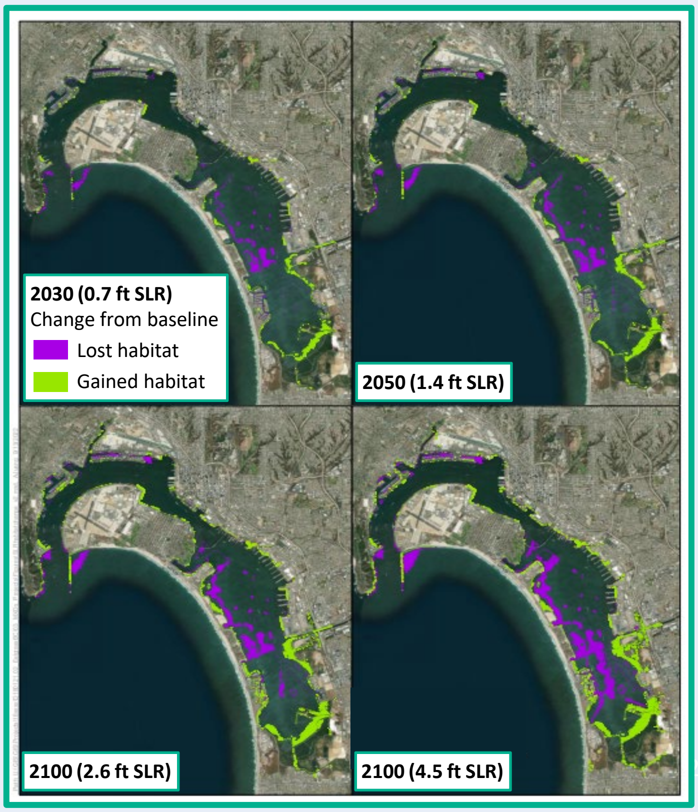
San Diego Bay Eelgrass Blue Carbon Study

In 2022, the Port again partnered with the **U.S. Maritime Administration**, as well as the **U.S. Navy Region Southwest**, to expand the scope of the initial assessment of carbon storage in San Diego Bay's eelgrass beds. The second year of study focused on estimating the carbon sequestration rate, or how fast carbon is captured and permanently stored in the bay each year, and building a **carbon budget** model.

Key Findings: Planning for Sea Level Rise

Sea level rise may affect where and how much eelgrass grows in the bay

- Modelling of future sea level rise scenarios predict the total extent of eelgrass habitat in the bay will decrease over time. Even with this potential loss, the bay's remaining eelgrass is still expected to remove between 50,800 and 209,600 Mt CO_2e from the atmosphere by 2100.
- Eelgrass can also trap and store sediment which, over time, can help raise sea floor elevations. This process, called accretion, was not included in the sea level rise model, but could assist eelgrass in keeping up with sea level rise.



2022 San Diego Bay Eelgrass Blue Carbon Study
Environmental Science Associates

- The maps to the left show four sea level rise scenarios. Purple areas shows where potential loss of eelgrass may occur. Green areas show potential new eelgrass habitat.

Mitigating eelgrass loss

- To limit loss of eelgrass due to sea level rise, habitats should be allowed to adapt and migrate inland into areas where infrastructure allows. Eelgrass restoration and mitigation are critical, proactive efforts that could help alleviate the potential loss of eelgrass posed by sea level rise.

Eelgrass beds vary interannually

- When comparing eelgrass samples between 2021 and 2022, there were differences in canopy height (how tall the eelgrass grows) which influences eelgrass biomass and, in turn, may influence carbon sequestration rates and storage into sediments. Eelgrass beds are dynamic systems, and their carbon benefits may change with oceanographic conditions.

