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An attempt to estimate fishing effort in a mixed fishery: application to the Portuguese monkfish and megrims commercial landings

by

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Abstract

An attempt is made in order to derive better monkfish (*Lophius budegassa* and *Lophius piscatorius*) and megrims (*Lepidorhombus boscii* and *Lepidorhombus whiffiagonis*) catch-per-unit-effort indices of the Portuguese commercial trawl fleet and hence improve the assessment of these stocks in ICES Division VIIIc and IXa. These species are captured in Portuguese waters in bottom trawl mixed fisheries and in artisanal fisheries using mainly gillnets. Portuguese data on artisanal fishing effort is not available and the trawl fishing effort has been estimated, up to now, based on the total fleet effort. The cpue analysis, performed between 1988 and 1993, reveals that monkfish trawl cpue in Portuguese waters has decreased after 1989, whereas megrims trawl cpue has been relatively stable along the analyzed period. The Portuguese commercial trawl fishing effort is provided, by species, for the period 1988-1993.

Introduction

Every fishing gear can catch a large variety of species, and many different species occur on most fishing grounds. In fact, very few fisheries are based solely on a single species (Gulland, 1983). Table 1 presents the Portuguese bottom trawl fleet landings, in tonnes, by main species or group, observed in 1991 and 1992 (GEPP, 1991 and 1992) (data relative to 1993 is not yet available). Due to the large variety of species landed, as shown for 1991 and 1992, this fleet is characterized as a bottom trawl mixed fishery. Nevertheless, it may be divided into two major groups: the one aiming at fish capture, hereafter referred to as the fish trawl fleet, with a minimum legal mesh size of 65mm and operating along the coast, and the one aiming at crustaceans capture and therefore referred to as crustacean trawl fleet, operating with a minimum legal mesh size of 55mm, mainly in the area south of Lisbon (Alentejo and Algarve). In 1993 there were 131 active fish trawlers and 33 active crustacean trawlers.

Both fleets catch monkfish and megrims. Since monkfish species is not distinguished in the landings, the Portuguese landings by species is estimated on the basis of their relative proportions in the sampled landings for the area north of Lisbon and on that observed in Portuguese fishing surveys for the area south of Lisbon (Azevedo, 1992). This is also the case of megrims Portuguese landings, where the landings by species are estimated using the proportions of each species observed in research surveys (Silva, 1992). Table 2 presents the trawl and total (trawl plus artisanal) landings by species, between 1986 and 1993.

Monkfish is mainly caught by the artisanal fleet, whereas megrims are by the trawl fleet. It is observed that the 1991 and 1992 trawl monkfish landings, 533 and 363 tonnes, respectively (as computed from Table 2) represent 2% and 1% of the total fish landings reported for those years (Table 1 - 27432 and 25752 tonnes). For megrims, these proportions turn to be 1% in 1991 and 1992.

The first question arises when we attempt to distinguish between what is called a target fishery and a by-catch. At the extremes there are two relatively simple situations: one species is so important that the fishermen's policies are in no way affected by the abundance of other species; in the other case, the species concerned is so scarce that, though valuable enough to be kept when caught, its abundance is never so significant as to affect policy (Gulland, 1983). The Portuguese bottom trawl fishery is therefore classified as an intermediate case. On the other hand, as supported by the EEC Council Regulation, laying down certain technical measures for the conservation of fishery resources (EEC, 1983), fish trawl by-catch is defined, for some protected species: the catch weight of those species must not exceed 10% of the total catches (Title II, article 8). This proportion is defined to

be of 60% for the crustacean trawl by-catch (Title II, article 9). In 1985 a proposal to rectify the EEC regulation 171/83 (EEC, 1985) defines a fish target fishery (Title I, article 2) as the one where the target species total catch exceeds 50% of the combined catches of fish, molluscs and crustaceans and a crustacean target fishery if this proportion exceeds 30%. Nowadays, these percentages vary according to the protected species and EEC region (EEC, 1992): in the region 3, which includes the Portuguese waters, the minimum percentage of target species vary between 30% (the case of norway lobster and shrimps) and 50% (for mackerel, blue whiting, herring, pelagic cephalopods and horse-mackerel) or 80% if the cumulative catch of the last 5 species referred is considered. The by-catch proportions, relative to the cases referred, are defined to be of 60% (norway lobster and shrimps) and of 10% for the remaining species. Nevertheless, it is not referred the basis for the establishment of these values.

