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Portuguese Cod Fisheries in NAFO Divisions 3N and 30 - 1993

by

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**ABSTRACT**

Statistical and biological data from the Portuguese trawl and gillnet cod fisheries in Divisions 3N and 30 are studied for the period 1989 - 93. Catch rates and mean length in the catches were standardized in order to look at the fluctuation of these indices throughout the years, months and divisions separately, cancelling the effect of the two other simultaneous sources of variation. Despite the opportunistic peak on the 1993 cod trawl catch rate in Div. 3N, closely related to a couple of good year classes recruiting at the time to the trawl operating in the Regulatory Area, there is a general downward trend in both catch rates and mean lengths, followed by a decline of the mean weights at age.

Along with this process, a shrinkage of the age structure, as regards the older age groups presented in the exploitable 3NO cod stock, makes this cod stock and the associated fisheries more and more dependent of the strength and survival of the strong year classes of 1989 and 1990.

**INTRODUCTION:** Status of the 3NO cod fisheries compared with other Portuguese fisheries in the NAFO Regulatory Area.

The Portuguese total nominal catches in Div. 3NO jumped from 1,757 ton in 1989 to 17,834 ton in 1991 and in 1993 were still kept at 16,520 ton. Following the same trend, the fishing effort of the trawl fleet increased its presence in the tail of the Bank namely since 1991 (tables 1 and 2A; fig's 1A and 2A). However this increase was not due to the increase of reported catches of cod, which declined from 2144 ton in 1990 to 521 ton in 1993, but to the sudden increase of reported catches from some unregulated resources. In fact nominal catches of skate in Div. 3N were raised from 243 ton in 1989 to 7,012 ton in 1991 and in 1993 were still of 3,576 ton; Greenland Halibut catches in Div. 3N, that in 1989 were minimal (19.1 ton), reached a maximum of 4,789 ton in 1993; finally redfish catches in Div. 30 showed an identical pattern going up from 12 ton in 1989 to 4,794 ton in 1993 (table 1, fig. 1B).

The evolution of the nominal catches reflects the changes recorded in the fleets behaviour during the period. These changes were determined not only by the severe fishing restrictions of the traditional target species such as cod and American plaice enforced in recent years, but also by the very opportunistic activity of the fleets, namely of the freezer trawlers, directing their effort to species and/or areas providing the highest catch rates (in a given year and season). Despite cod being a priority species for both fleets, Div. 3N represents only 8% of the trawl directed effort to cod for the whole period and Regulatory Area, due to more attractive catch rates recorded meanwhile in Divisions 3L and 3M (no trawl effort to cod has been recorded so far in Div. 30). Even considering just Div. 3N, cod takes no more than 11% of the trawl effort spent, well below the redfish (30%), Greenland halibut and American plaice fisheries (both 23%) (table 2B, fig. 2C).

Being basically salter vessels, cod had to be the target species of the gillnetters justifying around 80% of the gillnet effort in Div. 3NO. Nevertheless, and just as it happened with trawl, only 22% of the gillnet effort directed to cod over the past 5 years has been allocated in the tail of the Bank, the bulk of it being applied in Flemish Cap. The main reason for this bias seemed to be related with the type of gillnetters composing the Portuguese fleet : one category of gillnetters operating the gear directly from the vessel, which constituted the majority of vessels, and those employing small launches to deploy the nets, which were a couple of vessels until 1990 and only one vessel since 1991. While the majority of the vessels from the first category was able to concentrate its effort on cod in the deeper bottoms of Flemish Cap, the second category, restrained to board in the nets from small launches, stayed fishing for cod in the shallower grounds of the Bank. In 1992 and 1993 the quota restrictions, together with a decline in the cod catch rates forced the remaining gillnetter of the second category to spent around half of its effort catching redhake, mainly in Div. 3O (table 2C, fig. 2C).

Although 3NO cod is a stock with a small proportion of the directed effort recorded for the Portuguese trawlers and gillnetters operating in NAFO Regulatory Area, it is still one of the main stocks with a wide sampling coverage of its catches between 1989 and 1993. At a time when the surveys and assessment results indicate a depressed state of this stock (Davis et al., 1994) the purpose of the present work is to analyse the main information obtained from the Portuguese commercial fisheries, on a stock assessment perspective.

#### MATERIAL AND METHODS

##### 1. Collection and processing of data from the commercial fisheries.

Since 1989 and on behalf of a project funded by the European Community, Portugal expanded the sampling at sea of its fisheries in the NAFO Regulatory Area, in order to get a more realistic picture of the fleets behaviour and of their impact on the major stocks of the Northwest Atlantic. Most of the vessels surveyed since 1989 have operated with the same gears, crew and officers. Therefore the results obtained for the study period became comparable with higher reliability.

Catch and effort data were obtained on board, through direct consultation of the personal skipper logbooks. No significant discards were recorded on the vessels sampled. On a daily basis information on catch by species was recorded, as well as for each tow, effort in hours, position and depth range.

Directed effort and catch rates were exclusively derived from the surveyed vessels. A quantitative criteria was used to determine the target species for each fishing day, being the species or the couple of species (if their amounts where similar) with the highest proportion in the daily catch. Skates were only considered as target species in Div. 3N when similar positions were recorded in consecutive days with high catches of skates. For each year, division and gear the nominal effort in fishing days was splitted in directed effort for each target species (tables 2B and C) using the annual proportions recorded in the corresponding vessels sampled in that year and division.

Following the guidelines recommended by the NAFO Scientific Council, information on length and age composition of the catches, sex ratio and weight parameters were obtained. Information on length and age composition of catches is available for both trawl and gillnet gears between 1989 and 1993. For 1989 data came only from gillnets. The Hodder cod length weight relationship (1964) was used to compute the mean weight of the catches and the mean weights at age. Length and age data from Div. 3N and 3O were treated concurrently.

All the data analyzed in this work had been presented to the NAFO Scientific Council in the form of the Portuguese research reports for 1989 to 1993.

##### 2. Standardization of catch rates and mean lengths in the catch.

In order analyse the evolution of the exploited population

structure and the abundance trends derived from the data, an additive model was used to standardize the monthly catch rates and the monthly mean lengths in the catch. The purpose of this exercise is to look at the fluctuation of these parameters throughout the years, months and divisions separately, cancelling the effect of the two other simultaneous sources of variation. The method is described as follows using catch rates but it works the same way with the mean lengths.

The analysis below relates to the monthly cod catch rates, estimated by the average (weighted by the daily effort) of the observed cod catch rates of each day, whenever cod is considered one of the target species (or the target species) of the day.

The amount of variation between the catch rates recorded in different years, months across the fishing season and divisions (only in the case of the gillnet catch rates, since this fishery covers both divisions 3N and 3O) was found by the calculation of anomalies using an additive model (Hodges and Lehmann, 1962).

In summary, the three variables recorded for all catch rates (year, month and division) are divided into a convenient number of categories. In this study each one of the 5 years (1989-1993), 12 months and 2 Divisions (when required by the stock and fishery distribution) are recognised as separate categories. For each year every monthly catch rate can subsequently be allocated to a year, month and division and the anomaly for each category is found by calculating the arithmetic mean of all the catch rates within the category and subtracting from this figure the global mean catch rate for the entire set of data available for that particular gear. The anomaly will thus indicate the overall size and direction of any difference between the catch rates in a particular category and all the categories combined. A more detailed examination of the trends between the years, months or divisions of the catch rates observed in a certain stock can then be made by subtracting the effect of the other two variables. Using the years as an example, each monthly catch rate is corrected by subtracting from it the anomalies corresponding to the month and division within which that catch rate was observed. By grouping the resulting corrected catch rates according to the year and finding the mean corrected catch rate for each year, a set of values is derived which reflects the trends of the catch rates between years regardless the month and position of each observation.

Formally, for a particular category  $i$  of variable  $p$

$$\text{Anom } i = \frac{\sum_{j=1}^{n_i} \text{cpue}_j}{n_i} - \text{CPUE}$$

( $1 < i < N_p$ )

where  $N_p$  = number of categories within variable  $p$   
 $n_i$  = number of observations (monthly catch rates within bounds of category  $i$ )  
 $\text{cpue}_j$  = value of the  $j$ th cpue in category  $i$   
 $\text{CPUE}$  = mean cpue for the entire 1989-1993 data set

The mean values of the corrected catch rates for each year, month and division considered are presented in tables 3a to 3c and fig. 3a with the associated standard errors ( $\pm 2$  standard errors in the figures) and coefficients of variation (whenever the number of observed monthly catch rates within a category was greater than one). Observations were ignored for the analysis in the cases where only one observation was available for the year and month variables. The mean values of the corrected mean lengths were presented the same way in table 4c and fig. 4b.

For trawl, the annual mean length in the catch and the respective age composition were used to get from the corrected catch rates of each year the cpue's at age which are presented as year class cpue's (table 3d and fig. 3b).

RESULTS AND DISCUSSION

1. Catch rate trends and year classes relative strength.

With no records for 1989, cod trawl catch rates slide from 0.376 ton/h to 0.231 ton/h between 1990 and 1992 in Div. 3N

(table 3a; Fig. 3a). By 1990 this division was the one with the lowest catch rates for cod from the three NAFO divisions where the Portuguese trawl fleet operated. There were no records of a trawl fishery directed to cod in Div. 3O. The reason for these low catch rates is related to the lowest recruitments of the last 30 years, occurring between 1983 and 1988 (Davis et al., 1994). However in the fall of 1991 the strong year class of 1989 entered into the trawl fishery (table 3d and fig. 3b), but the increase in the number of fish caught at age 2 in 1991 was not big enough to buffer the decline in the trawl catch rate of that year. In 1992, and for reasons that remained unclear, the 1989 year class is poorly represented in the trawl and catch rates reached the minimum of the analyzed period. That could be associated with a shift of the trawl effort to deep grounds towards Greenland halibut and a limited cod trawl fishery confined to those depths, where very young cod is less abundant (table 2b and fig. 2c). In fact maximum depths recorded for Portuguese cod catches in the Regulatory Area were observed in 1992 (February and March) in Div. 3N, down to 1330m/1450m. Only in 1993 the growth of the 1989 year class together with the recruitment of the equally strong 1990 year class (table 3d and fig. 3b) doubled the 3NO cod trawl catch rate (table 3a and fig. 3a). However at the same time the older year classes were almost vanished from the trawl catches.

