Ocean nourishment sequestering carbon dioxide in the deep ocean

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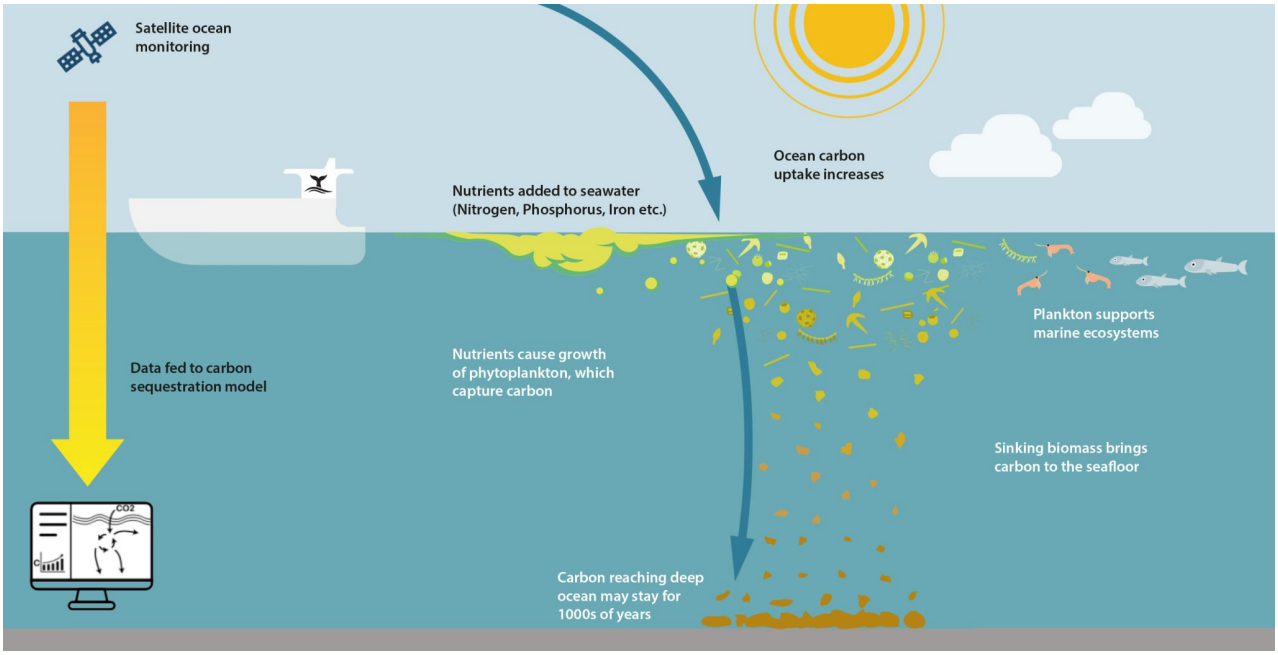

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Phytoplankton have been essential to life on Earth for over 35 billion years. Through photosynthesis, they consume carbon dioxide on a scale comparable to that of forests and other land plants. Edwina Tanner from the WhaleX Foundation shares insights on this and discusses the potential for plankton-based solutions in marine carbon dioxide removal (mCDR) and ocean nourishment

Great whales act as climate engineers, stimulating productivity by providing nutrients to microscopic phytoplankton, the planet's real climate giants.

Millions of tiny phytoplankton are critical components of the Earth's system, producing at least 50% of the oxygen we breathe and playing a crucial role in the global carbon cycle. They are the invisible forest that represents around 80% of the biomass in the ocean that is eaten or dies and then sinks as marine snow to sequester gigatonnes of atmospheric carbon dioxide annually. Measurements by satellites show that phytoplankton represent the 'fast' carbon cycle that operates on the scale of days to weeks compared to decades or centuries, as do the forests on land. The UN Plankton Manifesto recognizes the heavy lifting that phytoplankton do, outlining the triple planetary crisis – biodiversity, climate, and pollution that plankton-based solutions can address (United Nations, 2024).