Table 1 - Portuguese total trawl landings (tonnes) by main species and group, between 1991 and 1992.

Species and group	1991	1992
Horse mackerel	9809	11225
Sharks and skates	400	358
Blue whiting	2600	1928
Mackerel	1550	1164
Common squids	1278	1049
Hake	1100	1152
Pouting	1059	1204
Octopuses	1016	1004
Sardine	609	365
Blue jack mackerel	527	340
Large scaled gurnard	429	388
Small spotted dogfish	325	281
Axillary seabream	304	280
Norway lobster	288	213
Seabreams	286	255
Squids	228	306
Chub mackerel	169	194
Groupers	149	234
Deepwater rose shrimp	126	53
Common sole	120	76
European conger	96	87
Flat fish	94	82
Cuttlefishes	87	94
Red mullets	87	75
Pargo breams	81	224
Meagre	62	33
Shrimps	55	39
Fish	27432	25752
Molluscs	2900	2510
Crustaceans	315	331
TOTAL	30647	28593

Table 2 - Portuguese trawl and total (trawl + artisanal) monkfish and megrims estimated landings by species, registered in tonnes, for the period 1986-1993.

Year	<i>Lophius piscatorius</i>		<i>Lophius budegassa</i>		<i>Lepidorhombus boscii</i>		<i>Lepidorhombus whiffiagonis</i>	
	Trawl	Total	Trawl	Total	Trawl	Total	Trawl	Total
1986	167	1077	200	1047	106	128	45	53
1987	194	1058	232	1036	86	107	39	47
1988	157	974	188	948	146	207	75	101
1989	259	859	272	814	183	276	92	136
1990	326	932	387	1012	164	220	86	111
1991	224	1053	309	1025	166	207	86	104
1992	76	854	287	1219	280	324	33	37
1993	112	894	194	643	180	221	32	38

Although, when considering the Portuguese monkfish and megrims trawl landings relative to the total trawl landings, they really represent a small proportion, a more detailed inspection of the landing species composition by boat suggests that different features occur. Therefore, three approaches are considered, in order to estimate the monkfish and megrims trawl fishing effort, the results being compared. The basic idea underlying this analysis is to provide the best catch-per-unit-effort indices for monkfish and megrims from the available data, and hence improve the assessment of these stocks.

Material and methods

As already stated, three different approaches were considered, in order to estimate, separately, the monkfish and megrims fishing effort of the Portuguese trawl fleet. The criterion used are as follow:

- i) The total bottom trawl fishing effort was computed. Therefore, all boats fishing effort, either landing monkfish or not, constituted the basic data. The same procedure was applied to megrims.
- ii) Those boats landing monkfish were retained. The same procedure was applied to megrims.
- iii) Only those boats classified as monkfish or megrims targeting boats were considered. This criteria was established after an early analysis by boat, on an annual basis, of the boat monkfish and megrims landing proportion relative to the total annual landings (including all

species). This analysis was considered to be a useful tool for classifying boats into different groups or categories and hence to allow to better chose (specify) the option considered under this criteria. Ketchen (1964) *in* Gulland (1983) supports this criteria since he suggests the analysis of those boats that contain more than some threshold percentage of the species concerned.

Fishing effort units should be selected as those considered to be related to fishing mortality or rather fishing power. In general, a measure which can be shown to be linearly related to the catch rate is a suitable measure and Sparre and Ursin (1989) suggest for trawl fisheries the number of fishing hours times engine horse power. According to Gulland (1983), the total time of actual fishing with the gear on the bottom gives the best effort estimate, being also useful the total number of days absent from port. The units used are: the total towing time and the total number of hauls. This latter unit was considered more appropriate than the total number of days absent from port since no corrections for loss steaming time or, eventually, for bad weather time loss were possible when computing the total number of trips. The raw data was computed from the fishing logbooks and the period covered was between 1988 and 1993, since before 1988 the fishing effort is not available.

