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THE SMALL-SCALE HAND-JIG SQUID FISHERY IN THE NORTHWESTERN IBERIAN PENINSULA ANALYSED USING A MODEL BASED ON SHORT FISHERY STATISTICS SURVEY

by

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ABSTRACT

A small-scale squid hand-jig fishery targeting the squids *Loligo vulgaris* and *Loligo forbesi* exists in the northwestern Iberian Peninsula. The importance of this fishery is evaluated using a model based on a short survey of fishery statistics. A total of 46 ports in Galicia operate that small-scale squid hand-jig fishery. These ports were classified into three categories, according to characteristics which affect fishery duration. Aguiño, Cedeira and Mugardos were selected as "model port" for each of the three categories. The catch per unit effort and total catch were estimated for each of these model ports. Total catch for each port was estimated taking into account the catch obtained in each model port multiply by a suitable correction coefficient based on the number of boats in each specific port. The ports of each of the three categories were considered separately. This allows to obtain the total catch of the 46 Galician ports where this fishing activity takes place. It was calculated that the small-scale hand-jig fishery unloaded 282 tonnes of squid in Galicia in 1992. The accuracy of the model based on a short survey of fishery statistics was tested by comparing estimates of catches with real squid landing data recorded in Aguiño in 1992. It was observed that the difference between both estimates (15.5 and 14.6 tonnes, respectively) was 5.8%. Information on the characteristics of this fishery, seasonality, type and the number of fishing boats is included in this article. This paper represents the first step toward assessing the magnitude of the squid resource in the hand-jig Galician fishery.

INTRODUCTION

The loliginid squid fishery in Spain is centred on two species, *Loligo vulgaris* Lamarck, 1797 and *Loligo forbesi* Steenstrup, 1856. Most catches are of *L. vulgaris* which is the most common species in the Atlantic and the only one present in the Mediterranean in appreciable quantities. *L. forbesi* is also caught, particularly along the Atlantic coast. It is impossible to determine the amount of *L. forbesi* and *L. vulgaris* since both species are included in the official fishing statistics for *L. vulgaris* (Guerra and Pérez-Gándaras, 1983;

Guerra et al., 1994). In the north-western Iberian Peninsula (Galicia), both these squid species are caught as by-catch in the multi-species trawler fishery and by directed small-scale hand-jig fishery (Guerra et al., 1994).

The hand-jig fishery has largely remained unknown, being considered of little importance in contrast with the trawler fishery from which annual catches have increased to approximately 400 tonnes. A preliminary study (Guerra et al., 1994) showed that the hand-jig fishery was subject to variable exploitation. Catches are not recorded in the official landings statistics, and there are no data on production or exploitation rates. Juvenile, maturing and adults individuals of both species are caught in this fishery. It is felt that monthly catch during the 5 month of most intense fishing activity may be in the order of 70 - 90 tonnes, a figure which would double the total annual catch in Galicia (Guerra et al., 1994).

The particular characteristics of the hand-jig fishery, (i.e. seasonality, variability, dispersion, unsuitability or non-existence of data on catches and effort (Guerra et al., 1994)), make management based on a application of models currently in use for multispecies fisheries imposible (Pierce and Guerra, 1994). Gómez-Muñoz (1990) has, nevertheless, developed a simple model for multispecies small-scale fisheries. This model was successfully applied to several fisheries in Mexico with a wide range of fishing methods and similar characteristics to the Galician hand-jig squid fishery. This model involves carrying out a survey among fishermen. The results are then used to estimate the total catch and catch per unit effort (CPUE) during the fishery period. The small-scale hand-jig fishery in Galicia differs from that considered in the study by Gómez-Muñoz (1990) in that it is more specific and uses only one fishing method. This article describes catch levels and fishery performance from the small-scale hand-jig fishery in Galicia for the first time, based on a simple survey of fishermen carried out from April to November 1993 to estimate the catch levels for 1992.

MATERIAL AND METHODS

From data on ports in Galicia, obtained during a monthly squid sampling programme, between January, 1991 and December, 1992, five representative fishing sites of Galicia were selected. The ports of Cedeira, Finisterre, Mugardos, Bueu and Aguiño (Fig. 1) were visited monthly, between April and October, 1993. The squid fishermen were interviewed personally on site. The surveys provided general information on squid fishing, i.e. area, fishing season, catches, number of boats in each port, number of trips per month, catch per trip, etc., besides some other necessary data to apply to the chosen model (Gómez-Muñoz, 1990). Twenty four fishermen were interviewed from the selected ports, wich represent about 4.5% of all fishermen. Inquiries to each fisherman were carried out as many times as was necessary to obtain all the information required.

