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Assessment of Cod Stock in the NAFO Subarea 3 based on the 1988 Trawl-acoustic Survey Data

by

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Abstract

The cod stock state in Divisions 3M, 3NO and 3KL is studied based on the 1988 trawl-acoustic survey data and compared with the data of preceding (1977-1987) surveys.

In 1988 the Flemish Cap (3M) cod stock was below the mean long-term level; the stock is in a depressive state so far. A declining trend for the South Newfoundland (3NO) cod stock is observed, though that of the Labrador (3KL) cod in 1977-1987 was above the average level.

In spring-summer 1977-1988 outside the 200-mile zone (Divs 3NO) the biomass of cod amounted in average to 10.8%, in Div. 3L - to 6% of the total biomass value in the two Divisions.

Introduction

The 1988 survey was a continuation of a long-term series of observations of bottom commercial fishes stock state in the NAFO Subarea 3. This paper is aimed to give characteristics of the cod biological state and also to assess their stock state in Divs 3M, 3NO, 3KL in 1988 compared to 1977-1988.

Materials and methods

Trawl surveys in 1977-1982 differed from those in 1983-1988 in technique and duration of haulings (Bulatova, Chumakov, 1986). In order to preserve the series of observations and to obtain compatible indices of cod abundance and biomass the data for 1977-1982 were fitted to the 1983-1988 survey data (Bulatova et al, 1988).

In 1988 a traditional trawl survey was conducted in March by R/V MB-1202 "Persey III" in Divs 3NO, in April-May - in Divs 3KL

and in June - in Div. 3M. The survey was conducted by a stratified random survey pattern in accordance with the NAFO technique (Doubleday, 1981). Average amount (in specimens) and weight (kg) of cod taken by a bottom trawl per 30 minutes hauling over an area of 0.0135 sq.n.miles were taken for the indices of cod abundance and biomass. Calculating the total abundance and biomass by Divisions we considered only those strata where cod were found in catches.

Since 1987 trawl surveys have been made together with hydroacoustic surveys which allowed us to assess the part of the cod stock which was distributed in pelagic layers, i.e. outside the bottom trawl zone. A chart of acoustic tacks, coinciding with the 1988 trawl survey route, is presented in Fig. 1. The pelagic component of the stock was assessed in accordance with an experimental trawl-acoustic survey method worked out by Mamylov (1988). The indices of cod abundance and biomass in the bottom and pelagic layers calculated according to this method were summarized to obtain the total stock estimates for each of the Divisions.

A part of the cod stock distributed in spring-summer outside the fishing zone was estimated proportionally to the areas of strata located outside the 200-mile fishing zone.

Stock assessment

Div. 3M

From the data of trawl surveys conducted in the period 1977-1988 the abundance and biomass of cod varied within the range from 10 million to 157 million specimens and from 80,000 to 135,000 tons. Their maximum values were registered in 1977 and minimum ones - in 1980, 1987 and 1988 (Table 1). During the whole period under consideration the cod abundance averaged to $44.6 \cdot 10^6$ specimens, and the biomass - $31.3 \cdot 10^3$ tons.

According to the trawl survey results indices of cod abundance and biomass in 1988 were below the mean long-term value and also below the 1987 level, though having compared the two trawl-acoustic surveys we may conclude that in 1988 cod had predominantly pelagic distribution and on the whole their stock was slightly larger than that in 1987 (Table 2, Fig. 2). From the trawl acoustic survey results the abundance of cod amounted to $150 \cdot 10^6$ specimens, and the biomass was $34 \cdot 10^3$ tons.

Juvenile fish of 20-35 cm long, at age 2-3, from the 1986 and 1985 year classes were predominant in catches (Tables 3, 4). Cod at age 4 and older amounted to not more that 5.4%. Recruitment to the stock of the 1987 year class was weakly pronounced.

Practically all the cod were immature. Due to lack of mature fish a depressive state of the Flemish Cap cod stock will continue, presumably, until 1991-92 when the abundant 1986 year class recruits reach maturity. At present the stock state is below the mean long - term.

Divs 3NO

Since 1982 the stock of cod in Divs 3NO has begun to grow, first, because of fishery limitation and, second, due to good recruitment with the 1980-82 year classes, the abundance of which is above average (Tables 5, 6, 7, 8). Abundances of the consequent year classes were lower and in 1987-88 a trend towards stock decline was observed.

As the 1988 trawl survey shows the principal decline of the stock size has taken place in Div. 30 whereas in Div. 3N both the abundance and biomass of cod were somewhat higher compared to 1987. In total the abundance of cod in the two Divs was at the 1987 level ($55 \cdot 10^6$ specimens), and their biomass was twice lower ($110 \cdot 10^3$ tons) (Table 7).

Canadian scientists give an estimate of abundance which is similar to that of ours ($52 \cdot 10^6$ specimens), but their estimate of biomass is slightly higher ($180 \cdot 10^3$ t), besides, both estimates are below the 1987 level (Baird, Bishop, 1988).

Comparing the trawl-acoustic surveys data one can see that in 1987 only 11% and in 1988 over 70% of cod were distributed in pelagic waters (Fig. 3, Table 2). These data also show that in 1988 the fish abundance was 3 times higher and their biomass - by 1.2 times lower than those in 1987 ($190 \cdot 10^6$ specimens and $260 \cdot 10^3$ t, respectively).

Thus, at equal or even higher abundance (depending on a technique of assessment) the biomass of cod was anyway below the 1987 level, and the estimates of the trawl-acoustic survey turned out to be lower than those obtained during the 1984-86 trawl surveys only.

In 1988 juvenile cod, 18-32 cm long, composed the bulk of cat-

ches in Div. 3N; a by-catch of cod over 50 cm in length did not excede 3.8%. In Div. 30 cod of 24-35 cm long were predominant but the portion of large fish amounted to 32% (Table 3). By their age composition the southern Newfoundland cod consisted of 2-3 year-olds of the 1985 and 1986 year classes (76%),and fish at age 4 and older amounted to about 15% (Table 4). Judging by a number of fish of different ages in an average catch per tow the abundance of cod of the 1985 and 1986 year classes is lower than that of the 1980-82 year classes (Table 8). Hence, poor recruitment together with low abundance of cod of the 1983 and 1984 year classes will result in some decline of the cod stock in Divs 3NO in the nearest future.