Results

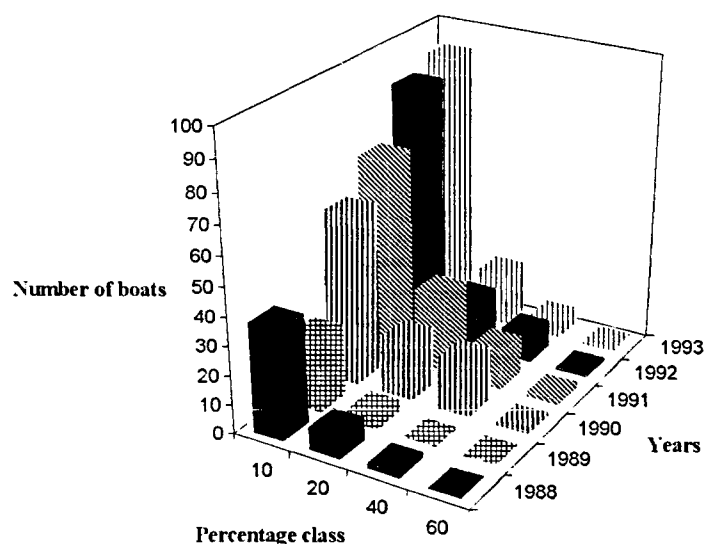
Table 3 presents the monkfish and megrims maximum percentage observed when computing, by boat, the annual monkfish and megrims landing proportion relative to the total annual landings. Although for megrims these percentages are relatively small (maximum ranging from 7% to 15%), the analysis regarding monkfish reveals that some trawl boats may be considered to be targeting this species.

Table 3 - Maximum boat proportion of monkfish and megrims landings observed by year.

Species	Year					
	1988	1989	1990	1991	1992	1993
Monkfish	27	18	41	46	46	67
Megrims	8	12	11	15	7	10

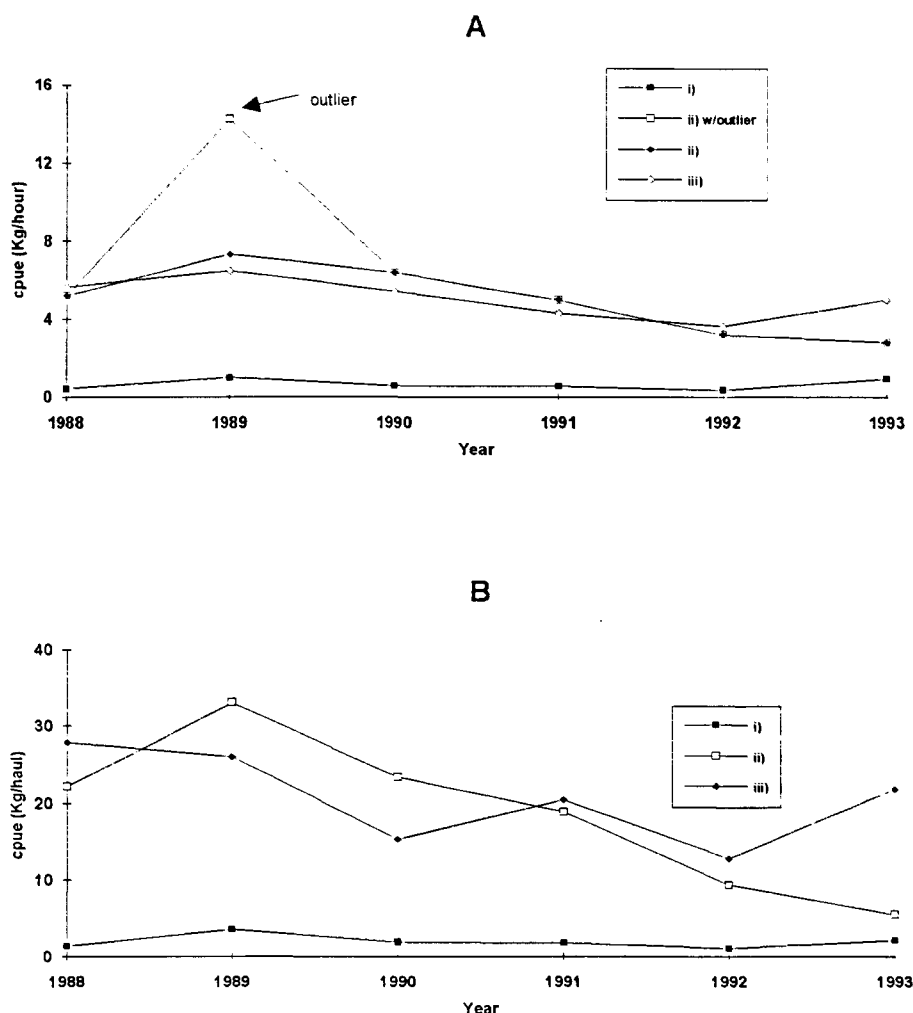
The resulting histogram of the monkfish annual frequency distribution by percentage class (Figure 1) is skewed to the right, since highest frequencies appear in the lowest percentage classes. It is also observed that the frequencies pertaining to the highest percentage classes (20-60%) correspond mainly to boats belonging to the crustacean trawl fleet. A threshold percentage of 20% was assumed for monkfish and therefore, the cases (boats) where the percentage class was $\geq 20\%$ (Figure 1) were classified as belonging to the boats group targeting monkfish and originating cpue under criteria iii). Year 1989 was an exception, since the cases included in the 18% maximum (Table 3) were considered.