Phytoplankton and carbon dioxide management

Phytoplankton use carbon dioxide via photosynthesis to convert chlorophyll, sunlight, and a variety of essential nutrients into energy while expelling oxygen. Primary production determines how much carbon is fixed in the ocean. The tiny plankton, plants (phytoplankton), and animals (zooplankton) that live in surface waters feed all the fish and marine mammals, including whales. If plankton are not eaten, then they aggregate, poop, or die and sink, exporting carbon to the deep ocean. One of the main nutrients that plants need to grow is nitrogen. But plants, including phytoplankton, can't take in nitrogen from the air the way they can absorb carbon dioxide or oxygen. In around 70% of the ocean, phytoplankton growth is limited by nitrogen in the form they can use, while in other places, iron or phosphorus, or a mixture of elements limit the growth of plankton. These places need geo specific targeted fertilisers to stimulate growth and maintain biodiversity.

Before commercial whaling, blue whales would have transported 24,000 tonnes of nitrogen as well as other nutrients via the whale conveyor belt. The ecosystem services provided by whales, injecting bioavailable nutrients into the surface waters, promote primary production that directly and indirectly sequesters carbon. Plankton are everywhere in the ocean and form the most important biological carbon pump on the planet. They also feed the bottom of the marine food chain upon which all marine life depends. Whale nutrient plumes (including faeces and urine) are rich in nitrogen, iron, and phosphorus, which are important nutrients for phytoplankton to grow. Thus, enhancing phytoplankton productivity via the release of nutrients similar to that of whale excrement increases the removal of carbon dioxide from the atmosphere, contributing to climate regulation.

A carbon pollution removal system

As climate change accelerates, there is increasing interest in the ability of phytoplankton to trap excess atmospheric carbon pollution using photosynthesis. Ocean Nourishment (Figure) is a plankton-based marine Carbon Dioxide Removal (mCDR) solution to the climate crisis. It aims to regenerate ocean ecosystems by purposefully placing nutrients back into the ocean where they are needed. Ocean Nourishment featured in the top 100 carbon removal solutions in the XPRIZE Carbon Removal global competition. The Ocean Nourishment solution fertilises the ocean with geo specific nutrients that are limiting phytoplankton growth at the bottom of the marine food chain, simulating what whales have been doing over the past 40 million years. This innovation looks to nature because nature has always figured it out first – and best – after millions of years of evolution.

The marine carbon cycle

Globally, the ocean's biological carbon pump transfers about 10.2 gigatonnes of carbon each year into its interior, removing its negative effects on climate (Nowicki et al., 2022). The carbon that sinks to the depths is effectively locked up for several thousand years. The ocean's biological carbon pump transfers the carbon from the surface ocean to the deep ocean by several distinct pathways, including gravitational settling of organic particles, mixing and circulation of suspended organic carbon, and active transport by

vertically migrating plankton. It is estimated that four times as much carbon is sequestered due to zooplankton faecal pellet sinking compared to phytoplankton aggregates. The complex biological interactions of zooplankton and phytoplankton in the environment are crucial to our understanding of the marine carbon cycle.

Plankton-based mCDR solutions

Plankton-based mCDR solutions are not only a method for sinking carbon in the ocean naturally but also provide co benefits in the form of regenerating ocean productivity and biodiversity while helping the climate. To develop plankton-based mCDR the solutions we need are to better observe plankton in their natural environment and better understand them in the laboratory. WhaleX is developing accurate, accessible technologies to do this, as well as models for looking at the dynamics of plankton today and forecasting what may happen in the future. Experiments with simulated whale excreta hold great potential for capturing carbon and giving a vital kick to the base of the marine food chain. There are still a lot of unknowns, such as how much carbon is sequestered at depth, as well as the amount of nutrients actually making it into the food cycle. These are questions that WhaleX is attempting to answer, together with the larger marine science community.

Conducting a series of experiments using a culture system (photobioreactor) provides a contained environment for incrementally and safely scaling up the Ocean Nourishment mCDR solution.

Phytoplankton, light drifters, have been fundamental to life on this planet for over 35 billion years, providing essential services that sustain our planet's health. Plankton are the canary in the coal mine, as fisheries, whales, and industry all revolve around plankton. Phytoplankton are the source of the oil and natural gas that we have consumed, which is the root cause of the current climate crisis, and they are what is going to help bring us out of this. In a nutshell plankton assure the health of our oceans which in turn ensures the health of our planet.

References

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2. Nowicki, Michael; DeVries, Tim; Siegel, David A. (March 2022). "Quantifying the Carbon Export and Sequestration Pathways of the Ocean's Biological Carbon Pump." Global Biogeochemical Cycles. 36 (3). Bibcode:2022GBioC..3607083N. doi:10.1029/2021GB007083.S2CID246458736.

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