The application of longline mussel aquaculture to establish subtidal reefs: Nature-based solutions in coastal defense

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As the pressures on coastal communities increase due to climate change, there's a growing need for coastal protection that is resilient, adaptable, and ecologically beneficial. In recent years, nature-inspired designs have been recognized as possible sustainable solutions to safeguard the coasts from erosion, floods and storms. The Coastbusters project aims to develop such a solution by adapting a traditional aquaculture technique to establish mussel beds of the coast of Belgium. In order to facilitate this bed development, a longline aquaculture technique was adopted where dropper lines were hung into the water column to collect mussel spat. Instead of harvesting the mussels from the dropper lines after reaching commercial size, the mussels were left growing on the lines until they became too heavy and fell on the seabed, initiating the formation of a mussel bed. This technique provides a constant supply of mussels to the seafloor to help combat the external pressures associated with such a harsh environment.

This work aimed to analyze the success of the Coastbusters bivalve reef set-up on establishing a mussel bed as well as the potential effects it might have on surrounding infaunal communities. Hence, four questions were put forward: (1) Did a mussel bed evolve under the dropper lines? (2) Which environmental pressures were encountered? (3) Which dropper line material and structure was found to be most suitable in order to create the mussel bed? (4) Did infaunal communities change at the reef site? To answer these questions, the state of the different dropper lines and the seabed was recorded in-situ by divers seasonally after the installation of the dropper lines. Additionally, dropper lines of different materials and designs were removed, and the attached mussels were gathered and analyzed in the lab. Van Veen samples were taken according to a BACI - design under the dropper lines and in two control sites. Video fragments were qualitatively analyzed while dropper line and Van Veen samples were quantitatively analysed. From the video surveys it was apparent that mussels had successfully settled on the bare sediment in a high-energy environment. However, a seasonal variability was determined in the presence of the mussel patches, being most abundant in late summer, early fall and absent during winter and spring months.This variability suggests that storms and strong wave action associated with winter months could have wiped out the young mussel patches. Predation might be another explanation to the sudden disappearance of mussel patches, as many predators, such as *Asterias rubens* and *Cancer maenas*, were observed feeding on the mussel beds. The two different dropper line designs tested were a filamentous and non-filamentous design. The filamentous design hosted the highest number of mussels, but at a smaller size-class. The non-filamentous designs had a smaller number of mussels but at a larger size class. A structure incorporating both designs may be the best in future iterations, to take advantage of the high recruitment capabilities of the filamentous dropper lines and the ability of the non-filamentous dropper lines to foster larger mussels that are more robust and can resist predation. No significant changes in infaunal communities were detected between the reef and control sites. With a trend towards lower diversity and a higher abundance of oligochaetes in the reef site, the first effects of organic enrichment by the mussels might become clearer in the long term.

This study will help future projects to create mussel reefs effectively in a high stress environment, leading to novel nature inspired solutions to protect our coastlines.

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