Tables 9 and 10 present some data on abundance and biomass of cod distributed outside the 200-mile zone in spring-summer during the period 1977-1988 in Divs 3NO. The fish abundance outside the fishing zone varied considerably accounting from 3 to 55 per cent of the total cod abundance in Divs 3NO. Their biomass was $6 \cdot 10^3$ - $37 \cdot 10^3$ tons or 2-33%. In 1986-88 the biomass of cod outside the zone did not excede $5 \cdot 10^3$ - $10 \cdot 10^3$ tons.

Divs 3KL.

From the trawl survey data the cod stock in Div. 3L in 1988 was at the 1987 level, though lower than the 1983-86 level (Table 11). From the trawl-acoustic data the stock was approximately 2 times higher than that in 1987 and amounted to 284 $\cdot 10^6$ specimens in abundance and $383 \cdot 10^3$ tons in biomass (Table 2).

Fish of 30-35 cm and 48-62 cm in length, at age 3 and 5-7, respectively, belonging to the 1985, 1981-1983 year classes were predominant.

During the 1977-1988 period the biomass of cod outside the 200-mile zone averaged to 6%, and their abundance - to 10% of the total stock in Div. 3L (Tables 12, 13). From the Canadian data (Wells et al., 1988) an average per cent of biomass outside the zone was lower (2.8%) in springs of the period mentioned.

In Div. 3K the cod stock was 2-2.5 times higher in 1988 than in 1987 and approached the 1984-86 level (Table 14). From the trawl-acoustic estimate the abundance and biomass of cod were $535 \cdot 10^6$ specimens and $474 \cdot 10^3$ t, respectively (Table 2).

Cod distribution (mean density of their concentrations by stra-

ta in pelagic and bottom layers) is given in Fig. 4. Fish of 45-56 cm in length, at age 5-6 of the 1982-83 year classes were predominant in catches (Table 3, 4). During the latest 3 years the age-length composition of cod was practically the same. Hence, we may assume that the Labrador cod stock is rather stable, its size is close to the 1984-86 level and above the mean long-term (during 1977-1988 mean abundance of cod was $253.6 \cdot 10^6$ specimens and their biomass - $314.8 \cdot 10^3$ t).

Conclusions

1. In 1988 the Flemish Cap cod stock was about the 1987 level but below the mean long-term during the 1977-1988 period. The stock remains in a depressive state because of a lack of mature fish.
2. A declining trend for Divs 3NO cod stocks has been observed since 1987 which may be explained by lower abundance of the 1983-86 year classes compared to that in 1980-82. Compared to 1987 the biomass of cod in 1988 was twice lower though the abundance was at the same level. In general the stock was poorer than that in 1984-86.
3. The labrador cod stock (3KL) is rather stable, close to the 1984-86 level and above the mean long-term for 1977-1988.
4. In 1977-1988 the biomass of cod outside the fishing zone in Divs 3NO averaged to 10.8%, that in Div. 3L - to 6% of the total biomass in Divs 3NO and 3L, respectively.

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Table 1 Mean catches per hauling, abundance and biomass of cod in Div. 3M

(from bottom trawl survey data, 1977-1988)

Year	Area, sq.n.miles	Number of haulings	Mean catch per tow		Abundance (individuals • 10^6)			Biomass (tons • 10^3)		
			Number, in	Weight, kg	Maximum	Mean	Minimum	Maximum	Mean	Minimum
I977	908I	24	234.30	20I.30	262.88	I57.6I	52.33	262.58	I35.40	8.23
I978	7467	30	42.35	39.90	38.24	23.42	8.60	30.79	22.07	I3.36
I979	908I	64	80.60	60.95	I02.73	54.22	5.70	7I.78	40.99	I0.2I
I980	908I	76	I4.60	I7.90	I2.64	9.82	7.00	I6.3I	I2.02	7.74
I98I	7745	29	28.35	43.45	24.58	I6.28	7.98	34.83	24.93	I5.02
I982	908I	62	I5.35	20.55	I4.03	I0.34	6.66	23.87	I3.83	3.79
I983	908I	I03	97.40	34.30	I00.39	65.53	30.67	3I.07	23.07	I5.06
I984	908I	I03	90.20	46.40	75.40	60.68	45.96	39.29	3I.2I	23.I3
I985	908I	I06	I5.09	4I.70	44.64	37.06	29.48	34.66	28.07	2I.48
I986	908I	I08	55.30	38.70	53.29	37.20	2I.II	36.76	26.06	I5.36
I987	8479	I04	58.60	I6.20	50.96	36.82	22.68	I3.28	I0.I5	7.02
I988	84II	97	42.90	I2.40	37.90	26.73	I5.50	I0.45	7.72	4.99

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Table 2 Abundance (10^6 specimens) and biomass (10^3 tons) of cod in NAFO Subarea 3 (from trawl-acoustic survey data, 1987-1988)

Division	1987				1988			
	Trawl survey	Acoustic survey	Total for two surveys	Pelagic portion, per cent	Trawl survey	Acoustic survey	Total for two surveys	Pelagic fish portion, per cent
	I32.9	I36.0	268.9	50	306.2	228.8	535.0	43
	I30.5	I34.8	265.3	5I	33I.2	I43.3	474.5	30
	74.4	29.4	I02.8	29	89.4	I94.9	284.3	68
	I3I.9	45.3	I77.2	26	I59.4	223.8	383.2	58
	54.2	6.7	60.9	II	55.4	I35.2	I90.6	7I
	289.8	36.9	326.7	II	IIO.2	I49.8	260.0	58
	36.8	40.2	77.0	52	26.7	I23.8	I50.5	82
	I2.3	9.3	2I.6	43	7.7	26.5	34.2	77

