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ABUNDANCE AND DISTRIBUTION OF MEGRIMS, *Lepidorhombus boscii* AND *L. whiffiagonis*, IN ICES DIVISION IXa (PORTUGUESE WATERS)

by

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ABSTRACT

The geographic and bathymetric distribution of megrims off the Portuguese continental coast is described, based on a series of groundfish and crustaceans surveys carried out by R/V "Noruega" of IPIMAR during 1990-1993. A log-linear model was used to analyse four-spot-megrim data while in the case of megrim, a visual inspection of raw data was performed. The results suggest an abundance decrease of four-spot-megrim from 1990 to 1991. This species occur mainly at depths greater than 200m and a seasonal abundance pattern is observed but with oposite trends between the north and the south Portuguese coast. A poor 1990 recruitment is also evidenced by the data showing agreement with VPA results. Megrim is also more abundant at the slope and abundance levels show a decline since 1990.

Introduction

Megrims are caught in Portuguese bottom trawl fisheries, by the fleet which explores crustaceans stocks and by the one that explores a mixture of groundfish species. Two megrim species, four-spot-megrim (*Lepidorhombus boscii*) and megrim (*L. whiffiagonis*), occur in Portuguese waters and, according to estimates based on groundfish surveys (Silva, 1992), the abundance of four-spot-megrim is nearly four times that of megrim.

Landings are not separated by species. In the last eight years landings ranged from around 150 t to around 400 t showing an increasing trend between 1986 and 1989 and since then a gradual decline; in 1993 the landings reached 259 t.

Megrims from Portuguese waters belong to the stocks from ICES Divisions VIIIc and IXa and are assessed by the ICES Working Group on the Assessment of Southern Shelf Demersal Stocks. The last stock assessment (ICES, 1994) indicates that four-spot-megrim stock is within safe biological limits (ACFM, 1994). No analytical assessment was performed on megrim stock but catch-per-unit-effort (cpue) data was used to analyse the state of this stock. ACFM (1994) stresses the marked decline in abundance between 1990 and 1992.

An annual TAC of 6000 t has been established for 1994, being the Portuguese quota 180 t (EEC, 1993).

Portuguese groundfish surveys abundance indices have been used to tune the analytical stock assessment of four-spot-megrim and to support the analysis of the state of this stock. Catch data from these surveys will be used here to study the geographic and bathymetric distribution of megrims and to investigate abundance trends in the last four years. This analysis will be complemented and confronted with information from deep-sea crustaceans surveys carried out between 1990 and 1992 off the southwest and south Portuguese coast.

Material and methods

Sampling procedure

Megrim and four-spot-megrim catch data came from two different types of survey (hereafter referred as sampling sources) carried out by R/V "Noruega" from Instituto Português de Investigação Marítima (IPIMAR):

(i) groundfish surveys (for a detailed description see Cardador, 1983) - these surveys follow a stratified fixed station sampling scheme with one hour tows at a mean speed of 3.5 knots. A Norwegian Campbell Trawl (NCT) net with rollers and 20 mm cod end mesh size was used. Surveys were carried out in the period 1990-1993, during summer (June/July) and autumn (October/November) and covered all the Portuguese continental coast from 20m to 750m depth.

(ii) deep-sea crustaceans surveys (for a detailed description see Figueiredo, 1994) - sampling was carried out at fixed stations with one hour hauls at a mean towing speed of 3 knots. A bottom trawl specifically designed for crustaceans capture was used. Surveys were carried out in August 1990, 1991 and 1992 and covered the southwest and south coast (south of 38°30'N) at soft grounds ranging from 100m to 850m deep.

Megrims are seldom caught at grounds less than 100m depth and both species are scarce throughout the south coast of Portugal (Algarve). Therefore, these areas were excluded from the analysis.

Data analysis

L. whiffiagonis presents a low abundance along the Portuguese coast generating a high number of zero catches and very low observed frequencies in samples from both sampling sources. A visual inspection of raw data was performed for this species.

L. boscii observed frequencies (mean number of fish/hour) were classified into categories exhaustive and mutually exclusive (Everitt, 1980). The analysis of the contingency tables were carried out fitting log-linear models.

In the analysis of discrete data where the errors are well approximated by the Poisson distribution, the systematic effects are often multiplicative. When we are dealing with counts and the distribution of the independent variable, X, is the Poisson distribution, than $E(X)=\mu$, where $\mu > 0$. Models for counts based on independence in crossclassified data lead naturally to multiplicative effects, what is expressed by the log link function, resulting in $\eta=\log \mu$ and hence $\mu=e^{\eta}$. So, additive effects contributing to η (linear predictor) become multiplicative effects contributing to μ (expected value) (McCullagh and Nelder, 1991). The saturated linear model for a two-dimensional table may thus be expressed as: $\eta_{ij} = \mu+\alpha_i+\beta_j+\gamma_{ij}$, where μ represents the overall mean effect, α and β represent the main effects and γ the interaction effects.

