ABSTRACT

The vertical distribution of larval fish is known to affect their horizontal transport and dispersion if the currents vary with depth. Three-dimensional numerical circulation models, and simple algorithms for vertical distribution and migration, are presently being used to estimate larval transport. The ultimate goal is to predict year class strength. However, the algorithms for vertical distribution and migration are the weakest components of such physical-biological models and they limit our ability to predict larval transport and hence year class success.

In this thesis, a literature review is presented to summarize the observed frequencies, phases and amplitudes of vertical migration for herring (*Clupea harengus* L.), cod (*Gadus morhua* L.) and capelin (*Mallotus villosus* Müller) larvae. After pooling the diel vertical migration (*DVM*) data, linear models are used to test for length dependent changes in the amplitude of diel vertical migration (*LDVM*). No significant relationships are found for herring, but a significant relationship ($p < 0.05$) is found for larval cod. The capelin data exhibit the strongest *LDVM* ($p < 0.01$), but the relationship rests heavily on data from just one source.

A Lagrangian model is used to examine the time-varying vertical distribution of larval cod. The vertical migration algorithm is based on "directed" daytime swimming towards a food maximum, and "passive" floating or sinking at night. Random displacements in the vertical are included to simulate turbulence due to wind mixing. A novel feature of the model is that daytime swimming and night-time buoyancy are both functions of larval condition which, in turn, is determined by larval feeding success over the last few days. The Lagrangian frame of reference allows larval condition and depth to be tracked through time. The model can reproduce the wide range of observed vertical distribution and migration patterns reported in the literature, including: 1) "up at night" *DVM*; 2) "up at day" *DVM*; 3) increased dispersion at night and 4) the formation of distinct patches of good and poor condition larvae.

Net avoidance as a function of light and condition is included in the Lagrangian model through the addition of a simple "probability of capture" submodel. Light-related avoidance leads to an *apparent DVM* due to undersampling of larvae in the well-lit surface layer during the day. As expected, when condition is taken into account, the poor condition larvae at the surface are captured more readily, and good condition larvae are able to avoid the net. Thus light and condition can have opposing effects on the probability of capture, and hence the vertical distribution of larval fish. The model is used to define the depth range over which this probability of avoidance is important.

An attractive feature of the Lagrangian model is that it is based on assumptions that are readily testable in both laboratory and field. Based on my review of the literature and the Lagrangian modelling, I argue that carefully planned field experiments are the next logical step in the development of a general algorithm for the vertical distribution, migration and hence transport of larval fish.