Note: abundance - above the line
biomass - beneath the line

Table 3. Length composition of cod in NAFO Subarea 3 in 1987-88, per cent

Fish length, cm	3K		3L		3N		3O		3M	
	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988
6- 8	-	-	-	+	-	+	2	-	-	-
9- II	-	-	I	3	2	2	3	2	3	-
I2- I4	-	I	3	3	5	3	3	-	I4I	I
I5- I7	+	+	2	9	52	I0	3	9	323	8
I8- 20	I	4	4	II	2I2	I87	23	24	I9I	58
2I- 23	3	I2	7	I4	384	285	58	6I	59	I39
24- 26	5	II	9	I7	I08	I4I	55	I29	60	I70
27- 29	4	8	I0	48	I8	II3	I4	I55	38	I76
30- 32	2I	I5	20	70	25	II5	9	I39	I2	I39
33- 35	30	I7	20	67	49	56	I2	99	3	I27
36- 38	67	26	32	47	34	22	I4	33	8	77
39- 4I	I2I	60	40	32	I4	I0	2I	I0	27	43
42- 44	I49	87	7I	33	I3	8	23	4	32	26
45- 47	I65	I70	94	53	II	4	3I	7	23	I0
48- 50	I32	206	I07	82	8	6	30	9	I6	2
5I- 53	I06	I30	I03	75	8	I	36	6	I4	I
54- 56	64	I09	I05	82	7	+	28	II	II	3
57- 59	45	68	II2	90	4	4	33	I4	II	5
60- 62	3I	35	69	65	5	2	35	I4	7	4
63- 65	23	I9	5I	57	5	3	3I	I6	5	3
66- 68	I2	I0	30	4I	5	I	33	I9	4	2
69- 7I	5	3	29	25	3	+	33	I2	3	I
72- 74	6	I	I6	I8	2	2	29	9	2	+
75- 77	3	2	I3	I2	2	I	25	8	2	I
78- 80	2	I	I2	I3	I	I	32	22	I	I
8I- 83	I	+	4	7	2	-	I7	9	I	+
84- 86	2	I	4	5	2	2	3I	I3	I	+
87- 89	I	I	5	3	2	I	35	I5	+	-
90- 92	+	+	4	I	I	+	45	I6	I	+
93- 95	I	+	2	2	I	+	36	20	I	-
96- 98	-	+	3	2	I	I	32	2I	-	+
99-I0I	-	-	2	3	I	-	52	I4	+	-
I02-I04	-	-	2	2	I	I	28	23	-	-
I05-I07	-	-	3	I	2	2	3I	8	-	-
I08-II0	-	-	2	I	I	3	28	II	+	-
III-II3	-	-	2	I	I	2	II	I0	-	-
II4-II6	+	-	I	I	I	3	I0	I0	-	+
II7-II9	-	+	I	I	3	3	II	7	-	-
I20-I22	+	-	I	I	I	I	8	4	-	-
I23-I25	-	-	I	I	2	I	2	3	+	-
I26-I28	-	-	+	I	I	2	I	I	-	-
I29-I3I	-	-	+	-	-	I	4	2	-	-
I32-I34	-	-	-	-	-	-	I	-	-	-
I35-I37	-	-	-	-	+	-	-	2	-	-
I38-I40	-	-	-	-	-	+	I	I	-	-
No. of fish per cent	I000	998	997	I000	I000	I000	I000	I002	I000	I00I
No. of spec.	6553	I2995	38I2	57I4	3545	2589	I838	II52	6076	4I80
Mean length cm	47.I8	48.58	53.62	49.88	27.I8	27.86	67.84	47.48	23.54	29.88

Table 4 Age composition of cod in NAFO Subarea 3 (from trawl survey data, 1986–1988), per cent

Age, years	3K			3L			3NO			3M		
	1986	1987	1988	1986	1987	1988	1986	1987	1988	1986	1987	1988
1	-	1	1	-	5	17	2	36	83	7	751	2
2	5	11	31	7	21	50	42	525	444	472	75	630
3	79	97	45	87	62	176	117	99	319	174	102	315
4	214	257	131	287	130	105	392	47	21	149	23	43
5	434	434	453	332	240	126	219	49	7	176	28	4
6	146	121	253	148	201	242	96	45	20	14	17	4
7	52	56	62	84	199	176	43	37	19	3	3	3
8	41	15	18	23	79	68	40	35	18	1	+	-
9	17	5	3	11	26	23	21	38	20	1	-	-
10	6	2	1	11	12	88	12	35	21	+	+	-
11	2	-	1	7	8	5	9	24	15	1	-	-
12	2	-	-	2	9	4	4	19	9	-	-	+
13	1	+	+	+	4	1	2	7	4	1	-	-
14	1	-	-	-	1	1	1	3	-	+	-	-
15	+	-	-	-	2	-	+	+	-	-	-	-
16	-	-	-	-	1	+	-	+	-	-	-	-
17	-	-	-	-	-	-	+	-	-	-	-	-
18	-	-	-	-	-	-	+	-	-	-	-	-
No.of fish, per cent	1000	999	999	999	1000	1002	1000	999	1000	999	999	1001
No.of fish taken, ind.	11449	6553	12995	8990	3812	5714	7613	5373	3738	4954	6076	4180
No.of age definitions	440	434	511	641	624	639	654	775	579	489	506	355
Mean age, years	5.13	4.82	5.14	5.06	5.84	5.32	4.79	3.96	3.16	3.11	1.57	2.44

Table 5 Mean catch per hauling, abundance and biomass of cod in Div. 3N (NAFO)

(from trawl surveys data, 1977-1988)

