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Catch Rate *Versus* Biomass Trends for 3M Cod, 1988-95: Why They Don't Match?

by

A. M. Ávila de Melo and R. Alpoim
Instituto Protugués de Investigacao Maritima
Av. Brasilia, 1400 Lisboa, Portugal

The effective use of 130mm mesh size in the trawl fisheries on the NAFO Regulatory Area since May 1995 had implied a change in the fishing pattern of the 3M cod. Two series of cpue's were rebuilt for the period 1988 - 1995, one from the observed monthly values of monitored vessels and another derived from the former and correspondig to catch rates that would had occured over the same interval if a 130mm mesh size in the codend had been applied. The first series is considered to represent catches from 2 years old cod while the second from an age between 4 and 5. The differences observed when compairing the two series with the EC survey biomasses of the corresponding two segments of the population are related with the shrinkage of its distribution over this most recent decline. Taking these apparent contradictions into account it is concluded that for the time being and in 3M cod VPA based assessments, tunning matrices derived from commercial catch rates at age should not be used for any age in the population.

Introduction

Being cod a traditional priority species for Portuguese trawl in NAFO Regulatory Area, Flemish Cap has been the ground were most of its fishing effort to cod took place in several recent years. In fact the appearance of good recruitments in 1985/86 and 1990/91, toghether with diminuishing fishing opportunities on the nose and tail of the Grand Bank, lead to rapid and high concentrations of trawl effort on Flemish Cap in 1989/90 and 1993/94, resulting on total estimated cod catches (including those from pair trawlers, gillneters, longliners and flags of convenience) at levels of 40.000tons and 30.000tons respectively. As regards Portuguese trawl fleet, and based on observed data, 3M cod fishery peaked in 1994 with 39% of the trawl effort applied to this stock (Ávila de Melo *et al.*, 1995) and a maximum standardized cpue for 1988-95 interval of almost 1 ton/hour (Table 3). However, either from the revised 1995 assessment of this cod stock (Vazquez *et al.*, 1995) and from the EC Flemish Cap survey results (Vazquez, 1996), the total 3M cod biomass was at much lower level in 1994 than in 1989, when a maximum was reached for this time series.

In 1995 cod trawl cpue halved the 1994 value, following this time a new drop in the survey biomass, but the impact on catch rates of the effective use of 130mm trawl mesh size since May 95 (with the enforcement of an observer on board of each fishing vessel on behalf of the actual NAFO Observer Programme) needs to be investigate. The purpose of the present work is to derive a "new" cpue series from the observed one, corresponding to the yields expected if a 130mm mesh size was used over the same time period, and to compare the trends of the two catch rate series (observed and estimated) with the correspondent biomasses of the stock segments affected by those two different fishing patterns.

Material and methods

Observed catch and effort data from eleven Portuguese trawlers fishing for cod in Flemish Cap on several trips made during the 1988 - 1995 period were reviewed on a haul by haul basis. With the exception of one side trawler, all the other ten vessels were OTB2 stern trawlers from the early seventies with quite similar fishing efficiency The daily catch and effort data from each of

these trawlers were used to estimate the direct effort to 3M cod and associated catch on a monhtly basis. The catch rates available for each month/year were then averaged using the number of fishing days as a weighting factor. The observed monthly cpue's so obtained for the 1988/95 period were then standardized by an aditive model already fully described in a previous paper (Ávila de Melo and Alpoim, 1995) in order to built annual series of observed 3M cod cpue's corrected for the month of each observation.

Portuguese cod trawl catches were sampled on board every year on the months corresponding to the peaks of the fishery in Flemish Cap. The 3M cod length frequencies of the trawl catch were presented annually in the Portuguese Research Reports covering the study period, and are representative of the total catch taken each year, *i.e.* including any eventual discards. Mean weights at length for each year were available from the respective 3M cod length weight relationship obtained from EC bottom trawl survey of Flemish Cap in July, 1988 - 1995.

The major uncertainty however remained to the real mesh size of the codend in use till April 1995. From the length data collected on board on behalf of the Portuguese Sampling Programme, length frequencies of cod and American plaice trawl catches from Flemish Cap and the tail of the Grand Bank showed over the last years a high proportion of undersized fish. This fact indicates that not only that the mesh sizes were well bellow 130mm, but also should be similar within the trawl fleet since no significant differences were detected between samples from different vessels taken at the same time and division. Furthermore, the proportions in the 1991 3N cod catch and 1988 and 1992 3M cod catches of fish with lengths between 24cm and 27cm indicated that a mesh size somewhere around 60mm/ 70mm should be in pratice in some of the NAFO trawl fisheries. As a working hipothesys we decided to consider that the 3M cod trawl catches from January 1988 till April 1995 were taken with an effective mesh size of 65mm.

In order to derive an estimated cpue series for 130mm covering the whole study interval (i.e. from January 1988 to December 1995) we calculate for each year an yield rate to apply to the observed monthly cpue's up to April 1995 (considered to correspond to a 65mm mesh size). The observed monthly cpue's from May to December 1995 (corresponding finally to 130mm mesh size) were then incorporated in to the previous estimated cpue matrix. This new cpue matrix for 130mm mesh size has finally been standardized using the same model first applied to the observed values.