Figure 1 - Monkfish annual frequency distribution of the trawl boats landing proportion relative to their total annual landings.



The monkfish catch-per-unit-effort (cpue), expressed in Kg/hour (Figure 2-A) and in Kg/haul (Figure 2-B), obtained under criteria i) to iii) is plotted for the period 1988-1993 to analyze the annual trend of the commercial catch rate.

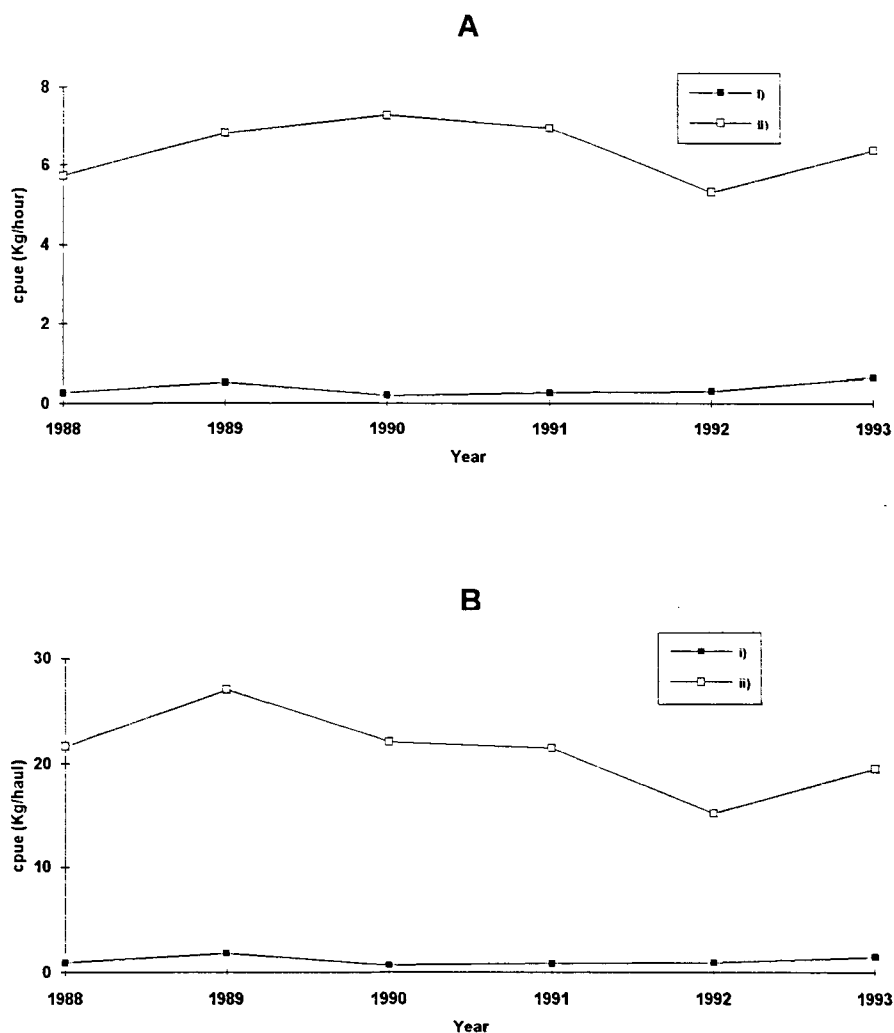
Figure 2 - Monkfish Portuguese trawl cpue (A - Kg/hour; B - Kg/haul) for the period 1988-1993, by criteria.



