Climate Restoration and the Ocean Restoration Research and Development Act of 2024

Frequently Asked Questions
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1. **What is the Ocean Restoration Research and Development Act ("Ocean Restoration Act") and what does it seek to accomplish?** Rising carbon emissions and declining biological productivity has resulted in a serious decline in ocean health in many regions around the globe. This bipartisan bill seeks to reverse that decline and help restore oceans to former levels of ecological balance and marine life productivity through a technique known as Ocean Iron Fertilization (OIF) and other marine carbon dioxide removal (mCDR) techniques. (see more discussion regarding OIF below, Qs 9-18 and 21) The legislation, if enacted, would direct the Secretary of DOE to establish a pilot program for applied research and that builds upon the recommendations of a 2021 NAS report.[1] The legislation would direct DOE to provide up to $33M/year for five years (with a requirement for matching funds) for the private sector, state, tribes and academic collaboration, and would require a report to Congress after the first year. The pilot program will also help provide the environmental impact data needed to inform the development of a permitting program. Time is of the essence and this Act is needed to expedite this important work as soon as feasibly possible.

2. **Why does the legislation focus mostly on OIF when the NAS report looked at several other ocean carbon dioxide removal techniques, such as seaweed cultivation and alkalinity enhancement?** Of the six ocean CDR approaches reviewed by NAS, the NAS report stated that among the biotic approaches, OIF and seaweed cultivation offer the greatest opportunities for evaluating the viability of biotic ocean CDR approaches. OIF is the least cost method with the potential to remove up to 60 gigatons of carbon per year.[2] (see more discussion regarding OIF below) However, the legislation would authorize other mCDR techniques, such as ocean alkalinity enhancement and kelp and seaweed cultivation, under DOE's R&D program.

3. **Why does the legislation only provide $33 million in federal funding per year?** In its 2021 report, the NAS recommended a minimum of $33 million per year was needed to advance our understanding of OIF. With the required non-federal matching funds, this legislation would double that amount, accelerating our understanding of the benefits.

4. **What regulatory permitting program exists for OIF or other marine CDR techniques?** Currently, there is no established permitting process designed to regulate the implementation of mCDR leading to significant uncertainty as to how projects will be treated. However, the federal Clean Water Act and/or the Marine Protection, Research and Sanctuary Act (otherwise known as the "Ocean Dumping" Act), with regulatory oversight by U.S. EPA, are being used on an interim basis to permit certain mCDR research projects. The Ocean Restoration Act, which will entail the creation of a temporary permitting and authorization program by DOE, in consultation with the U.S. EPA and NOAA, is critical to collecting data that will inform the formation of a future mCDR regulatory permitting program.

[1] See Dec. 2021 NAS Report, A Research Strategy for Ocean Carbon Dioxide Removal and Sequestration, available at: https://www.nationalacademies.org/our-work/a-research-strategy-for-ocean-carbon-dioxide-removal-and-sequestration

[2] See July 23 Climate Restoration Working Paper, P. Fiekowsky and C. Douglis, available at www.PeterFiekowsky.com/resources.

5. **What is the connection between phytoplankton and climate?** Phytoplankton plays a critical role in regulating climate through their role in the global carbon cycle. Phytoplankton are tiny, plant-like organisms that float near the surface of the ocean and form the base of the ocean food chain. They are responsible for producing approximately 50% of the oxygen we breathe and play a significant role in regulating the Earth's climate.[3] Phytoplankton absorb CO2 from the atmosphere through photosynthesis, converting the carbon dioxide into organic matter. This process not only removes CO2 from the atmosphere but also helps to transfer carbon from the surface of the ocean to the food chain and into the deep ocean, where the carbon is stored for long periods of time. Decreased phytoplankton populations can lead to lower amounts of oxygen production and less CO2 absorption which can contribute to increased atmospheric CO2 concentrations and global warming. Overall, phytoplankton play an essential role in the global carbon cycle and are an important factor in regulating the Earth's climate.

6. **Why is ocean phytoplankton in serious decline?** In 2010 one study published in the journal of Nature found that ocean phytoplankton populations had declined by approximately 40% since 1950. However, more recent studies, for example, involving the Gulf of Maine have confirmed reductions by as much as 65% over the last two decades.[4] Recent studies suggest that warming waters due to climate change and a drop in atmospheric dust are contributing to the serious decline in phytoplankton.