From the observations recorded in Div. 3N in the first, second and fourth quarters there are no major fluctuations on the mean corrected monthly trawl catch rates around the year (Table 3B).

The Portuguese gillnet fishery to cod in the Div. 3NO has been oscillating between the two divisions over the studied period following the grounds with higher concentrations in each season (Table 2c and fig 2c.). First the gillnet catch rates were stable at two distinct levels: a lower one, around 5.7 kg/net/day, for the first years of 1989 and 1990, and an upper one for 1991 and 1992, around 8.5 Kg/net/day (Table 3a and fig.3a). From 1989 to 1991 the fishery has been dominated by the same age groups of 9 to 11 years old, and in 1992 this age range increased up to 10 to 12 years old. For 1991 and 1992 the most abundant age groups in the catch came from the above average year classes of 1981 and 1982 which might have induced the important increase in the catch rates over these years, when compared with the earlier values (Table 6a and fig. 5). However in 1993 those age groups that used to be the most abundant ones in the gillnet catches loose their importance with the exception of the 1982 year class, still relatively well represented at 11 years old. Younger ages of 7 and 8 (coming from the poor recruitments of the mid eighties) dominated the 1993 catches (table 6A and fig.5).

Less and smaller cod catchable by the gear led the gillnet catch rates to a drop from 8.2 kg/net/day to 3.1 kg/net/day between the two last years for the period (table 3a and fig 3).

No differences were found between the mean corrected catch rates for the two divisions as well as for the mean values by month, although two peaks are recorded in April and November but coming from a single observation each (table 3b).

## 2. Evolution of the length and age structure of the exploited stock.

Mean length of trawl cod catches, when corrected for the month of each observation, declined from 50.2cm in 1990 to 40.6cm in 1991 (table 4c and fig. 4b), due to the income of the strong 1989 year class during the third quarter of this year, dominating the catches at age 2, along with the vanishing of fish older than age 6 from the trawl catches (table 5a and fig. 5). The slight increase of the corrected mean length for 1992 (42.8cm) can be attributed to the growth of the 1989 year class, still dominating the trawl catches although to a lesser extent, together with a much higher proportion of the ages 4 to 6 compared to the previous year, probably as a consequence of a deeper distribution of both the cod and the fishing effort in that year, as mentioned before. Mean length fall again to 34.1cm in 1993 with the income of the 1990 year class, representing, together with the 1989 year class, 91% of the catches (table 4c and 5a; fig's 4b and 5). Along with this process a continuous shrinkage of the upper limit of the length spectrum of the catches is also evident (table 4a and fig. 4a) as well as a more or less pronounced decline of the

mean weights at age for the most important age groups presented in the trawl catches over the period (table 5b and fig. 6a).

Cod catches from gillnets came from a large range of lengths (30-144cms) and are essentially composed by adult fish, older than in Div. 3M. The lower limit of the length distribution moved towards smaller lengths from one year to the other, despite the mesh size of the gillnets being kept unchanged over the period (table 5b and fig. 4a). Mean length of the gillnet catches, when corrected for the month of each observation, decline steadily from 101.5cm to 87.0cm between 1989 and 1993 (table 4c and fig. 4b). From 1989 to 1992 catches were dominated by ages 8-12 but in 1993 age 7 was by far the most abundant age group in the gillnet catches. Nevertheless cod older than 13 was still relatively well represented throughout the years (table 6a and fig. 5). For the most abundant ages in the gillnet catches mean weights at age declined from 1989 to 93, although at a smaller rate than the trawl weights at age (table 6b and fig. 6b).

#### CONCLUSIONS

Despite the peak on the trawl catch rate in 1993, closely related to a couple of good recruitments, there is a general downward trend observed on the main parameters from the Portuguese commercial fisheries, reflecting the size and the structure of the exploited 3NO cod stock. This decline, observed in the catch rates of trawl and gillnets although at different time intervals (1990 - 92 for trawl and 1991 - 93 for gillnets) is followed by a leftward shift of the length distributions of either catches. From sampling, lower mean lengths in the catch are continuously recorded, indicating that smaller and younger individuals are being caught. Along with this process, a shrinkage of the age structure, as regards the older age groups presented in the exploitable stock, makes the 3NO cod fisheries more and more dependent of the strength and survival of the strong year classes from 1989 and 1990.

In recent times and as regards cod stocks, namely 3M cod, strong year classes are exploited too much too soon by the trawl, from just the inception of recruitment until the vicinity of maturity and so their impact on the recovery of the spawning stock is minimal. This is usually caused by the trawl fishing pattern that becomes worse as fish becomes scarce. However this southern cod stock has never been a priority for the Portuguese fleets when compared either with the northern and the Flemish Cap cod or with the major targets of the Portuguese trawlers in Divisions 3N and 3O, which have been during the study period Greenland halibut and redfish. And as for the gillnetters based in the tail of the Bank, the number of vessels declined from 2 to 1 in 1991.

Being so the present scenario should not only be related with high fishing mortality and inadequate trawl fishing pattern, but should also partly reflect the succession of extremely poor recruitments during six consecutive years in the mid eighties aggravated by the environmental anomalies recorded 1990 onwards, namely the extremely low air and sea temperatures and the expansion of the cool intermediate layer. Those anomalies were severe enough to affect the major fish stocks of the Grand Bank and Labrador since 1991, pushing to deeper bottoms fishes like cod and american plaice and preventing the success of potentially good recruitment.

The 3NO cod stock is at low level and stressed by an adverse environment. Nevertheless the fishing pressure has been drastically reduced over the recent past and two strong year classes had finally appeared and will (most probably) survived despite their premature recruitment to trawl. If the fishing effort is kept at a low level, the recovery of the 3NO cod stock seems now closely associated with the evolution of the climatic and oceanographic conditions on the Northwest Atlantic for the next coming years.

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TABLE 1: PORTUGUESE NOMINAL CATCHES (ton) ON THE NAFO REGULATORY AREA, 1989-93.

SPECIES	YEAR	DIVISION				TOTAL by gear		TOTAL
		3N		3O		OT	GN	
		OT	GN	OT	GN			
Cod	1989	239.9	555.5		117.7	239.9	673.2	913.1
	1990	1026.6	1043.5	42.7	31.9	1069.3	1075.4	2144.7
	1991	674.1	196.6	17.6	172.0	691.7	368.6	1060.3
	1992	182.5	246.9	12.1	6.1	194.6	253.0	447.6
	1993	210.0	237.5	14.8	58.5	224.8	296.0	520.8
Redfish	1989	436.6		12.1		448.7	0.0	448.7
	1990	1224.7	9.3	82.6		1307.3	9.3	1316.6
	1991	3272.9	0.2	3.4		3276.3	0.2	3276.5
	1992	1143.1	5.2	1466.5	1.0	2609.6	6.2	2615.8
	1993	155.2	97.0	4794.3	0.3	4949.5	97.3	5046.8
American plaice	1989	60.5	31.0		7.6	60.5	38.6	99.1
	1990	161.5	24.7	29.6		191.1	24.7	215.8
	1991	62.5	3.8	3.3	7.1	65.8	10.9	76.7
	1992	51.0	4.8	4.8	0.2	55.8	5.0	60.8
	1993	89.7	0.3	21.9	4.4	111.6	4.7	116.3
Greenland halibut	1989	19.1				19.1	0.0	19.1
	1990	789.3		13.0		802.3	0.0	802.3
	1991	3232.0	0.4	28.4	0.4	3260.4	0.8	3261.2
	1992	3506.4	11.8	387.1	10.5	3893.5	22.3	3915.8
	1993	4788.8	18.5	205.7	0.6	4994.5	19.1	5013.6
Skates	1989	243.0	9.9		3.4	243.0	13.3	256.3
	1990	3563.8	8.4	21.0		3584.8	8.4	3593.2
	1991	7011.8	1.5	79.6	0.1	7091.4	1.6	7093.0
	1992	2038.0	5.0	356.9	4.5	2394.9	9.5	2404.4
	1993	3576.1	0.1	176.8	12.5	3752.9	12.6	3765.5
Others	1989	15.9	10.2			15.9	10.2	26.1
	1990	1945.2	352.5	59.0	1.5	2004.2	354.0	2358.2
	1991	2789.7	282.5	79.1	251.4	2868.8	533.9	3402.7
	1992	1331.6	124.4	668.0	321.8	1999.6	446.2	2445.8
	1993	1484.8	241.1	158.7	172.0	1643.5	413.1	2056.6
TOTAL	1989	1015.0	601.5	12.1	128.7	1027.1	730.2	1757.3
	1990	8551.3	1312.3	239.0	33.4	8790.3	1345.7	10136.0
	1991	16903.3	361.8	199.2	369.3	17102.5	731.1	17833.6
	1992	8067.4	386.3	2723.7	319.7	10791.1	706.0	11497.1
	1993	10304.6	594.5	5372.2	248.3	15676.8	842.8	16519.6

TABLE 2-A: PORTUGUESE NOMINAL EFFORT IN DIV. 3NO.

YEAR	DIVISION											
	3N				3O				TOTAL			
	OT		GNS		OT		GNS		OT		GNS	
	DAYS	HOURS	DAYS	NETS	DAYS	HOURS	DAYS	NETS	DAYS	HOURS	DAYS	NETS
1989	99	1425	125	49967	3	42	74	28405	102	1467	199	78372
1990	697	9226	201	67766	23	304	11	4069	720	9530	212	71835
1991	1440	21883	60	18709	24	332	32	11363	1464	22215	92	30072
1992	887	11233	104	49156	214	2281	70	25852	1101	13514	174	75008
1993	1088	14745	77	18480	321	4156	111	37838	1409	18901	188	56318
<b>TOTAL</b>	<b>4211</b>	<b>58512.3</b>	<b>567</b>	<b>204078</b>	<b>585</b>	<b>7115</b>	<b>298</b>	<b>107527</b>	<b>4796</b>	<b>65627</b>	<b>865</b>	<b>311605</b>

TABLE 2-B: TRAWL DIRECTED NOMINAL EFFORT IN FISHING DAYS IN DIV. 3N AND 3O, 1989-93.

