

Marine Carbon Dioxide Removal



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What Is Marine CDR?

- Carbon dioxide removal (CDR) is a climate strategy that removes carbon dioxide (CO₂) pollution from the atmosphere or hydrosphere and sequesters it, preventing it from continuing to warm the planet.
- The ocean is an important carbon sink, absorbing a significant amount (about one third) of the total CO₂ emitted from burning fossil fuels and other human activities.
- Marine CDR (mCDR) seeks to leverage the ocean's sink capacity to store even more CO₂. In theory, the oceans can play crucial roles in carbon drawdown.
- However, much more research is needed before mCDR can be safely deployed at scale with the necessary community engagement practices and strict guidelines for safety, monitoring, and verification standards.
- Methods for pursuing mCDR include:
 - Ocean alkalinity enhancement (OAE)
 - Macroalgae cultivation
 - Electrochemical marine CDR
 - Nutrient fertilization
 - Artificial upwelling and downwelling

Potential Benefits of mCDR:

- By removing CO₂ from the atmosphere and upper ocean mCDR technologies could help reduce lingering CO₂ emissions and contribute to the portfolio of climate tools needed to offset global warming and ocean acidification in the coming years.
- Land based CDR methods may not be feasible at the scale necessary to remove between 100 and 1,000 gigatons of CO₂ worldwide to meet climate goals.
- Though more research is needed, it is possible that mCDR strategies could generate potential benefits for communities. For example, ocean alkalinity enhancement approaches are being studied for their potential to locally reduce ocean acidification impacts.

Carbon pollution in the ocean is having devastating effects, including changing the water's chemistry, causing it to become too acidic, and harming shellfish and other marine life. While mCDR technology and pathways are still in the early stages of research and development, NWF has been working to promote the research needed to understand the potential impacts of mCDR to the ocean and coastal communities, as well as investigating any possible co-benefits.

Potential Risks and Key Considerations:

- Ocean governance: Clarification and focus is needed to determine where mCDR fits within existing governance and regulatory frameworks, both in the United States and internationally.
- Uncertainty: The ocean is immensely difficult to model and there are substantial knowledge gaps. Many important questions must be answered as field trials in the ocean advance and before full-scale deployment.
- Efficacy: Given the ocean's complexity, it is very difficult to accurately measure CO₂ removed via mCDR. There is much that still needs to be done to gain an understanding of baseline conditions in addition to monitoring, reporting, and verification of projects to ensure that they are safe and effective.
- Ecological impacts: Each mCDR method poses the risk of potential complications for marine ecosystems (e.g., trace amounts of toxic minerals from OAE, or ocean floor ecosystem disturbance from sinking macroalgae). Research must be designed to maximize our understanding of possible impacts of mCDR approaches on ocean ecosystems.
- Community engagement: Many coastal communities, including Tribes and Indigenous peoples, have complex and interconnected relationships with the ocean. Robust community engagement on the front end of mCDR research projects and field trials is critical to informing project success. It is important to note that when approaching work with Tribes and Indigenous peoples, the principal of free, prior, and informed consent wherein Indigenous peoples have the right to give or withhold their consent for any actions that would affect their lands, territories, or rights is a United Nations recognized right, and must be incorporated in any successful Tribal engagement.

State of Deployment in the U.S.:

- Most mCDR in the U.S. is in the research and testing phase. The Federal government is supporting at least 36 mCDR research projects across 17 states as of April 2024. To learn more, check out the following resources:
 - If you're interested in learning about U.S. mCDR projects in the field trial stage, check out this database from Ocean Visions.
 - The White House Office of Science and Technology Policy (OSTP) announced a new Fast Track Action Committee on Marine Carbon Dioxide Removal. The committee will create an implementation and research plan for mCDR to help guide its deployment in the US.
 - The CDR Research Strategy was created by the National Oceanic and Atmospheric Administration (NOAA) as a part of the agency's Climate Interventions Portfolio.
- The Aspen Institute published a Code of Conduct for mCDR research and highlighted the importance of balancing the urgency of deployment with meaningful community engagement and risk assessment.
- The National Academies of Science, Engineering, and Medicine (NASEM) published a Research Strategy for Ocean-based Carbon Removal and Sequestration which identified unanswered scientific and technical questions, estimated costs, and made recommendations for research implementation.