Year	Area, sq. miles	No. of haulings	Mean catch per tow		Abundance (Nos . 10^6)			Biomass (tons • 10^3)		
			Specimens	Weight, kg	Maximum	Mean	Minimum	Maximum	Mean	Minumum
1977	16455	43	91.26	80.87	136.00	109.48	82.95	119.39	97.80	76.17
1978	15240	42	87.27	70.56	212.71	98.52	-15.66	151.67	79.66	7.76
1979	16276	45	20.74	18.44	28.03	25.01	21.99	24.48	22.23	19.99
1980	15902	51	23.44	29.43	38.58	27.61	16.65	47.79	34.67	21.55
1981	15203	42	21.53	34.97	33.35	24.25	15.15	55.74	39.39	23.03
1982	16428	52	62.89	69.21	123.09	76.52	29.96	119.47	84.21	48.96
1983	16997	69	61.30	96.10	106.31	77.16	48.00	179.11	121.00	62.90
1984	16142	71	82.40	99.80	131.58	98.57	65.55	178.30	119.28	60.26
1985	17102	76	223.80	224.50	445.14	282.17	119.20	459.73	283.23	106.73
1986	16300	67	81.42	132.01	156.50	98.30	40.11	229.69	159.39	89.10
1987	16455	72	12.11	23.26	27.26	14.76	2.26	39.49	28.35	17.22
1988	14856	59	34.20	36.30	86.65	37.61	-11.42	62.00	39.95	17.90

Table 6 Mean catch per hauling, abundance and biomass of cod in Div. 30

(from trawl surveys data, 1977-1988)

Year	Area, sq.n.miles	No. of haulings	Mean catch per tow		Abundance (Nos • 10^6)			Biomass (tons • 10^3)		
			Specimens	Weight, kg	Maximum	Mean	Minimum	Maximum	Mean	Minimum
I977	I6743	42	4I.73	42.57	69.98	5I.75	33.53	70.64	52.80	34.96
I978	I350I	37	2I.62	2I.78	28.87	2I.63	I4.38	32.00	2I.78	II.57
I979	I7259	42	I5.I3	20.9I	29.67	I9.35	9.03	48.I5	26.74	5.33
I980	I6734	48	I4.65	29.52	25.24	I8.I7	II.09	50.78	36.6I	22.44
I98I	I49I8	29	I2.29	I6.07	I6.3I	I3.58	I0.86	23.I5	I7.76	I2.37
I982	I6775	40	48.I7	67.40	I02.82	59.86	I6.89	I30.5I	83.74	36.98
I983	I7586	45	47.45	46.20	92.II	60.I8	28.25	87.45	6I.85	36.24
I984	I7752	59	II2.20	I22.20	250.00	I60.70	7I.37	I95.75	I47.49	99.24
I985	I7648	55	I82.48	I33.47	503.06	238.54	-25.97	297.95	I74.47	5I.00
I986	I8287	78	I28.I0	I98.70	277.20	I7I.50	65.80	405.3I	266.02	I26.73
I987	I7875	66	29.77	I97.46	7I.74	39.42	7.I0	575.I8	26I.47	-52.23
I988	I8I47	79	I3.20	52.30	26.28	I7.80	9.32	I3I.45	70.27	9.09

Table 7 Mean catch per hauling, abundance and biomass of cod in Divs 3NO (from trawl surveys data, 1977-1988)

Indices	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Area investigated, sq.mi	33198	28741	33535	32636	30121	33203	34583	33894	34748	34371	34330	33003
Mean catch, in numbers	65.6	56.4	17.9	18.9	17.0	55.5	53.6	103.3	202.3	106.0	21.3	22.6
Mean catch, kg	61.2	47.6	19.7	29.4	25.6	68.3	71.4	106.3	177.8	167.1	113.9	45.1
Abundance, (10^6) specimens	161.2	120.2	44.4	45.8	37.8	136.4	137.3	259.3	520.7	269.8	54.2	55.4
Biomass, Thousand tons	150.6	101.4	49.0	71.3	57.2	168.0	182.8	266.8	457.7	426.4	289.8	110.2

Table 8. Average amount of cod at different ages in a catch per unit area of trawling (0.0135 mi^2) in Divs 3NO (from trawl survey data, 1977-1988)

Age, years	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.3	0.2	1.5	0.1	0.5	0.8	3.1	1.2	3.4	0.2	0.8	1.9
2	14.8	3.7	2.1	5.4	0.9	13.4	4.7	17.6	18.0	4.4	11.2	10.1
3	23.0	18.4	3.8	3.6	6.6	10.0	12.4	33.4	64.3	12.4	2.1	7.2
4	13.1	16.8	3.8	2.4	4.2	10.3	9.4	25.1	50.4	41.7	1.0	0.5
5	7.5	10.8	3.4	2.6	1.9	10.2	7.7	12.5	40.3	23.2	1.0	0.2
6	3.7	4.0	1.4	2.2	1.2	3.8	7.6	5.9	12.7	10.2	1.0	0.5
7	1.8	1.6	0.8	1.2	0.8	2.5	3.3	3.5	6.7	4.6	0.8	0.4
8	0.8	0.6	0.4	0.7	0.4	2.0	2.0	1.8	2.8	4.2	0.8	0.4
9	0.3	0.2	0.2	0.3	0.2	1.2	1.9	1.1	1.2	2.5	0.8	0.5
10	0.1	0.1	0.2	0.2	0.1	0.7	0.9	0.8	1.2	1.3	0.7	0.5
11	0.1	+	0.1	0.1	0.1	0.3	0.4	0.2	0.6	0.6	0.5	0.3
12	0.1	+	0.1	+	0.1	0.2	0.1	0.1	0.4	0.4	0.4	0.2
13	+	+	+	+	+	0.1	+	+	0.2	0.2	0.1	0.1
14	+	-	+	+	+	+	+	0.1	-	+	0.1	-
15	+	-	+	+	+	+	0.1	-	+	+	+	-
16	+	-	+	-	+	+	-	-	+	-	+	-
17	-	-	+	-	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	+	-	-
Average amount per hauling, in number	65.6	56.4	17.9	18.9	17.0	55.5	53.6	103.3	202.3	106.0	21.3	22.7

Table 9 Abundance of cod (10^3 specimens) in Divs 3NO outside the 200-mile zone

(from trawl surveys data, 1977-1988)