COD directed effort in fishing days							COD directed effort rates						
Div.	1989	1990	1991	1992	1993	TOTAL	Div.	1989	1990	1991	1992	1993	TOTAL
3L		563	1595	448		2606	3L		36.3	84.7	51.5		49.7
3N		77	261	56	55	450	3N		5.0	13.9	6.4	11.3	8.6
3O						0	3O						
3NO		77	261	56	55	450	3NO		5.0	13.9	6.4	11.3	8.6
3M	456	910	27	366	435	2194	3M	100.0	58.7	1.4	42.1	88.7	41.8
<b>TOTAL</b>	<b>456</b>	<b>1551</b>	<b>1883</b>	<b>870</b>	<b>490</b>	<b>5250</b>							

3N directed effort in fishing days							3N directed effort rates						
SPECIES	1989	1990	1991	1992	1993	TOTAL	SPECIES	1989	1990	1991	1992	1993	TOTAL
COD		77	261	56	55	450	COD		11.1	18.1	6.3	5.1	10.7
REDFISH		290	511	88	390	1280	REDFISH		41.7	35.5	9.9	35.9	30.4
AM. PLAICE		184	584	40	163	971	AM. PLAICE		26.4	40.6	4.5	15.0	23.1
G. HALIBUT			83	575	326	985	G. HALIBUT			5.8	64.9	29.9	23.4
SKATE	99	145		128	148	520	SKATE	100.0	20.8		14.4	13.6	12.3
ROUGHEAD G.					6	6	ROUGHEAD G.					0.6	0.1
	99	697	1440	887	1088	4211							

3O directed effort in fishing days							3O directed effort rates						
SPECIES	1989	1990	1991	1992	1993	TOTAL	SPECIES	1989	1990	1991	1992	1993	TOTAL
COD							COD						
REDFISH	3	23	24	71	321	442	REDFISH	100.0	100.0	100.0	33.3	100.0	75.6
AM. PLAICE							AM. PLAICE						
G. HALIBUT				143		143	G. HALIBUT				66.7		24.4
SKATE							SKATE						
ROUGHEAD G.							ROUGHEAD G.						
	3	23	24	214	321	585							

3NO directed effort in fishing days							3NO directed effort rates						
SPECIES	1989	1990	1991	1992	1993	TOTAL	SPECIES	1989	1990	1991	1992	1993	TOTAL
COD		77	261	56	55	450	COD		10.8	17.8	5.1	3.9	9.4
REDFISH		313	535	159	711	1722	REDFISH	2.9	43.5	36.6	14.5	50.5	35.9
AM. PLAICE		184	584	40	163	971	AM. PLAICE		25.5	39.9	3.6	11.6	20.2
G. HALIBUT			83	718	326	1127	G. HALIBUT			5.7	65.2	23.1	23.5
SKATE	99	145		128	148	520	SKATE	97.1	20.2		11.6	10.5	10.8
ROUGHEAD G.					6	6	ROUGHEAD G.					0.4	0.1
<b>TOTAL</b>	<b>102</b>	<b>720</b>	<b>1464</b>	<b>1101</b>	<b>1409</b>	<b>4796</b>							





TABLE 3-C: TRAWL AND GILLNET FISHERIES FOR COD ON DIV.3NO, 1989-93:  
mean cpue by division corrected for the year and month of  
each observed catch rate.

TRAWL			GILLNETS				
	CPUE	ST.ERROR	C.V.	CPUE	ST.ERROR	C.V.	
3N	0.328	0.038	47.3	6.360	0.776	55.9	3N
3O				6.622	1.351	61.2	3O
3NO				6.438	0.665	56.6	3NO

Note: trawl and gillnet catch rates given in ton/fishing hour  
and kg/nets\*fishing day

TABLE 3-D: TRAWL FISHERY FOR COD ON DIV. 3N, 1990-93: mean annual cpue's at age by year class corrected for the month of each observed catch rate.

YEAR	YEAR CLASS																			
	92	91	90	89	88	87	86	85	84	83	82	81	80	79	78	77	76	75	74	73
1990				0.0	27.2	22.6	45.3	27.2	13.6	13.6	22.6	31.7	4.5	0.0	0.0	4.5	0.0	4.5	0.0	0.0
Ages in 1990				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1991			4.7	733.3	114.8	63.6	23.4	5.7	1.1	0.5	0.6	0.6	0.2	0.4	0.1	0.0	0.0	0.4	0.4	0.4
Ages in 1991			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1992		0.0	4.0	150.6	67.9	40.3	31.1	11.2	1.2	1.3	1.4	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Ages in 1992		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		
1993	0.0	57.2	746.3	501.8	40.1	13.9	7.4	1.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ages in 1993	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17			

TABLE 4-A: COD, DIVISION 3N, 1990-93: length composition of the trawl catches.

LENGTH GROUP	1990	1991	1992	1993	LENGTH GROUP
18		1.2			18
21		25.9		3.6	21
24		161.6	5.2	38.2	24
27	3.7	302.9	28.9	188.2	27
30	56.0	244.2	135.8	241.5	30
33	74.6	99.2	212.0	190.3	33
36	123.1	46.9	141.7	103.5	36
39	119.4	35.1	82.1	110.2	39
42	100.7	26.1	84.7	51.7	42
45	82.1	17.9	69.0	31.8	45
48	63.4	12.8	56.2	23.3	48
51	26.1	7.9	46.1	8.6	51
54	22.4	5.4	36.1	4.4	54
57	29.9	3.9	30.3	0.6	57
60	33.6	2.0	24.5		60
63	18.7	0.7	17.4	2.4	63
66	41.0	1.7	10.3	0.4	66
69	41.0	0.5	3.7	0.6	69
72	52.2	0.9	4.4	0.3	72
75	48.5	0.7			75
78	29.9	0.2	4.6	0.3	78
81	11.2	0.6	0.2		81
84			2.3		84
87	11.2	0.1	4.6		87
90		0.2			90
93					93
96	3.7				96
99					99
102		0.1			102
105					105
108	3.7	0.1			108
111					111
114	3.7	0.4			114
117					117
120		0.7			120

No. SAMPLES	4	41	18	14
SAMPLING WEIGHT(kg)	463.8	2628	976	1901
No. F. MEASURED	268	5349	1370	4439
MEAN LENGTH(cm)	51.1	31.4	41.4	34.3
MEAN WEIGHT (g)	1731	320	747	377
DEPTH RANGE (m)	100/725	50/830	185/1450	235/1229

TABLE 4-B: COD, DIVISION 3NO, 1989-93: length composition of the gillnet catches.

LENGTH GROUP	1989	1990	1991	1992	1993	LENGTH GROUP
30					0.3	30
33					0.9	33
36					0.2	36
39		0.2			1.0	39
42					4.3	42
45				0.5	4.8	45
48			0.1	0.1	2.8	48
51			0.2	1.5	1.5	51
54			1.0	2.8	3.4	54
57			0.3	4.1	4.1	57
60		0.4	0.5	15.9	10.0	60
63	0.4	0.6	2.6	19.8	19.4	63
66		2.0	3.8	19.0	41.0	66
69	0.4	4.4	7.5	14.3	59.7	69
72	1.7	5.4	14.4	13.5	77.8	72
75	6.6	11.3	32.8	10.6	93.1	75
78	11.3	15.7	54.4	9.1	96.3	78
81	18.2	11.9	74.0	7.4	65.3	81
84	31.4	16.7	92.8	10.5	60.1	84
87	50.3	15.7	81.5	16.1	32.7	87
90	77.4	21.7	84.2	45.5	26.8	90
93	112.3	44.6	78.4	96.6	33.0	93
96	122.3	89.9	82.9	113.7	40.1	96
99	122.8	174.1	78.0	131.3	58.5	99
102	114.3	120.2	74.7	126.9	53.8	102
105	86.7	118.2	65.5	109.8	60.9	105
108	74.5	97.9	48.4	94.8	44.6	108
111	51.9	75.6	40.1	39.9	29.4	111
114	41.1	73.0	27.3	38.7	21.6	114
117	29.4	38.8	19.1	22.9	14.4	117
120	23.4	26.5	16.0	16.8	14.2	120
123	13.5	15.3	9.9	9.3	10.6	123
126	5.7	11.3	5.9	4.9	9.7	126
129	2.9	2.8	2.2	2.4	1.7	129
132	0.8	1.0	1.0	0.7	1.3	132
135	0.6	4.0	0.3	0.5	0.4	135
138	0.1	0.2	0.1	0.1	0.4	138
141						141
144		0.4		0.1		144

No. SAMPLES	89	92	96	71	59
SAMPLING WEIGHT(kg)	85813	62628	199713	69645	25427
No.F.MEASURED	7857	4973	8398	7430	3655
MEAN LENGTH(cm)	1008	103.8	95.1	98.8	88.0
MEAN WEIGHT (g)	10922	12594	8246	9285	6900
DEPTH RANGE (m)	55-73	49-67	41/180	54/396	65/180



TABLE 5-B: COD, DIVISION 3N, 1990-93: mean weight (Kg) at age of the trawl catches.

	1990	1991	1992	1993	
AGE	MEAN WEIGHT	MEAN WEIGHT	MEAN WEIGHT	MEAN WEIGHT	AGE
1		0.079			1
2	0.357	0.201	0.246	0.123	2
3	0.617	0.398	0.331	0.244	3
4	1.086	0.645	0.636	0.502	4
5	1.440	1.209	1.036	0.995	5
6	1.981	1.849	1.649	1.367	6
7	3.448	3.379	2.598	1.656	7
8	4.196	3.473	3.393	2.962	8
9	4.778	4.786	2.759		9
10	8.287	4.676	4.596	4.399	10
11		2.959		5.514	11
12		10.385			12
13	14.010	10.924	3.448	6.137	13
14					14
15	11.876	20.450			15
16		16.390			16
17		15.211			17

LENGTH/WEIGHT RELATIONSHIP:

$\log w = -5.2106 + 3.0849 \log l$  (Hodder, 1964)

TABLE 5-C: COD, DIVISION 3N, 1990-93: mean length (cm) at age of the trawl catches.

