

# SIMULATING ANCHOVY'S FULL LIFE CYCLE IN THE BLACK SEA: A COUPLED BIOGEOCHEMICAL-DEB-MOVEMENT-IBM MODEL

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## **Abstract text:**

European anchovy (*Engraulis encrasicolus*) is an abundant small pelagic fish in the Black Sea and supports a significant commercial fishery. Anchovy is highly sensitive to climate fluctuations that affect environmental and biological conditions. Presently, reconstructed biomass and population data from stock assessments lack detailed spatial resolution. We are developing a 2D full-life-cycle individual-based population model for Black Sea anchovy. The model is one-way coupled to a Black Sea hydrodynamics-biogeochemical model (NEMO-BAMHBI) that provides temperature, circulation (transport), and prey for the anchovy. The individual-based model (IBM) uses the same grid as the NEMO-BAMHBI model. Individual anchovy progress daily through six life stages (egg, yolksac larvae, early larvae, late larvae, juvenile, and adult) and we follow individuals until age-4. A dynamic energy budget (DEB) submodel is used to simulate growth across all life stages and generate egg production. The model incorporates micro- and meso-zooplankton from early larvae to adult stages. Movement is based on a kinesis algorithm with temperature and food as cues; eggs and yolksac larvae are physically transported by a particle tracking model. A super-individual approach is utilized for computational efficiency. Calibration proceeded by separately tuning the DEB, movement, and natural and density-dependent mortality, and then comparing predictions to data from the local stock assessment report when all were combined into the full 2D population model. We are presently evaluating the full model using a baseline simulation from 1990 to 2023. We will then use simulation experiments to explore the mechanisms that cause high and low recruitment years, population responses to changes in harvest, and the effects of invasive species that compete for common prey. We plan to use the modeling to provide insights into the sustainability and resilience of the Black Sea anchovy population to climate, harvest, and stressors. Better understanding of the spatiotemporal variation in population dynamics can inform fishery management and conservation strategies.

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