7. **Why is iron dust important to the ocean health and climate?** Iron is an essential nutrient for phytoplankton growth and therefore plays an important role in the biological pump in the ocean. Aeolian deposition is the major source of iron in the deep ocean. While iron in coastal waters is present in much higher concentrations (parts per million) from high inputs of nutrients from land-based sources, iron in the deep ocean tens or hundreds of miles offshore is significantly limited (parts per trillion).

   Aeolian dust, also known as wind-blown or atmospheric dust, is a crucial source of nutrients for the world's oceans. Phytoplankton, which form the base of the marine food web, rely on dust from land-based sources for key nutrients, such as iron.[5] There is growing evidence that aeolian dust in certain regions of world, such as the Sahar and Sahel regions of Africa, is declining due to changes in climate and weather patterns. The reduction in aeolian dust is negatively impacting phytoplankton populations and thus the ocean's overall health.

8. **What is the biologic pump?** The biological pump is the process by which organic matter, including carbon, is transported from the surface of the ocean to the deep ocean by respiration, remineralization and sinking of organic particles that are ultimately sequestered and removed from the atmosphere for long periods of time. Iron limitation is a common factor that restricts phytoplankton growth in many areas of the ocean. Researchers have shown that adding iron to iron-limited regions of the ocean stimulates phytoplankton growth and increases the export of carbon from the surface to the deep ocean.

9. **What is Ocean Iron Fertilization (OIF)**? OIF is the addition of trace amounts of iron (i.e., parts per trillion) to stimulate the growth of phytoplankton, a type of microscopic marine organism that is the foundation of the ocean food web.

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[3] See Woods Hole Oceanographic Institute, *Does the Ocean Produce Oxygen?,* available at: https://www.whoi.edu/know-your-ocean/did-you-know/does-the-ocean-produce-oxygen/

[4] See Science, *Critical Ocean Organisms Are Disappearing*, available at: https://www.science.org/content/article/critical-ocean-organisms-are-disappearing; NASA, *Phytoplankton Productivity Down in Gulf of Maine*, available at: https://earthobservatory.nasa.gov/images/149915/phytoplankton-productivity-down-in-gulf-of-maine

[5] See Earth, *Atmospheric dust plays surprisingly crucial role in stabilizing ocean ecosystems*, available at: https://www.earth.com/news/atmospheric-dust-plays-surprisingly-crucial-role-in-stabilizing-ocean-ecosystems/

10. **Why is OIF important?** OIF has the potential to mitigate the impacts of climate change by sequestering CO2 from the atmosphere and restore the ocean's health. In 2021, the National Academies of Science (NAS) evaluated six ocean-based carbon dioxide removal methods, including OIF, that potentially could be deployed to more rapidly sequester large amounts of atmospheric CO2 in response to climate change. According to the NAS,

> *Several manuscripts and reports have been written on the results of these OIF studies . . . and a consensus has been established that an increase in photosynthetic CO2 uptake can generally be achieved. As an ocean CDR approach, this open-ocean testing of the impact of Fe enrichment puts this method far ahead of others in terms of the knowledge base. (emphasis added)*

We know much about OIF, which mimics mother nature by adding trace amounts of iron dust (parts per trillion) to the ocean, similar to volcanic eruptions, aeolian dust storms, and deep ocean upwellings.[6] Because OIF stimulates phytoplankton growth, it can also help restore fisheries and other ocean creatures, such as ocean birds and whales, that are in decline due to reductions in phytoplankton and ocean productivity.

11. **How does OIF work to drawdown CO2 from the atmosphere**? Iron is an essential catalytic element necessary for phytoplankton photosynthesis and many areas of the ocean are iron-deficient. Thus, adding tiny amounts of this mineral helps algae grow and absorb large amounts of CO2. When CO2 is taken up by phytoplankton, CO2 from the atmosphere is pulled into the ocean to replace it.
As the base of the ocean's food chain, the new phytoplankton algae also help restore fish populations which consume a portion of it. Phytoplankton that dies before being consumed sinks into the deep ocean, where the absorbed carbon remains sequestered for hundreds and in some cases thousands of years. Krill, fish, crabs, whales, and the whole resulting food chain sequester carbon when animals respire, defecate, die and decay in the deep ocean. "Once dissolved in the ocean, a carbon atom will stay there, on average, more than 500 years, estimates Michael McElroy, Butler professor of environmental science." Nature has used this same process to cool the planet, creating 10 ice ages over the last million years.[7] OIF simply mimics nature and accelerates the process of carbon sequestration.

