

Bayesian mixture modeling to assess year-to-year fluctuations in age structure of Mediterranean anchovy and sardine

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Abstract:

Since 2009, the Gulf of Lions has shifted to a different regime, characterised by both a lower anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*) biomass. To better understand these changes, we investigated the magnitude and the timing of variations in growth, body condition and size and age structure of anchovy and sardine since 1992, using scientific pelagic trawl data. To circumvent usual difficulties in the ageing procedure, mixture models have been applied to decompose size structures into a mixture of Gaussian curves representing age categories. We developed a Bayesian framework that combined the use of size distributions with independent priors, i.e. age-length keys from otolith readings. These finite mixture models were run using the R package 'Rstan' (Stan Development Team 2012). The model provided consistent results, despite the typical absence of multiple distinct peaks in the size structure. For anchovy and sardine a period with per age larger individuals and mostly higher proportions of oldest ages was detected around 2005-2007, in contrast to the most recent years that were characterized by the rarity of old/large fish. The distinguished periods are similar to our findings for growth, condition and size structure. In particular, we conclude that the disappearance of larger individuals since 2011 is due to the combination of both slower growth and the loss of the oldest fish. The analyses of the investigated biological parameters allowed us to obtain a deeper insight into the population structure and dynamics, as well as their current "state of health".

References

Stan Development Team. 2012. Stan: A C++ Library for Probability and Sampling, version 1.3. Available from <http://mc-stan.org/>.