U.S. Department of Transportation Maritime Administration

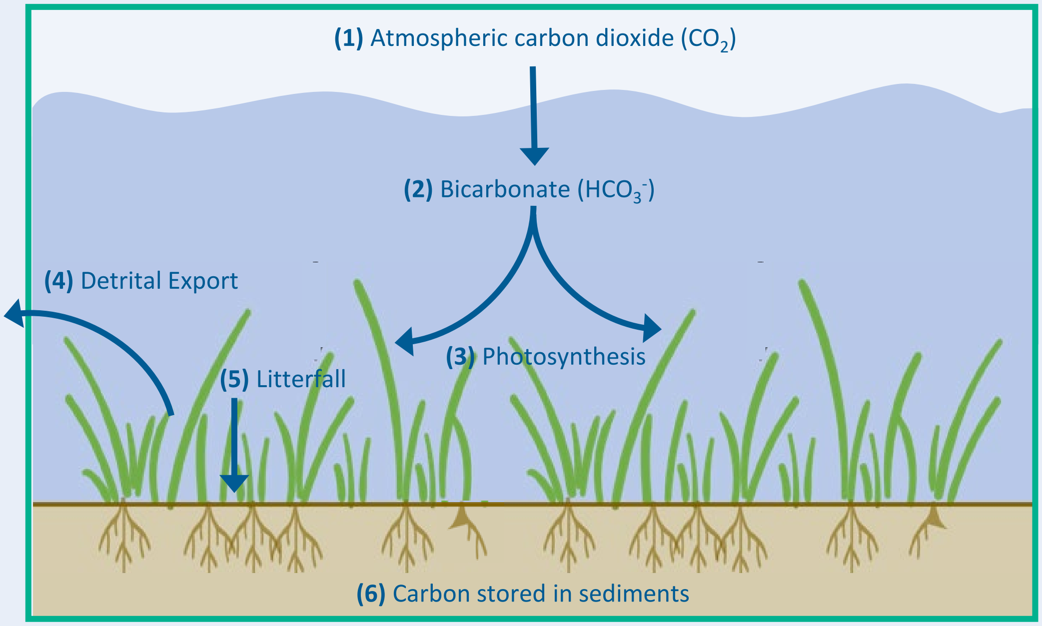
PORT of SAN DIEGO Environment

Key Findings: Building a Carbon Budget

A **carbon budget** helps researchers figure out how much carbon is coming into and leaving a system, even if it's hard to measure those inputs and outputs directly. This helps us understand how changes, like expanding or losing eelgrass habitat, might impact the total amount of carbon in the system.

What is the bicarbonate pathway?

- CO_2 in the atmosphere **(1)** is absorbed by the ocean and converted into **bicarbonate** (HCO_3^-) **(2)**. Eelgrass has adapted to be able to draw bicarbonate from the water and convert it into CO_2 for use in photosynthesis **(3)**, which builds plant material (biomass). This process drives more CO_2 from the atmosphere into the oceans. Bicarbonate is not easily converted back into CO_2, which means bicarbonate represents a long-term storage mechanism for carbon in seawater.



Modeling carbon sequestration rates

- Eelgrass ecosystems accumulate lots of organic matter, such as dead plant material and other organic debris, called detritus. Some detritus undergoes **detrital export (4)**, a process where material is carried away by tides, ocean currents, or animals. Detritus that remains within the eelgrass bed falls to the seafloor, called **litterfall (5)**, and can be buried in sediments over time **(6)**.
- The amount of carbon stored in eelgrass sediments is estimated by collecting soil samples and testing the amount of carbon in them. **Radioisotope dating**, a technique using naturally occurring isotopes and their decay rates, is then used to measure how old the sediments are and the rate at which new sediment, and therefore carbon, is accumulated.
- Once the detrital export, litterfall, sediment carbon, and bicarbonate steps of the carbon budget are calculated, the rate at which carbon is sequestered (the **sequestration rate**) can be estimated.
- Using the carbon budget method, it's estimated that the bay's eelgrass beds sequester approximately **1,195 Mt of CO_2e per year**, or same amount of CO_2 that **284 cars** emit annually.