12. **Is OIF safe?** First, OIF mimics mother nature by adding trace amounts of iron dust (parts per trillion) to the ocean, similar to volcanic eruptions, aeolian dust storms, and deep ocean upwellings associated with increased marine productivity.[8] While some have speculated that OIF could have negative impacts, of the 13 OIF projects conducted since 1993, none have caused or contributed to a harmful algal bloom (HABs). Furthermore, there are no known cases of natural algal blooms in the deep ocean causing widespread harm to the ocean ecosystem. In the ocean, HABs are often associated with nutrient-rich waters, especially those impacted by agricultural runoff, sewer discharges, and other sources of

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[6] See Science, *How Volcanoes Feed Plankton*, available at: https://www.science.org/content/article/how-volcanoes-feed-plankton ; see also, *The Conversation, How Australia's biggest dust storm went on to green the ocean*, available at: https://theconversation.com/how-australias-biggest-dust-storm-went-on-to-green-the-ocean-47695; see also, *Phytoplankton response to an intense dust storm in the Tasman Sea in September-October, 2009*, available at: https://research.usq.edu.au/item/q2q4x/phytoplankton-response-to-an-intense-dust-storm-in-the-tasman-sea-in-september-october-2009

[7] See Carbon Brief, *Explainer: How the rise and fall of CO2 levels influenced the ice ages*, available at: https://www.carbonbrief.org/explainer-how-the-rise-and-fall-of-co2-levels-influenced-the-ice-ages/; see also Princeton Univ., *What caused the ice ages? Tiny ocean fossils offer key evidence,* 2020*,* available at https://www.princeton.edu/news/2020/12/10/what-caused-ice-ages-tiny-ocean-fossils-offer-key-evidence.

[8] See Science, *How Volcanoes Feed Plankton*, available at: https://www.science.org/content/article/how-volcanoes-feed-plankton ; see also, The Conversation, *How Australia's biggest dust storm went on to green the ocean*: https://theconversation.com/how-australias-biggest-dust-storm-went-on-to-green-the-ocean-47695; see also, *Phytoplankton response to an intense dust storm in the Tasman Sea in September-October*, 2009, available at: https://research.usq.edu.au/item/q2q4x/phytoplankton-response-to-an-intense-dust-storm-in-the-tasman-sea-in-september-october-2009

pollutants. HABs are most common in near-shore coastal waters where nutrients can accumulate and be carried by currents into shallow, confined areas, such as estuaries and bays, where water circulation is limited. Since OIF projects will involve close monitoring and performed in the deep oceans in iron-limited locations, OIF is not expected to cause any harm. As we learn more in the process of scaling up OIF, adjustments can be made to address any unintended consequences. The key to proceeding safely will require close monitoring of the ocean chemistry and biological response.

13. **What are the potential benefits of OIF?** Because OIF increases ocean productivity, it can serve as a nature-based solution to global warming by absorbing more carbon dioxide from the atmosphere through photosynthesis. It also can help increase fisheries productivity in parts of the ocean where phytoplankton are in serious decline.

14. **Can OIF increase fish populations, such as salmon?** Phytoplankton are the foundation of the aquatic food web, the primary producers, feeding everything from microscopic, animal-like zooplankton to multi-ton whales. Small fish and invertebrates also graze on the plant-like organisms, and then those smaller animals are eaten by bigger ones.[9] So, when OIF is conducted in the right location in the ocean, it will invariably help increase fisheries' productivity.

15. **Can OIF help other ocean creatures such as sea birds and whales?** Yes, there is growing evidence that the precipitous decline in ocean phytoplankton in parts of the ocean is having a negative impact on all trophic levels of the ocean, including sea birds and whales.[10] OIF can also potentially help endangered mammals, such as the Right Whale, which has been impacted by a recent, due to a sharp decline in phytoplankton in the Gulf of Maine.[11]

    Similar to plants, phytoplankton capture large amounts of CO2 and convert it to useable cellular energy. Not only does this remove carbon from the atmosphere, but it also produces food and oxygen that animals need to survive.[12]

16. **How does OIF work to increase salmon population?** Young salmon spend much of their life history in open ocean, often opting for ocean eddies, where circular currents are easier for the young fish to feed and live and avoid predation. OIF can specifically target the mesoscale eddies where these young fish are located, essentially resulting in increased food for the young.[13] NOAA maintains satellites that monitor the location of these eddies on an hour-by-hour basis.[14]

17. **Aren't algal blooms bad?** Under certain conditions, harmful algal blooms (HABs) can be detrimental to fish and other aquatic organisms creating low oxygen levels (e.g., hypoxia) or toxic conditions from, example, cyanobacteria. To date, all documented cases of HABs have occurred in freshwater lakes and

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[9] See NASA Earth Observatory, *What are Phytoplankton*, available at: https://earthobservatory.nasa.gov/features/Phytoplankton#:~:text=Importance%20of%20phytoplankton,-By%20Rebecca%20Lindsey&text=Phytoplankton%20are%20the%20foundation%20of,are%20eaten%20by%20bigger%20ones.