Stratum	Depth, m	Stratum area, mi^2	Off the zone area, %	1977 May-June	1978 June	1979 April	1980 May	1981 June	1982 May-June	1983 May-June	1984 May	1985 May	1986 April-May	1987 March-April	1988 March-April
375	55	1593	17	1336	328	238	95	412	1294	3471	831	1320	627	54	72
376	55	1499	84	2327	186	291	660	1116	2131	617	3556	14077	70	70	-
374	56-91	931	23	753	-	16	173	-	604	636	518	2663	82	47	31
360	-"-	2992	80	6597	6597	714	3199	1498	4681	6347	710	7260	72	570	18829
353	-"-	1282	10	238	-	191	10	109	40	206	318	30	258	40	732
382	93-182	647	56	5060	748	285	2033	1021	427	2640	1299	1263	-	-	-
377	-"-	100	100	1702	609	198	310	667	925	657	511	1961	32	2	-
359	-"-	421	100	10812	1949	1306	7176	1102	28246	1335	6842	148	1068	460	7469
354	-"-	474	38	828	141	116	349	12	267	7	1534	145	18	439	338
381	184-273	182	73	175	799	179	624	551	1413	495	526	1697	1634	15	148
378	-"-	139	100	3740	487	11058	2808	-	3717	4543	2965	3331	178	154	340
358	-"-	225	100	14608	4304	1636	925	4846	1778	138	1450	6592	667	8530	539
355	-"-	103	58	162	19	24	82	-	6	-	147	440	4	236	100
380	275-364	116	75	1274	58	314	307	516	125	1265	1206	1187	322	242	1137
379	-"-	106	100	2840	18	10	-	291	952	830	2640	1068	2285	374	277
357	-"-	164	100	4009	27	61	804	33	398	44	128	3966	468	1005	154
356	-"-	61	55	-	-	3	3	1	75	2	1	4	26	20	74
727	366-546	160	94	11	50	55	-	151	270	1114	61	11	543	294	142
725	-"-	105	100	3177	-	12	-	8	-	-	-	3	612	78	18
723	-"-	155	100	1128	-	-	-	-	1309	23	-	83	-	224	134
721	-"-	76	74	-	-	-	-	-	-	-	-	2	-	12	110
Abundance off the zone (10^6)		-	19	60.78	16.32	16.71	19.56	12.33	48.66	24.37	25.24	47.25	8.97	12.87	30.64
Total abundance (10^6 specimens)		-	-	161.23	120.15	44.36	45.78	37.83	136.38	137.34	259.27	520.71	269.80	54.18	55.41
Abundance off the zone, per cent from the total abundance		-	-	37.70	13.58	37.64	42.71	32.62	35.67	17.70	9.70	9.07	3.32	23.74	55.30

Table 10 Biomass of cod (tons) in Divs 3NO outside the 200-mile zone (from trawl surveys data, 1977-1988)

Stratum	Depth, m	Area off the zone,%	1977 May-June	1978 June	1979 April	1980 May	1981 June	1982 May-June	1983 May-June	1984 May	1985 May	1986 April-May	1987 March-April	1988 March-April
375	55	17	2280	382	573	271	768	2499	11430	708	2065	3295	990	1190
376	55	84	4956	279	140	1359	1009	2039	825	3393	12858	689	1152	-
374	56-91	23	1091	-	71	588	-	879	115	411	2892	594	129	491
360	-"-	80	11679	13997	356	5280	2193	6151	1837	615	1709	25	57	2161
353	-"-	10	573	-	409	45	30	74	10	778	30	1281	22	848
382	93-182	56	1193	632	134	2763	1034	287	1185	1024	413	-	-	-
377	-"-	100	702	341	123	243	319	507	130	107	461	7	2	-
359	-"-	100	3577	1305	846	2772	411	16025	505	2927	17	446	29	190
354	-"-	38	585	95	97	776	13	217	3	523	71	67	38	244
381	184-273	73	200	772	340	784	369	2050	538	591	1530	1263	164	81
378	-"-	100	1660	340	7254	1503	-	2144	3007	2328	2341	40	55	106
358	-"-	100	6642	1812	858	1217	2623	1280	71	1685	4944	290	780	93
355	-"-	58	270	37	51	85	-	16	-	80	211	6	43	31
380	275-364	75	760	78	2607	592	790	91	1122	844	1172	283	493	316
379	-"-	100	1853	31	14	-	171	1078	493	1612	535	1036	160	142
357	-"-	100	3927	33	131	988	149	337	62	93	3449	242	711	71
356	-"-	55	-	-	9	8	3	288	4	2	20	69	40	76
727	366-546	94	44	61	134	-	142	382	936	95	12	199	145	117
725	-"-	100	1614	-	14	-	27	-	-	-	7	488	83	27
723	-"-	100	1019	-	-	-	-	672	37	-	94	-	574	103
721	-"-	74	-	-	-	-	-	-	-	-	4	-	52	114
Biomass off the zone, 10^3 tons		19	44.63	20.20	14.16	19.27	19.15	37.02	22.31	17.82	34.84	10.32	5.72	6.40
Total biomass in Divs 3NO, 10^3 tons		-	150.60	101.44	48.97	71.28	57.15	167.95	182.85	266.77	457.70	425.41	289.82	110.22
Biomass off the zone from total biomass, per cent		-	29.63	19.91	28.90	27.03	33.48	22.04	12.20	6.68	7.61	2.43	1.97	5.81

Table 11 Mean catches per hauling, abundance and biomass of cod in Div. 3L

(from trawl surveys data, 1977-1988)

Year	Area, sq. miles	Number of haulings	Mean catch per tow		Abundance (10^6 specimens)			Biomass (10^3 tons)		
			Number	Weight, kg	Maximum	Mean	Minimum	Maximum	Mean	Minumum
1977	28008	58	49.60	38.40	141.96	102.89	63.82	110.24	79.66	49.08
1978	25664	47	19.44	24.58	45.69	36.96	28.22	63.62	46.73	29.85
1979	28956	55	48.72	72.76	139.42	104.51	69.60	196.02	156.07	116.12
1980	30327	62	34.25	58.87	95.33	76.95	58.57	166.57	132.26	97.94
1981	27840	49	31.61	50.09	88.58	65.20	41.83	141.21	103.31	65.40
1982	29079	52	32.57	56.74	82.13	70.18	58.29	145.60	122.22	98.84
1983	31599	83	51.93	86.53	152.32	121.54	90.76	254.13	202.54	150.95
1984	33243	92	126.64	155.66	388.29	311.85	235.42	476.47	383.30	290.13
1985	31509	85	77.41	75.86	246.50	180.70	114.90	236.56	177.06	117.56
1986	33333	108	120.30	177.08	384.13	297.03	209.93	544.53	437.23	329.93
1987	33333	115	29.73	53.83	91.47	73.41	55.34	167.84	132.91	97.97
1988	33333	114	36.20	64.50	119.62	89.43	59.25	224.25	159.37	94.48