It is observed a high monkfish cpue value in 1989, obtained under criteria ii) and pointed out as an outlier (Figure 2-A), which is explained by the unusually high cpue observed on a particular boat, along this year; this feature was also observed for megrims. This case was considered to result from a systematic record incorrectness and was, therefore, discarded. Monkfish cpue, as suggested from Figure 2-A, has decreased between 1989 and 1992 (according to criteria ii): 1989=7.3 Kg/hour, 1992=3.2 Kg/hour and according to criteria iii): 1989=6.5 Kg/hour, 1992=3.6 Kg/hour). Data relative to 1993 must be considered provisional, since only partial effort data was available, and may thus explain the cpue trend differences observed in that year. The cpue analysis performed with haul units (Figure 2-B) show similar trends, with the exception of the year 1991, criteria iii).

Figure 3 presents the megrims cpue trend for the 6 years period and expressed in Kg/hours (Figure 3-A) and in Kg/hauls (Figure 3-B). Megrims cpue trend is very similar, apart from the criteria and units used (hours or hauls), and reveal that cpue has been relatively stable along the analyzed period, ranging from 5.3 Kg/hour in 1992 to 7.3 Kg/hour in 1990, according to criteria ii) and from 0.2 Kg/hour in 1990 to 0.7 Kg/hour in 1993, according to criteria iii), although a slight decrease in 1992 is suggested by criteria ii).

Figure 3 - Megrims Portuguese trawl cpue (A - Kg/hour; B - Kg/haul) for the period between 1988-1993, by criteria.



Conclusion

Although no important cpue trend differences are outlined regarding the criterion used, both for monkfish and megrims, it is emphasized that criteria iii) may tend to increase the catchability coefficient at low real densities of the species concerned, because only unusually productive operations were included in the calculations. On the contrary, criteria i) is considered that might provide unsatisfactory effort measures, since different fishing boats strategies are suggested by the preliminary analysis performed. Therefore, criteria ii), that is, the one retaining the fishing effort of the boats landing monkfish or megrims, was selected as the one that produces, for both species, better cpue indices. It is then concluded that monkfish trawl cpue has been decreasing since 1989 and that megrims trawl cpue has been stable in the last 6 years (1988-1993).

Criteria ii) was then used to compute the Portuguese trawl fishing effort by species. The resulting annual trawl fishing effort, measured as the total towing hours and the total number of hauls, as well as the cpue and the total number of boats (Nb. boats) used to compute these data, is presented in Table 4 for monkfish and in Table 5 for megrims.

Table 4 - Monkfish Portuguese trawl fishing effort (in total hours trawling and total number of hauls) and cpue, by year.

Year	Effort			cpue	
	Nb. boats	Hours	Hauls	Kg/hour	Kg/haul
1988	47	66509	15562	5.19	22.17
1989	29	72572	16105	7.32	33.00
1990	83	111936	30444	6.37	23.41
1991	90	107233	28164	4.97	18.92
1992	95	113228	38905	3.20	9.31
1993*	44	108175	56218	2.83	5.45

* provisional data

Table 5 - Megrim Portuguese trawl fishing effort (in total hours trawling and total number of hauls) and cpue, by year.

