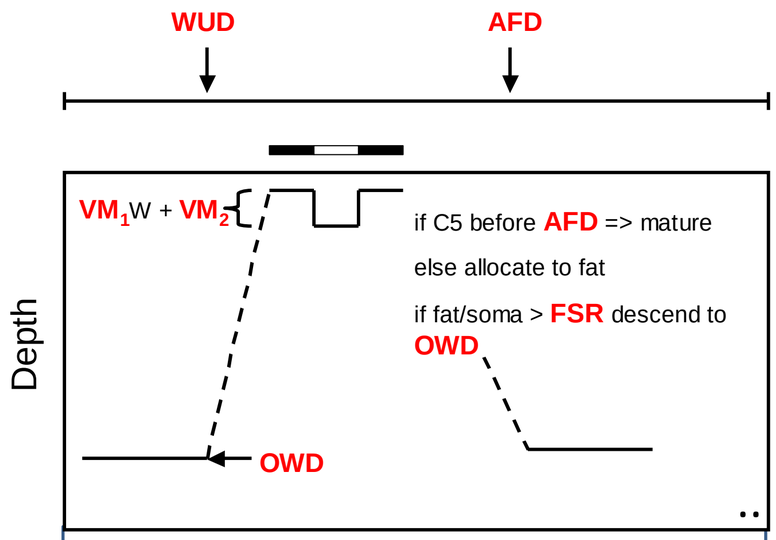
Modelling emergent traits in *Calanus finmarchicus*

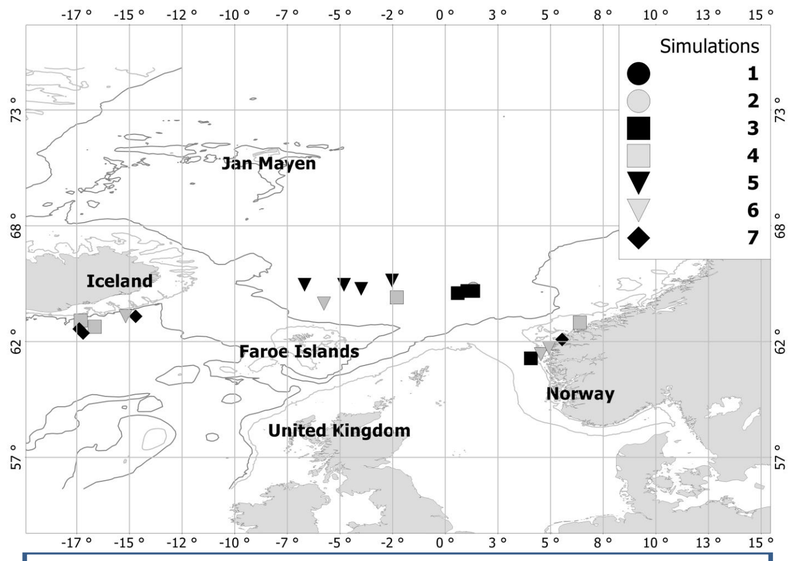
Geir Huse, Webjørn Melle, Morten D. Skogen,
Solfrid Sætre Hjøllo, Einar Svendsen, Paul Budgell

Contact: geir.huse@imr.no, Institute of Marine Research, Box 1870 Nordnes, N-5817 Bergen

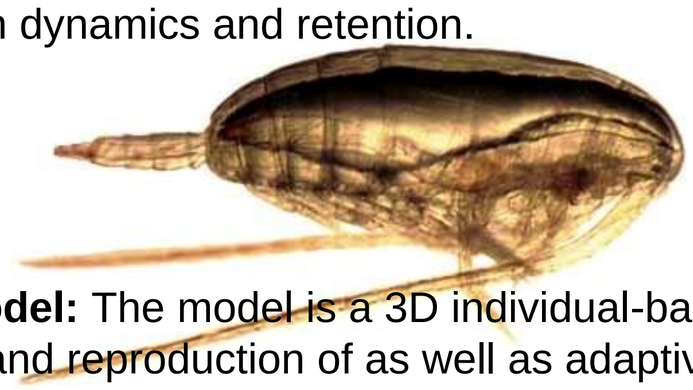


The conceptual framework of the life history traits of the *Calanus* IBM. The strategy variables, whose values are evolved during the spin up simulation, are given in bold. OWD is the overwintering depth, WUD is the date at which the overwintering C5 starts ascent towards the surface, VM_1(W) and VM_2 gives the deepening of the *Calanus* during day as a function of the weight of their total weight (W), AFD is the date after which an individual becoming C5 will prepare for overwintering, whereas before this date the individual will mature and reproduce in the same season, FSR gives the fat to soma ratio at which a C5 will descend to the OWD for overwintering in diapause.

1) Motivation: The purpose of the model is to evolve behavioural and life history strategies of *C. finmarchicus* using an individual based model with a genetic algorithm, a physiological model, and a detailed description of the biophysical environment in order to improve understanding of behavioural and life history strategies and their effect on population dynamics and retention.



The average centre of mass at the end of the year in the 30 last years in four replicates of 7 different simulations . The contours give the 200m and 500m depth.



2) The model: The model is a 3D individual-based model taking into account growth, mortality, and reproduction of as well as adaptive traits, which control the interaction with the environment. The model covers the entire life cycle of *C. finmarchicus*, and the key life history features and vertical movement are emergent properties resulting from many generations of evolution using a genetic algorithm. Four replicate runs are performed for each simulation.

3) Results:

- Simulated populations remain viable within the Norwegian Sea over hundred years
- With fixed spatial position there were small differences between the replicates
- Inter-annual variability in forcing resulted in increased difference in fitness between years
- Simulations with spatial-, but without inter-annual variability gave large differences in centre of mass, fitness and life history strategies between replicates due to the repetition of a single year with a particular current pattern
- In simulations with both spatial and inter-annual variability the replicates had small variability
- Increased predator density resulted in increased day depth and shorter time spent in surface waters

No space-time variability (Sim 1)

Spatial variability (Sim 3)

Low predator density (Sim 6)

High predator density (Sim 7)