To calculate the annual yield rates we considered that the selection curves from Northwest Atlantic cod stocks could be derived from the logistic equation (Halliday and White, 1989):

$$S(L) = 1 / (1+ \exp (\alpha \ (1 - L / L\ 50)) \qquad (1)$$

Where

S(L) = selection of the Lth length group
L50 = Length at wich 50% of fish is retained in the codend (= SF x mesh size)

A value for α , the parameter defining the shape of the ogive, of 9 was adopted from Clay (1979, in Halliday and White, 1989). This value of α can be derived from L50 and the selection range (r) by the equation:

$$\alpha = 2 \ln (3) L50 / r \qquad (2)$$

Clay (1979, in Halliday and White, 1989) used the predicted value of r for 130mm mesh size from the regression analysis of selection range data compiled by Holden (1971) against mesh size and a selection factor (SF) of 3.75 calculated by the same author for 66mm - 168mm mesh sizes (Halliday and White, 1989). The L50 for 130mm mesh size for that selection factor is then 48.8 cm. Although not tabled in Haliday's work (1989), the selection range for 130mm can be derived from equation (2) assuming the α and L50 values mentioned above. These values were also assumed in equation (1) to give the 130mm mesh size selection at length for length groups from 19cm to 112 cm (minimum and maximum recorded in 1988 - 1995 3M cod length sampling of trawl catches).

We considered in this work that the selection range increases with mesh size, but the ratio

$$\beta = r / L50 \qquad (3)$$

is kept constant for both 3M cod and the mesh size interval considered (65mm - 130mm). This implies that the selection curve for 65mm mesh size is a logistic of same shape than the one for 130mm, since, from equation (2), α should be the same. Beimg so the L(50) and selection at length for 65mm mesh size can be easily derived from the former selectivity parameters. For each

length group within the length range of the cacth, a retention rate is finally given by the ratio between the selections for 130mm and 65mm, representing at each length the proportion of cod retained in a 65mm codend that will also be caught if the mesh size doubled. Selectivity parameters, selection at length for 65mm and 130mm and 130mm / 65mm retention rate series are presented in Table 1.
In Tables 2 is calculated the yield rate to be applied to the catch rate observations of each year in order to built the estimated 130mm catch rate matrix. From the observed per mille length frequency of the annual catch and the 130mm / 65mm retention rate series is calculated the corresponding catch in numbers at length if a 130mm mesh size had been used (the first series will totalize a thousand fish and the second a somewhat smaller number). Obviously for 1995 the lenght frequency considered was representative of the 3M trawl catches only till April. With mean weights at length given by length weight relationship from that year survey, both those catch in numbers at length are converted in catch in weight at length and summed up. The annual yield rate is then given by the ratio between the total catch in weight for 130mm and 65mm mesh sizes.

Results and Discusion.

If we consider that 3M cod at the beginning of age two has a length in the vicinity of 24cm (= L50 for 65mm mesh size) and that 49cm (= L50 for 130mm mesh size) is a length reached somewhere between age four and five; if recent studies pointing out a shift of spawning to younger ages (Saborido-Rey and Junquera, 1995) observed in Flemish Cap over the last years, confirm that the first spawn is now occurring at age four; then the observed cpue series should be related with the 2+ biomass of this stock and the estimated one with the recent levels of spawning stock biomass. For the pourposes of this work spawning stock biomass is considered to be given by 50% of age 4 biomass add to the 5+ biomass. Yield rates would then reflect the importance (quantified in terms of proportion in weight) of adult fish against young fish in the trawl catch (and, in a certain way, in the population). Both 2+biomass and spawning stock biomass are calculated from 1988 - 1995 EC survey results as a sum of products of abundances and mean weights at age.
The annual yield rates, presented for each year in each one of Tables 2, are as follows:

	1988	1989	1990	1991	1992	1993	1994	1995
Yield rate	0.148	0.451	0.548	0.622	0.209	0.375	0.324	0.618

These values, regarded as convertion factors to estimate cpue's for 130mm mesh size from the observed values, are put in graphic on Fig. 1. From this figure two distinct periods of the recent hiof this 3M trawl fishery can be easily identified. The first one, from 1988 to 1991, presents a steady increase of the yield rates (meaning a decreasing difference between observed and estimated cpue's) as a consequence of the invidual growth from one year to the next of the survivors from both 1985 and 1986 year classes wich, till 1991, were still well represented in the trawl catch (Godinho, 1989; Ávila de Melo *et al.*, 1990; Godinho *et al.*, 1991; Alpoim *et al.*, 1992) Over exploitation lead those year classes to an almost null presence in the trawl catches next year, justifying the drop in the yeld rate from 1991 to 1992 (i.e. a sharp increase in the difference between observed and estimated cpue's) . The second period, although presenting also an increase of the yield rate from a minimum in the first year (1992) to a maximum in the last (1995), both around the minimum and maximum former observed, don't showed however the same patterm of variation within years. In fact yield rate increased in 1993, due to growth of cod from the 1990 cohort, but slightly declined again in 1994. This could only mean that the strong 1990 year class had a short passage through the fishery and in 1994 had already been replaced by the 1991 year class (Ávila de Melo *et al.*, 1993; Alpoim *et al.*,1994; Ávila de Melo *et al.*, 1995). From survey results (Vazquez, 1996) this 1991 year class was the most abundant cohort at ages 1 and 2 since 1998, and its few survivors in 1995 are the only ones responsible for the increase in the yield rate last year (Godinho *et al.*,1996). Taking in to account what these rates represent, the variation of its values throughout the study period indicate that in Flemish Cap and as regards cod, strong year classes "lived" longer in the fishery during the late eighties/ early nineties than over the last four years considered.
Observed cpue's are presented in Table 3 and Figure 2, compared with 2+biomass from EC bottom trawl surveys. The 1995 value for the observed cpue can be considered representative of the cod trawl fishery for last year since we estimate that in 1995 about 85% of the Portuguese trawl catches had been taken during the first quarter of the year, prior to the effective enforcement of 130mm mesh size in the codend. Both cpue's and biomasses have also been transformed in relative values to the first year of the time interval, in order to make easy the comparison of the respective trends. The contradiction between the two series is evident: the 2+biomass presents an overall drastic decline from 1989 onwards, only interrupted in 1993 with the income to the