	1990	1991	1992	1993	
AGE	MEAN LENGTH	MEAN LENGTH	MEAN LENGTH	MEAN LENGTH	AGE
1		21.4			1
2	35.0	28.7	30.4	24.7	2
3	41.8	35.6	33.9	30.7	3
4	50.2	41.7	41.7	38.7	4
5	55.0	51.3	48.9	48.6	5
6	61.0	59.0	56.5	53.7	6
7	73.0	72.1	65.5	56.3	7
8	77.8	72.8	71.5	69.0	8
9	81.1	80.7	67.7		9
10	97.0	80.0	79.0	79.0	10
11		69.3		85.0	11
12		102.0			12
13	115.0	106.0	73.0	88.0	13
14					14
15	109.0	130.0			15
16		121.0			16
17		118.0			17

TABLE 6-A: COD, DIVISION 3NO, 1989-93: age composition (%) of the gillnet catches.

AGE	1989	1990	1991	1992	1993	AGE
3		0.2			1.4	3
4				1.7	16.1	4
5	0.7	3.1	3.7	10.9	18.5	5
6	2.2	5.5	24.1	59.9	33.0	6
7	16.6	15.3	39.2	37.7	280.2	7
8	71.5	66.8	103.7	20.7	184.4	8
9	290.5	164.3	242.4	80.6	41.1	9
10	224.8	192.6	280.7	258.0	53.9	10
11	159.3	161.9	110.5	266.0	118.3	11
12	84.6	126.3	62.0	125.9	84.1	12
13	57.2	88.7	48.1	49.5	51.2	13
14	59.3	83.1	33.6	35.7	34.6	14
15	24.5	56.0	24.9	23.4	32.9	15
16	4.9	27.9	18.7	15.8	18.2	16
17	1.8	6.0	5.1	11.4	12.9	17
18	1.9	0.3	2.8	2.0	15.0	18
19	0.1	1.6	0.2	0.5	1.5	19
20			0.1	0.2	2.2	20
21		0.2				21
22					0.7	22
-----						
FISH AGED	697	1134	1152	931	675	

TABLE 6-B: COD, DIVISION 3NO, 1989-93: mean weight at age (kg) of the gillnet catches.

AGE	1989	1990	1991	1992	1993	AGE
3		0.539			0.323	3
4				1.324	0.993	4
5	3.448	2.807	2.140	2.009	2.159	5
6	4.054	3.397	3.770	2.660	2.881	6
7	5.193	4.604	4.425	3.549	3.917	7
8	6.556	6.296	5.622	6.322	4.630	8
9	7.681	8.343	6.550	7.848	6.160	9
10	9.051	9.488	8.016	8.879	7.464	10
11	10.259	10.712	9.839	9.906	9.213	11
12	11.568	11.551	10.999	10.814	10.498	12
13	13.070	12.643	12.337	12.952	11.041	13
14	13.935	14.121	12.887	13.316	11.865	14
15	14.611	13.336	14.107	14.322	12.933	15
16	14.843	12.578	14.872	14.823	14.768	16
17	17.764	11.863	14.333	15.791	15.045	17
18	15.002	17.677	17.088	18.759	15.120	18
19	25.141	15.672	20.531	19.472	19.029	19
20			19.029	17.677	17.931	20
21		20.450				21
22					16.390	22

LENGTH/WEIGHT RELATIONSHIP:

$$\log w = -5.2106 + 3.0849 \log l$$

(Hodder, 1964)

TABLE 6-C: COD, DIVISION 3NO, 1989-93: mean length at age (kg) of the gillnet catches.

AGE	1989	1990	1991	1992	1993	AGE
3		40.0			33.8	3
4				53.1	47.9	4
5	73.0	68.3	61.9	60.8	62.2	5
6	76.9	72.6	74.6	66.7	68.5	6
7	83.4	80.2	78.8	73.0	75.5	7
8	89.9	88.7	85.0	88.4	79.7	8
9	94.6	97.2	89.3	94.8	87.6	9
10	99.8	101.3	95.2	98.8	92.9	10
11	104.0	105.4	101.7	102.4	99.7	11
12	108.1	108.0	105.6	105.3	104.0	12
13	112.4	111.2	109.6	111.8	106.1	13
14	114.8	115.3	111.2	112.7	108.1	14
15	116.6	113.2	114.5	115.4	111.6	15
16	117.2	111.0	116.7	116.5	116.4	16
17	124.2	109.0	115.1	118.9	116.8	17
18	117.6	124.0	122.2	126.0	116.7	18
19	139.0	119.3	130.0	127.8	127.0	19
20			127.0	124.0	124.1	20
21		130.0				21
22					121.0	22

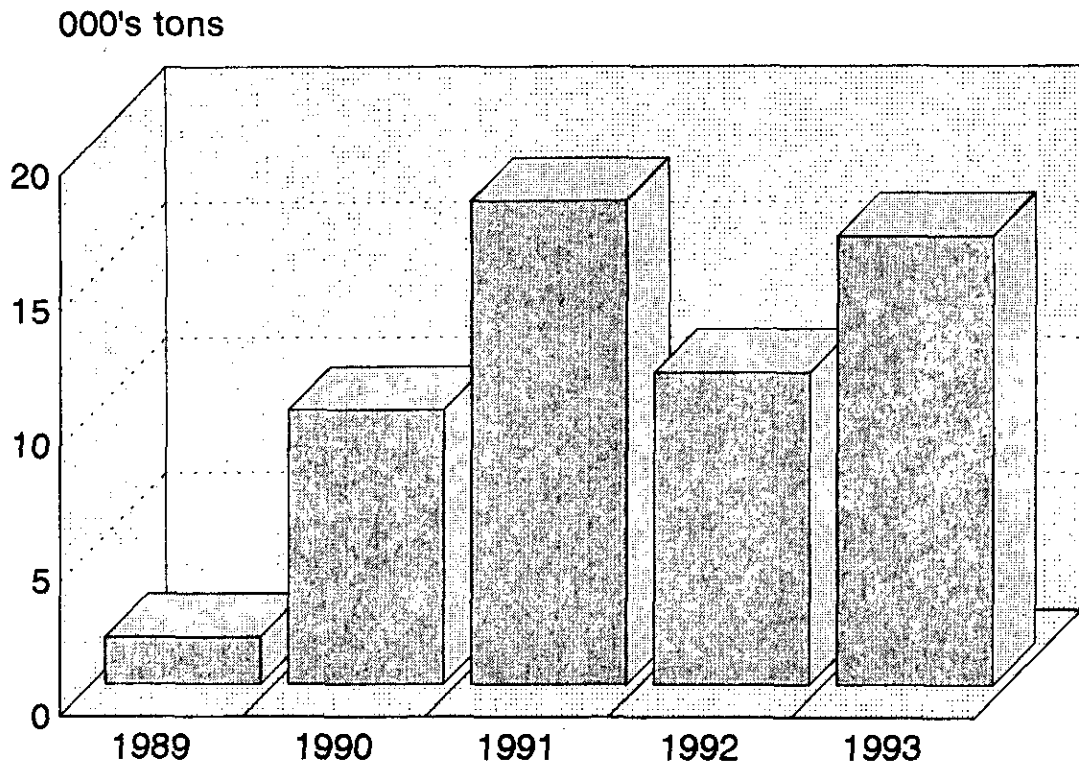


Fig. 1A: Portuguese total catches on the NAFO Div. 3NO, 1989 - 1993.



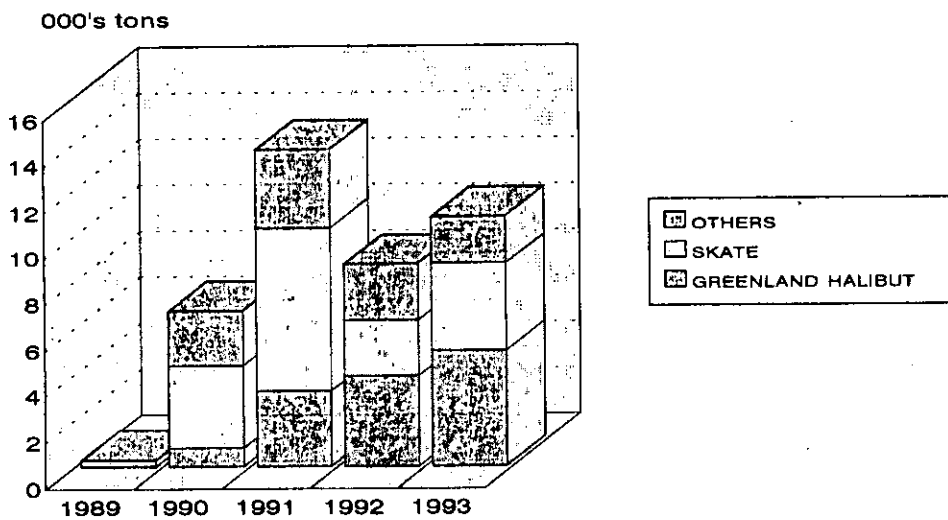
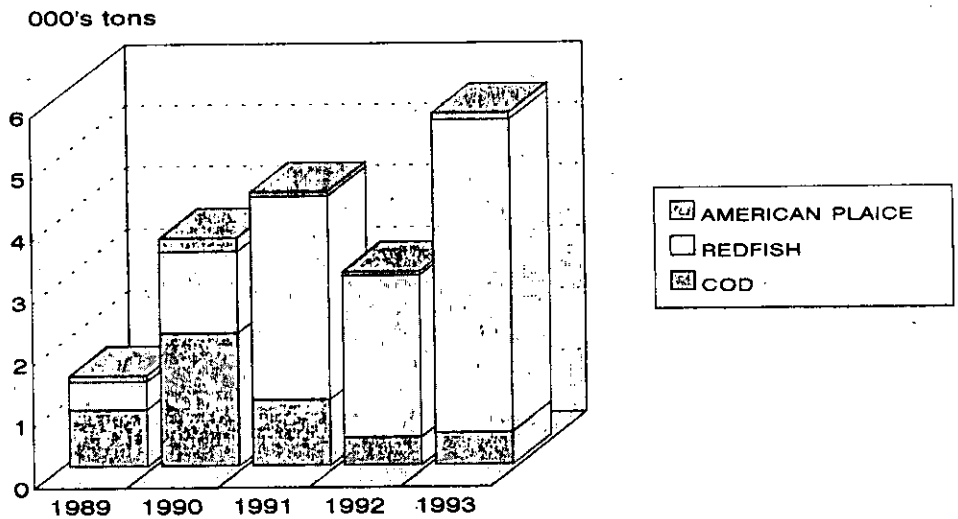


Fig. 1B: Portuguese nominal catches by species on NAFO Div. 3NO, 1989 - 1993.

