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Status of Cod Stock in NAFO Subarea 3 From 1993 Trawl-Acoustic Survey Data

by

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Abstract

The paper presents both estimates of cod stock in Div. 3M, 3NO, 3L obtained from April-July 1993 trawl-acoustic survey, and biostatistical data for 1977-1993.

According to the results of trawl-acoustic survey cod stock in Div. 3M was estimated to be at a low level but a little higher than in 1991 and amounted for 23.4×10^6 fish with biomass 13.0×10^3 tons.

In Div. 3NO cod abundance increased 4.8 times compared to 1991 and constituted 186.6×10^6 fish with biomass a little higher than in 1991 and accounted for 178.4×10^3 tons.

Cod stock in Div. 3L was not covered completely because of the restriction of area permitted for survey.

Introduction

Regular PINRO observations over commercial fish stocks in NAFO Subarea 3 have been continued in April-July 1993. The aim of the paper is to analyse results obtained from estimation of abundance and biomass of cod in Div.3M, 3NO and 3L in 1993 compare to the similar data for 1977-1991.

Materials and Methods

Trawl survey was conducted by stratified-random method used in NAFO (Doubleday, 1981) and followed by acoustic survey. Acoustic observations allowed to assess a part of cod stock distributed above rea of fishing by bottom trawl (Mamylov, 1988). Hauls were performed by bottom trawl with a small-mesh insertion (12 mm) in the codend. Duration of a haul was 30 min. with the vessel speed of 3.5 knots. The total stock was estimated as the sum of pelagic component obtained by acoustic method and estimate by trawl.

To characterize year-to-year variations of stocks 1993 results and data from trawl surveys since 1977, as well as trawl-acoustic surveys beginning from 1987 (Bulatova, 1990; Kuzmin, 1992) were used. In 1992 the Grand Newfoundland Bank area was not covered by trawl-acoustic survey. Strata in which catches were not taken but cod was observed according to historical data were included in calculations.

Results

Div.3M. In June-July 1993 on the Flemish Cap shallows water temperature in the bottom layer fluctuated from 2.4° to 2.9°C and increased with depth from 3.0° to 3.7°C. In this period concentrations of cod were rarefied over the bank shallows, mainly on the ground. The largest catches were taken over southern and eastern slopes of the bank and did not exceed 340 kg (Fig.1). Fish 27-35 cm long (Table 1) at age 2-3 (Table 2) related to 1990-1991 yearclasses dominated in catches. Immature fish constituted the bulk of concentrations (Table 3).

According to the 1993 trawl survey over the Flemish Cap cod stock abundance and biomass increased 2.2 times and 1.9 times, respectively, compared to 1991 but still remained at a low level compared to 1983-1989 (Table 4).

Divs.3NO. Trawl survey over the southern slopes of the Grand Newfoundland Bank (Divs.3NO) was carried out in April-May 1993. In this period in the north and over eastern slope of the bank up to 200-m isobath a reduction of water temperature in the bottom layer by 0.5°-1.5°C and considerable increase of water temperature on the southern and southwestern slopes by 0.5°-3.0°C was observed compare to the mean long-term temperature. This appeared to be the main factor determining behaviour and distribution of the main commercial fish species. Cod were mainly distributed along the Grand Newfoundland Bank slope and a little rarely in the central part. Maximal catches were taken in Div.3N (2.9 t) and 3O (6.9 t) at 155-395 m depth. Cod 18-96 cm long occurred over the whole Div. 3N and fish 30-44 cm long at age 3-4 from 1989-1990 yearclasses were predominant (Tables 1, 2, 5). In Div.3O (the southwestern slope)larger fish 18-147 cm in length occurred in catches, and shifting of large fish from shallow part of the bank to Div.3O slope was observed like in 1991. Maximal catch taken on the slope of Div.3O (stratum 719) included mainly large fish with modal length of 114-119 cm at age 10-13 from 1980-1983 yearclasses (Tables 1, 2). In 1993 percentage of mature fish (64%) was observed to increase compare to 1991 (25%).

According to the 1993 trawl survey data abundance and biomass of cod in Div. 3N increased 6.9 times and 3.3 times, respectively, compared to 1991 (Table 6). However, in Div. 3O abundance was observed to increase 1.5 times and biomass reduced 1.5 times (Tables 7, 8). The main reason for decrease of cod biomass is reduction in abundance of fish from older age groups 1980-1988.

