Modeling dispersal and spatial connectivity of macro-invertebrates in Danish waters: An agent-based approach

Marine organisms with planktonic life stages are subjected to extensive transport that results from the interactions between ocean currents and their behavioral responses to environmental changes in the course of their life. Questions remain on the identification of key drivers of dispersal and connectivity in marine populations as they can have multiple uses in the conservation and management of marine ecosystems. Here we investigate whether the open Kattegat, at the entrance to Baltic Sea, is the main source of recruitment to the benthos in associated estuaries and coastal sites through export of planktonic invertebrate larvae. We couple a 3D hydrodynamic ocean model (MIKE3FM) to an agent-based model and simulate the dispersal of macro-invertebrate populations in Danish waters. We use characteristic dispersal traits of the larval community (pelagic larval duration, spawning season, and settling behavior) and simulate dispersal processes within the muddy bottom habitats to derive recruitment rates and potential donor populations leading to population connectivity patterns on each site, one bay and two Danish fjords. We then use our recruitment results in the bay to compare them with field data on species diversity in the same area. A total of 48 different combinations of pelagic larval durations and spawning seasons of macro-invertebrates are simulated in two years 2004 and 2010. From these results, we conclude that the central and southern parts of the Danish waters are identified as important spawning grounds whereas the Kattegat does not seem to be the main provider of larvae into the selected sites. The model also predicts higher abundance and recruitment rates of macro-invertebrate larvae in 2010 compared to 2004. These results are supported by comparable species distribution data collected in the study area. Our results show the importance of an integrated modeling tool combining ocean circulation and biological traits to obtain a detailed description of dispersal and connectivity of macro-invertebrate community in the area, which can provide a more accurate baseline to manage marine biodiversity.

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