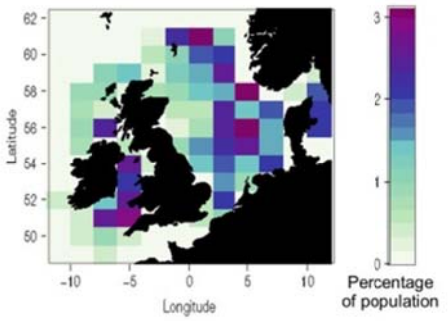
Strathclyde Spatial Population Dynamics Model (StrathSPACE)



Model type: StrathSPACE is a framework for simulating the combined space and size structured dynamics of a single-species marine population, incorporating the effects of birth, death, growth, active migration and passive transport by water currents. This is achieved by modelling the transfers of numbers of individuals between and along sequences of size classes at each spatial location in a grid covering the model region. Transfer of numbers between different spatial locations to represent active migration or passive drift due to water currents are calculated from the outputs of particle tracking models, which are run separately beforehand. These make use of water flow data and environmental conditions simulated by 3-dimensional hydrodynamic models. Typically, StrathSPACE models are hand-tuning by adjusting a small number of key parameters (2-5) so as to achieve a best-match between model results and observed data. The tuned model is then been compared with other 'independent' data that were not involved in the tuning to check for consistency. Details of the fitting procedures are application-specific and depend on the availability of observed data.

Existing Models for UK shelf seas:
StrathSPACE models are defined in terms of both their geographic domain, and the species that they represent. In terms of geographic domain, models exist for a) the whole North Atlantic (40°N – 80°N) at ~50km spatial resolution, b) the eastern North Atlantic at ~30km resolution, c) the northwest European shelf (North Sea, west of Scotland, Celtic Sea, (48°N – 62°N) at ~30km resolution, d) northwestern North Sea (56°N-60°N) at ~ 20km resolution. All of these models cover UK waters. In terms of the species represented, the North Atlantic models represent population dynamics of the copepods *Calanus finmarchicus* and *Calanus helgolandicus*. The eastern North Atlantic model represents the blue whiting stock and fishery. European shelf models have been configured to simulate haddock and cod populations and fisheries, whilst the northwestern North Sea model represents sandeels.

Existing uses:
- North Atlantic model - simulating the population dynamics of the copepods *Calanus finmarchicus* and *Calanus helgolandicus,* assessing the spatial connectivity of their populations, and their spatial responses to warming[1].
- Eastern North Atlantic model - modelling the effects of large scale changes in Atlantic circulation on the population dynamics and fishery yields of blue whiting.
- European shelf model – modelling the spatial population patterns and spatial fishery harvesting strategies for haddock and cod; modelling the displacement of fishing effort from small scale closed areas as a conservation measure that contributed to development of the Cod Recovery Plan in the North Sea[2].
- European shelf model – assessing the population consequences of genetic structure in North Sea cod[3].
- Northwestern North Sea model – simulation the spatial population dynamics of sandeel[4][5]

Potential new uses:
- Modelling the population dynamics of scallops in the North Sea in relation to closed areas and wind-farms.
- Modelling the spatial distribution and productivity of mesopelagic fish and crustaceans in the North Atlantic.

Key modelling issues:
So far, each StrathSPACE application has been a project in itself requiring careful configuration, re-coding and testing. The basic code has evolved considerably but the latest version (eastern North Atlantic blue whiting) is close to a state in which it could be regarded as a 'package' which can be configured to represent any relevant species in any domain. The key factor governing the model domain is the availability of external driving data for the particle tracking from a suitable hydrodynamic model.

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[1] Speirs et al. (2006). Mar. Ecol. Prog. Ser. 131, 183-192.
[2] Andrews et al. (2006). Can. J. Fish. Aquat. Sci. 63, 1027-1048.
[3] Darby et al. (2006). Defra Reference: SFCD15, Cefas Contract report, p62-75.
[4] Heath et al. (2014). ICES J. Mar. Sci. 71, 794-807. (published online 17 Nov 2013).