Year	Effort			cpue	
	Nb. boats	Hours	Hauls	Kg/hour	Kg/haul
1988	44	38564	10216	5.73	21.64
1989	20	40386	10177	6.82	27.05
1990	57	34372	11315	7.27	22.10
1991	45	36194	11662	6.94	21.53
1992	60	58632	20476	5.33	15.26
1993*	26	33286	10813	6.36	19.57

* provisional data

The analysis of Tables 4 and 5 suggests that the trawl fishing regime, measured as hours trawling/haul, has changed during the analyzed period, being concluded that total towing hours should be used as the appropriate fishing effort measure, both for monkfish and megrims. Therefore, the resulting Portuguese trawl fishing effort was computed by species, on the basis of their relative proportions in the trawl landings and the results are presented in Table 5 for *Lophius piscatorius* and *L. budegassa* and in Table 7 for *Lepidorhombus boscii* and *L. whiffiagonis*.

Table 6 - *Lophius piscatorius* and *L. budegassa*: Portuguese trawl fishing effort (expressed in total hours trawling) between 1988 and 1993.

Year	Hours	
	<i>L. piscatorius</i>	<i>L. budegassa</i>
1988	30266	36243
1989	35419	37153
1990	51128	60808
1991	45070	62163
1992	23642	89586
1993*	39674	68501

* provisional data

Table 7 - *Lepidorhombus boscii* and *L. whiffiagonis*: Portuguese trawl fishing effort (expressed in total hours trawling) for the period 1988-1993.

Year	Hours	
	<i>L. boscii</i>	<i>L. whiffiagonis</i>
1988	25486	13078
1989	26857	13530
1990	22551	11821
1991	23869	12325
1992	52514	6118
1993*	28307	4979

* provisional data

Since this analysis have revised, after 1988, the Portuguese trawl effort data for monkfish stocks, as well as the trawl effort and catch data for megrims stocks in ICES Division VIIIc and IXa, it is considered that they can contribute to improve the assessment of these stocks.

References

- Azevedo, 1992. Update of monkfish Portuguese catch statistics. Working paper presented to the 1992 meeting of the ICES Working Group on the Assessment of Southern Shelf Demersal Stocks. Copenhagen, 8-17 September. 14pp.
- EEC, 1983. EEC Council Regulation N° 171/83, laying down certain technical measures for the conservation of fishery resources. *OJ*, L24, 27.01.83.
- EEC, 1985. Proposal to the EEC Regulation establishing certain technical measures for the conservation of fishery resources. Proposal presented by the Commission to the Council. COM(85) 710 final. Brussels, 13.12.85 (unpublished).
- EEC, 1992. EEC Council Regulation N° 345/92, amending the EEC Council Regulation N° 3094/86 which lay down certain technical measures for the conservation of fishery resources. *OJ*, L42, 27.01.92.
- GEPP, 1991. Recursos da Pesca. *Série estatística 1991*, Vol. 5, A-B.
- GEPP, 1992. Recursos da Pesca. *Série estatística 1992*, Vol. 6, A-B.

- Gulland, J.A., 1983. *Fish stock assessment. A manual of basic methods*. John Wiley & Sons. N.Y.
- Ketchen, K.S., 1964. Measures of abundance from fisheries for more than one species. Rapp. P.-V. Reun. ICES, 155: 113-116.
- Silva, A., 1992. Preliminary data on four-spot-megrim (*Lepidorhombus boscii*) and megrim (*Lepidorhombus whiffiagonis*) from Portuguese groundfish surveys. Working document to the 1992 meeting of the ICES Working Group on the Assessment of the Southern Demersal Stocks. Copenhagen, 8-17 September, 1992. 18pp.
- Sparre, P.; Ursin, E., 1989. Introduction to tropical fish stock assessment. Part 1 - Manual. *FAO Fish. Techn. Paper*, 306/1.