The parsimonious hierarchical log-linear model was selected using a backward elimination procedure. Partial and marginal associations obtained from the full model were examined as a starting point for measuring the discrepancy for an intermediate model with less parameters. Sampling zeros corresponding to accidentally empty cells (zero observed values), when present, were properly taken into account when fitting the model and delta=0.5 was added to all observed frequencies. The likelihood ratio Chi-square statistic, χ^2_L (exhibiting additive properties) and a 1% significance level was considered when judging the model's fit. This significant level, being more stringent, was adopted in order to overcome the risk of trusting the probability values for statistical significance when violations of the assumptions associated with the χ^2 approximation, such as small sample size and empty cells, occur (Upton, 1980; Wickens, 1989).

To quantify the effects of the variables and of their interactions in the selected model, the corresponding parameters (λ) were estimated based on the constraint that $\Sigma\lambda=0$ and thus allowing that unique values for estimates of the intrinsically aliased parameters were produced. To extract the global data pattern from the selected model we analyzed the relative importance of these parameters. The λ's are random variables and when the sample size is large, their sampling distribution is roughly normal, centred about the true value, being this way fully characterized by their standard errors. In these circumstances, the standardized parameter estimates can be referred to tables of the standard normal distribution and confidence intervals for the λ's can be constructed (Upton, 1980; Everitt, 1980). However, these results should be interpreted with caution, particularly in small samples because: if the Poisson distribution model is used as the link function then, one should be aware that the Normal approximation to Poisson is asymptotic; the tests and variance estimates are correct also only asymptotically and the estimates of parameters standard error are subject to sampling fluctuation (Wickens, 1989).

Furthermore, the statistical tests are usually performed on several parameters, creating multiple-inference problems if the family wise error rate is not properly controlled. For these reasons, the standardized parameters were not analyzed in this study, although it is a common procedure suggested by some authors (Upton, 1980; Everitt, 1980).

Systematic departure from model was checked using standardized residuals plot and transforming the fitted values to obtain a constant information scale of the error distribution (McCullagh and Nelder, 1991).

The variables considered by sampling source were as follows (codes represented in brackets):

(i) groundfish surveys
Year: 1990 (Y1), 1991 (Y2), 1992 (Y3), 1993 (Y4)
Season: Summer (S1), Autumn (S2)
Area: Nw (A1), Sw (A2)
Depth strata: ≤ 200 m (D1), > 200 m (D2)

(ii) crustacean surveys
Year: 1990 (Y1), 1991 (Y2), 1992 (Y3)
Depth strata: ≤ 200 m (D1), > 200 m (D2)
Length group: ≤ 21 cm (L1), > 21 cm (L2)

The are division, Nw (northwest) and Sw (southwest), was based on the 39°20'N parallel. The criteria for the establishment of these areas were the differences in their oceanographic and topographic characteristics (Serrão, 1989). The depth strata levels correspond, along most the extent of the Portuguese coast, to the continental shelf (≤ 200m) and to the slope (>200 m). The length group division was based on the species length at first maturity (Fontela and Patiño, 1991) and thus levels L1 and L2 will hereafter be referred as juveniles and adults.

Results

Megrim

(i) groundfish surveys
The observed frequencies according to the variables/levels previously defined ranged from 0 to a maximum of 3 individuals/hour. Although observed frequencies are

generally very low the largest values occur invariably in the southern area at depths greater than 200m.

(ii) crustaceans surveys

The observed frequencies (Table 1) suggest that:

- an abundance decrease occurs after 1990, although opposite trends are observed in each depth strata;
- juveniles are less abundant than adults;
- apart from the year 1990, abundance is higher at depths greater than 200m.

Table 1 - *L. whiffiagonis*: Observed frequencies for cells year (Y), depth (D) and length group (L) for crustacean surveys.

		L1	L2
Y1	D1	2	36
	D2	0	7
Y2	D1	1	8
	D2	3	15
Y3	D1	6	0
	D2	4	19

Four-spot-megrim

(i) groundfish surveys

The observed frequencies for all the levels of the variables included in the analysis are shown in Table 2.

The best log-linear model fitted to the data was: $F_{ijkl}=\mu+Y_i+S_j+A_k+D_l+SA_{jk}+AD_{kl}$ where F=ln(expected frequencies), with $\chi^2_L=11.30$ and 23 degrees of freedom resulting on p=0.98.

Table 2 - Observed frequencies for all the levels of variables year (Y), season (S), area (A) and depth (D) in groundfish surveys.

		A1		A2	
		D1	D2	D1	D2
Y1	S1	1	8	0	9
	S2	1	6	1	26
Y2	S1	1	7	0	10
	S2	0	4	0	14
Y3	S1	1	4	1	8
	S2	1	1	0	8
Y4	S1	0	0	0	6
	S2	0	3	1	10

Table 3 presents the parameter estimates for the main effects and interactions selected by the model. The following conclusions are withdrawn from this analysis:

- there is a declining trend in the mean abundance of four-spot-megrim along the years;
- the season presents a small contribution to the explanation of the data and the retention of this main effect is probably due to the existence of an interaction with the area. Parameter values indicate an overall higher abundance in the autumn but a different seasonal pattern in each area: in the northern area, abundance is higher in summer while in the southern area larger numbers occur in autumn;
- parameter values for main effects area and depth indicate that four-spot-megrim is more abundant in the south and at depths greater than 200m. The association between these two factors suggests a distinct depth distribution pattern in each area: the abundance difference between the two depth strata is larger in the southern area.

