Assessing morpho-sedimentary and benthic recovery dynamics after intensive aggregate extraction on tidal sandbanks

López López Lucía[1], Degrendele Koen[2], Roche Marc[2], Barette Florian[2], Van Lancker Vera[3], Terseleer Nathan[3] and De Backer Annelies[1]

[1] ILVO Marine Research, Flanders Research Institute for Agriculture, Fisheries and Food (ILVO), Jacobsenstraat 1, 8400 Oostende, Belgium
E-mail: lucia.lopezlopez@ilvo.vlaanderen.be
[2] Continental Shelf Service, Federal Public Service Economy, Boulevard du Roi Albert II, 16, 1000, Brussels, Belgium
[3] Directorate Natural Environment, Royal Belgian Institute of Natural Sciences, Vautierstraat 29, B-1000, Brussels, Belgium

Marine sand and gravel extraction plays a crucial role in supplying raw materials for construction and coastal protection. However, this activity profoundly impacts the marine environment, altering seabed structure and benthic biodiversity. While the immediate ecological effects of aggregate extraction are well-documented, the recovery dynamics following extraction cessation remain less understood. This study addresses this knowledge gap by examining the recovery of morpho-sedimentary characteristics and macrobenthic communities in two closed extraction zones in the Belgian Part of the North Sea (BPNS): Buiten Ratel (BR) and Thorntonbank (TB), both of which experienced intensive extraction over several years.

The analysis is based on long-term monitoring data from multibeam surveys and grab sampling, collected over time and starting two years before cessation and continuing up to eight years post-closure at BR and two years post-closure at TB. Recovery trajectories were evaluated using physical parameters (bathymetry, backscatter, dune characteristics, seabed mobility, and sediment granulometry) and biological metrics (community composition, species richness, density, and biomass).

Extraction-induced seabed depressions persisted in both zones post-closure, with no evidence of natural infill. Despite this, extraction tracks gradually disappeared, accompanied by the reformation of sand ripples and localized sediment reorganization. These changes led to an increase in medium sands (250–500 µm) and a reduction in coarse material (>1600 µm). This shift in sediment composition triggered cascading effects on benthic communities, which progressively shifted towards the medium sand community observed at reference locations. In the dynamic sandy environment of the BPNS, this process of morpho-sedimentary and benthic recovery required approximately 4 to 8 years at BR. At TB, with only two years since closure, significant recovery has yet to occur, though early trends mirror those at BR.
Our findings demonstrate that intensively extracted areas in dynamic sandy environments can recover to reference conditions over time. The results also underscore the importance of integrating physical and biological data to deepen our understanding of recovery processes, revealing the interplay between morpho-sedimentary dynamics and benthic recolonization. These insights provide critical contributions to evidence-based marine resource management strategies in the BPNS, supporting the long-term health of essential marine ecosystems.

Keywords
Sand Extraction; Post-extraction Recovery Dynamics; Macrobenthic Communities; Morpho-sedimentary Characteristics; Belgian North Sea

Pre-doc presentation