Between October and November, 1993, other forty one small-scale squid fishing sites in Galicia were also visited. In order to classified these fishing sites, the general characteristics of the fishery, number of fishermen and number of boats used in each site were recorded.

Also, in Aguiño, data on the real squid landings per boat and per day in 1992 were obtained from the daily sales registers at the port exchange. Aguiño is the only site in Galicia where this is possible. Catch per unit effort (CPUE) was estimated monthly from the total weight in kilogrammes of squid caught per month (CA_m), the average number of trips per boat per month (T_m), and the average number of boats per month present throughout the

fishing season (B_y), according to the following equation:

$$CPUE = \frac{CA_m}{T_m * B_y} \quad (1)$$

Only in the case of Aguiño is possible to validate model estimates against empirical data for catch and CPUE. Therefore, the raw data of CPUE and the total catches in Aguiño for 1992 were compared with estimates which generated the model for this port, making it possible to determine the margin of error between the model estimate and the real data.

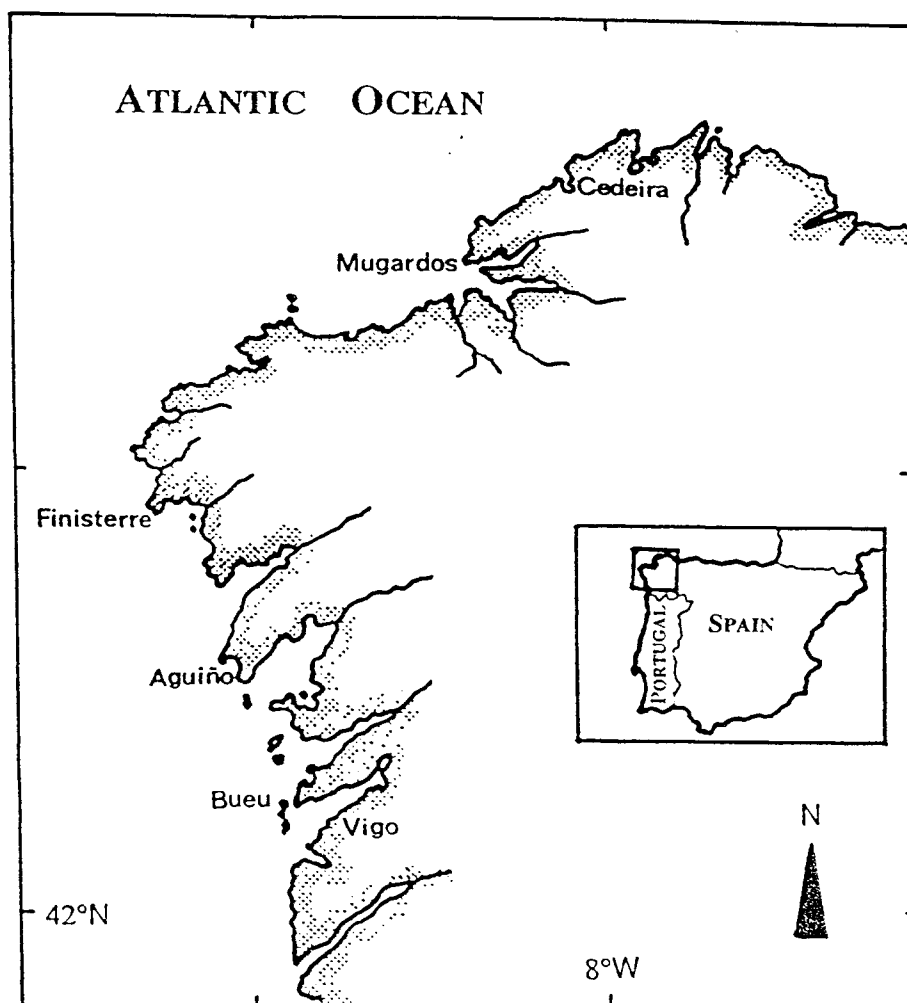


Figure 1. Study area (Galicia, northwest Spain), showing the main ports where the study on the small-scale hand-jig fishery was made.

