How do different human activities affect functional diversity in soft-bottom macrobenthos?

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There is an increasing awareness that knowledge of the functional diversity of a community is key to understand how the community responds to environmental and anthropogenic stressors. It is also expected that indicators derived from biological traits could be more suitable to quantify the sensitivity of benthic communities and can be used to detect changes in ecosystem functioning within environmental impact assessments. The Belgian Part of The North Sea (BPNS) represents a highly dynamic area that is subject to a variety of human activities. Within this study, three different physical impacts -dredge disposal, sand extraction and offshore wind energy– were used to assess differences in functional diversity of macrobenthos communities between impact- and reference areas.

A total of ten traits were selected, subdivided in 47 modalities, incorporating both response- and effect traits. Functional diversity was then quantified by calculating different indices: functional richness, functional divergence, functional evenness, functional dispersion and Rao's quadratic entropy. Shifts in trait composition due to anthropogenic pressure were determined by Fuzzy Correspondence analysis (FCA). Based on a ranking list of the response and effect traits in the FCA across impact and disturbance levels, the sensitivity of the 10 traits was evaluated. The analyses were performed on data from 2006-2016 at five dredge disposal sites, from 2004-2016 at three main sand extraction areas and from 2017-2018 at two offshore wind farms (C-Power and Belwind).

Results revealed that under chronic disturbance such as high dumping or extraction, the functional diversity indices showed a clear response, especially in terms of functional richness. However, variations (decrease/increase) in index values were found between sites of the studied impact areas. Within the offshore wind farms, findings for the functional diversity indices were less pronounced and also seem to vary between impact areas (C-Power vs. Belwind). Nevertheless, in the FCA, a shift in trait composition was observed towards more species that had an attached lifestyle. This is in contrast with the dredging sites, where a shift towards free-living species was observed, and at the extraction sites, which had a bigger proportion of species living at the surface level. A general trend for the three impacts is the shift towards a dominance of small-bodied, short-lived species without a larval stage.

The different types of impacts and levels of disturbance provided the ideal platform to assess the potential of biological trait-based indicators. While responses appear to be complex and case-dependent, results from this study show that the implementation of this type of analysis should be considered as a complementary tool in future environmental impact assessments.

Keywords: Functional diversity indices; Macrobenthos; BPNS; Dredging; Sand extraction; Offshore wind farms; Fuzzy correspondence analysis