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Larval cod in ponds and models: The role of habitat selection

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Individual based models (IBMs) provide a method for specifying physiological and developmental features, differences in the history of individuals and therefore recognition of critical or sensitive periods in the early life history of fish. Growth of a cod larva is largely determined by prey density and environmental conditions in addition to larval size. Building on previous process-based models, we developed an IBM including larval foraging, metabolism, temperature- and food-limited growth, and environmental factors such as temperature, turbulence and light. Using data from a macrocosm study on growth and feeding of Atlantic cod (*Gadus morhua L.*), we verify the model by simulating the experiment. Temperature and zooplankton abundance (Fig. 1a; b) from the experiment are used as forcing of the IBM and a variety of variables from the simulations are compared with rearing experiment data, e.g. prey preference, larval body size, and specific growth rates. We also explore the implications of habitat selection by the larvae and how this affects realised growth rates. This is done by assigning various vertical behavioral rules to individual larvae. The simulated specific growth rates (Fig. 2b) are compared with the observed cod larvae distribution (Fig. 2a) in the macrocosm.

The model suggests that larvae are not food limited in the pond, despite periods with very low prey availability. This IBM will be embedded in a 3D physical model to study drift trajectories and growth patterns of Northeast Arctic cod offspring from the spawning grounds in Lofoten to the Barents Sea. A trans-Atlantic collaboration with the US-GLOBEC also opens for the application of the model on Georges Bank and for model inter-comparison in different regions.

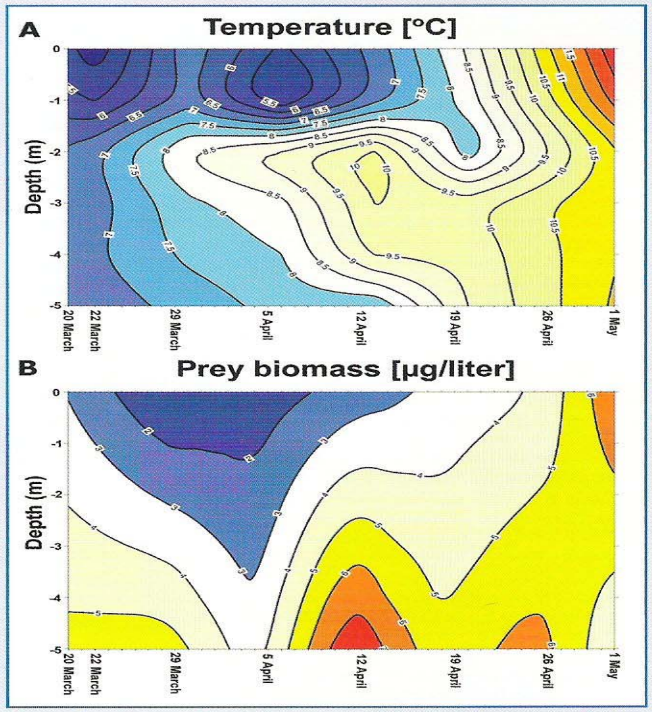

Figure 1. a) The distribution of temperature with time and depth in the macrocosm. Very low values at the surface were caused by periods of cold weather which coincides with high abundance of cod larvae observed at the bottom. b) Total biomass distribution in the macrocosm (in µgdw L^{-1}). Prey density and temperature are the main determinants of growth rates in the pond.

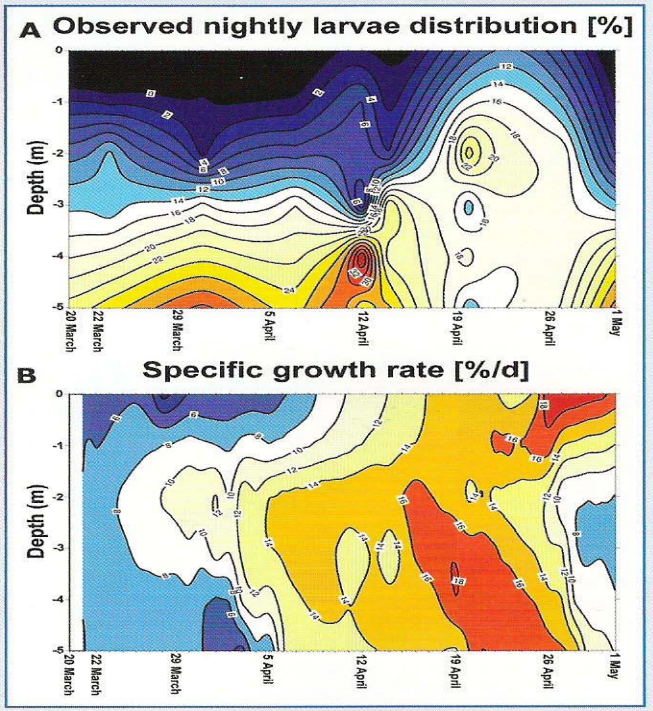

Figure 2. a) Observed distribution of cod larvae in the macrocosm (% per metre). Samples were made at night to reduce net avoidance of larger larvae. b) The modelled specific growth rate as a function of depth and time. The growth rates are typically higher below 2 metres depth where the temperature increases and prey density is higher. Towards the end of the macrocosm experiment the temperature has mixed throughout the water column and this clearly affects the growth rates.