JULY 4, 2019

BLOG

How Kelp Naturally Combats Global Climate Change

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When we think of kelp, we conjure up images of magical underwater forests. Recent research, however, suggests that in addition to creating beautiful habitats, macroalgae such as kelp play a large role reducing the effects of global warming. Kelp has an incredibly fast growth rate (up to two feet per day) and exports a large portion of its biomass out into the deep sea, allowing kelp to permanently remove carbon dioxide from the atmosphere. Removing carbon dioxide from the atmosphere will play a necessary role in preventing rising temperatures and future climate catastrophe.

Sequestering greenhouse gases

As the concentration of greenhouse gases such as carbon dioxide rise at unprecedented rates, people are focused on decreasing the amount of carbon dioxide we put into the air. While the most effective way of doing this is by reducing carbon emissions, experts increasingly think that this will not be enough. **According to the Intergovernmental Panel on Climate Change**, the leading international body on climate change, we need to actively remove or sequester away carbon dioxide from the atmosphere to achieve negative carbon emissions and prevent climate catastrophe. By 2050, we should plan to have net zero emissions, meaning that all carbon emissions need to be balanced by carbon removal.

One way to sequester carbon dioxide is using biology. When plants such as trees photosynthesize and grow, carbon in the form of carbon dioxide is removed from the atmosphere and converted into biomass, such as a branch or leaf on a growing tree. Although trees store carbon, this storage is vulnerable since deforestation or forest degradation release this carbon back into the atmosphere, undoing the benefits. When thinking about carbon sequestration, we need to focus on permanent solutions.

Coastal ecosystems sequester away surprisingly large amounts of carbon – they can sequester up to 20 times more carbon per acre than land forests. Marine plants that contribute to this carbon sequestration, such as mangroves and seagrass, live in rich soil. When these plants die, some of the leaves, branches, roots, and stems get buried underwater in the soil – and because of low oxygen concentrations underwater, the plant material can stay buried for decades or longer before breaking down and releasing carbon dioxide. Unfortunately, because the carbon is stored close to the shore, it can be easily disturbed by runoff, human activity, or storms and released back into the atmosphere sooner than it otherwise might have.

What makes macroalgae so special?

Unlike mangroves and seagrass, macroalgae such as kelp usually grow near the shore in rocky and eroding conditions where plant materials cannot get buried. Instead, bits of macroalgae get exported to the deep sea, where the carbon can be sequestered. Because the carbon from macroalgae is stored far away from the shore, it is less likely to be disturbed and returned to the atmosphere.

In addition to leaf-like structures and roots that we are generally familiar with, macroalgae have gas-filled bladders that help them float towards the surface where they receives more sunlight

for photosynthesis (Figure 1). These gas-filled bladders allow bits of macroalgae to float for long distances and be carried far away from where the macroalgae is grown. Because they contain unpalatable compounds, macroalgae remain mostly uneaten as they travels across the ocean. Eventually, the air bladders burst and the macroalgae sink down towards the deep-sea floor, where the carbon is thought to be sequestered away from the atmosphere for centuries (and potentially up to millions of years).

