

# Carbon sequestration benefits of deep-sea deposition of Sargassum

## Beneficios de la deposición de Sargazo en aguas profundas para el secuestro de carbono

## Avantages de la séquestration du carbone par le dépôt de Sargassum en eaux profondes

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### EXTENDED ABSTRACT

#### INTRODUCTION

The Caribbean is highly impacted by both climate change and the recent massive increase in Sargassum inundations. Sargassum sequesters carbon dioxide from the surface ocean and potentially also directly from the atmosphere through photosynthesis. Roughly 183 kg of carbon dioxide (CO<sub>2</sub>) are sequestered as carbon inside each wet ton of Sargassum. When Sargassum decomposes on the beach or in landfills, it releases that carbon as methane (CH<sub>4</sub>) back into the atmosphere. Experiments and calculations done by Carbonwave showed that around 500 kg of CO<sub>2</sub>eq are released from a ton of Sargassum during this decomposition, making Sargassum a net emitter when left rotting on the beach or in landfills.

Companies that convert Sargassum into useful products can quantify the positive impact they have on the climate by preventing the release of methane from Sargassum in landfills. They can be accredited carbon credits from Gold Standard through the *Methodology for collection of Sargassum and other Macroalgae to avoid emissions from decomposition and to use for beneficial products*. Even more beneficial are approaches where the carbon in the Sargassum is sequestered for 100 years or longer. Transforming Sargassum into biochar locks at least half of the carbon in the Sargassum into the biochar for geological time scales. Accredited carbon credits can be obtained through Puro.earth's Biochar Methodology.

Some Sargassum naturally sinks to the deep sea, where it also sequesters the carbon for long time scales. As such it is one of the feedstocks considered for carbon storage through artificial sinking to the deep sea. Carbon credit verifiers as well as scientists and companies are currently assessing if the sinking of biomass to the deep sea is a viable pathway for carbon sequestration. One of the major unknowns is the environmental impact on the deep sea.

#### METHODS

To determine the possible environmental impact that sinking Sargassum could have on the deep sea, a literature review was conducted on Sargassum in the deep sea. A total of fifteen scientific publications were found on the topics of natural sinking of Sargassum, Sargassum biomass observed in the deep sea and interactions observed between deep sea fauna and Sargassum. The findings of these studies are summarized below. Only key papers are cited as not to exceed the 5-citation limit of the extended abstract format.

#### RESULTS

Sargassum's buoyancy comes from its aerocysts. The walls of the aerocysts can sustain pressure for a certain amount of time before they burst, leading to sinking of the Sargassum. If Sargassum is brought down to 30 m depth, aerocysts will stay intact for an average of 17 hours, while they will burst within a minute at 103 m depth (Johnson and Richardson 1977). When wind speeds reach 25 kt, Sargassum will be carried to 100 m depths through Langmuir downwelling, leading to natural sinking of Sargassum. Once the aerocysts are burst, Sargassum will sink at 2.8-4 cm/sec, reaching 5000 m depth in 40-41 hours (Backer et al. 2018).

Sargassum represents a potentially large and consistent carbon flux to deep-sea ecosystems which are generally limited in organic carbon (Baker et al. 2018). In the Sargasso Sea, four times as much Sargassum biomass is found on the deep-sea floor than at the surface ocean and 10% of the total particulate organic matter (POM) in its deep-sea community originates from Sargassum. Similarly, in the Gulf of Mexico, Sargassum was the most common natural ocean-produced material found on the seafloor during surveys done at 200-3000 m depth. Furthermore, a recent study counted Sargassum observations per 100 m of deep-sea floor survey. They found Sargassum 1.4-4.11 times per 100 m survey in the Gulf of Mexico, 3.32-11.23 times in Puerto Rico waters and 0-2.25 times off the coast of Florida and North Carolina (Pries et al. 2023). Observed Sargassum were found to be generally well preserved (Baker et al. 2018) including clumps of varying sizes and varying degrees of degradation. Even in sediment cores, Sargassum blades as well as a high concentration of decomposing Sargassum were found. These findings indicated either a steady sedimentation rate that replaces degraded materials, or a very slow degradation rate.

Of the fifteen studies found during this literature review, eleven studies reported faunal interactions with Sargassum. Across all studies, twelve species were identified to interact with Sargassum. Only three of the 237 observed Sargassum

pieces by Pries et al., 2023 (1.7%), had fauna interacting with it, indicating that faunal interactions are rather rare. However, one species found to specialize in Sargassum, *Bathypsurus nybelini*, was found carrying Sargassum in 19 of the 32 observations of the species by Peoples et al., 2024. This deep-sea species is morphologically adapted to feed on Sargassum using large paddles for a specialized swimming stroke and mouthparts for tearing. Its gut microbiome can degrade macroalgal polysaccharides and fix nitrogen, helping it in digesting Sargassum (Peoples et al. 2024).

The only experimental Sargassum deployment ever done, placed Sargassum together with a camera for 48 hours at 5160–5550 m depth (Fleury and Drazen 2013). The isopod *Bathypsurus* sp. was observed to remove Sargassum pieces while an ophiuroid was observed handling a piece of Sargassum for 30 minutes (Fleury and Drazen 2013), likely feeding on it. Polychaetes and amphipods were observed on the Sargassum and *Barathrites* sp. was observed swimming under Sargassum (Fleury and Drazen 2013). Four additional species (cf *Hymenopenaeus*, *P. armatus*, galatheid crab and an unidentifid Orphidid) were found around the bait (Fleury and Drazen 2013).

### CONCLUSION

Because Sargassum sinks naturally to the deep sea and is abundant on the deep-sea floor, sinking of Sargassum for carbon sequestration could work without major environmental impacts. However, our knowledge of what happens to Sargassum in the deep sea is limited and mainly based on observational studies. More studies, specifically long-term experimental studies are needed to measure possible environmental impacts and Sargassum degradation rate.

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KEYWORDS: Faunal interaction, Sinking speed, Carbon deposition, biochar, Decomposition rate.