Table 3 - Parameter values for *L.boscii* groundfish surveys best log-linear model.

Parameter codes	Estimate	Parameter codes	Estimate
Y1	0.48	**S1A1**	0.19
Y2	0.15	**S1A2**	-0.19
Y3	-0.24	**S2A1**	-0.19
Y4	-0.39	**S2A2**	0.19
S1	-0.06	**A1D1**	0.31
S2	0.06	**A1D2**	-0.31
A1	-0.17	**A2D1**	-0.31
A2	0.17	**A2D2**	0.31
D1	-0.99		
D2	0.99		

(ii) crustacean surveys

Table 4 presents the observed frequencies. The model of the form: $F_{ijk}=\mu+Y_i+D_j+L_k+YD_{ij}+YL_{ik}+DL_{jk}$ was retained as the best one. Fitting this model to the contingency table resulted in a $\chi^2_L=3.17$ on 2 degrees of freedom and hence a p value of 0.21. Any other model with fewer terms do not adequately fit to the data.

The estimated parameter values for this model, following the constraints previously referred, are presented in Table 5.

Table 4 - *L. boscii*: Observed frequencies for cells year (Y), depth (D) and length group (L) for crustacean surveys.

		L1	L2
Y1	D1	186	30
	D2	103	38
Y2	D1	88	32
	D2	149	64
Y3	D1	158	42
	D2	187	77

Table 5 - *L.boscii* (crustacean surveys): parameter estimates for the main effects and first order interactions according to the selected log-linear model.

Parameter codes	Estimate	Parameter codes	Estimate	Parameter codes	Estimate	Parameter codes	Estimate
L1	0.584	**Y1D1**	0.274	**Y1L1**	0.123	**D1L1**	0.116
L2	-0.584	**Y2D1**	-0.208	**Y2L1**	-0.094	**D2L1**	-0.116
Y1	-0.129	**Y3D1**	-0.066	**Y3L1**	-0.029	**D1L2**	-0.116
Y2	-0.101	**Y1D2**	-0.274	**Y1L2**	-0.123	**D2L2**	0.116
Y3	0.230	**Y2D2**	0.208	**Y2L2**	0.094		
D1	-0.131	**Y3D2**	0.066	**Y3L2**	0.029		
D2	0.131						

It appears unlikely that the discrepancies between the model-derived expected values and the data were very large, since the model retained is just below the saturated model. Nevertheless, it is inferred from this analysis that:

- juvenile four-spot-megrim are more abundant than adult. This feature is suggested from the observed frequencies and emphasized by the estimated parameters;
- variations appear along the years (Y1-Y3), the results suggesting an abundance decline in 1991 followed by an increase in 1992 (λ_{Y3}=.23);
- a decrease in juvenile abundance occurred in 1991 (Y1L1-Y3L1);
- the main effect depth is retained in the model mainly on account of the hierarchy principle and, in particular, of the interaction effects with years 1990 and 1991. The interaction with the length groups show a positive association between D1L1 and D2L2. Nevertheless, the results indicate an overall higher abundance at depths greater than 200m.

Conclusions

Megrims are secondary target species in either of the survey types analysed in this paper: groundfish surveys were designed to study the distribution and to provide abundance indices mainly for hake and horse mackerel and crustaceans surveys aim the study of deep-sea crustaceans. Therefore, the conclusions which follow should be considered as preliminary.

Megrim

The abundance decrease after 1990, suggested by the analysis of the crustacean data, agrees both with the information from the Spanish surveys abundance index and the cpue trawl fleet series of the ICES Division VIIIc (ICES, 1994).

Regarding depth distribution, both crustacean and demersal surveys suggest higher abundance at depths greater than 200m.

Four-spot-megrim

Both log-linear models indicate a decrease in four-spot-megrim abundance between 1990 and 1991, showing agreement with the decline in stock numbers, estimated by VPA (ICES, 1994), in the same period. The low 1991 juveniles abundance corresponding to a weak 1990 yearclass is evidenced by crustaceans surveys data and also conforms with the decline in recruitment (1 year old fish) revealed by VPA (ICES, 1994).

A season effect was selected showing distinct seasonal patterns in each area: higher abundance levels in the northern area occur during the summer, while in the southern area those occur in autumn.

This species has a wide depth distribution occurring from 30m to 750m depth but it is more abundant in the slope (>200 m). This pattern is observed both in groundfish and crustaceans surveys and agrees with the results of Dwivedi (1964) which show that, in the Cantabrian Sea, four-spot-megrim occurs from less than 100m to 600m depth being more abundant in the range 300-400m. On the other hand, these results contrasts with both the findings of López-Veiga *et al.* (1976) and Sánchez and Olaso (1987) for the Galician shelf and the Cantabrian Sea, respectively. These authors observed higher catch rates in the depth range 100-200m.

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