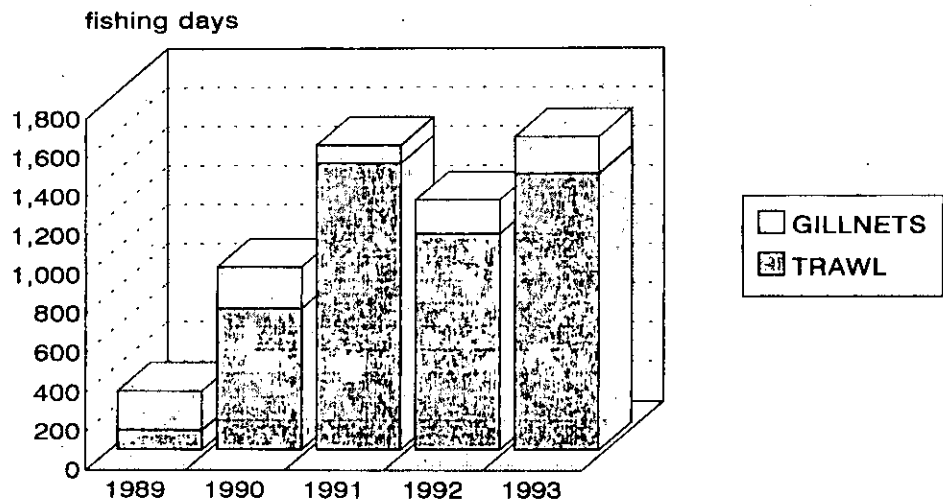
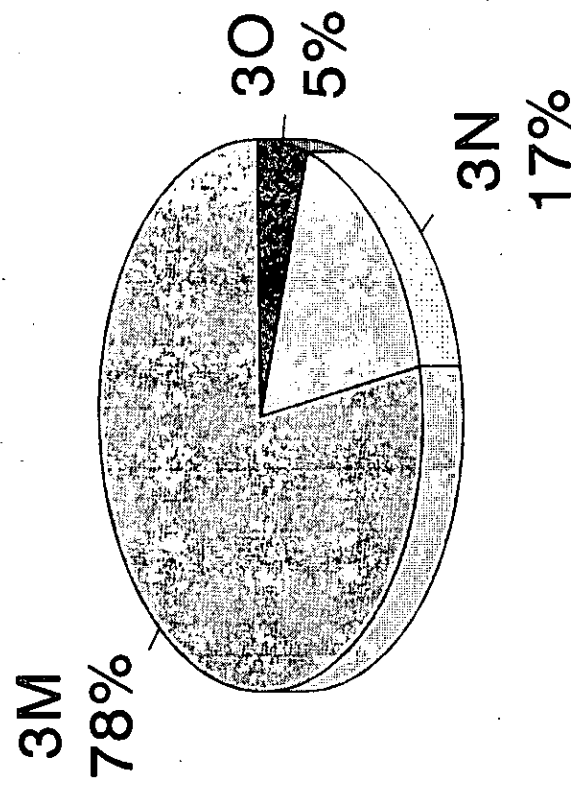


Fig 2A: Portuguese total effort by gear on the NAFO Div. 3NO, 1989 - 1993.

# GILLNETS



# TRAWL

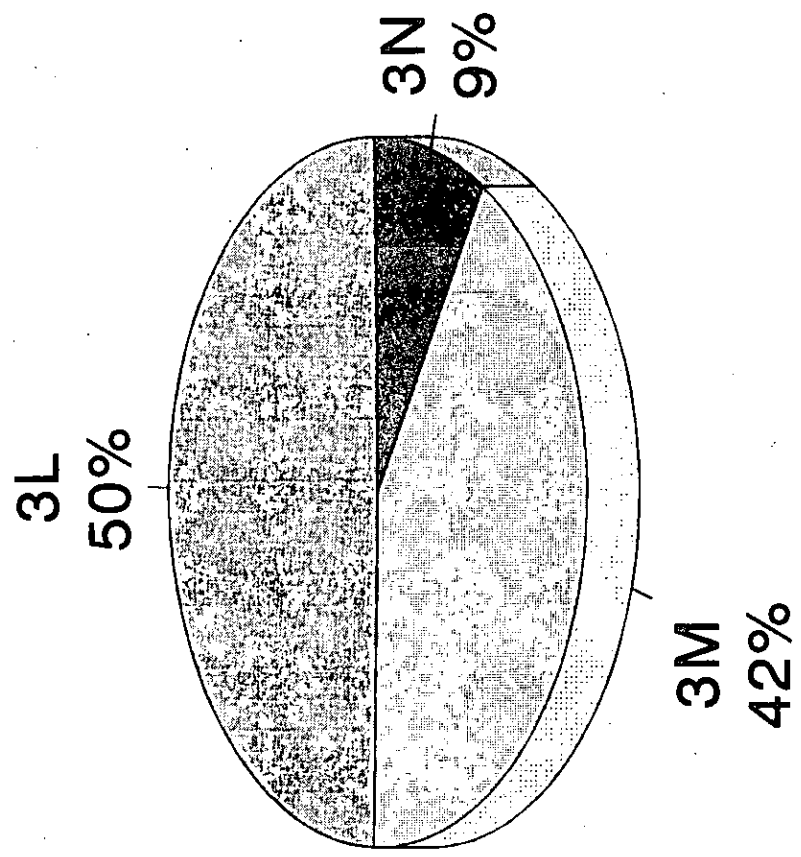
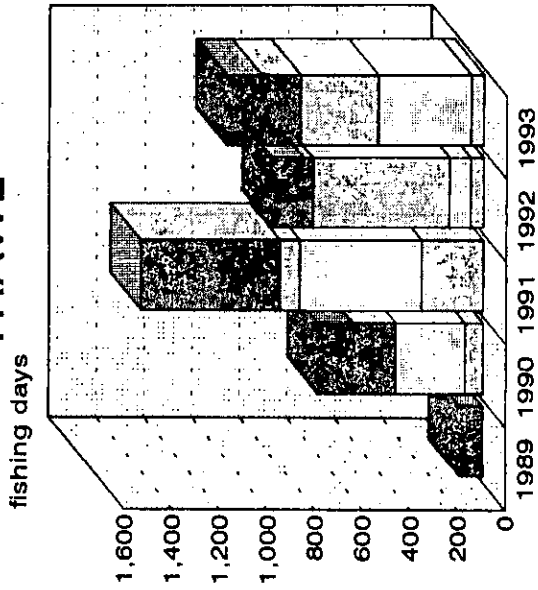
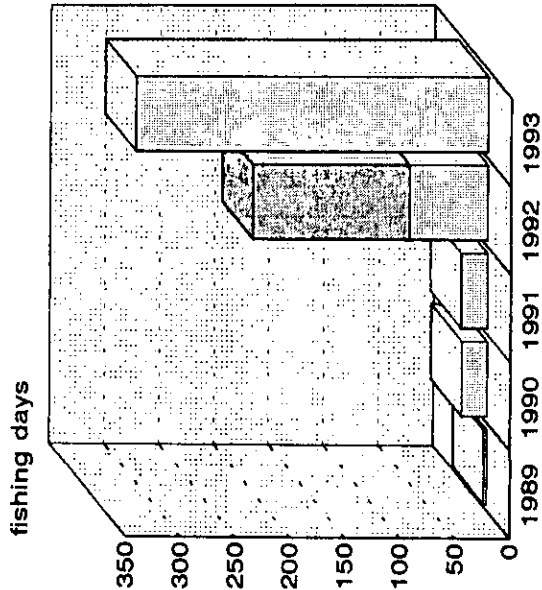


Fig 2B: Portuguese cod effort distribution by gear and division, 1989 - 1993.

