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MODEL STUDIES OF FISH EGG AND LARVAL TRANSPORT IN THE KATTEGATT AND THE NORTH ATLANTIC

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Akademisk avhandling för filosofie doktorsexamen i **Oceanografi**, som med tillstånd från Naturvetenskapliga fakulteten kommer att offentligt försvaras fredag den **22 mars 2013, kl. 10.00** i Hörsalen, Institutionen för geovetenskaper, Guldhedsgatan 5C, Göteborg.

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ISBN: 978-91-628-8601-1
ISSN: 1400-3813

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ABSTRACT

For the early life stages of fish, the dispersal and retention are important factors regarding present and future survivorship, growth and reproduction. The main objective of this thesis is to analyse fish egg and larval transport in two different marine systems, the Kattegat and the North Atlantic. The focus is on two different species, namely Atlantic cod (*Gadus morhua*) eggs in the Kattegat-Öresund-Belt area and European eel (*Anguilla anguilla*) leptocephalus larvae in the North Atlantic.

The stock of cod in the Kattegat has been severely depleted due to fishery and is presently classified as exhibiting reduced reproductive capacity. It is, therefore, of interest to update information on cod spawning activity and get an understanding of the dispersal of eggs. As to evaluate spawning, data were analysed from dedicated egg surveys in the Kattegat between 2004 and 2006. Genetically identified cod eggs confirmed that cod were spawning in the studied area during the sampling period. The estimated daily egg production was high in the south-eastern part of the surveyed area (~20 eggs m^{-2} d^{-1}) while it was low (0–5 eggs m^{-2} d^{-1}) in the central and northern part. This emphasises the importance of the southernmost spawning area in the Kattegat, close to the Öresund. A process oriented model was used to investigate transport of cod eggs and early larvae in relation to egg density as well as how the interannual variation of retention and dispersal is related to the meteorological forcing. The model results clearly indicated that transport is highly dependent on the egg density; lighter eggs are transported northwards, whereas heavier eggs are retained to a larger extent or are transported southwards. An optimum of retention is defined in the density range 1023-1026 kg m^{-3}. Combining the model results of the amount of retention, distribution and sedimentation with observations of vertical distribution of cod-like eggs in the range 1017-1022 kg m^{-3}, suggests that gadoid eggs are mainly retained in the southern Kattegat, but also simultaneously dispersed northwards. Further investigation showed that interannual variation of retention, transport and sedimentation are highly correlated to the changes of local wind forcing. Strong westerly winds induce southward transport and high sedimentation while weak variable winds tend to retain eggs in the spawning area. The results of this study provide a starting point for future studies of spawning and life history characteristics of the Kattegat cod, and also in studies designed to entangle the stock complex in the Kattegat-Öresund-Belt area.

Climatic variation affecting the ocean conditions for passive drift of eel larvae is one of the factors suspected to be related to the decline of eel recruitment. A simple Lagrangian model was used to simulate the passive drift of the European eel (*Anguilla anguilla*) leptocephalus larvae from the spawning area in the Sargasso Sea to the European shelf (20°W). The simulation utilised the velocity data from a reanalysis of ocean climate, the Simple Ocean Data Assimilation (SODA 2.1.6), for the period from 1958 to 2008. The period which was modelled covers the time of a regime shift in eel recruitment in the 1980s. The average drift time and latitudinal distribution of the arrival of larvae (particles in the model) was explored for a range of constant depth levels and instantaneous mortalities. The model showed that the proportion of eel larvae carried by the North-east Atlantic current to northern latitudes of arrival was greater before 1970 whereas there was an increase in amount of eel larvae being entrained into the southbound current branches in later part of simulation. The overall success of drift from the spawning area to the eastern Atlantic clearly contradicts that this could explain the dramatic recruitment decline.

Keywords: dispersal, retention, passive drift, egg, larvae, Atlantic cod, leptocephalus, spawning, egg buoyancy, Kattegat, North Atlantic