exploited stock of the 1991 cohort, while cpue's steadly increase till 1994, just as the reduction of stock biomass would had, on the short term, a positive effect in the fishery. This "magic" quicly ended in 1995, with the observed cpue "back to the real world" at the same speed that stock biomass hit the bottom. This apparent contradiction can be explained by the behaviour of Flemish Cap cod as regards its distribution over the bank during this recent decline of the population. From the maps presented on Figure 4 a progressive shrinkage of 3M cod distribution is evident since 1991 and, for 1994 and 1995, the remainder of the population was confined to small patches on the center / east south of Flemish Cap. These progressive concentrations of cod could easily be tracked by experienced skipers and rapidly produce excelent yields till near the exaustion of fish.

Estimated cpue's for 130mm mesh size and spawning stock biomass, given by 50% of age 4 biomass add to the 5+ biomass, are presented in Table 4 and Figure 3. Each series again present different trends, but in this case estimated cpue's for "adult" cod fluctuate from 1989 onwards around a level three times higher than the one recorded in 1988, while spawning stock biomass falled between 1990 (its maximum in recent years) and 1992, slowly declining since then. The survival of the 1985/86 year classes was still big enough to induce an increase in the spawning stock biomass in the early nineties (together with a shift in maturity towards younger ages). The good recruitments then produced didn't had the same chance and so the adult component of this stock ended near to collapse in 1995. The correspondant estimated cpue's first took advantage of the remainder of the abundant cohorts from mid eighties and for last years of the study period were kept at a high level by the shrinkage of the population distribution, also reflected in adult cod.

Conclusions

Flemish Cap is an ecossistem where the abundance of its exploited populations is (still?) basically determined by fishing mortality. The 3M cod didn't suffer extra (and unquantified) natural mortality caused by extreme ocenographic anomalies, predation by seals or starvation in deep waters as occurred in neighbour stocks. The actual state of the stock is near collapse due to a high and rapid concentration of fishing effort on a population in decline. This sock had showed a pronounced shrinkage of its distribution while sustaining a fishery with improving yields. Therefore, and while this opportunistic scenario of recruitment based casual fishery remains unchanged, tunning matrices derived from commercial catch rates at age should not be used in any type of calibration of last year's fishing mortalities, for any age in the population.

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Table 1: Cod, Division 3M. Selection parameters and retention rates for 130mm against 65mm mesh size.

COD 3M			
Mesh size (cm)	6.5	13	
SF ->	3.75	3.75	(Holden, 1971)
L75-L25 ->	5.951	11.902	
L50	24.4	48.8	
L75-L25/L50 ->	0.244	0.244	
ALFA ->	9	9	(Clay, 1979)

	Selection at length for		Retention rate
Length group	65mm	130mm	130mm/65mm
19	0.121	0.004	0.034
22	0.294	0.007	0.024
25	0.557	0.012	0.022
28	0.792	0.021	0.027
31	0.920	0.036	0.040
34	0.972	0.062	0.063
37	0.991	0.103	0.104
40	0.997	0.166	0.166
43	0.999	0.257	0.257
46	1.000	0.376	0.376
49	1.000	0.512	0.512
52	1.000	0.646	0.646
55	1.000	0.760	0.760
58	1.000	0.847	0.847
61	1.000	0.906	0.906
64	1.000	0.944	0.944
67	1.000	0.967	0.967
70	1.000	0.981	0.981
73	1.000	0.989	0.989
76	1.000	0.994	0.994
79	1.000	0.996	0.996
82	1.000	0.998	0.998
85	1.000	0.999	0.999
88	1.000	0.999	0.999
91	1.000	1.000	1.000
94	1.000	1.000	1.000
97	1.000	1.000	1.000
100	1.000	1.000	1.000
103	1.000	1.000	1.000
106	1.000	1.000	1.000
109	1.000	1.000	1.000
112	1.000	1.000	1.000

Table 2: Cod, Division 3M. Annual yeld rate between a catch weight estimated if 1,000 fish would pass through a 130mm mesh size codend and the weight of 1000 fish caught with 65mm mesh size codend.

(Length weight relationships derived from EC 1988 - 1995 July bottom trawl surveys)

Year 1988 a-> 0.006535 (Vazquez, 1988)
b-> 3.0901

	Per mille 65mm		catch weight (Kg)	Retention rate	catch numbers	catch weight (Kg)
Length group	Length frequencies	Mean weight (g)	65mm	130mm/65mm	130mm	130mm
19	1	58	0.1	0.034		
22	17	92	1.6	0.024		
25	61	136	8.3	0.022	1	0.2
28	91	194	17.6	0.027	2	0.5
31	202	265	53.6	0.040	8	2.1
34	252	353	88.9	0.063	16	5.6
37	190	458	87.1	0.104	20	9.0
40	105	583	61.2	0.166	17	10.2
43	50	729	36.5	0.257	13	9.4
46	18	898	16.2	0.376	7	6.1
49	7	1092	7.6	0.512	4	3.9
52	2	1312	2.6	0.646	1	1.7
55						
58						
61	1	2148	2.1	0.906	1	1.9
64	2	2492	5.0	0.944	2	4.7
67	1	2871	2.9	0.967	1	2.8
TOTAL	1000		391		93	58
					Yeld rate 88	**0.148**