Table 12 Abundance of cod (10^3 specimens) in Div. 3L outside the 200-mile zone

(from trawl surveys data, 1977-1988)

Stratum	Depth, m	Area off the zone, %	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
385	93-183	5	4	190	11	286	61	196	124	1287	172	37	5	5
390	-"-	55	493	996	4193	2575	151	211	784	8347	5687	106	61	91
389	184-273	62	10821	976	5194	1221	4897	3794	1251	8044	2375	1376	980	650
391	-"-	100	742	470	115	73	3245	1053	822	3665	3306	181	313	856
387	274-365	37	182	-	10	30	243	216	544	1348	249	584	92	1233
388	-"-	99	2118	437	106	318	2541	1839	18730	494	1264	1271	203	2074
392	-"-	100	414	-	1383	1920	38	43	399	82	709	2202	301	501
729	366-546	100	-	-	-	3	-	-	10	-	-	4	11	4
731	-"-	100	225	-	165	351	-	-	1940	20	9	1239	35	1678
733	-"-	50	3	-	18	9	6	18	14	12	4	8	607	2022
730	548-728	100	2	-	-	-	-	-	-	-	-	-	-	-
732	-"-	100	-	-	-	-	-	-	-	-	-	-	-	-
734	-"-	67	-	-	-	-	-	-	-	-	-	-	-	-
Abundance off the zone, 10^6 specimens			15.00	3.07	11.19	6.78	11.18	7.37	24.62	23.20	13.78	7.01	2.61	9.11
Total abundance, 10^6 specimens			102.89	36.96	104.51	76.95	65.20	70.18	121.50	311.90	180.70	297.03	73.41	89.43
Abundance off the zone, per cent from total			14.58	8.31	10.71	8.81	17.15	10.50	20.26	7.44	7.63	2.36	3.56	10.19

Table 13 Biomass of cod (tons) in Div. 3L outside the 200-mile zone (from trawl surveys data, 1977-1988)

Stratum	Depth, m	Area off the zone, %	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
385	93-183	5	2	137	11	430	74	284	183	1610	175	230	3	9
390	-"-	55	322	1117	4867	3389	241	905	744	5400	1428	147	8	15
389	184-273	62	4279	754	4416	1183	4364	5406	1427	7007	1268	796	326	150
391	-"-	100	564	366	251	115	3133	771	658	1776	956	285	111	389
387	274-365	37	192	-	20	79	440	403	758	8176	429	453	39	573
388	-"-	99	662	450	239	437	2820	1866	26050	609	841	856	106	445
392	-"-	100	336	-	1477	1289	86	99	456	86	800	766	211	137
729	366-546	100	-	-	-	13	-	-	11	-	-	14	8	18
731	-"-	100	243	-	299	420	-	-	2061	49	36	834	24	1192
733	-"-	50	9	-	119	12	29	23	47	32	22	19	916	3125
730	548-728	100	3	-	-	-	-	-	-	-	-	-	-	-
732	-"-	100	-	-	-	-	-	-	-	-	-	-	-	-
734	-"-	67	-	-	-	-	-	-	-	-	-	-	-	-
Biomass off the zone, 10^3 tons			6.61	2.82	11.70	7.37	11.19	9.76	32.39	24.75	5.95	4.40	4.68	6.05
Total biomass, 10^3 tons			76.66	46.73	156.07	132.26	103.31	122.22	202.30	383.30	177.06	437.23	131.92	159.37
Biomass off the zone, per cent from total			8.62	6.03	7.50	5.57	10.83	7.99	16.01	6.46	3.36	1.01	3.55	3.80

Table 14 **Mean catches per hauling, abundance and biomass of cod in Div. 3K**

(from trawl surveys data, 1977-1988)

Year	Area, sq.miles	Number of haulings	Mean catch per tow		Abundance (10^6 specimens)			Biomass (10^3 tons)		
			Number	Weight, kg	Maximum	Mean	Minimum	Maximum	Mean	Minimum
1977	24329	50	16.73	14.80	38.09	30.15	22.22	33.99	26.68	19.37
1978	24260	51	6.78	7.58	17.01	12.19	7.37	18.11	13.63	9.14
1979	22963	51	32.53	44.03	88.01	55.34	22.67	109.54	74.89	40.25
1980	23410	57	26.74	39.19	59.31	46.38	33.45	84.28	67.96	51.64
1981	20719	46	12.57	20.05	22.49	19.30	16.11	35.32	30.78	26.23
1982	23614	55	12.56	24.59	25.65	21.96	18.26	50.30	43.01	35.73
1983	26015	75	18.25	28.98	44.90	35.18	25.46	70.87	55.85	40.83
1984	26213	88	152.41	182.98	421.84	295.94	170.03	522.67	355.30	187.92
1985	17497	47	220.65	187.94	420.99	285.99	150.99	348.79	243.59	138.39
1986	26546	97	139.28	139.72	329.71	270.43	211.15	335.45	271.30	207.15
1987	25581	93	70.12	68.88	214.76	132.86	50.96	206.27	130.52	54.76
1988	26546	95	157.70	170.60	530.50	306.15	81.81	563.61	331.21	98.81

