HARNESSING BLUE CARBON: NATURE'S ALLY IN THE CLIMATE CRISIS

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Ocean as a carbon sink

The ocean is nature's most powerful carbon sink—absorbing 25 percent of annual carbon emissions. Over the past century, the ocean's ability to capture and store so-called blue carbon has been significantly reduced by coastal development, pollution, and habitat destruction. Restoring blue carbon ecosystems so that they can protect the planet from climate change will require a combination of conservation, restoration, and innovation.

Blue carbon coastal habitats—including mangroves, tidal marshes, and seagrass meadows—constitute only two percent of the ocean, but are responsible for half of its carbon absorption. Mangroves can store three to five times more carbon than terrestrial forests of the same size. Compared to tropical rainforests, sea grass and marshes absorb carbon four times more effectively. Macroalgaes—including seaweed and kelp—are also powerful blue carbon sinks. And small, fast-growing microalgaes have gained recognition for their powerful blue carbon sequestration.

Humans have destroyed over half of global mangroves in the process of building coastal developments and aquaculture farms. At least 30 percent of tidal marshes and sea grass meadows have been lost as well. And rising seawater temperatures have led to a decline in kelp forests.

When these blue carbon ecosystems are damaged or degraded, they lose their capacity as carbon sinks and release massive amounts of previously stored carbon dioxide—up to one billion tons annually. This exceeds the annual emissions of the United Kingdom, France, and Italy combined.

The necessity of blue carbon ecosystem conservation exists within a complicated reality. Aquaculture, the world's fastest growing food industry that employs 22 million people worldwide and plays a vital role in global food security, is one of the main culprits of blue carbon ecosystem destruction. In particular, Southeast Asian shrimp aquaculture is the primary driver of mangrove loss, as it often involves converting coastal mangrove forests into ponds.

Smart aquaculture projects

With aquaculture growth projected to continue, sustainable aquaculture practices must become a global priority. When better practices are instituted, it is possible for

aquaculture to restore blue carbon ecosystems instead of destroying them.
For example, several of the Subnational Climate Fund's partner projects combine blue carbon ecosystem restoration and regenerative aquaculture (see "our future is Blue"). Seawater Solutions showcases this approach by revitalizing degraded African coastal land using seawater, and then creating mangroves and wetlands as well as sustainable aquaculture projects.

Similarly, in Southeast Asia, blue carbon aquaculture projects spearheaded by the IUCN are attempting to transform shrimp aquaculture to prove that it is possible for shrimp aquaculture and environmental restoration to occur simultaneously. Currently, there is still much progress to be made in reforming shrimp aquaculture. This challenge is compounded by the fact that Asian farms—primarily in countries that lack the necessary funds and regulatory will to establish and enforce widespread sustainable production—produce a vast majority of the world's aquaculture, especially shrimp.

Wonder aquatic plants

Kelp and algae aquaculture are effectively manmade blue carbon ecosystems.

Naturally grown algae has up to fifty times the carbon sequestration ability of trees, and when grown in bioreactors, algae becomes several hundred times more effective than trees at capturing carbon. Because of this, bioreactor-grown algae are a potent natural method of carbon capture and storage.

Fully harnessing the climate change mitigating power of algae aquaculture requires supporting the industry in countries with strong growth opportunities.

A new study by the Subnational Climate Fund found that the Global South has vast potential to increase the capacity of seaweed farming—providing economic benefits while increasing blue carbon sequestration. Expanding this nascent blue carbon industry requires initiatives that develop, accelerate, and scale regenerative aquaculture technology.

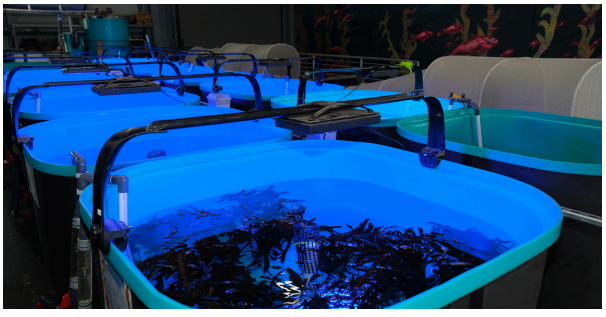
Accelerating regenerative aquaculture is a cornerstone of AltaSea at the Port of Los Angeles, the world's leading blue economy campus. At AltaSea, Pacific Mariculture and various other blue technology innovators are advancing technologies for regenerative bivalve and algae aquaculture.

Many of these innovations involve growing bivalves, kelp, and even shrimp in bioreactors and closed-loop systems—the aquatic equivalent of greenhouse farming—instead of in the ocean. At scale, these technologies will be vital to protecting blue carbon ecosystems from the impacts of traditional aquaculture.

Also at AltaSea, the Kelp Ark lab has created a "biobank" that houses, cultivates, and preserves genetic diversity in kelp and algae species. The lab's researchers identify and crossbreed strains of kelp that can withstand warmer, more acidic waters—helping these blue carbon ecosystems survive climate change. Kelp Ark is also building a genetically diverse seed bank of 'farmable' seaweed—species that simultaneously produce valuable byproducts and harness the power of algae to sequester carbon—that can be distributed to aquafarmers worldwide.

AltaSea's regenerative aquaculture leaders recognize that conservation and innovation are both essential to the future of blue carbon. Kelp Ark and its partners rushed to collect and preserve kelp species impacted by the historically devastating 2025 Los Angeles wildfires.

During coastal wildfires like the ones seen in 2025, ash, debris, and toxins like arsenic enter the ocean in large amounts. Rain exacerbates the problem, sending toxins and debris into the coastal environment and increasing the likelihood of kelp forest die-off. By collecting and safeguarding species from impacted ecosystems, Kelp Ark ensured these blue carbon ecosystems can be restored when conditions improve.



Enabling kelp forests, mangroves, and other blue carbon ecosystems to thrive safeguards their role as long-term carbon sinks, allows them to capture climate-damaging emissions, and prevents them from releasing previously absorbed carbon back into the atmosphere. In the fight against climate change, the importance of conserving remaining blue carbon ecosystems and restoring those that have been degraded cannot be overstated.

About AltaSea:

AltaSea in the Port of Los Angeles California, is dedicated to accelerating scientific collaboration, advancing the Blue Economy through business innovation, and job creation, and inspiring the next generation, all for a more sustainable, just, and equitable world.

Terry Tamminen
President and CEO, AltaSea

Terry served as Secretary of the California Environmental Protection Agency and later Cabinet Secretary, the Chief Policy Advisor to Governor Arnold Schwarzenegger. Terry cofounded the R20 (now Catalytic Finance Foundation), a public-private partnership working globally to deploy climate solutions at scale, and provides climate policy advice to 7th Generation Advisors and Pegasus Capital Advisors.

Emily Vidovich

Emily is an environmental journalist specializing in ocean conservation and climate change mitigation. She obtained her bachelor's degree at George Washington University and a Masters in Global Environmental Studies at a university in Tokyo, Japan. Born and raised in the Port of Los Angeles, she now works in research and communications at AltaSea.