The use of the model by Gómez-Muñoz (1990) to calculate the total catch of squid by the small-scale hand-jig fishery in Galicia involved the following steps:

A) Obtaining TE, an auxiliary variable (Z in Gómez-Muñoz, 1990) which, proportionally, corresponds to the elapsed time between the month when maximum catch occurs and the end of the fishing season, calculated using the equation:

$$TE = \frac{I (S+L-M_{\max}-1)}{M_{\max}-S} \quad (2)$$

where S represents the month when the fishing season commences (eg. January = 1), L is the length of the fishing season in months, M_{\max} is the month when maximum catch occurs, and lastly, I is an estimate of the relative rate of decrease in catch (slow decrease, $I=1$; intermediary decrease, $I=2$; rapid decrease $I=3$). In this case, it was observed that squid catches experienced a rapid decrease, with a maximum of catches moving to the right, i.e. towards the end of the fishing period. Therefore, the maximum catch occurs in the beginning of the fishing season.

B) Calculation of $f_{(x)}$ using the equation:

$$f_{(x)} = e^{\frac{-x^2}{2}} \quad (3)$$

$f_{(x)}$ represents the bell shaped function relating CPUE trip⁻¹ and time in months.

C) In the case of a given value of time t within the fishing season, the corresponding value of x to evaluate $f_{(x)}$, in the month t, is obtained from:

$$x = \frac{I (t-S-L+1) + TE (t-S)}{L-1} \quad (4)$$

These values are included in the interval (-I,TE). This expression is valid only when the maximum catch occurs in the beginning of the fishing season (Gómez-Muñoz, 1990), which is the case of this squid hand-jig fishery.

D) Obtaining the monthly CPUE (C_t) according to the expression:

$$C_t = \frac{C_{\max} (f_{(x)} - f_{(I)}) + C_{\min} (1 - f_{(x)})}{1 - f_{(I)}} \quad (5)$$

where $f_{(I)}$ corresponds to the value of the function estimated in equation 3, substituting

x for I, C_{\max} and C_{\min} being the maximum and minimum catches, respectively, recorded in the survey.

The most immediate application of this model is in calculating the total catch for each port. Given the characteristics of the fishery studied, the method applied was as follows.

Since the real number of fishing trips made by the whole fleet was unknown, the Total Catch (TC) was estimated using the equation:

$$TC = v * B * L * C_m \quad (6)$$

where v is the average number of trips per month per boat from interviews, B is the average number of boats per month in a port and L, the length of the fishing season for each port in months, which is constant among ports of the same of the categories described below. The average CPUE (C_m) for the entire season was calculated using the expression:

$$C_m = \frac{\sum C_t}{L} \quad (7)$$

The total catches by the small-scale hand-jig fishery for the whole of Galicia were calculated in the following manner: A) Three categories of fishing ports were defined, each with a "model port" which was selected from among the five representative fishing sites where surveys were performed: Category A (with Aguiño as "model port"), comprising ports where the geographical and meteorological conditions make squid fishing possible throughout the year; Category B (model port Cedeira), constituted by ports where the geographical and meteorological conditions make squid fishing possible only during the summer and autumn months; Category C (model port Mugardos), formed by ports where sports fishing is practiced during the summer months. B) To each "model port" an arbitrary fishing power equivalent to the unit was assigned. C) The other fishing ports in Galicia were classified into each of the three categories defined. D) According to the number of boats in each port, in comparison with those at the model port, the relative fishing power for each fishing site was estimated. E) The total annual catch for each of the other ports ($TC_{(p)}$) was calculated based on the total catch for each model port ($TC_{(t)}$), according to the expression:

$$TC_{(p)} = \left(\frac{V_p}{V_t} \right) * TC_{(t)} \quad (8)$$

where V_t and V_p , respectively, are the total number of estimated fishing trips per fishing season for the model port and the fishing site, calculated according to:

$$V_{(i)} = v * B * L \quad (9)$$

Finally, the total squid catch in the small-scale hand-jig fishery for 1992 was estimated by summing up the catches calculated for each fishing site on the Galician coast for that year.