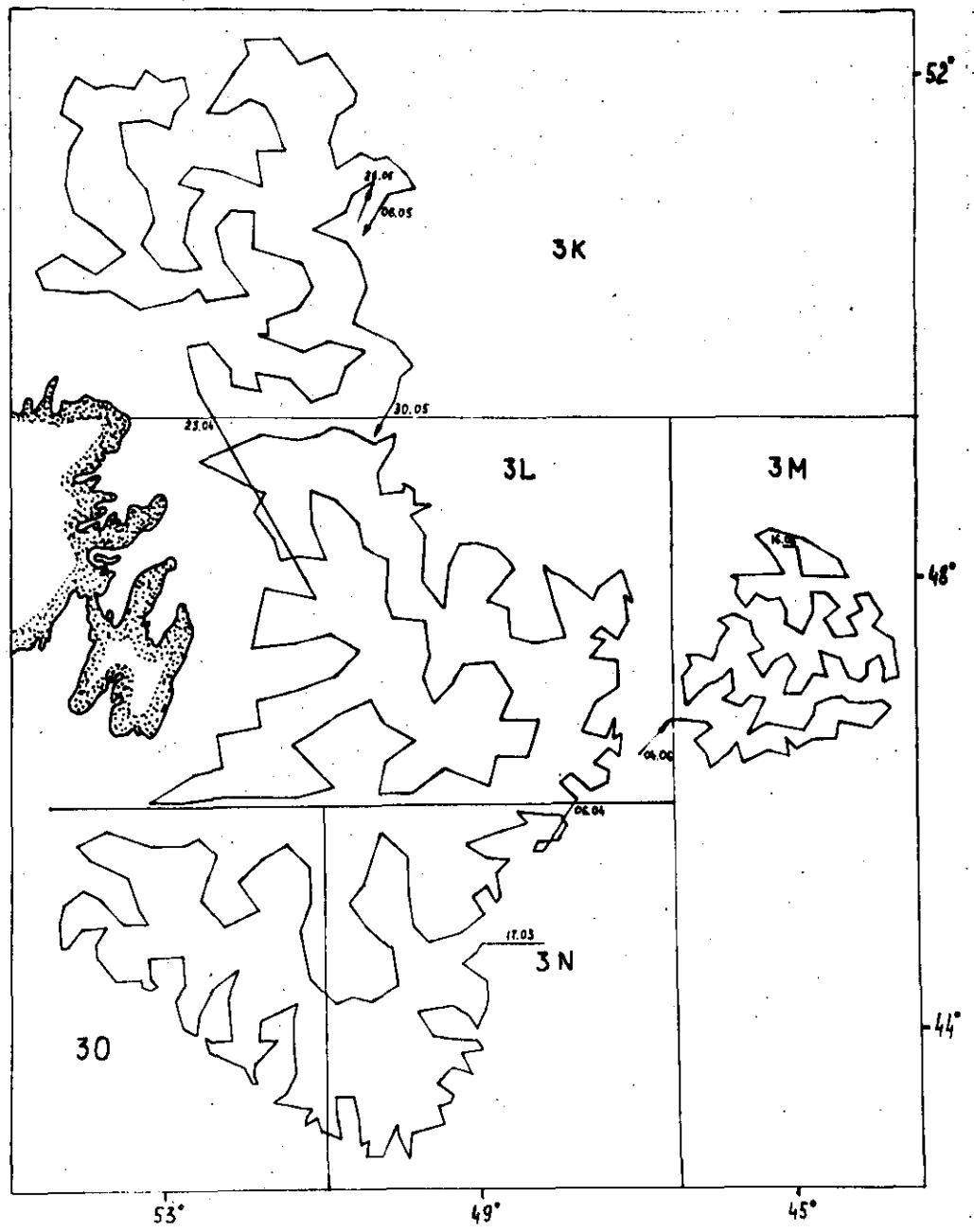

Fig.1. Trawl-acoustic survey route.

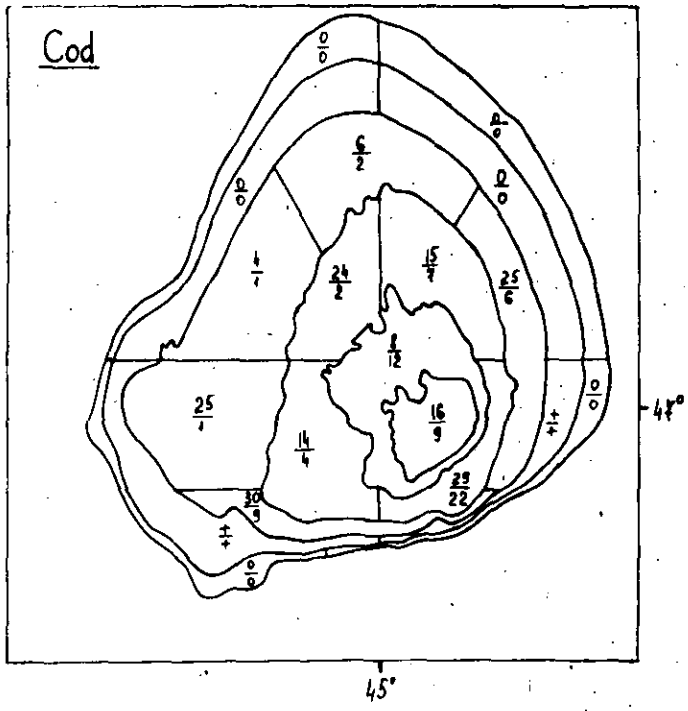

Fig. 2. Cod distribution on the Flemish Cap Bank in June 1988. Here and hereinafter figures present cod concentration densities expressed in average echo-intensity units by strata: in pelagic layer (above the line) and in bottom layer (beneath the line).

