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Accelerating Ocean and Climate Restoration

OCEAN-BASED CLIMATE SOLUTIONS

Ocean & Climate: Inextricably Linked

Covering 70 percent of Earth's surface, the ocean has buffered humanity and terrestrial organisms from the worst effects to date of climate disruption by both directly absorbing about 30 percent of all anthropogenic carbon dioxide (CO₂) pollution and absorbing more than 90 percent of the excess heat trapped in the biosphere by CO₂ pollution.

However, just as climate change has come at a high cost for communities around the world, it has also come at a high cost to the ocean and its unique biodiversity. Together, the excess heat and absorbed CO₂ are bleaching corals, melting sea ice, and acidifying the sea at alarming rates—unraveling marine ecosystems and crippling the ability of the ocean to support the billions of people and other creatures dependent upon it. These changes also further drive destabilization of our climate.

Ongoing climate disruption poses such an existential threat to the ocean that traditional protection efforts unfortunately are no longer enough; we simply cannot protect the ocean without slowing and ultimately reversing climate change. And while this means we must rapidly reduce emissions, we are too far along for this alone to be enough. Carbon dioxide removal has also become a necessity. In fact, climate scientists estimate that we must remove between 100 and 1000 gigatons by the end of this century just to have a chance at holding temperatures to a 1.5°C increase—the goal set out in the Paris Agreement.

"We need to reset our goals from 1.5 degrees of warming and being worse off in 2050 than we are today, to a more inspiring target of restoring our climate and ocean."