RESULTS

Description of the fishery

This hand-jig fishery which specifically targets squid, *L. vulgaris* and *L. forbesi*, is exploited by three types of fishermen: retired, professionals and sports fishers. The retired fishermen are the majority in this fishery, whereas the professionals are only active when the yield is high. The sports fishermen only fish squid as a hobby during the summer holidays and at weekends.

The fishing fleet comprises an average of 555 boats during 1992 in Galicia. These are wood crafts from 2 to 4 metres long, which are rowed or are equipped with small 4 to 5 h.p. outboard motors. There are larger boats, from 5 to 12 metres in length with more powerful engines ranging from 12 to 60 h.p. In the northern zone of Galicia where small vessels fish further out at sea than in the south, 30-32 h.p. engines are the most commonly used.

Squid jigging is mostly carried out by single boats manned by one fisherman. Lights are not used to attract squid. Squid are fished in shallow waters: from the pier or small fishing boats. Inside the rias (drowned tectonic valleys), squid are mainly caught at depths of between 4 and 22 m. In less sheltered areas or outside the rias, the most common depth is 40 m. Catches are generally made in the early hours of the morning, although fishing also takes place before nightfall. On the northern side of Galicia, *L. vulgaris* and *L. forbesi* are caught approximately equally, whereas on the southwestern side, *L. vulgaris* is the more frequently caught.

The length of the fishing season varies, according to the geographic location of the port and the meteorological conditions. In the case of sheltered sites, the fishery may last the whole year. At other more exposed sites, the fishing season may only be during the summer and autumn months. In all these cases, fishing days are restricted to when the sea is calm. All squid caught in this fishery are consumed locally and fresh.

Catches in Aguiño for 1992

Figure 2 shows the monthly variation in the number of fishing boats and the monthly catch per boat in the port of Aguiño for 1992. At this port, there were catches throughout the year, the summer and early autumn being the periods of highest fishing activity.

The CPUE in the small-scale hand-jig fishery of Aguiño during 1992 (Table 1) increased from January to March, decreased in April and then increased from May to September, when the maximum CPUE of 12.44 kg per boat and trip occurred. The total squid catch in Aguiño for 1992 was 15.5 tonnes.

Types of ports

A total of 46 ports and sites in Galicia operate an small-scale hand-jig fishery, with an average fishing fleet of 555 boats during 1992 in Galicia. These ports were classified into the three categories described (Table 2).

Category A: Model port, Aguiño. Twelve ports are included in this category.

Category B: Model port, Cedeira. Twenty seven ports are included in this category.

Category C: Model port, Mugardos. Seven ports are included in this category.