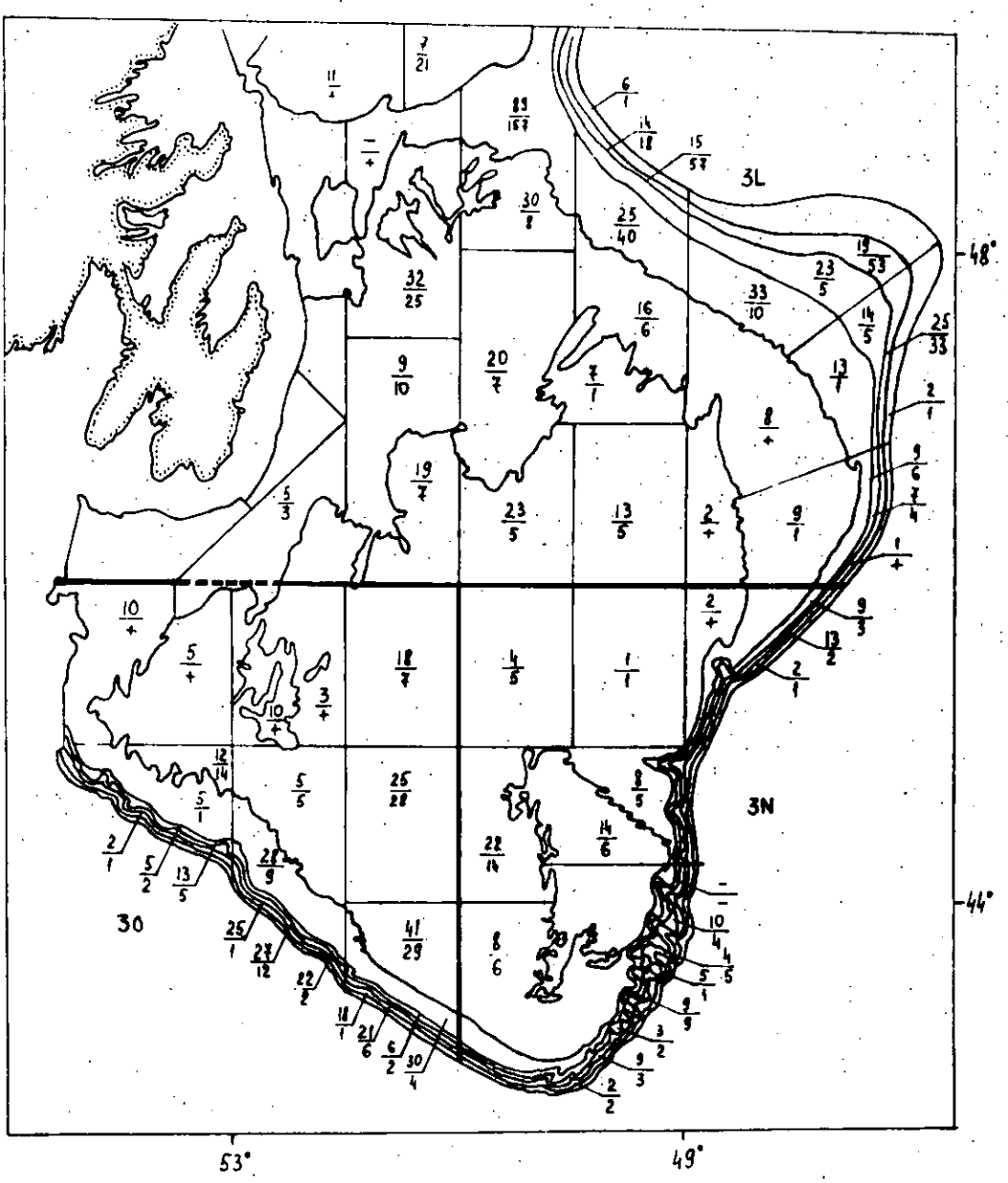

Fig. 3. Cod distribution on the Grand Bank in March-April 1988

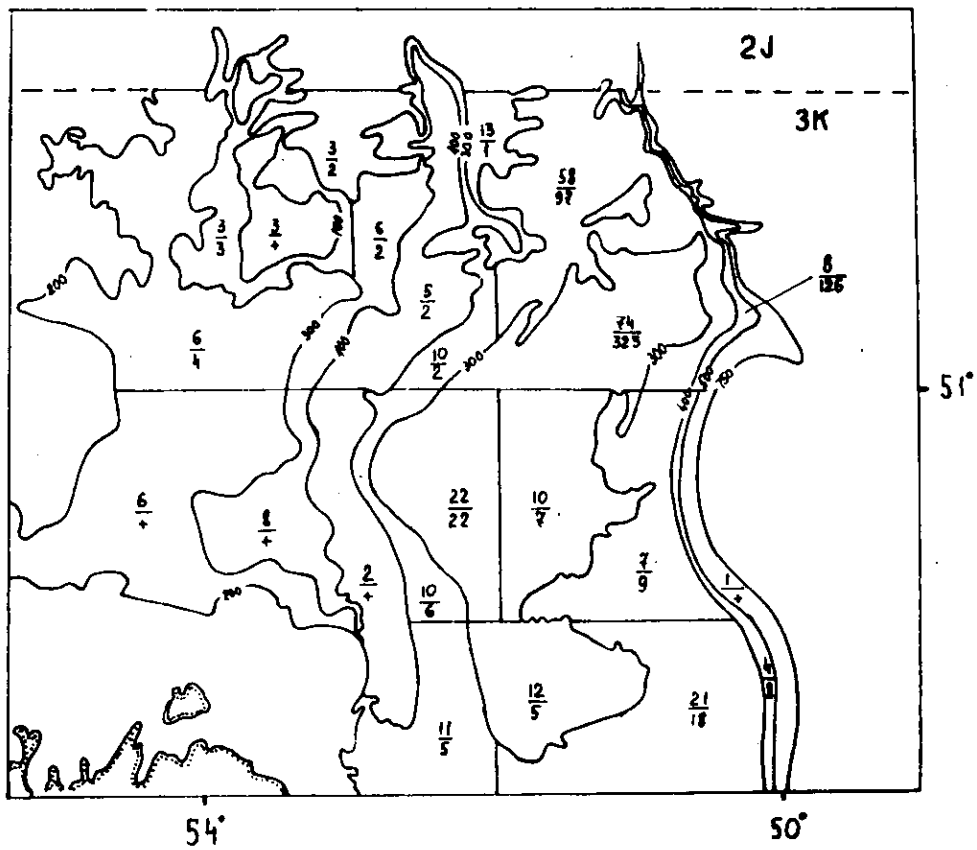

Fig. 4. Cod distribution in Div. 3K in May 1988