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A Dynamic Energy Budget Individual-based Model (DEB-IBM) for the Japanese Anchovy *Engraulis japonicus*

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ABSTRACT

An individual-based model based on Dynamic Energy Budget theory (DEB-IBM) was constructed for the Japanese anchovy *Engraulis japonicus*, a small pelagic fish important ecologically and economically in the Northwest Pacific. The DEB parameters were estimated using data from the literature. Results of the parameter estimation process suggest that anchovy allocate a high amount of energy towards somatic maintenance. Using monthly mean temperatures as model input, the DEB-IBM successfully reproduced key life history traits and patterns of growth, but failed to accurately simulate the timing of metamorphosis. The model underestimated the average number of batches spawned per year and the average spawning frequency. The close fit between model validation results and observed anchovy larval growth suggest that food conditions in Sagami Bay, Japan are generally optimal, although anchovy may face food shortages in the peak of summer. To examine the potential effect of moderate levels of climate change on the life history traits of anchovy, DEB-IBM simulations were run from 2015 – 2100 using predicted monthly mean temperatures as forcing input. While the length at metamorphosis and length at sexual maturity are not expected to change significantly, the age at metamorphosis and age at sexual maturity are expected to decrease in the future as sea temperatures rise. Spawning events are expected to become more frequent, and the relative batch fecundity and ultimate size are predicted to remain constant until 2100. The results of this study suggest the Japanese anchovy is a species generally well adapted to spatial and temporal environmental variability. The predicted trend of earlier sexual maturation and smaller egg size may harm recruitment rates in the future via increased egg mortality.

Keywords: Dynamic Energy Budget theory, Individual-based model, DEB-IBM, DEB, *Engraulis japonicus*, anchovy, population model, energetic model