[10] See CBS News, *Gray whales are starving and dying off at an alarming rate along the Pacific Coast*, available at: https://www.cbsnews.com/news/gray-whales-starving-dying-pacific/; see

[11] See Press Herald, *Scientists link warming of Gulf of Mexico to decline in right whale's food supply*, available at: https://www.pressherald.com/2019/05/13/warmer-gulf-choking-off-right-whale-food-supply-researchers-find/

[12] See International Fund for Animal Welfare, *Whale poop and phytoplankton, the dynamic duo fighting climate change*, available at: https://www.ifaw.org/journal/whale-poop-phytoplankton-climate-change#:~:text=Similar%20to%20plants%2C%20phytoplankton%20capture,that%20animals%20need%20to%20survive.

[13] See NOAA, *Can You Catch More Fish When the Water Is Spinning*? https://www.fisheries.noaa.gov/feature-story/can-you-catch-more-fish-when-water-spinning; See also, *Effects of the Sitka Eddy on juvenile pink salmon in the eastern Gulf of Alaska*, available at: https://www.sciencedirect.com/science/article/abs/pii/S0967064517303879

[14] See NOAA, https://www.gfdl.noaa.gov/ocean-mesoscale-eddies/.

shallow coastal waters where water circulation is limited and excess nutrients from stormwater runoff occur. Importantly, not all algal blooms are bad and, in fact, phytoplankton blooms are critical to supporting aquatic and marine life and producing oxygen we breathe.[15]

18. **What is hypoxia and is there a risk that OIF will cause dead zones similar to what we are fighting against in the Chesapeake Bay and Gulf of Mexico?** Hypoxia refers to water conditions where the concentration of oxygen is so low (less than 2 ppm) that the conditions create "dead zones" where very few fish and organisms can survive. Hypoxia most often occurs in shallow estuaries and coastal waters from excess nitrates (e.g., >10 ppm) where water mixing and circulation is limited. There are many physical, chemical, and biological factors that combine to create dead zones, but nutrient pollution from agricultural runoff and sewage is the primary cause of those zones created by humans. There is no documented evidence of hypoxic conditions, natural or otherwise, ever occurring in the deep ocean. Since OIF is conducted in the deep ocean far from coastal areas with only parts-per-trillion of iron being added, it is highly unlikely that OIF will cause hypoxia.

OIF and Climate Restoration

19. **What is climate restoration?** Climate Restoration means restoring Earth's atmospheric CO2 to preindustrial levels (below 300 ppm, i.e., parts per million) which proved optimum for human survival.

20. **Is "net zero" sufficient to restore the climate?** While achieving net-zero emissions is important and will stabilize the climate, it will stabilize with CO2 levels 50% higher than humans have ever survived long-term, above 450 ppm. This is higher than any time in the last 4 million years. The stabilization goal from 1992 is now 30 years too late and we need to restore a historically safe climate. Until 100 years ago, the human-friendly CO2 level never exceeded 300 ppm. Therefore, in addition to halting any further CO2 emissions, we must draw down the CO2 already emitted. In research already completed, OIF has proven to be one of the most natural, safe and effective ways to do this.

21. **Why is OIF better at climate restoration than other carbon dioxide removal techniques?** OIF is the most effective CDR technique, based on three criteria to effectively restore the climate. First, it must remove carbon from the atmosphere permanently or nearly so. Second, it must be deployable on a scale commensurate with the problem. And third, it must be financeable/affordable. So far, OIF is one of the few strategies identified that meets all these criteria. It can remove carbon and store it away in the deep ocean for very long periods of time. It can be deployed on a scale sufficient to the challenge at hand. Lastly, implementing this strategy would use only minimal public funds to do additional research and fine tune the logistics of deployment. Thereafter, it would cost about $1 billion per year to remove 60 gigatons of CO2 annually and promises to pay for itself many times over in proceeds from a revitalized fishing industry.

[15] See Alaska Public Media, *Massive algae bloom in the Gulf of Alaska could be good for marine life, researchers say*, available at: https://alaskapublic.org/2021/09/16/massive-algae-bloom-in-the-gulf-of-alaska-could-be-good-for-marine-life-researchers-say/