# TRAWL

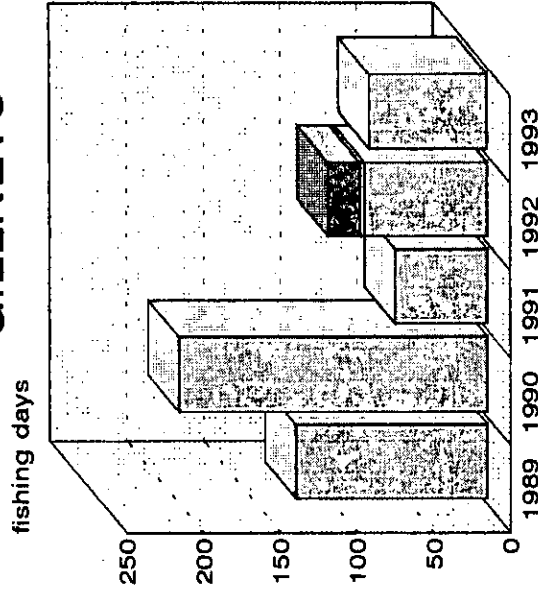


3N



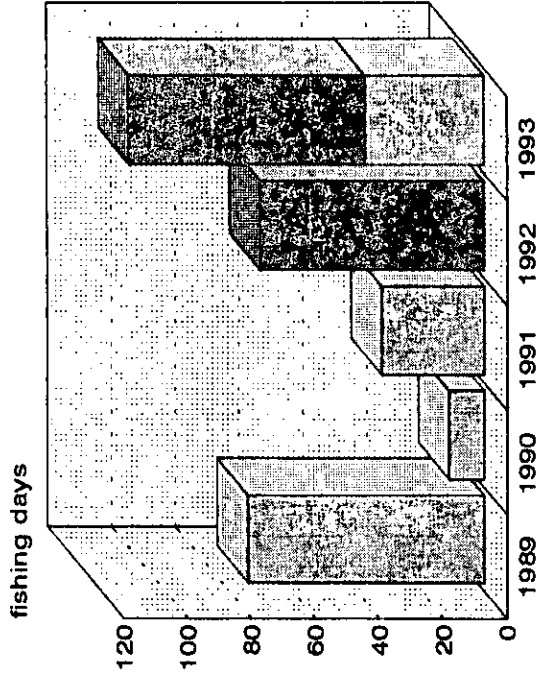
3O

# GILLNETS



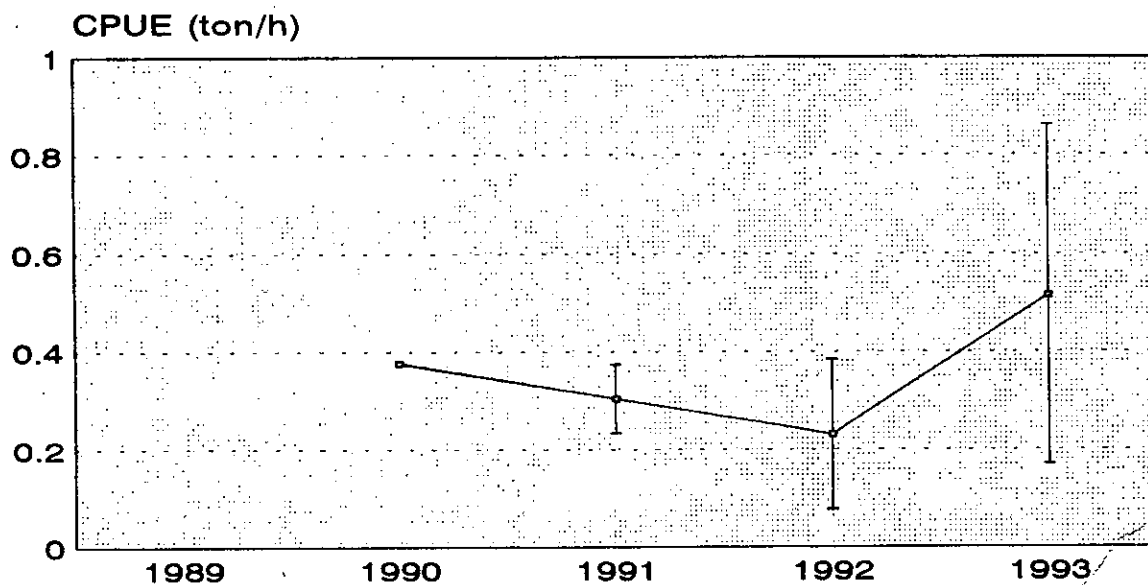
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3N

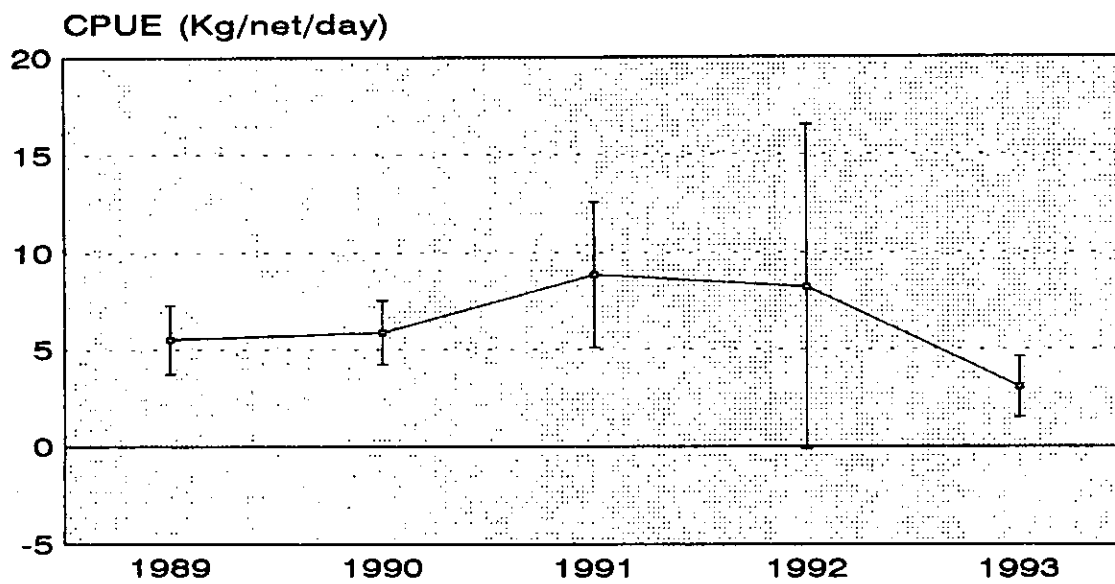


3O

Fig 2C: Portuguese trawl and gillnet directed effort in Div.3N and 3O by species, 1989 - 1993.

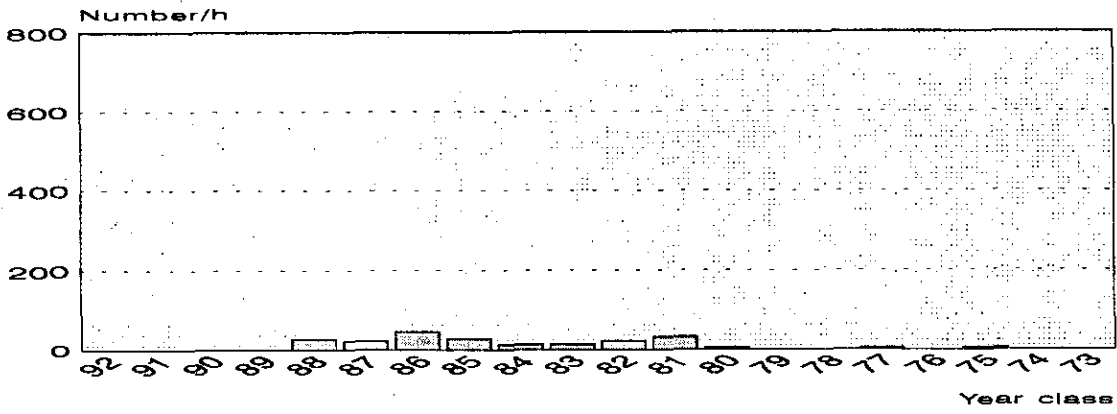


Div. 3N  
TRAWL

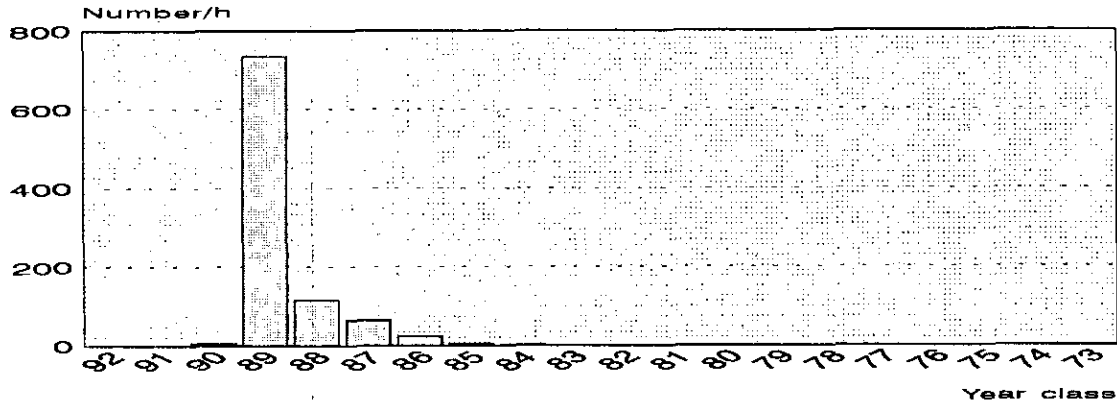


Div. 3NO  
GILLNETS

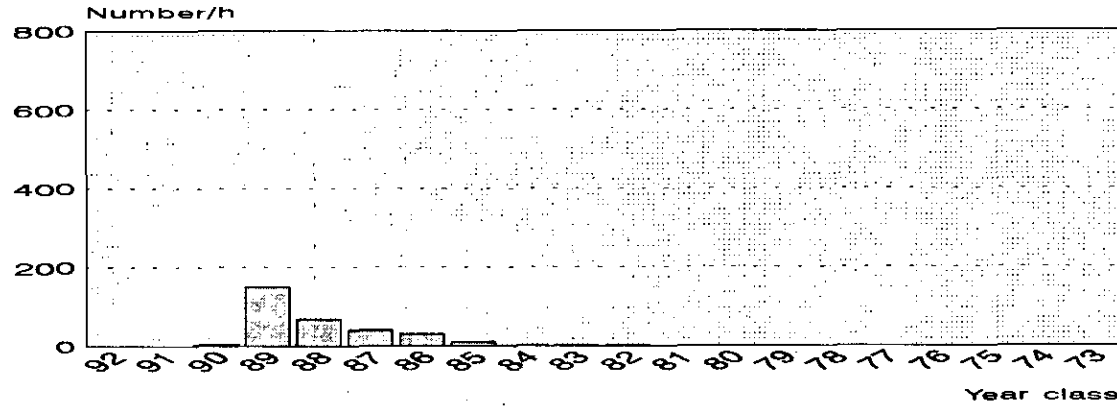
Fig. 3A: 3NO Cod catch rates, 1989 - 1993.