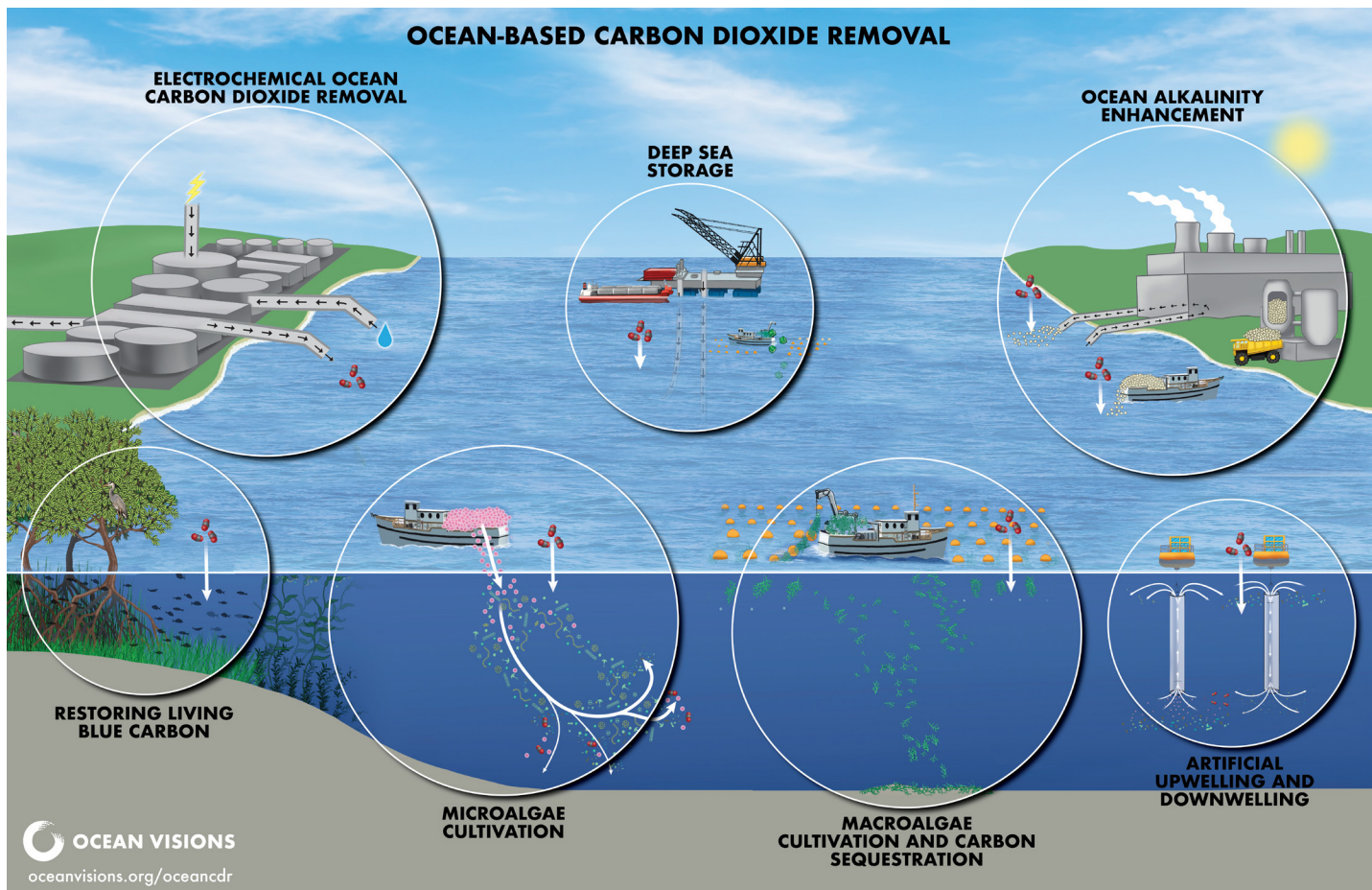
—Ocean Visions CEO Brad Ack

What is Ocean-Based Carbon Dioxide Removal?

Carbon dioxide removal (CDR) can take many forms, from land management practices such as forest restoration, to technologies like direct air capture. To date, most CDR development has been focused on land-based solutions. But the power of the ocean to sequester and safely store carbon dioxide is massive compared to that of its terrestrial counterparts. The ocean already holds more carbon than any other part of Earth’s biosphere and the sheer scale of the ocean also means that any ocean-based climate solutions proven to be viable and safe have the potential to go to the scale needed. Ocean-based CDR can be divided into two broad categories—biological and non-biological (chemical/physical), with some overlap between the two.

Biological Approaches that Harness the Power of Plants and Photosynthesis	Chemical Approaches that Increase the Ocean’s Capacity to Absorb Carbon Dioxide	Hybrid Methods
Seaweed Cultivation for Carbon Sequestration Cultivating seaweeds (macroalgae) and sequestering the carbon embedded in it. Cultivation opportunities include existing coastal farms and expansion into offshore waters. Sequestration options include burial in the deep sea/land and/or harvesting for bioenergy, as well as production of long-lived bio-products.	Ocean Alkalinity Enhancement Surface addition of alkaline minerals (either mined or manufactured) to seawater to increase alkalinity and, therefore, carbon storage in seawater.	Direct Ocean Capture Use of chemistry, electrochemistry, gas exchange, or other methods to capture and/or store atmospheric CO ₂ from seawater.
Microalgae Cultivation and Sequestration Cultivating microalgae and sequestering the carbon embedded in it. Microalgae can be fertilized from surface application of nutrients (e.g., nitrogen, phosphorus, and/or iron), as well as artificial upwelling of nutrient-rich deep ocean water. Sequestration pathways include artificial downwelling and/or harvesting for shore-based bioenergy, as well as production of stable bio-products.	Coastal Enhanced Weathering Application of silicate minerals in high-energy beach environments where natural chemical weathering can be accelerated. This process converts CO ₂ in the atmosphere into stable, long-lived bicarbonate in the ocean.	Accelerated Weathering of Limestone Limestone can be dissolved in a reactor with a concentrated source of CO ₂ , trapping the CO ₂ as stable, long-lived bicarbonate in the ocean. As long as the CO ₂ represents net removal, this is a carbon removal pathway.
Blue Carbon Management Restoration and protection of blue carbon ecosystems, including mangroves, salt marshes, and seagrass meadows, to ensure continued carbon sequestration and long-term below-ground storage of organic carbon.		Deep Storage Use of the ocean’s deep stable layers, seafloor, and sediment to store CO ₂ captured via a shore-based carbon removal process. Methods include biomass sinking and liquid CO ₂ injection and via ships, platforms, or pipes.





Accelerating the Testing and Development of Potential Ocean-Based Climate Solutions

Ocean Visions, working with experts from around the globe, developed a series of digital road maps to capture the state of various ocean-based CDR pathways, their potential impacts, knowledge gaps, and a set of “first-order” priorities.

Numerous disciplines across both the ocean and climate sectors have a role to play in advancing responsible and equitable research and development (R&D):

Scientists, researchers, and innovators:

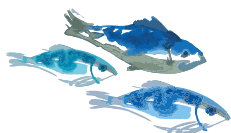
- Iterate and explore a full array of possible approaches
- Address and fill key knowledge gaps in technology development and impacts assessment
- Engage in field testing of promising pathways with careful monitoring and evaluation frameworks

Policymakers and investors:

- Develop new capacity (including regulatory frameworks and infrastructure) to support accelerated R&D
- Build a supportive and equitable enabling environment for R&D, including financial support and transparent governance regimes

Conservation, climate, and ocean advocates:

- Engage in the development of this field to assure conservation and biodiversity values are paramount
- Build public awareness and understanding of ocean-based climate solutions



TO LEARN MORE about ocean-based carbon dioxide removal, visit www.oceanvisions.org/cdr