Table 2 (cont): Cod, division 3M. Annual yeld rate for 1989

Year 1989 a-> 0.006734 (Vazquez, 1989)
b-> 3.0801

	Per mille 65mm		catch weight (Kg)	Retention rate	catch numbers	catch weight (Kg)
Length group	Length frequencies	Mean weight (g)	65mm	130mm/65mm	130mm	130mm
22	1	92	0.1	0.024	0	0.0
25	4	136	0.5	0.022	0	0.0
28	9	193	1.8	0.027	0	0.0
31	25	264	6.5	0.040	1	0.3
34	47	351	16.4	0.063	3	1.0
37	85	456	38.5	0.104	9	4.0
40	137	579	79.5	0.166	23	13.2
43	179	724	129.4	0.257	46	33.3
46	183	891	162.9	0.376	69	61.2
49	159	1082	172.2	0.512	81	88.1
52	99	1299	128.4	0.646	64	82.9
55	47	1544	72.1	0.760	35	54.8
58	17	1819	30.2	0.847	14	25.6
61	4	2125	7.8	0.906	3	7.1
64	2	2463	5.0	0.944	2	4.7
67	2	2836	4.8	0.967	2	4.7
70	1	3246	4.7	0.981	1	4.6
73	2	3694	5.6	0.989	1	5.5
TOTAL	1000		866		355	391
					Yeld rate 89	**0.451**

Table 2 (cont): Cod, division 3M. Annual yeld rate for 1991.

Year 1990

a-> 0.008002 (Vazquez, 1990)
b-> 3.0422

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
19	0	62	0	0.034	0	0
22	5	97	0	0.024	0	0
25	14	143	2	0.022	0	0
28	10	202	2	0.027	0	0
31	18	276	5	0.040	1	0
34	41	365	15	0.063	3	1
37	81	472	38	0.104	8	4
40	132	598	79	0.166	22	13
43	162	746	121	0.257	42	31
46	147	915	134	0.376	55	50
49	125	1109	138	0.512	64	71
52	92	1329	123	0.646	60	79
55	66	1577	105	0.760	51	80
58	45	1853	83	0.847	38	70
61	28	2160	61	0.906	25	55
64	18	2500	45	0.944	17	42
67	8	2874	23	0.967	8	23
70	4	3284	12	0.981	3	11
73	1	3731	4	0.989	1	4
76	1	4217	3	0.994	1	2
79	0	4744	2	0.996	0	2
82	1	5314	4	0.998	1	4
85	0	5928	1	0.999	0	1
88	0	6587	2	0.999	0	2
91	0	7294	1	1.000	0	1
94	0	8051	1	1.000	0	1
97	0	8858	2	1.000	0	2
100	0	9718	1	1.000	0	1
103	0	10633	1	1.000	0	1
106	0	11603	1	1.000	0	1
TOTAL	1000		1008		401	552
				Yeld rate 90		**0.548**

Table 2 (cont): Cod, division 3M. Annual yeld rate for 1991.

Year	1991			a->	0.00853 (Vazquez, 1991)	
				b->	3.0212	
	Per mille 65mm		catch weight (Kg)	Retention rate	catch numbers	catch weight (Kg)
Length group	Length frequencies	Mean weight (g)	65mm	130mm/65mm	130mm	130mm
19	1.0	62	0	0.034	0	0
22	5.2	97	1	0.024	0	0
25	16.8	143	2	0.022	0	0
28	17.5	201	4	0.027	0	0
31	70.1	273	19	0.040	3	1
34	109.3	361	39	0.063	7	3
37	128.6	466	60	0.104	13	6
40	140.7	590	83	0.166	23	14
43	130.2	734	96	0.257	33	25
46	54.7	900	49	0.376	21	19
49	26.8	1090	29	0.512	14	15
52	37.4	1304	49	0.646	24	32
55	69.5	1545	107	0.760	53	82
58	56.1	1814	102	0.847	47	86
61	47.8	2112	101	0.906	43	91
64	38.5	2442	94	0.944	36	89
67	17.1	2805	48	0.967	17	46
70	21.8	3202	70	0.981	21	68
73	5.6	3634	20	0.989	6	20
76	1.3	4105	5	0.994	1	5
79	2.6	4614	12	0.996	3	12
82						
85	0.6	5756	3	0.999	1	3
88	0.3	6392	2	0.999	0	2
91	0.2	7073	2	1.000	0	2
94						
97						
100	0.3	9405	2	1.000	0	2
TOTAL	1000		1000		368	622
					Yeld rate 91	**0.622**

Table 2 (cont): Cod, division 3M. Annual yeld rate for 1992.

Year 1992

a-> 0.008881 (Vazquez, 1992)
b-> 3.0163

Length group	Per mille 65mm Length frequencies	Mean weight (g)	catch weight (Kg) 65mm	Retention rate 130mm/65mm	catch numbers 130mm	catch weight (Kg) 130mm
25	12.5	146	2	0.022	0	0
28	130.7	206	27	0.027	4	1
31	358.4	280	100	0.040	14	4
34	217.6	370	80	0.063	14	5
37	114.4	477	55	0.104	12	6
40	61.2	604	37	0.166	10	6
43	43.2	751	32	0.257	11	8
46	22.1	920	20	0.376	8	8
49	10.6	1113	12	0.512	5	6
52	9.1	1332	12	0.646	6	8
55	8.9	1577	14	0.760	7	11
58	4.7	1851	9	0.847	4	7
61	2.3	2156	5	0.906	2	5
64	1.6	2491	4	0.944	2	4
67	0.9	2861	2	0.967	1	2
70	0.5	3265	2	0.981	1	2
73	0.5	3705	2	0.989	0	2
76	0.1	4184	0	0.994	0	0
79	0.2	4702	1	0.996	0	1
82	0.3	5261	2	0.998	0	2
85	0.2	5864	1	0.999	0	1
TOTAL	1000		419		101	88
				Yeld rate 92		**0.209**

Table 2 (cont): Cod, division 3M. Annual yeld rate for 1993.