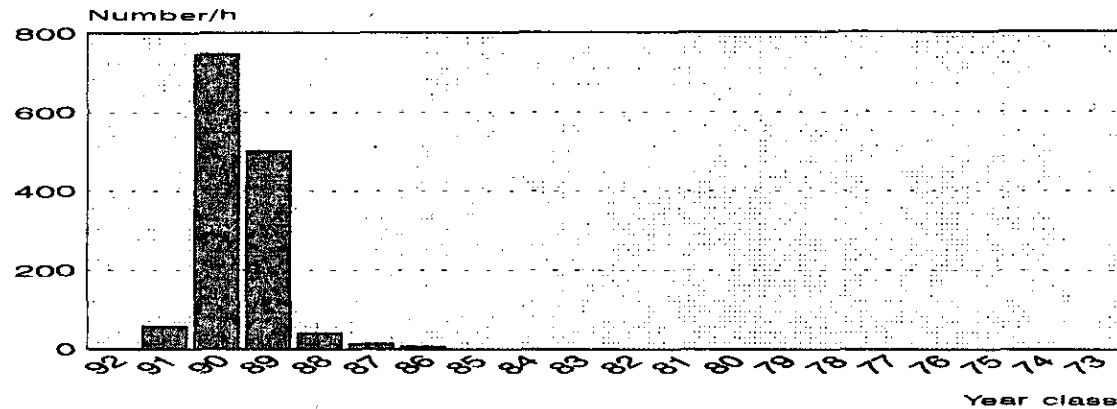
1990



1991

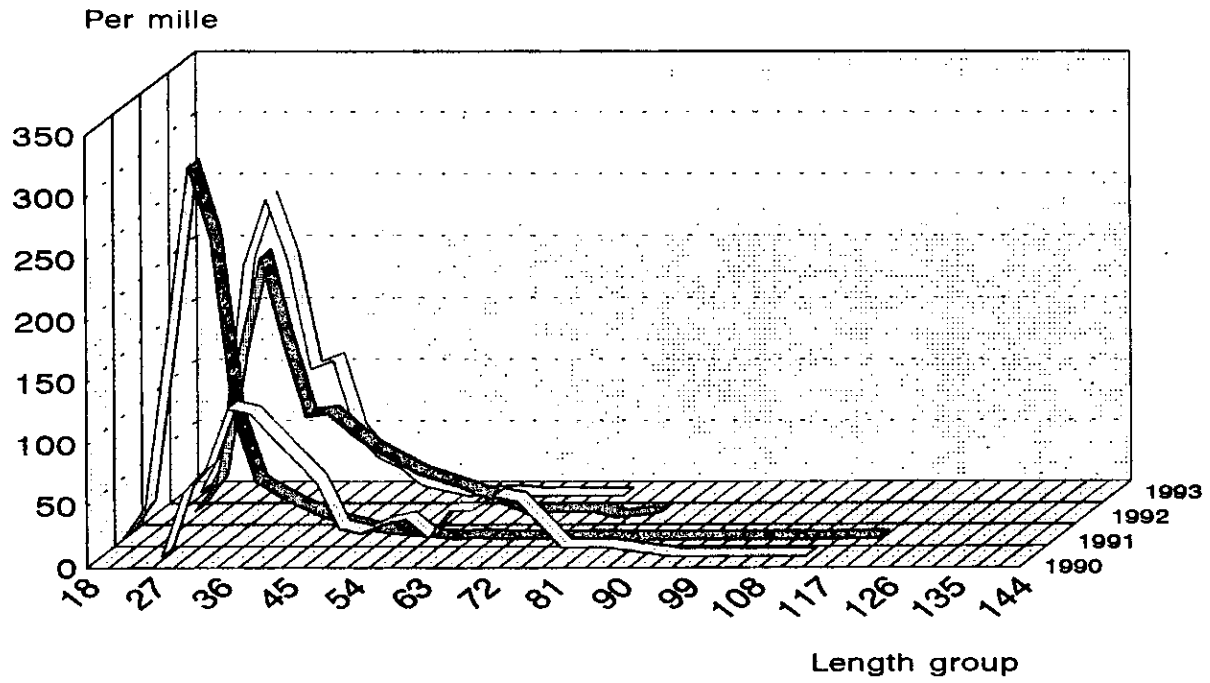


1992

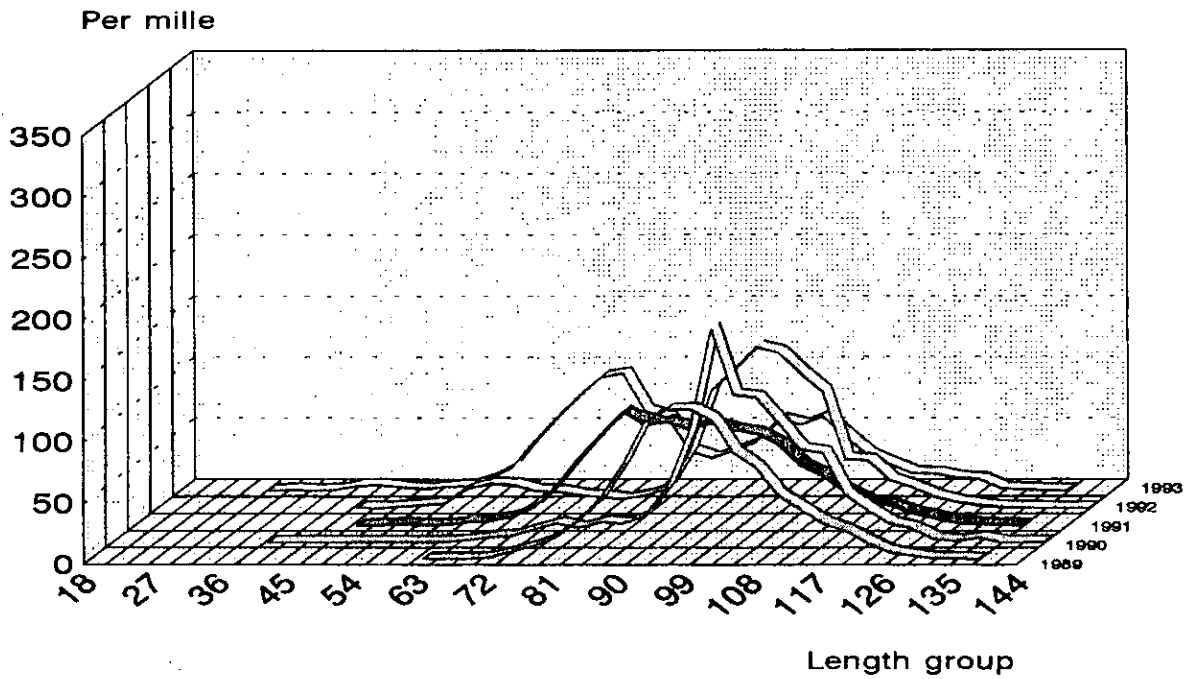


1993

Fig. 3B: Cod, Div. 3N, 1990 - 1993: mean annual trawl cpue's by year class.

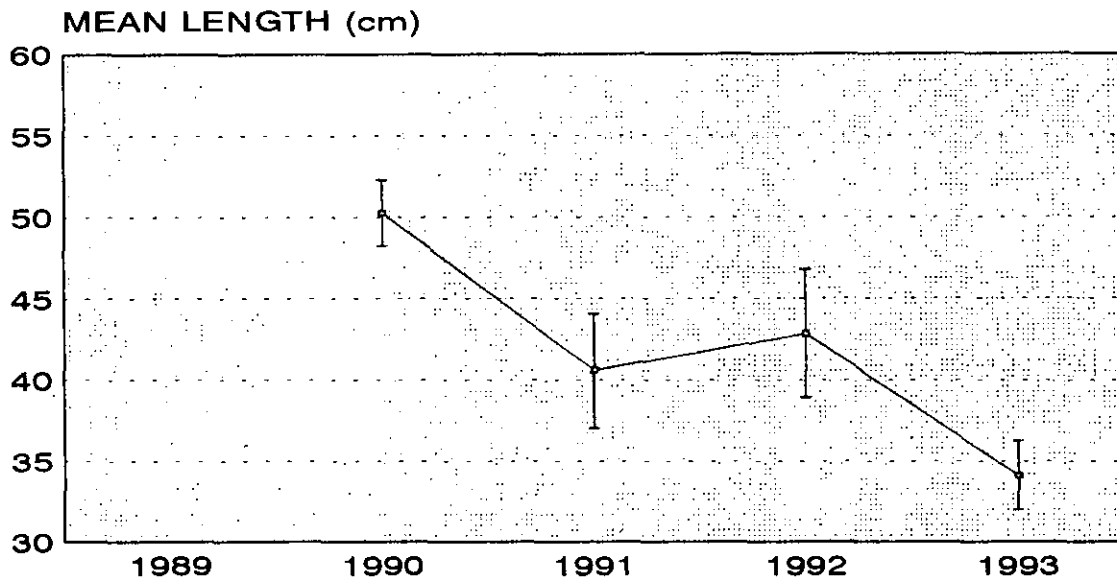


TRAWL



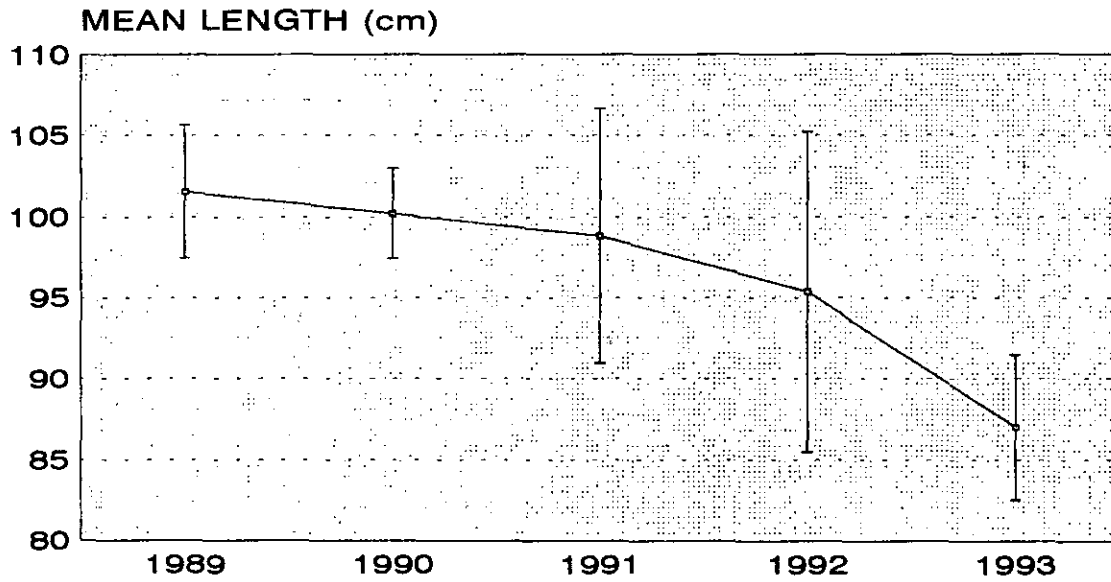
GILLNETS

Fig 4A: Cod, Div.3NO, 1989 - 1993: annual length composition of the trawl and gillnet catches.