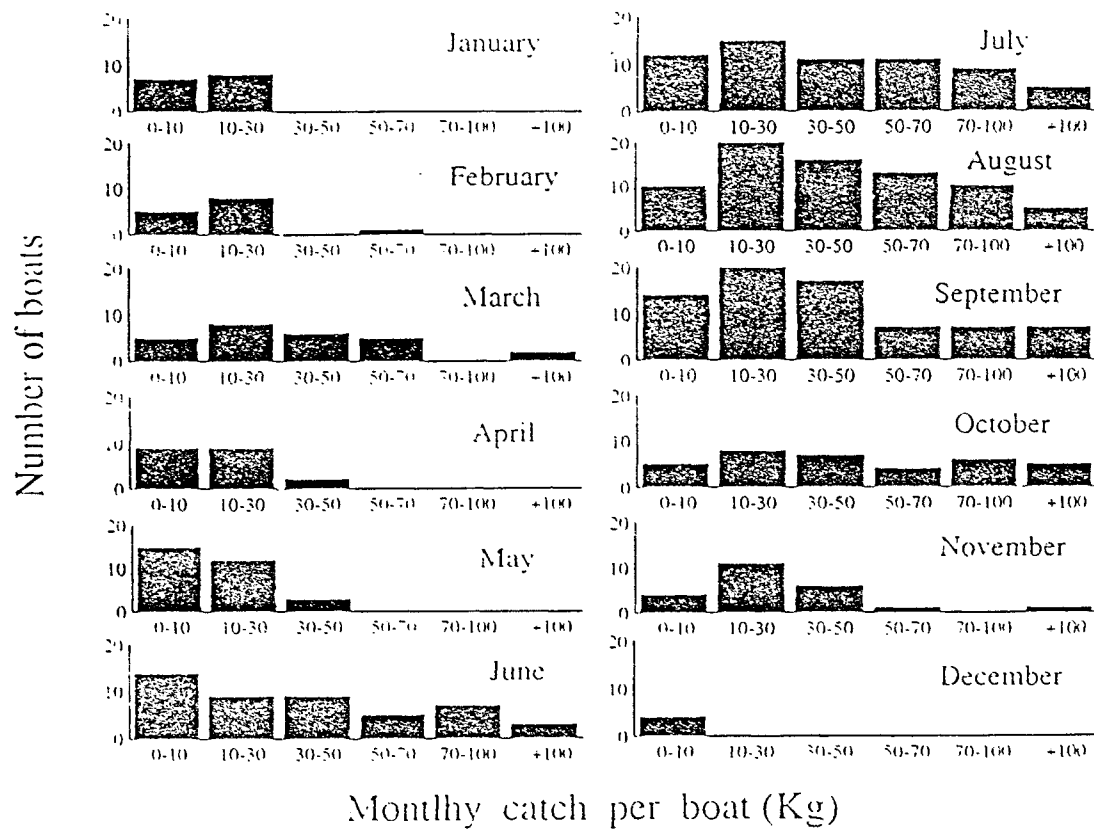


Figure 2. Number of boats and monthly catches per boat of *Loligo* spp. in the port of Aguiño, for 1992.

Table 1. Statistics for fishing *Loligo* spp and catch per unit effort per month in the small-scale hand-jig fishery of Aguiño for 1992.

Months	B _y	v	T _m	CA _m	Cb _m	CPUE
January	15	33	2.2	158.0	10.5	2.05
February	14	29	2.1	216.5	15.5	2.99
March	26	171	6.6	929.0	35.7	4.04
April	20	102	5.1	277.8	13.9	1.56
May	30	127	4.2	429.5	14.3	2.90
June	47	436	9.3	1894.5	40.3	5.83
July	62	513	8.3	2843.0	45.9	9.82
August	73	574	7.9	3249.0	44.5	11.81
September	71	494	7.0	3030.0	42.7	12.44
October	35	231	6.6	1829.5	52.3	7.92
November	23	87	3.8	656.5	28.5	4.96
December	4	5	1.3	10.5	2.6	0.24
Annual total	420	2802	64	15524	347	67
Annual average	35	233.5	5.3	1293.7	28.9	5.5

B_y: Number of boats per month; v: Average number of trips per month; T_m: Average number of trips per boat per month; CA_m: Total in kilogrammes of squid fished per month. Cb_m: Average number of kilogrammes fished per month per boat. CPUE: Kilogrammes per boat and trip.

Estimates based on the model

Twenty four fishermen were interviewed from the ports of Aguiño, Cedeira, Mugardos, Finisterre and Bueu. Based on this data, the CPUE for each port was estimated for 1992 (Table 3).

The monthly CPUE calculated from the sales statistics recorded in the port of Aguiño and the estimated CPUE from the model (Fig. 3) showed no significant differences ($r = 0.89$, $***P > 0.001$, $fd = 10$). The empirical annual catch was similar to the predicted annual catch (15.5 and 14.6 tonnes, respectively), with a 5.8% difference.

From equations (6) and (8) and values of tables 2 and 3, the total catch for the 46 Galician ports was estimated. This catches rose to 281.8 tonnes in 1992. By port type, these catches were distributed as follows: Category A: 34.4%; Category B: 63.4%; Category C: 2.2%.

The price of squid at first sale ranged from £3.90 to £8.90 sterling/kg. Considering an average value of £6.50 sterling/kg., this fishery generated approximately £1.8 million sterling in 1992.

Table 2. Ports in Galicia where there is an small-scale hand-jig fishery of *Loligo* spp and the estimated fishing power in 1992, relative to the "model port".