Year	1993			a->	0.007502	(Vazquez, 1993)
				b->	3.0572	
	Per mille 65mm		catch weight (Kg)	Retention rate	catch numbers	catch weight (Kg)
Length group	Length frequencies	Mean weight (g)	65mm	130mm/65mm	130mm	130mm
19		61	0	0.034	0	0
22	3.2	95	0	0.024	0	0
25	39.5	141	6	0.022	1	0
28	44.0	199	9	0.027	1	0
31	85.3	272	23	0.040	3	1
34	148.9	361	54	0.063	9	3
37	200.6	467	94	0.104	21	10
40	209.9	593	124	0.166	35	21
43	104.7	740	77	0.257	27	20
46	58.8	909	53	0.376	22	20
49	27.1	1103	30	0.512	14	15
52	17.8	1322	24	0.646	11	15
55	15.5	1570	24	0.760	12	19
58	11.0	1846	20	0.847	9	17
61	8.0	2154	17	0.906	7	16
64	6.9	2495	17	0.944	7	16
67	7.8	2870	22	0.967	8	22
70	3.2	3281	11	0.981	3	10
73	2.8	3730	10	0.989	3	10
76	2.5	4219	10	0.994	2	10
79	0.9	4749	4	0.996	1	4
82	1.0	5322	5	0.998	1	5
85	0.4	5940	2	0.999	0	2
88	0.1	6605	1	0.999	0	1
91	0.1	7317	1	1.000	0	1
94						
97	0.05	8895	0	1.000	0	0
100	0.05	9763	0	1.000	0	0
103						
106	0.05	11667	1	1.000	0	1
109						
112	0.05	13805	1	1.000	0	1
	1000		642		198	241
					Yeld rate 93	**0.375**

Table 2 (cont): Cod, division 3M. Annual yeld rate for 1994.

Year	1994				a->	0.006065	(Vazquez, 1994)
					b->	3.1249	
	Per mille 65mm		catch weight (Kg)	Retention rate	catch numbers	catch weight (Kg)	
Length group	Length frequencies	Mean weight (g)	65mm	130mm/65mm	130mm	130mm	
25	0.1	142	0	0.022	0	0	
28	0.4	202	0	0.027	0	0	
31	62.5	277	17	0.040	2	1	
34	102.7	370	38	0.063	7	2	
37	160.2	482	77	0.104	17	8	
40	224.4	615	138	0.166	37	23	
43	170.5	771	131	0.257	44	34	
46	147.3	952	140	0.376	55	53	
49	73.0	1160	85	0.512	37	43	
52	35.5	1397	50	0.646	23	32	
55	12.9	1665	21	0.760	10	16	
58	5.7	1965	11	0.847	5	9	
61	3.2	2300	7	0.906	3	7	
64	1.4	2673	4	0.944	1	4	
67							
70							
73							
76							
79							
82							
85	0.1	6487	1	0.999	0	1	
88							
91	0.1	8029	1	1.000	0	1	
TOTAL	1000		723		242	234	
					Yeld rate 94	**0.324**	

Table 2 (cont): Cod, division 3M. Annual yeld rate for 1995.

Year	1995				a->	0.007204	(Vazquez, 1995)
					b->	3.0632	
	Per mille 65mm		catch weight (Kg)	Retention rate	catch numbers	catch weight (Kg)	
Length group	Length frequencies	Mean weight (g)	65mm	130mm/65mm	130mm	130mm	
31	0.9	267	0	0.040	0	0	
34	19.3	354	7	0.063	1	0	
37	48.0	458	22	0.104	5	2	
40	126.4	582	74	0.166	21	12	
43	215.1	726	156	0.257	55	40	
46	176.8	893	158	0.376	66	59	
49	122.7	1084	133	0.512	63	68	
52	82.7	1300	107	0.646	53	69	
55	58.4	1544	90	0.760	44	69	
58	46.6	1817	85	0.847	39	72	
61	32.1	2120	68	0.906	29	62	
64	20.1	2456	49	0.944	19	47	
67	8.9	2826	25	0.967	9	24	
70	7.4	3232	24	0.981	7	23	
73	5.7	3675	21	0.989	6	21	
76	7.5	4158	31	0.994	7	31	
79	5.7	4681	27	0.996	6	27	
82	4.5	5248	23	0.998	4	23	
85	3.4	5858	20	0.999	3	20	
88	2.7	6515	17	0.999	3	17	
91	2.2	7220	16	1.000	2	16	
94	1.4	7974	11	1.000	1	11	
97	0.8	8779	7	1.000	1	7	
100	0.3	9638	3	1.000	0	3	
103	0.3	10551	3	1.000	0	3	
106						0	
109	0.2	12549	3	1.000	0	3	
						0	
TOTAL	1000		1180		447	729	
					Yeld rate 95	**0.618**	

TABLE 3: Cod Division 3M. Portuguese trawl catch rates, 1988-95 : observed mean annual cpue's corrected for the month of each observation. Stock biomass 2+ from EC survey. Relative values (BIOMr2+ and CPUEr) to 1988.