In the whole for Divs. 3NO a trend of Newfoundland cod stock restoration was observed. Total cod abundance in 1993 amounted to 186.6×10^6 fish and biomass 178.4×10^3 tons (Table 9).

Div.3L. Investigations were conducted in the end of May - beginning of July. In this period bottom layer temperature on the shoal was by 0.3°-1.5°C lower than the mean long-term one, and only negligible positive anomalies 0.5°-0.6°C were observed in the southern Div.3L on the 50°W. Cod concentrations were sparse and distributed in bottom layers, mainly in the eastern Div.3L (Fig.3). Maximal catch did not exceed 180 kg. Fish 30-48 cm in length at age 3-5 (Tables 1,2) dominated in catches. The bulk of fish (to 63%) were immature.

Estimation obtained for cod abundance and biomass in Div.3L did not reflect the actual status of cod stock because the area permitted for survey were restricted by Canadian authorities and assessment was not completed (Table 10).

Conclusions

Though cod stock on the Flemish Cap is observed to exceed the stock by estimation of 1991,it still remains at a low level. 1991 yearclass were predominant in catches.

In Divs.3NO a trend of Newfoundland cod stock restoration were observed. Age structure of cod catches were dominated by 1989-1990 yearclasses.

References

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Table 1. Length composition of cod in NAFO Subarea 3 from 1991 and 1993 trawl surveys data, %.

Length, cm	3L		3N		3O		3M	
	1991	1993	1991	1993	1991	1993	1991	1993
9- 11	-	-	+	-	-	-	-	-
12- 14	1	-	1	-	-	-	3	-
15- 17	1	1	26	-	12	-	30	-
18- 20	3	15	145	+	92	1	17	1
21- 23	16	48	188	2	109	1	8	4
24- 26	19	49	74	4	43	5	29	62
27- 29	38	84	24	13	15	12	23	223
30- 32	46	121	42	128	12	23	19	277
33- 35	76	119	52	208	23	41	115	148
36- 38	137	102	42	226	41	74	291	73
39- 41	115	110	48	205	25	126	170	58
42- 44	118	82	65	126	27	123	63	67
45- 47	119	57	97	44	21	96	30	45
48- 50	83	46	70	15	23	53	37	20
51- 53	77	50	63	10	21	29	45	6
54- 56	47	46	24	6	25	26	40	5
57- 59	31	31	18	4	25	20	32	1
60- 62	19	15	3	2	17	35	18	1
63- 65	11	15	3	4	23	26	11	2
66- 68	10	1	1	1	13	16	8	1
69- 71	7	1	-	1	10	14	3	1
72- 74	6	6	1	+	12	9	5	1
75- 77	6	1	1	1	13	6	1	1
78- 80	4	-	-	+	21	+	1	1
81- 83	2	-	1	-	27	4	-	+
84- 86	3	-	1	-	33	5	-	-
87- 89	2	-	+	-	35	2	-	-
90- 92	1	-	1	+	30	9	-	-
93- 95	1	-	-	-	29	7	-	-
96- 98	+	-	+	+	25	9	-	-
99-101	1	-	+	-	25	11	-	-
102-104	-	1	1	-	19	18	-	-
105-107	-	-	1	-	22	22	-	-
108-110	+	-	+	-	26	22	-	-
111-113	+	-	+	-	22	21	-	-
114-116	-	-	2	-	21	31	-	-
117-119	+	-	1	-	19	24	-	-
120-122	+	-	1	-	21	21	-	-
123-125	+	-	1	-	7	17	-	-
126-128	-	-	3	-	7	6	-	-
129-131	-	-	-	-	4	3	-	-
132-134	-	-	+	-	4	1	-	-
135-137	-	-	-	-	1	+	-	-
138-140	-	-	-	-	-	+	-	-
No. of fish, %.	1000	1001	1001	1000	1000	1000	999	998
No. of spec.	8876	715	2673	8583	2763	1896	1500	2088
Mean length, cm	43,76	38,86	34,80	37,98	62,48	63,33	39,87	33,84

Table 2. Age composition of cod in NAFO Subarea 3 from 1989-1993 trawl surveys data, %.

