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Environmental and fishery-driven dynamics of the common octopus (Octopus vulgaris) based on time-series analyses from leeward Algarve, southern Portugal

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Summary

Dynamic factor analysis was used to explore monthly landings per unit effort (LPUE) series of Octopus vulgaris and environmental variables recorded in the southwest Iberian Peninsula, south Portugal. Despite the large fluctuations in the octopus abundance series, results showed a strong aggregation pattern for the last 3 months of the year, possibly related to the input of new recruits to the fishery. The calculated common trend for the 12 months time-series presented significant correlations with autumn rainfall of the previous year (lag $^{-1}$), particularly for the October, November, and December series. Other important correlations were found for the Western Mediterranean Oscillation index (lag $^{-1}$), Ekman transport, summer river run-off (lag $^{-1}$), horizontal and vertical component of windstress, among others. The main trend describes a moderate steady increase in LPUE during the last 10 years, suggesting that octopus abundance has increased from 1990 to 2010. The strong correlations of the monthly octopus LPUE series, together with the annual life cycle, suggest that after environmentally controlled recruitment, population dynamics is largely fishery driven, resulting in strong seasonality in the landings.

Introduction

Statistical tools developed for short, non-stationary time-series were used to study the variations in the abundance of *O. vulgaris* and the recruitment dynamics in the south of Portugal. DFA has been successfully applied to fisheries data in recent years (Zuur et al., 2003; Zuur and Pierce, 2004; Erzini, 2005) with the main goal of finding common trends within the multiple time-series and to explore the relationships and interactions of these trends with explanatory environmental and fisheries variables. This technique, which is basically a smoothing method, can provide key information hidden within time-series and can incorporate explanatory variables. Here, DFA was used to estimate common trends for *O. vulgaris* LPUE time-series in the leeward Algarve region (southern Portugal), to explore the effects of local environmental variables and their different seasonal combinations on the LPUE time-series, and to gain insight on octopus recruitment.

Materials and methods

Official landings statistics for the period 1990 to 2010 were compiled from the Portuguese Institute for The Sea and Atmosphere (IPMA). A total of 9 environmental variables were collected for use in the analysis. In order to explore seasonal variability, 14 combinations for each explanatory variables were created according to the season of the year and its 1 yr lagged value. Three sets of DFA models were fitted in a stepwise method, using symmetric non-diagonal and diagonal matrices and Akaike's information criterion (AIC) used as a measure of goodness of fit to compare the models (Zuur et al., 2003).

Results and discussion

Octopus landings showed great variability and seasonality, oscillating between 7 tonnes in September 1990 to 250 tonnes in November 2007 (Fig. 1). LPUE by season of the year shows evidence of differences in relative abundance, with Winter (January to March) having the highest mean LPUE.

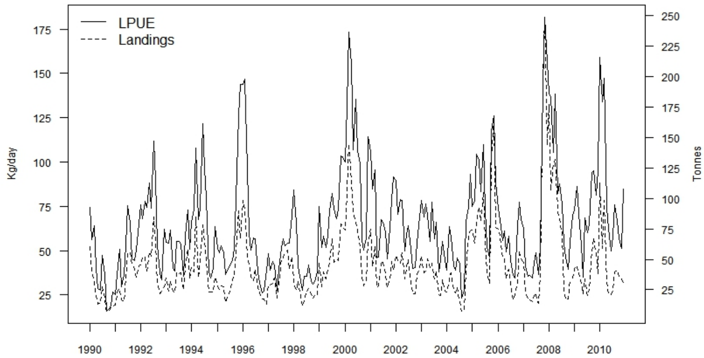

Fig. 1 Octopus vulgaris monthly landings (tonnes) and estimated LPUE from Santa Luzia harbour between 1990 and 2010.

For the first set of DFA models, without explanatory variables the best fit was for model with 4 common trends plus noise with an symmetrical non-diagonal matrix. For the second set of models, with one explanatory variable included, one common trend and a non-diagonal matrix, the autumn Rainfall (lag -1) resulted in a smaller AIC, especially for autumn months. For the third set of models, with one common trend and more than one explanatory variable was chosen as the best model, resulting from the combination of the rainy season value of Rainfall (lag -1) and WeMOi (lag -1) with the summer River Runoff (lag -1).

In spite of the large fluctuations in the octopus abundance series, where a smoothing technique might perhaps not be considered appropriate, the use of DFA as an exploratory technique gave consistent results confirmed by other multivariate techniques. The three multivariate techniques along with DFA showed the same aggregation pattern for the last three months of the year and the fits of the DFA models are quite good, especially for October, November and December. The main trend describes a steep rise in LPUE for the first quarter of the series, followed by a short drop for a couple of years and then a moderate and steady increase to the end of the series.

References

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