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Modelling rule-based behaviour: habitat selection and the growth–survival trade-off in larval cod

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Environmental variation can cause significant fluctuations in the survival of larval fish and plankton. Understanding these fluctuations is critical for developing more accurate fishery models, which are needed for both scientific and socio-economic research. Growth, survival, and dispersal of marine planktonic larvae rely strongly on their behaviour. Larval fish change their vertical positioning because of strong vertical gradients in light, temperature, predation pressure, and prey availability. Here, we explore how various behavioural rules predict vertical distribution, growth, and survival of larval cod (*Gadus morhua*) in a numerical model. The rules determine the trade-offs between larval growth, feeding rate, and predation rate, including their dependence on gut fullness and body mass. We evaluated the survival through size classes for different rules and random behaviour and compared model predictions with observed larval distribution patterns. The rules predicted the correct average depth position with larval size, but failed to predict the timing of the observed vertical distribution pattern. However, model simulations revealed significant increases in survival for larval and juvenile cod with active behaviour compared with larvae with random behaviour. Behaviour was important across all sizes of fish, and this study illustrates the value of incorporating behaviour in biophysical models.

Keywords: behavioural heuristics, diel vertical migration, individual-based model, larval cod, trade-off.

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