Age	3K			3L			3NO			3M		
	1990	1991	1993	1990	1991	1993	1990	1991	1993	1990	1991	1993
1	-	n	n	1	1	8	-	1	-	6	32	-
2	2	o	o	32	28	179	62	305	17	19	53	449
3	44			147	202	275	176	108	397	186	369	322
4	128			358	370	257	231	140	449	707	358	149
5	264	d	d	234	286	188	162	158	48	68	139	61
6	281	a	a	66	53	75	64	46	24	7	46	12
7	170	t	t	76	26	14	33	12	12	-	4	4
8	87	a	a	61	16	3	38	22	5	4	-	4
9	18			12	10	-	44	71	3	1	-	-
10	8			6	4	1	82	58	12	-	-	-
11	+			2	1	-	44	29	9	-	-	-
12	+			3	1	-	47	29	15	-	-	-
13	-			2	+	-	4	13	5	-	-	-
14	+			1	+	-	7	4	2	-	-	-
15	-			1	+	-	2	3	+	-	-	-
16	-			+	-	-	-	-	-	-	-	-
17	-			+	-	-	2	-	-	-	-	-
18	-			+	-	-	-	-	-	-	-	-
Fish number, %.	1002	-	-	1002	1000	1000	998	1000	1000	998	1000	1000
No. of fish in age sample, spec.	315	-	-	415	415	227	277	483	540	238	299	193
Mean age	5,77	-	-	4,79	4,37	3,74	5,80	4,99	4,03	3,87	3,67	2,89

Table 3. Number of mature and immature fish in catch per trawling from the data of 1983-1993 trawl surveys on the Flemish Cap Bank

Year	No. of immature fish, spec.	No. of mature fish, spec.	No. of mature fish, %	Total, spec.
1983	83.05	11.30	11.6	97.40
1984	76.50	13.71	15.2	90.20
1985	40.72	14.38	26.1	55.09
1986	44.66	8.64	15.6	55.30
1987	56.28	2.32	4.0	58.60
1988	42.14	0.79	1.8	42.90
1989	100.61	4.12	3.9	104.72
1990	6.20	1.20	16.3	7.40
1991	12.62	3.00	19.2	15.62
1993	24.72	5.54	18.3	30.26

Table 4. Mean catches per haul, abundance and biomass of cod in Div. 3M from 1977-1993 trawl surveys data

Year	Area, sq.mile	Number of hauls	Mean catch		Abudance, 10^6 fish			Biomass, 10^3 tons		
			Number, fish	Weight, kg	Maximum	Mean	Minimum	Maximum	Mean	Minimum
1977	9081	24	234.30	201.30	262.88	157.61	52.33	262.58	135.40	8.23
1978	7467	30	42.35	39.90	38.24	23.42	8.60	30.79	22.07	13.36
1979	9081	64	80.60	60.95	102.73	54.22	5.70	71.78	40.99	10.21
1980	9081	76	14.60	17.90	12.64	9.82	7.00	16.31	12.02	7.74
1981	7745	29	28.35	43.45	24.58	16.28	7.98	34.83	24.93	15.02
1982	9081	62	15.35	20.55	14.03	10.34	6.66	23.87	13.83	3.79
1983	9081	103	97.40	34.30	100.39	65.53	30.67	31.07	23.07	15.06
1984	9081	103	90.20	46.40	75.40	60.68	45.96	39.29	31.21	23.13
1985	9081	106	55.09	41.70	44.64	37.06	29.48	34.66	28.07	21.48
1986	9081	108	55.30	38.70	53.29	37.20	21.11	36.76	26.06	15.36
1987	8479	104	58.60	16.20	50.96	36.82	22.68	13.28	10.15	7.02
1988	8411	97	42.90	12.40	37.90	26.73	15.50	10.45	7.72	4.99
1989	9081	109	104.72	54.30	107.91	70.44	32.98	53.89	36.52	19.14
1990	7813	85	7.40	6.80	5.86	4.31	2.76	5.42	3.92	2.42
1991	9081	82	15.62	10.02	18.31	10.51	2.71	11.59	6.74	1.88
1993	10555	69	30.26	17.60	42.56	22.38	2.20		**13.02**	

Table 5. Mean number of cod at age 1-18 in catch per half-hour trawling in Divs. 3NO from 1977-1993 trawl surveys data, fish