YEAR	CPUE (ton/hour)	ST.ERROR	C.V.	BIOM.2+	BIOMr 2+	CPUEr
1988	0.507	0.133	64.1	33332	1.0	1
1989	0.821	0.048	17.4	99508	3.0	1.6
1990	0.485	0.100	65.0	51296	1.5	1.0
1991	0.694	0.434	88.5	29790	0.9	1.4
1992	0.890	0.222	50.0	18890	0.6	1.8
1993	0.973	0.185	56.9	54757	1.6	1.9
1994	0.998	0.167	44.3	41965	1.3	2.0
1995	0.493	0.172	85.5	8748	0.3	1.0

TABLE 4: Cod Division 3M. Portuguese trawl catch rates, 1988-95 : estimated mean annual cpue's for 130mm mesh size, corrected for the month of each observation. Spawning stock biomass from EC survey (SSB) as 50% biomass age 4 add to 5+biomass. Relative values (SSBr and CPUEr) to 1988.

YEAR	CPUE (ton/hour)	ST.ERROR	C.V.	SSB (tons)	SSBr	CPUEr
1988	0.106	0.032	75.1	11077	1.0	1.0
1989	0.379	0.028	21.9	18110	1.6	3.6
1990	0.257	0.062	76.7	55730	5.0	2.4
1991	0.382	0.170	63.0	24210	2.2	3.6
1992	0.229	0.068	59.7	8244	0.7	2.2
1993	0.370	0.073	59.1	8132	0.7	3.5
1994	0.326	0.053	42.8	6308	0.6	3.1
1995	0.324	0.078	58.6	4447	0.4	3.1

Fig. 1: 3M cod yield rates
to convert observed to 130mm cpue's

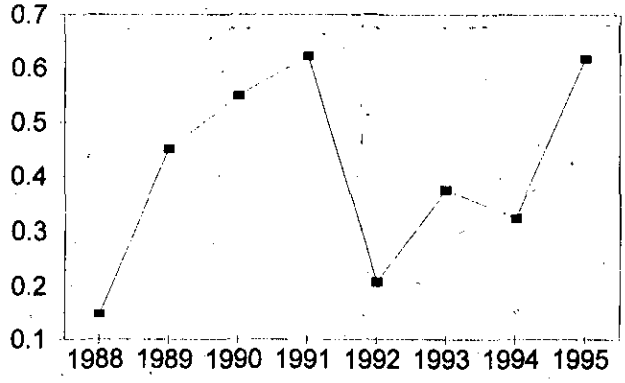


Fig. 2: 2+biomass versus obs. cpue's
(from EC surveys and Port. trawlers)

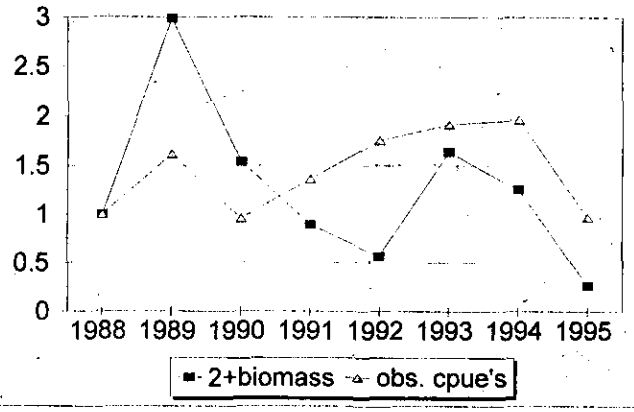
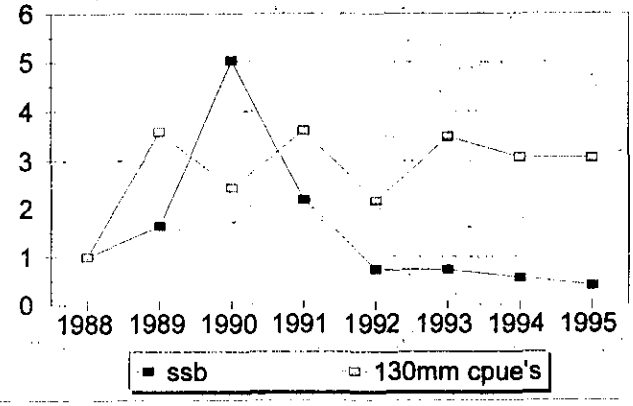


Fig. 3: SSB versus "130mm" cpue's
(from EC surveys and Port. trawlers)



