ICES CM 2016/I:262

Uncovering the environmental processes driving a seasonal migratory species characterized by strong inter annual fluctuations

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To manage populations whose presence strongly varies through space and time, it is critical to understand which the drivers behind such variations are. This biological understanding can only be made possible using long time series of environmental data, which availability is improving across the years thanks to satellite data and model predictions. Despite its high commercial value the red mullet (*Mullus surmuletus*) has no defined minimum landing size or landing quotas and we lack information on its population state in the North Sea and the Eastern English Channel. To understand what could be the drivers behind this species' variability of presence across seasons and years, we built spatio-temporal models using the Stochastic Partial Differential Equation approach within the Integrated Nested Laplace Approximation framework. Such framework is built to consider together both spatial and temporal random effects, thanks to its computational efficiency. It also allowed us to integrate four different sets of data (three scientific surveys and multiple commercial trips) across 20 years showing both spatial and temporal heterogeneity of sampling. Temperature was found to be the strongest predictor for the seasonal and annual variations of the species' distribution. Accounting for temperature variations across years also allowed exploring the significance of the previously observed northern shift of this species which could strongly influence its management process. Understanding what drives the spatial and temporal dynamics of this species will allow us to inform its assessment process and latter its exploitation.

Keywords: INLA, inter annual variation, *Mullus surmuletus*, random effects, seasonal migrations, spatio-temporal models.

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