Models of fish migrations of pelagic fish in the North Atlantic

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Some pelagic fish species such as capelin (Mallotus villosus) and herring (Clubea harangus) undertake extensive migrations covering distances of several hundred miles. We present discrete and continuous density models of fish migrations and spatial distributions where the movements of the fish are governed by factors such as the velocity of neighbouring fish, environmental factors such as sea temperature and/or food density, attracting regions such as spawning regions, random perturbations and influences of boundaries such as isotherms. The fish movements are modelled as an interacting particle system subject to the influences of external gradient fields in the discrete case and in the continuous case by a Kolmogorov type PDE for probability density where the direction of the velocity vector is given by the gradient of a "comfort function". This comfort function incorporates such factors as temperature, food density, distance to spawning grounds etc, which are believed to affect the behaviour of the fish.

The discrete model is to some extent motivated by observed feeding and migrating patterns of pelagic fish species such as capelin and herring. The fish move randomly in small schools with no net transport on the feeding grounds, but as a coherent group when migrating to spawning grounds. This behaviour can be imitated in the models by varying the magnitude

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of the noise. The direction of motion can be selected by introducing "directional noise" i.e. a skewed pdf for the random perturbations. The model simulations will be compared to observed spatial distribution of capelin in Icelandic waters and some parameters of motion estimated. We also discuss how a complex migration model can be reduced to a simpler one which is based on the concept of migration matrices.

References

[1] Simon Hubbard, Petro Babak, Sven Th. Sigurdsson and Kjartan G. Magnússon: A model of the formation of fish schools and migrations of fish. Ecological Modelling (in press)

[2] Kjartan G. Magnússon, Sven Th. Sigurdsson, Petro Babak, Stefán F. Gudmundsson and Eva Hlín Dereksdóttir: A continuous density Kolmogorov type model for a migrating fish stock. Report of the Science Institute, University of Iceland. RH-24-2002.