Site	TP	B	V _p	Fishing power
Aguiño *	A	33	2376	1.00 *
Aldán	A	2	144	0.06
Bueu	A	30	2160	0.91
Cabo de Cruz	A	40	2880	1.21
Cee	A	2	144	0.06
Corcubión	A	2	144	0.06
Finisterre	A	30	2160	0.91
Isla de Arosa	A	10	720	0.30
Lorbe	A	5	360	0.15
Miño	A	5	360	0.15
Muros	A	30	2160	0.91
Sada	A	30	2160	0.91
Cedeira *	B	25	1225	1.00 *
Aguete	B	20	980	0.80
Barquero	B	1	49	0.04
Baiona	B	10	490	0.40
Burela	B	10	490	0.40
Camariñas	B	30	1470	1.20
Camelle	B	10	490	0.40
Cangas	B	7	343	0.28
Cariño	B	35	1715	1.40
Cayón	B	10	490	0.40
Corme	B	10	490	0.40
O Grove	B	5	245	0.20
Escarabote	B	4	196	0.16
Espasante	B	10	490	0.40
Esteiro	B	10	490	0.40
Ezaro	B	2	98	0.08
Foz	B	15	735	0.60
Laxe	B	8	392	0.32
Lira	B	2	98	0.08
Malpica	B	15	735	0.60
Marín	B	10	490	0.40
Moaña	B	2	98	0.08
Muxía	B	4	196	0.16
Ribadeo	B	10	490	0.40
Rinlo	B	2	98	0.08
Vicedo	B	1	49	0.04
Vivero	B	17	833	0.68
Mugardos *	C	10	350	1.00 *
Ares	C	4	140	0.40
Pindo	C	12	420	1.20
Porto do Son	C	8	280	0.80
Portosin	C	8	280	0.80
Rianxo	C	1	35	0.10
Vilaxoan	C	8	280	0.80

TP: Type of port (A, B or C). B: Average number of boats per month. V_p: Estimated total number of trips per fishing season. (*); Model Port.

Table 3. Average catch per unit effort and total catch for the small-scale hand-jig fishery in five ports in Galicia.

Port	S	L	v	Cm	TC
Aguño	1	12	6	6.15	14614
Cedeira	6	7	7	12.78	15660
Finisterre	1	12	5	6.74	12128
Mugardos	5	6	7	2.93	1230
Bueu	1	12	6	5.49	11860

S: Month starting the fishing season (e.g. 1 = January). L: Length of the fishing season in months. v: Average number of trips per month. Cm: Average CPUE (Kilogrammes per trip per month). TC: Total catch in Kilogrammes.

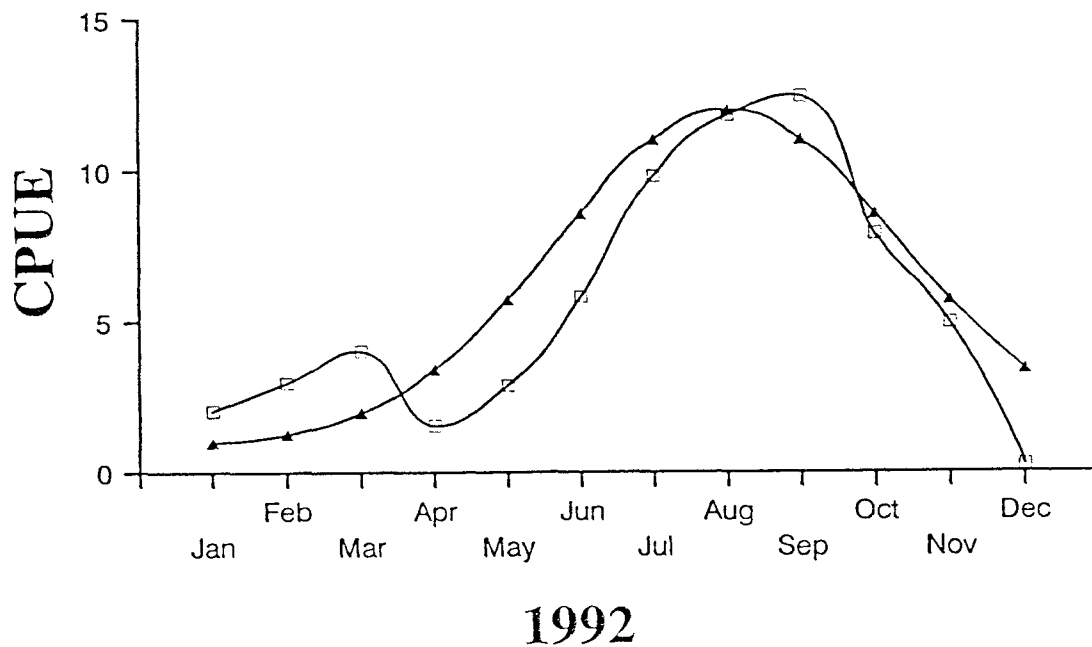


Figure 3. Monthly variation of the catch per unit effort (CPUE), in Kilogrammes per trip per boat, in the small-scale hand-jig fishery of *Loligo* spp, in Aguño, for 1992. Squares: CPUE calculated on squid sales data; Triangles: CPUE generated by the Gómez-Muñoz (1990) model.