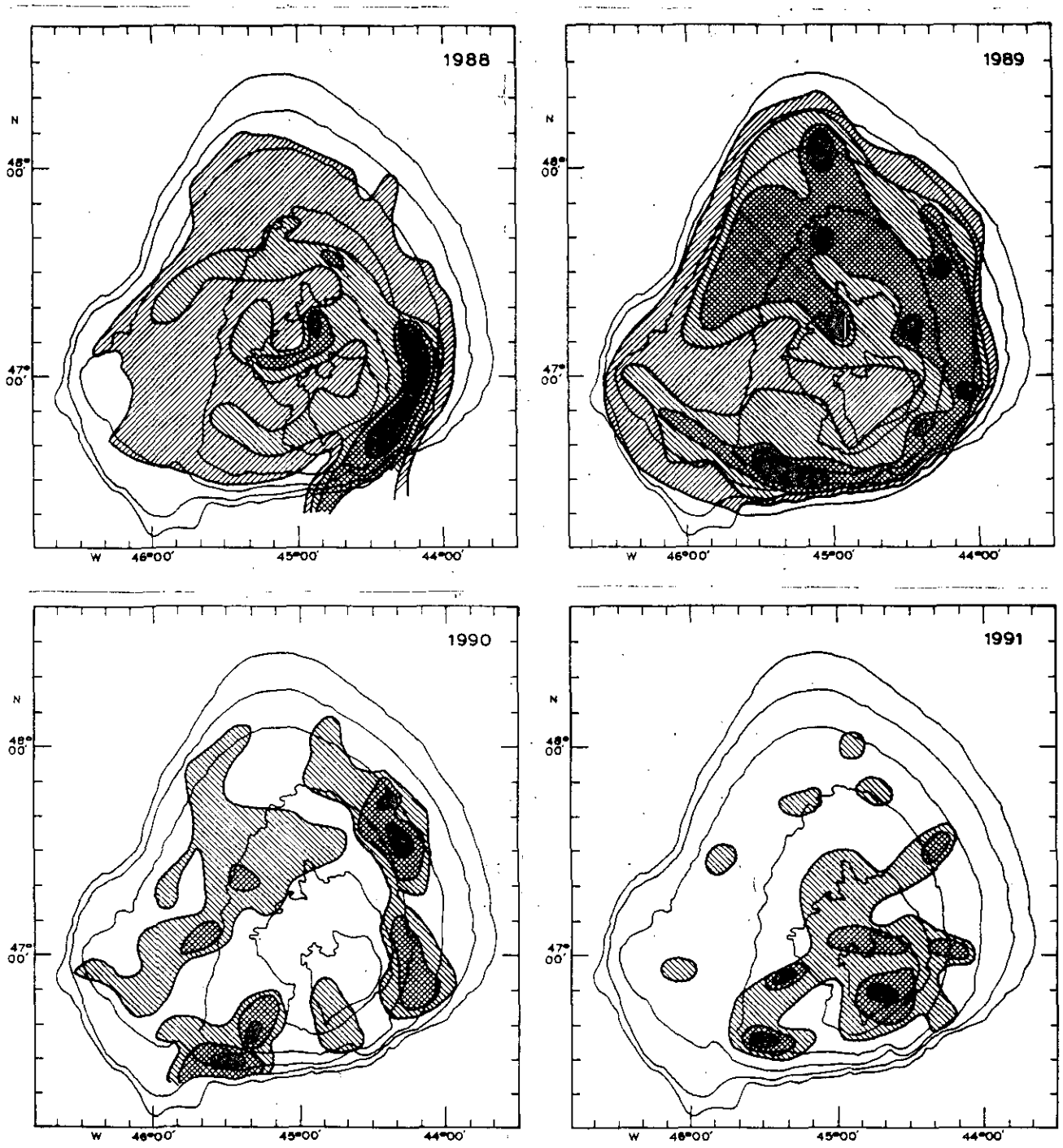


Figure 4 - Distribution of 3M cod from the half hour catches of EC bottom trawl surveys in Flemish Cap, 1988 - 1991.

