

Variation in ecosystem services within biogenic reefs: The role of reef-building species under distinct hydrodynamic conditions

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There is an urgent need to implement sustainable solutions to build climate-resilient coastlines as climate change makes coastal areas more vulnerable to erosion and flooding. To achieve this, Nature-based Solutions (NbS) such as biogenic reefs, mangroves, and dunes are proposed. In addition to coastal protection, NbS provide many other benefits, including biodiversity and a range of ecosystem services (ES) such as food (e.g., seafood), carbon sequestration, and recreational opportunities. This study, part of the Coastbusters 2.0 project (2020-2023), investigated biogenic reefs and how reef-building species (i.e., *Mytilus edulis* and *Lanice conchilega*) provide ES under distinct hydrodynamic conditions. A total of three ES were quantified at two sites in the Belgian part of the North Sea (near De Panne): (1) coastal protection, (2) carbon sequestration, and (3) water quality regulation. One of the sites, 2 km from the coast, is protected by a sandbank, while the other, 5 km from the coast, is unprotected and therefore more exposed to hydrodynamics. Quantification (and monetisation) was carried out using the SUSTainable Marine Ecosystem Services (SUMES) model, based on in-situ measurements (bathymetric, sedimentological, and biological data) and literature data. The results suggest that many factors, including hydrodynamic conditions, influence the provision of ES in biogenic reefs.

(1) Sediment stabilisation was only observed under low hydrodynamic conditions due to the higher settlement success of *M. edulis* and the presence of *L. conchilega*.

(2) *M. edulis* "produces" carbon under both low and high hydrodynamic conditions due to high respiration and biocalcification. However, low hydrodynamic conditions are more conducive to carbon burial, thereby promoting carbon sequestration.

(3) *M. edulis* patches showed higher denitrification rates under low hydrodynamic conditions compared to both high hydrodynamic conditions and *L. conchilega* patches due to divergent macrobenthic functional diversity.

In addition to environmental conditions (e.g., hydrodynamics), this study shows that the provision of ES in biogenic reefs differs between reef-building species. Reef builders show differences in temporal and spatial variation and physiological characteristics, both of which determine the degree of ES provision. These aspects need careful consideration when planning coastal protection measures and determining ES provision values.

Keywords

Nature-based Solutions; Biogenic Reefs; Ecosystem Services; Coastal Protection; *Mytilus Edulis*; *Lanice Conchilega*