DISCUSSION

Although the small-scale hand-jig fishery for loliginid squid also exists locally in various areas of the northeastern Atlantic and the Mediterranean (Worms, 1983; Sánchez, 1988; Cunha and Moreno, 1994; Guerra et al., 1994), only in the Azores, where the fishery targets *L. forbesi*, has it been described in detail (Martins, 1982; Porteiro, 1994). The similar characteristics of these small-scale fisheries, particularly along the coasts of Italy, Portugal and other regions of Spain, make it possible for models, such as the one by Gómez-Muñoz (1990), based on personal interviews with fishermen, to be useful for evaluating these fisheries.

This model requires certain initial information which is easily obtainable. However, since this information is based on the appraisals and memory of the fishermen, it is necessary to interview several at each port to obtain an average value. The greater the number of interviews, the more accurate are estimates of model parameters. It appears that the most reliable are the average values of the C_{max} and C_{min} , as well as the month when the C_{max} is most frequently attained (Gómez-Muñoz, 1990). Furthermore, if interviews are carried out on a monthly basis over a suitable period of time or during the season with the highest catch, the model parameters have a greater precision, generating more precise estimates of catches.

The main problem when using this model lies in the estimate of total catch for a given fishing site. The average number of fishing boats and monthly trips for each fishing site are difficult to obtain from the survey, owing to the irregularity of the fishery. This is the information which causes the greatest deviations in the calculation of total catches, and so it is necessary to exercise extreme caution when obtaining this data.

The model by Gómez-Muñoz was used to generate catch estimates for the port of Aguiño which are close to the real data obtained at the fish exchange. It must be pointed out, however, that there is a certain percentage of catch which does not appear at the fish exchange. In the case of Aguiño, this percentage is very low, although at other ports in Galicia, this may mean almost the whole catch from the resource. It is extremely difficult, therefore, to compare model estimates of catch with that from sales data for this fishery for other ports.

Squid caught in this fishery (282 tonnes) in 1992 was below the 400 tonnes per year figure indicated by Guerra et al. (1994). In Galicia, since the trawler fishery contributes approximately 400 tonnes per year of squid (Guerra et al., 1994), the small-scale hand-jig fishery would comprise 41.3% of the total catch (682 tonnes). Given the value of hand-jigged squid (£3.90-£8.90 sterling/kg), catches would generate £1.8 million sterling, whereas squid from the trawler fishery, sold at a lower price (£2.80-£4.40 sterling/kg), would generate £1 million sterling per year, i.e. the hand-jig fishery represents 64% of the income from squid fishing in Galicia. The income obtained per fisherman in the small-scale fishery, however, is so sporadic that exclusive dedication to this activity is not feasible, as this necessarily requires a change of target species and fishing gear, due to the seasonality of catches.

Since the jig fishery is specific and localized, it may be monitored with precision. This is difficult, however, owing to the characteristics of the fishermen (retired, professionals and sport fishers), and also to the type of legislation in force. Local legislation causes most of the hand-jigged squid to be sold outside the fish exchange and, as a result, this is not officially recorded.

Although the *L. vulgaris* and *L. forbesi* fisheries in Galicia appear to be stable and not overexploited (Guerra et al., 1994), a more rational, controlled management should be

introduced to improve harvesting of these species. The use of models, such as the one by Gómez-Muñoz (1990), marks a first step towards an assess of this small-scale fishery. Continued study, with monthly sampling of size frequencies and following microcohorts in the population to broaden existing biological information (Guerra and Rocha, 1994), would lead to a greater understanding of this fishery. This may then make it possible to apply frequently used models in other cephalopod fisheries (Pierce and Guerra, 1984), mainly whether these two commercial species are segregated in catch statistics.

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