Modelling larval migration in continental shelf seas

Supervisors

Jeff Polton, Alex Souza, Leonie Robinson (School of Biological Sciences, UoL)

Background

Increased pressure on the UK shelf seas from shipping, fishing and wind farm construction has led to increased pressure on the marine ecosystem. Strategic management of the marine environment is essential for both commercial as well as environmental reasons. Marine spatial planning will become one of the key strategic tools used by the UK government, through the Marine Management Organisation (MMO), and it is therefore of great importance that the spatial dynamics of the biological components of ecosystems are also well understood. At the same time, the UK government is committed to implementing a network of marine protected areas by 2012, and there is a real need to increase our understanding of ecological connectivity between protected areas in order to advise on suitable networks. Theory would suggest that the nodes (protected sites) of a network need to be linked ecologically in such a manner so that there is sufficient exchange between them to reduce the impact of say, disease or a pollution event in one node, but sufficiently isolated so that the protected status does not over restrict legitimate use of the seas.

Much of the research investment to date on understanding spatial dynamics of marine ecosystems, has been focused on single species, usually of commercial or conservation importance. Larval studies have also tended to use rather simplistic physical models to underpin the patterns of dispersal. Here we will use state of the art numerical simulations of the UK shelf seas, to investigate the ecological connectivity of different habitats, exploring the effects of local and regional variation in physics (e.g. tidal, density and wind-driven currents) and biota (e.g. interspecies variation in larval type).

Hypothesis

Our aim is to investigate the role of complex 3D flows on larval dispersal, and how this varies for different habitat types and regions of the UK shelf seas.POL is uniquely positioned to make a major contribution in this area, with support from its large modelling group, the project would use the locally developed Proudman Oceanographic Laboratory

Coastal Ocean Modelling System (POLCOMS), see for example Holt (2008), a parallel computer code specifically designed to simulate the shelf sea processes needed to assess the state of the ecosystem in UK coastal waters. The figure shows an example of the high resolution structures simulated by POLCOMS. POL also has all the benefits associated with being on the University of Liverpool campus.

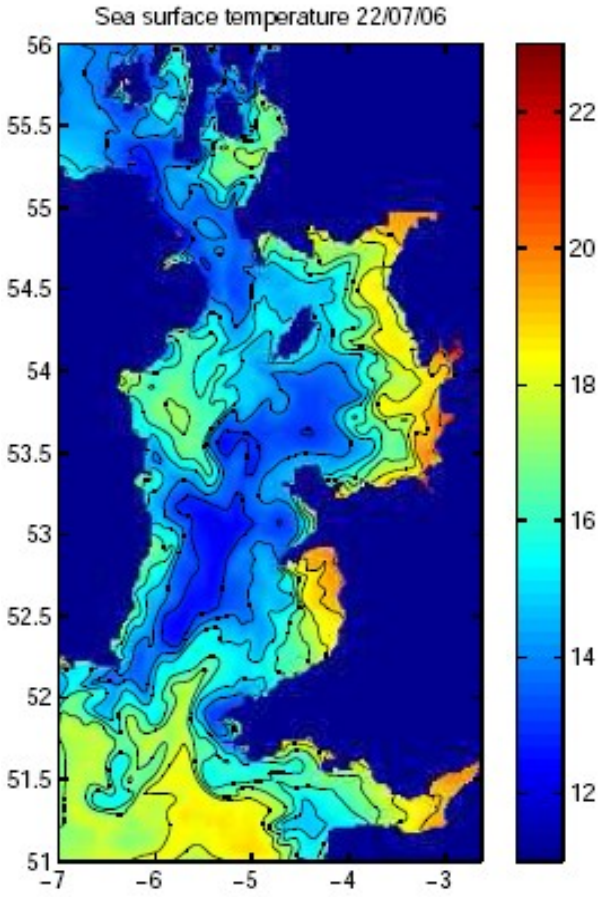

Figure 1. An example of the POLCOMS model high resolution output for the Irish Sea. Sea surface temperature simulated for 22 July 2006 on a 1.8km grid with 32 vertical levels.

Workplan

Year 1 – 2D tracers

Classes.

Become familiar with the POLCOMS model.

Literature review.

Dispersal of passive tracer (benthic larvae) in 2D POLCOMS using Lagrangian tracers.

Generate a map for UK waters showing dispersion pathways of fish larvae.

Year 2 – 3D tracers

Implement a 3D tracer algorithm. In particular how do initial depth of tracer, settling velocities, diffusion of tracers and convection events affect the fate of tracer position?

Compare the trajectory algorithm technique with concentration dispersal techniques as used in ecosystem model, ERSEM.

Investigate the trajectories from particular benthic assemblages in a number of different locations around the UK shelf seas.

Year 3 - Marine spatial planning

Investigate the impact of different network scenarios for marine protected areas around the UK, on the ecological connectivity of benthic habitats and their species.

Training provided

The student will participate in the training programme of the Department and University, as well as any appropriate courses offered at the Proudman Oceanography Laboratory. The project will provide experience in numerical modelling techniques, from coding to visualisation. The supervisors will also provide guidance in the development of a solid grounding in both the ecological theory and applied aspects of marine management required to appreciate the wider context of this project.

Applicants should have skills in a numerate science, such as physics, mathematics, physical oceanography or meteorology, and an enthusiasm to engage in numerical modelling. Previous knowledge of ocean sciences is not essential. At least some exposure to computer programming is essential. A successful candidate will display a willingness to engage with the ecological aspects of the problem though no previous experience or training is expected. Natural Environmet Research Council eligibility can be found at: http://www.nerc.ac.uk/funding/available/postgrad/eligibility.asp

Recent publications relevant to the research area

Some background reading for interested students:

Holt, J., and R. Proctor (2008), The seasonal circulation and volume transport on the northwest European continental shelf: A fine-resolution model study, *J. Geophys. Res.*, 113, C06021, doi:10.1029/2006JC004034.

Kinlan, B.P. and Gaines, S.D. 2003. Propagule dispersal in marine and terrestrial

environments: a community perspective. *Ecology*. 84: 2007-2020.

Marine Spatial Planning Pilot. Final Report (Feb 2006)
http://www.abpmer.net/mspp/docs/finals/MSPFinal_report.pdf

Palumbi, S.R. 2003. Population genetics, demographic connectivity and the design of marine reserves. *Ecological Applications* 13(1): 146-158.

van der Molen, J., Rogers, S.I., Ellis, J.R., Fox, C.J. and McCloghrie, P. 2007. Dispersal patterns of the eggs and larvae of spring-spawning fish in the Irish Sea, UK. *Journal of Sea Research*. 58: 313-330.