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1993
1	0.2	1.5	0.1	0.5	0.8	3.1	1.2	3.4	0.2	0.8	1.9	0.1	-	+	-
2	3.7	2.1	5.4	0.9	13.4	4.7	17.6	18.0	4.4	11.2	10.0	0.7	0.2	5.1	1.2
3	18.4	3.8	3.6	6.6	10.0	12.4	33.4	64.3	12.4	2.1	7.2	1.7	0.4	1.8	26.3
4	16.8	3.8	2.4	4.2	10.3	9.4	25.1	50.4	41.7	1.0	0.5	1.0	0.6	2.4	29.8
5	10.8	3.4	2.6	1.9	10.2	7.7	12.5	40.3	23.2	1.0	0.2	0.2	0.4	2.7	3.2
6	4.0	1.4	2.2	1.2	3.8	7.6	5.9	12.7	10.2	1.0	0.5	0.2	0.2	0.8	1.6
7	1.6	0.8	1.2	0.8	2.5	3.3	3.5	6.7	4.6	0.8	0.4	0.4	0.1	0.2	0.8
8	0.6	0.4	0.7	0.4	2.0	2.0	1.8	2.8	4.2	0.8	0.4	0.5	0.1	0.4	0.3
9	0.2	0.2	0.3	0.2	1.2	1.9	1.1	1.2	2.5	0.8	0.5	0.2	0.1	1.1	0.2
10	0.1	0.2	0.2	0.1	0.7	0.9	0.8	1.2	1.3	0.7	0.5	0.1	0.2	1.0	0.8
11	+	0.1	0.1	0.1	0.3	0.4	0.2	0.6	0.6	0.5	0.3	0.1	0.1	0.5	0.6
12	+	0.1	+	0.1	0.2	0.1	0.1	0.4	0.4	0.4	0.2	0.1	0.1	0.5	1.0
13	+	+	+	+	0.1	+	+	0.2	0.2	0.1	0.1	0.1	+	0.2	0.3
14	-	+	+	+	+	+	0.1	-	+	0.1	-	+	+	0.1	0.1
15	-	+	+	+	+	0.1	-	+	+	+	-	+	+	0.1	+
16	-	+	-	+	+	-	-	+	-	+	-	+	-	-	-
17	-	+	-	-	-	-	-	-	-	-	-	+	+	+	-
18	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-
Mean number for survey period	56.4	17.9	18.9	17.0	55.5	53.6	103.3	202.3	106.0	21.3	22.7	5.4	2.5	16.9	66.2

Table 6. Mean catches per trawling, abudance and biomass of cod in Div. 3N from 1977-1993 trawl surveys data

Year	Area, sq.mile	Number of hauls	Mean catch		Abudance, 10^6 fish			Biomass, 10^3 t		
			Number, fish	Weight, kg	Maximum	Mean	Minimum	Maximum	Mean	Minimum
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
1989	15503	94	5.53	47.20	8.57	6.35	4.13	85.05	54.18	23.30
1990	15260	63	2.00	22.00	3.61	2.25	0.89	46.17	24.90	3.63
1991	11574	61	13.11	23.81	19.74	11.24	2.73	33.60	20.41	7.21
1993	17875	80	107.29	93.00	220.96	77.65	-65.56		**67.34**	

Table 7. Mean catches per trawling, abundance and biomass of cod in Div. 3O from 1977-1993 trawl surveys data

Year	Area, sq.mile	Number of hauls	Mean catch		Abudance, 10^6 fish			Biomass, 10^3 t		
			Number, fish	Weight, kg	Maximum	Mean	Minimum	Maximum	Mean	Minimum
1977	16743	42	41.73	42.57	69.98	51.75	33.53	70.64	52.80	34.96
1978	13501	37	21.62	21.78	28.87	21.63	14.38	32.00	21.78	11.57
1979	17259	42	15.13	20.91	29.67	19.35	9.03	48.15	26.74	5.33
1980	16734	48	14.65	29.52	25.24	18.17	11.09	50.78	36.61	22.44
1981	14918	29	12.29	16.07	16.31	13.58	10.86	23.15	17.76	12.37
1982	16775	40	48.17	67.40	102.82	59.86	16.89	130.51	83.74	36.98
1983	17586	45	47.45	46.20	92.11	60.18	28.25	87.45	61.85	36.24
1984	17752	59	112.20	122.20	250.00	160.70	71.37	195.75	147.49	99.24
1985	17648	55	182.48	133.47	503.06	238.54	-25.97	297.95	174.47	51.00
1986	18287	78	128.10	198.70	277.20	171.50	65.80	405.31	266.02	126.73
1987	17875	66	29.77	197.46	71.74	39.42	7.10	575.18	261.47	-52.23
1988	18147	79	13.24	52.30	26.28	17.80	9.32	131.45	70.27	9.09
1989	18240	93	5.24	20.24	10.29	7.08	3.87	37.02	27.35	17.69
1990	13052	52	3.20	33.70	4.40	3.05	1.70	48.34	32.57	16.80
1991	16958	70	19.56	96.90	46.47	24.57	2.67	264.50	121.72	-21.06
1993	18456	78	24.30	54.20	81.62	36.09	-9.44		**80.48**	

