Do man-made structures impact the connectivity patterns of hard substrate species in the North Sea?

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Man-made structures such as wind farms proliferate in the North Sea, possibly acting as stepping stones for fouling species and hence allowing species to expand their distribution range over large distances. Effective marine management requires the understanding of how (artificial) hard structures are ecologically connected and what processes influence larval retention and dispersal. The transport of marine organisms from the spawning grounds to settlement areas is driven by hydrodynamic processes. However, the final dispersal pattern, larval survival and successful settlement of the larvae are affected by environmental factors, physiology, behaviour and reproductive strategies (spawning period areas). Biophysical models help assessing the dispersal potential of marine species during their pelagic phase.

**Introduction**

Artificial man-made structures could be settlement areas that arrive first from the coastal areas, larval export would occur with 22, 6 and 19 connections out of the 64 possible for mussels, oysters and limpets respectively.

**Methods**

We use a larval transport model coupled to a 3D hydrodynamic model adapted from [1] for three species with different life traits: Mytilus edulis, Ostrea edulis and Patella vulgata.

Simulations:

1) **Coastal release**: eggs are released from the coastal spawning grounds to assess the potential of wind farms to be colonised by coastal (natural) populations.

2) **Wind farm release**: eggs are released from the wind farm areas to assess the potential connectivity between them.

**Results**

**Dispersal**: For the coastal release, the oyster larvae dispersed less than mussels and limpets, which dispersed into the whole area, except far offshore.

**Connectivity**:

- For mussels, all wind farm areas received larvae from the coastal areas. For oysters, only the wind farm areas close to the coastal areas where spawning occurred received larvae. For limpets, no larvae arrived in the GE_2 area. For the three species, in areas where larvae have a mixed origin, the relative contribution of the different spawning areas was different.
- All wind farm areas could exchange larvae. The BE-NL settlement area is isolated for oysters and limpets whereas no local retention was found for mussels in this area. In NL, GE_1 and GE_2, there was a mixed origin of the larvae.

**Stepping stone**:

- Larvae spawned in the coastal areas ("natural populations") reached all wind farm areas for mussels; all wind farm areas except GE_2 for limpets and reach NL, BE-NL, FR, SUK and EUK for oysters. Retention was high for the EUK area for the three species.
- When larvae are released from wind farm areas where larvae arrived first from the coastal areas, larval export would occur with 22, 6 and 19 connections out of the 64 possible for mussels, oysters and limpets respectively.

**Conclusions**

- Artificial man-made structures could be settlement areas and could act as stepping-stone for the 3 species.
- Significant differences of connectivity between species
- Testing stepping stone hypothesis on several generations
- Comparison with genetic analysis

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