0 - 50 Kg 50 - 150 Kg 150 - 400Kg >400Kg

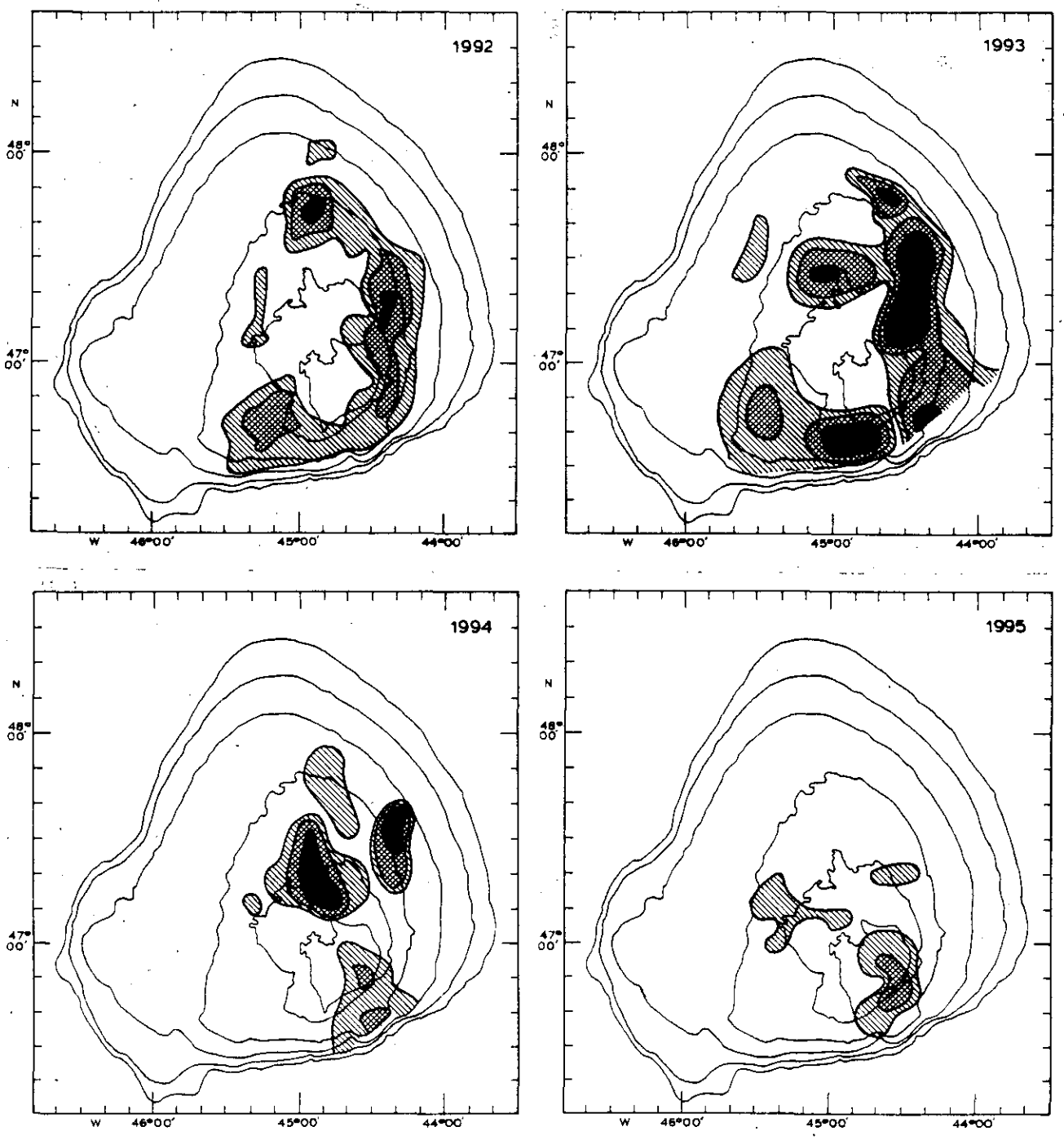


Figure 4 (cont.) - Distribution of 3M cod from the half hour catches of EC bottom trawl surveys in Flemish Cap, 1992 - 1995.

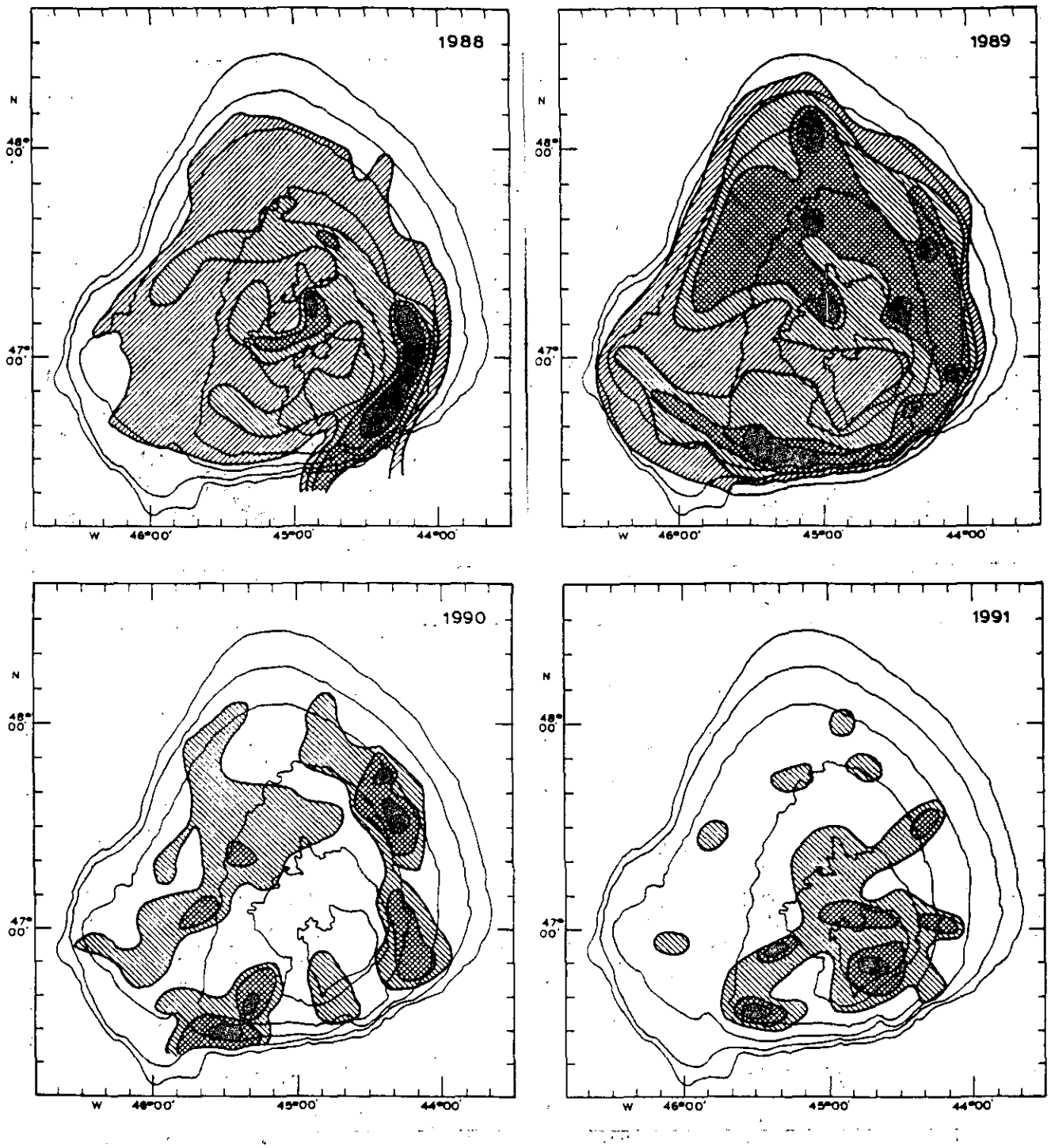


Figure 4 - Distribution of 3M cod from the half hour catches of EC bottom trawl surveys in Flemish Cap, 1988 - 1991.