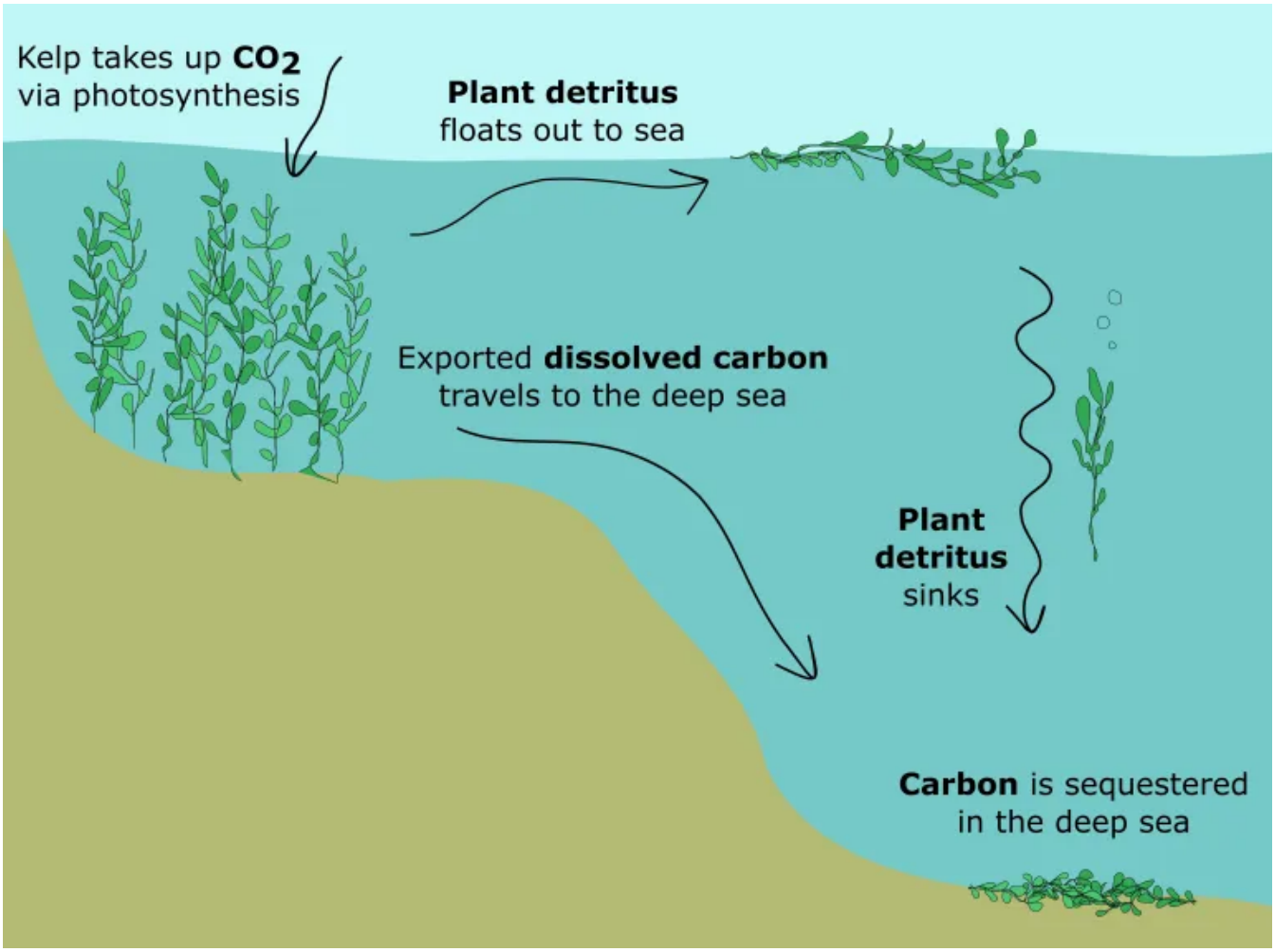

Figure 1: **Pathways for sequestration of macroalgae carbon into the deep sea.** As macroalgae grow, they removes carbon dioxide from the atmosphere. Most of the carbon sequestered by macroalgae is sent to the deep sea either in the form of dissolved carbon or in the form of plant detritus which easily floats out to sea thanks to gas-filled bladders. This figure was adapted from Krause-Jensen and Duarte, 2016.

From macroalgae found in the guts of deep-sea crustaceans, we have inferred for decades that macroalgae travel far from where they are grown and make their way to depths of over 6000 meters under water. The importance of macroalgae in sequestering away carbon has been overlooked until recently, however, because it is difficult to precisely measure how much carbon is sequestered and exported to the deep sea.

Research estimates of carbon sequestration by macroalgae

A paper published in 2016 in Nature Geosciences compiled data from previous studies in order to provide an estimate of how much atmospheric carbon is being removed by macroalgae. Their rough estimate suggests that around 200 million tons of carbon dioxide are being sequestered by macroalgae every year – about as much as the annual emissions of the state of **New York**.

These estimations, however, rely on indirect calculations. To improve the numbers on how much carbon is being sequestered by macroalgae, we need to be able to measure how much macroalgae ends up in the deep-sea. As macroalgae slowly degrade, they expel bits of DNA into the environment. Research groups are **planning** on **experimentally** measuring how much macroalgae gets buried each year by taking samples from the deep-sea and measuring the amount of macroalgal DNA.

Although carbon sequestration is necessary to slow climate change, carbon sequestration alone cannot prevent climate catastrophe unless we reduce our use of fossil fuels. Studies like this, however, highlight the importance of protecting valuable marine ecosystems such as kelp forests from environmental damage. As we decrease our use of fossil fuels, carbon sinks such as kelp forests will play a key role in getting us to net zero emissions.

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For more information:

- To read about carbon sequestration, check out **this article**.
- To learn more about the role of other marine ecosystems in sequestering carbon, read **this article**.
- **Here is a piece** about the role of macroalgae in carbon sequestration.

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