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Commentary

Intensive Clam Harvesting and Loss of Surface-Deposited Carbon Stocks in Seagrass Meadows

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DESCRIPTION

The numerous benefits that seagrass ecosystems offer, such as carbon sequestration, support for fisheries, and water filtrations, among others, make them valuable. However, anthropogenic effects, including coastal development, poor water quality, and physical disruption from fishing activities, have caused seagrass meadows to diminish over the past few decades. Bivalve harvesting is a type of fishing that takes place in subtidal and intertidal soft-bottom substrates that are frequently inhabited by seagrass meadows. Bivalve collecting has historically been a viable industry, but current intense shellfish bed exploitation has made it more likely that it may interact negatively with seagrass meadows. In addition, the physical disturbance caused by raking, trampling, and digging during bivalve harvesting reduces the biomass of seagrass.

Seagrass meadows, together with salt marshes and mangroves, contribute to climate change mitigation through carbon sequestration in the current context of global warming and the urgent need to apply mitigation techniques as per IPCC, 2019. The mitigation is predicated on these ecosystems' capacity to absorb atmospheric CO_2 and permanently store large amounts of organic carbon (C_{org}), commonly known as "blue carbon," in their sediments. Seagrass meadows reduce the speed of currents and waves, trapping debris and promoting the deposition and buildup of fine sediments beneath their canopies. Large volumes of organic carbon are quickly prevented from remineralizing by the "fine particles," favouring the growth of an anoxic environment. Seagrass meadows are among the most effective biomes for carbon sequestration because they may accrete vertically, allowing storage of vast stocks of carbon beneath their canopies. Due to their role in reducing atmospheric carbon emissions, coastal blue carbon habitats in the European Union are commercially valuable (estimated at 180 million US dollars in 2013). The erosion and oxygenation of the underlying sediment are accelerated by human activities that destroy and remove seagrass canopies, which cause remineralization and the release of organic carbon from the sediments into the atmosphere. The projected 0.15 Pg CO_2 emitted annually due to seagrass depletion has a severe impact on the environment, society, and economy (costing $ 6.1 billion annually in 2007 US dollars).

Bivalve harvesting on foot occurs in intertidal regions throughout the Atlantic and Cantabrian coasts of the Iberian Peninsula where shellfish beds and seagrass meadows, primarily made up of *Zostera noltei* Hornemann and occasionally interspersed with a few patches of *Zostera marina* Linnaeus, coexist. When *Z. noltei* canopies are subjected to clam harvesting, they are purposefully covered with sand to construct clam farms, which causes them to be broken up or removed owing to trampling, uprooting, and digging. As shown in a subtidal *Z. marina* meadow in NW Spain, where clam harvesting caused a 50% fall in sedimentary C_{org} stocks, these effects could lower the sedimentary carbon stores.

There are still some unanswered problems regarding the generalization and magnitude of how clam harvesting affects blue carbon stores in seagrass meadows, and it is unknown how different harvesting intensities would affect the C_{org} stocks. The spatiotemporal fluctuation of the carbon content in the surface sediments of *Zostera* spp. meadows may have an impact on how the sedimentary C_{org} stocks react to clam harvesting. Although *Z. noltei* is found along the eastern Atlantic coast, its blue carbon reserves are underrepresented in the worldwide estimations of carbon storage. This variability of C_{org} stocks is also apparent in the different seagrass species. Furthermore, as *Z. noltei* is a small coloniser seagrass with a faster rate of development than larger European seagrasses, it is unknown how its cover would rebound after being disturbed by clam harvesting.

Comparing highly impacted areas to control areas, the sedimentary C_{org} content and C_{org} stocks were approximately 4 times lower in the highly damaged areas. The C_{org} stocks in the affected areas were also damaged by the level of harvesting pressure. In comparison to control areas, the water content tends to be lower in affected locations. Because stocks increased in control regions but not in harvested areas, the effect of clam harvesting on the surficial sedimentary C_{org} stocks generally increased throughout the growing season. Significant drops in the C_{org} stocks in affected areas at the start of the growing season, in March. However, as the growing season progressed

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between May and October, C_{org} stock levels were somewhat or significantly reduced in affected locations. Increased imports of allochthonous (organic matter not generated from seagrass) and autochthonous (organic matter produced from seagrass) organic matter near the end of the growing season may be responsible for the rise in surficial sedimentary C_{org} stocks in control regions. Small, rapidly growing seagrass species provide less autochthonous carbon to the sediment than do bigger seagrass species, but as the growing season progresses, the meadows become denser and more productive, which can result in higher inputs of autochthonous matter to the sediment.