Div. 3N

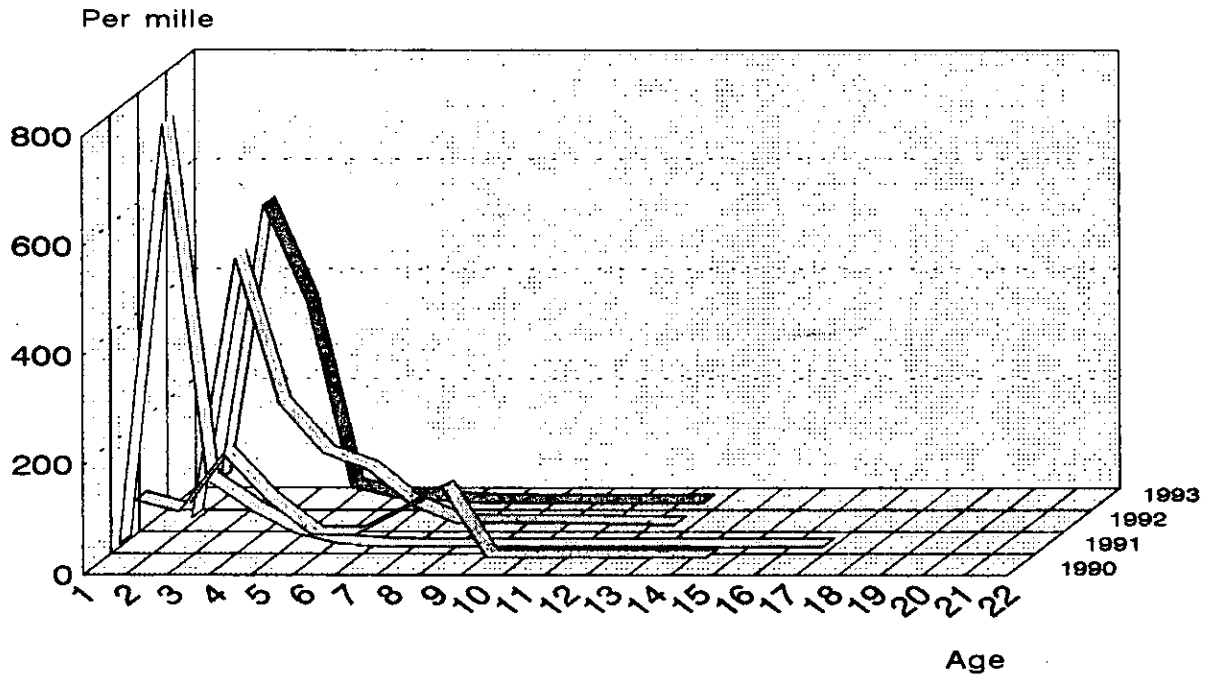
TRAWL



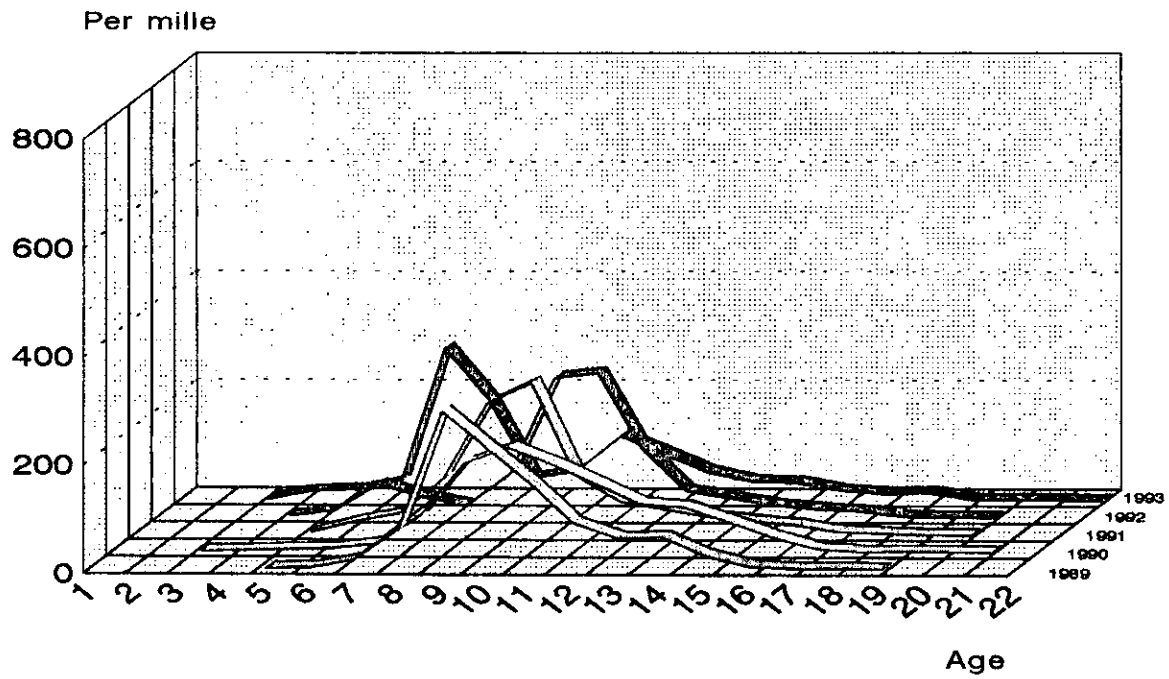
Div. 3NO

GILLNETS

Fig 4B: 3NO cod mean length of the catches, 1989 - 1993.



TRAWL



GILLNETS

Fig. 5: Cod, Div. 3NO, 1989 - 1993: annual age composition of the trawl and gillnet catches.



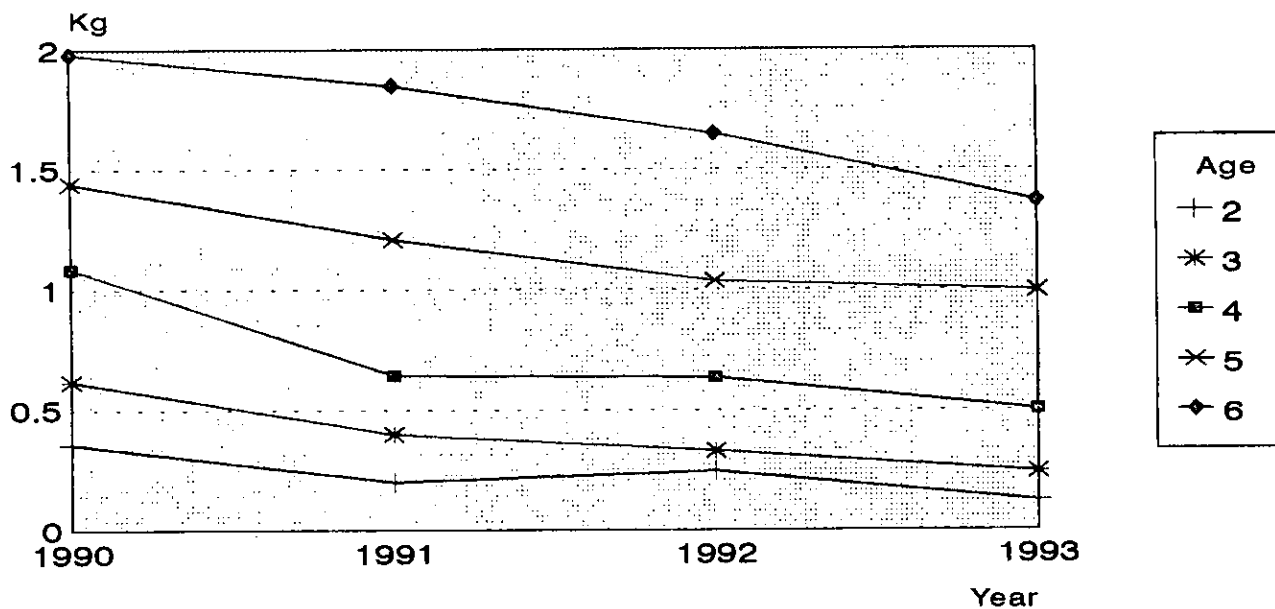


Fig. 6A: Cod, Div.3N, 1990 - 1993: mean weight at age of the trawl catches.

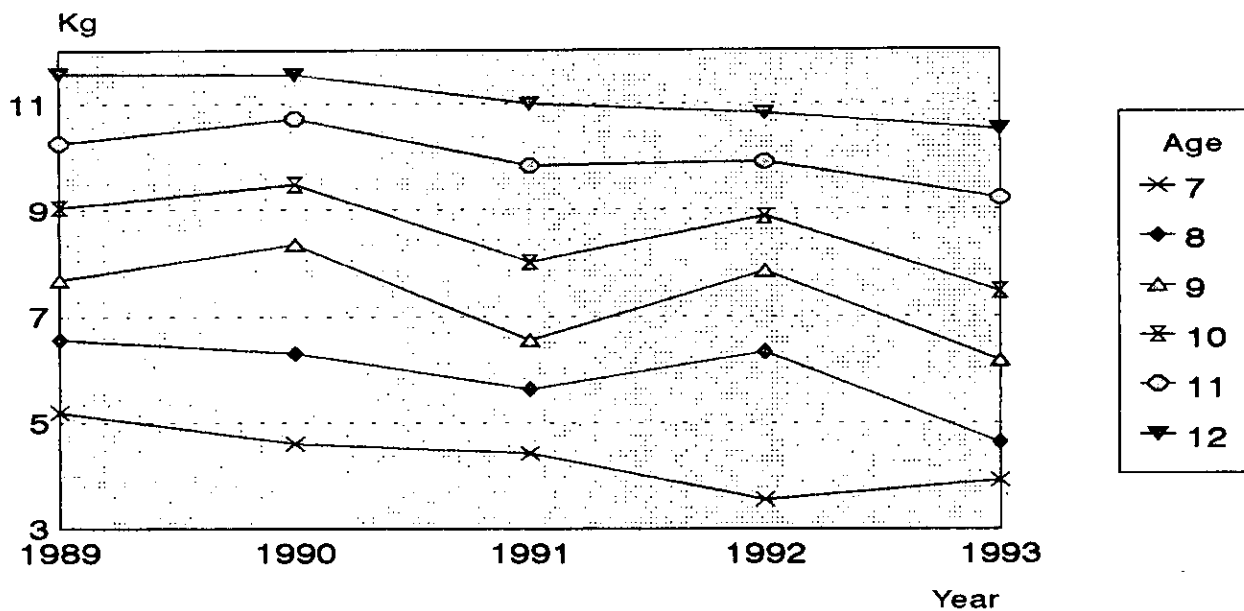


Fig. 6B: Cod, Div.3NO, 1989 - 1993: mean weight at age of the gillnet catches.