Table 8. Mean catches per trawling, abudance and biomass of cod in Div. 3NO from 1977-1993 trawl surveys data

Year	Area, sq.mile	Mean catch		Abundance, 10^6 fish	Biomass, 10^3 t
		Number, fish	Weight, kg		
1977	33198	65.6	61.2	161.2	150.6
1978	28741	56.4	47.6	120.2	101.4
1979	33535	17.9	19.7	44.4	49.0
1980	32636	18.9	29.4	45.8	71.3
1981	30121	17.0	25.6	37.8	57.2
1982	33203	55.5	68.3	136.4	168.0
1983	34583	53.6	71.4	137.3	182.8
1984	33894	103.3	106.3	259.3	266.8
1985	34748	202.3	177.8	520.7	457.7
1986	34371	106.0	167.1	269.8	425.4
1987	34330	21.3	113.9	54.2	289.8
1988	33003	22.6	45.1	55.4	110.2
1989	33743	5.4	32.6	13.4	81.5
1990	28312	2.5	27.4	5.2	57.5
1991	28532	16.9	67.3	35.8	142.1
1993	36331	66.3	71.3	113.7	**126.2**

Table 9. Estimation of abundance (10^6 fish) and biomass (10^3 t) of cod from 1987-1993 trawl and acoustic surveys data

Year	Survey	3K		3L		3NO		3M	
		Abundance	Biomass	Abundance	Biomass	Abundance	Biomass	Abudance	Biomass
1987	Trawl	132.9	130.5	73.4	131.9	54.2	289.8	36.8	10.2
	Acoustic	136.0	134.8	29.4	45.3	6.7	36.9	40.2	9.3
	Total	268.9	265.3	102.8	177.2	60.9	326.7	77.0	21.6
1988	Trawl	306.2	331.2	89.4	159.4	55.4	110.2	26.7	7.7
	Acoustic	228.8	143.3	194.9	223.8	135.2	149.8	123.8	26.5
	Total	535.0	474.5	284.3	383.2	190.6	260.0	150.5	34.2
1989	Trawl	230.0	352.2	123.2	195.5	13.4	81.5	70.4	36.5
	Acoustic	235.6	308.7	62.9	88.3	4.9	26.0	88.7	41.8
	Total	465.6	660.9	186.1	283.8	18.3	107.5	159.1	78.3
1990	Trawl	276.2	335.6	99.6	123.7	5.2	57.5	4.3	3.9
	Acoustic	193.2	213.4	77.8	101.5	2.6	2.8	14.7	11.3
	Total	469.4	549.0	177.4	225.2	7.8	60.3	19.0	15.2
1991	Trawl	No data		170.2	166.7	35.8	142.1	10.5	6.7
	Acoustic			27.8	22.7	3.4	8.9	2.4	1.5
	Total			198.0	189.4	39.2	151.0	12.9	8.2
1993	Trawl	No data		4.6*	**1.3***	113.7	**126.2**	22.4	**13.0**
	Acoustic			13.1*	**4.5***	72.9	**52.2**	1.0	**0.8**
	Total			17.7*	**5.8***	186.6	**178.4**	23.4	**13.8**

* Div. 3L was not fully covered due to being partly closed by Canadian authorities

Table 10. Mean catches per trawling, abundance and biomass of cod in Div. 3L from 1977-1993 trawl surveys data

Year	Area, sq.mile	Number of hauls	Mean catch		Abundance, 10^6 fish			Biomass, 10^3 t		
			Number, fish	Weight, kg	Maximum	Mean	Minimum	Maximum	Mean	Minimum
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
1989	33243	122	50.03	79.40	156.84	123.20	89.55	246.98	195.51	144.04
1990	32283	105	41.60	51.70	141.03	99.57	58.11	168.95	123.67	78.40
1991	31951	98	71.90	70.43	235.81	170.17	104.53	224.78	166.68	108.58
1993*	24392	74	9.66	2.70	6.68	4.64	2.61		**1.30**	

* Div. 3L was not fully covered due to being partly closed by Canadian authorities

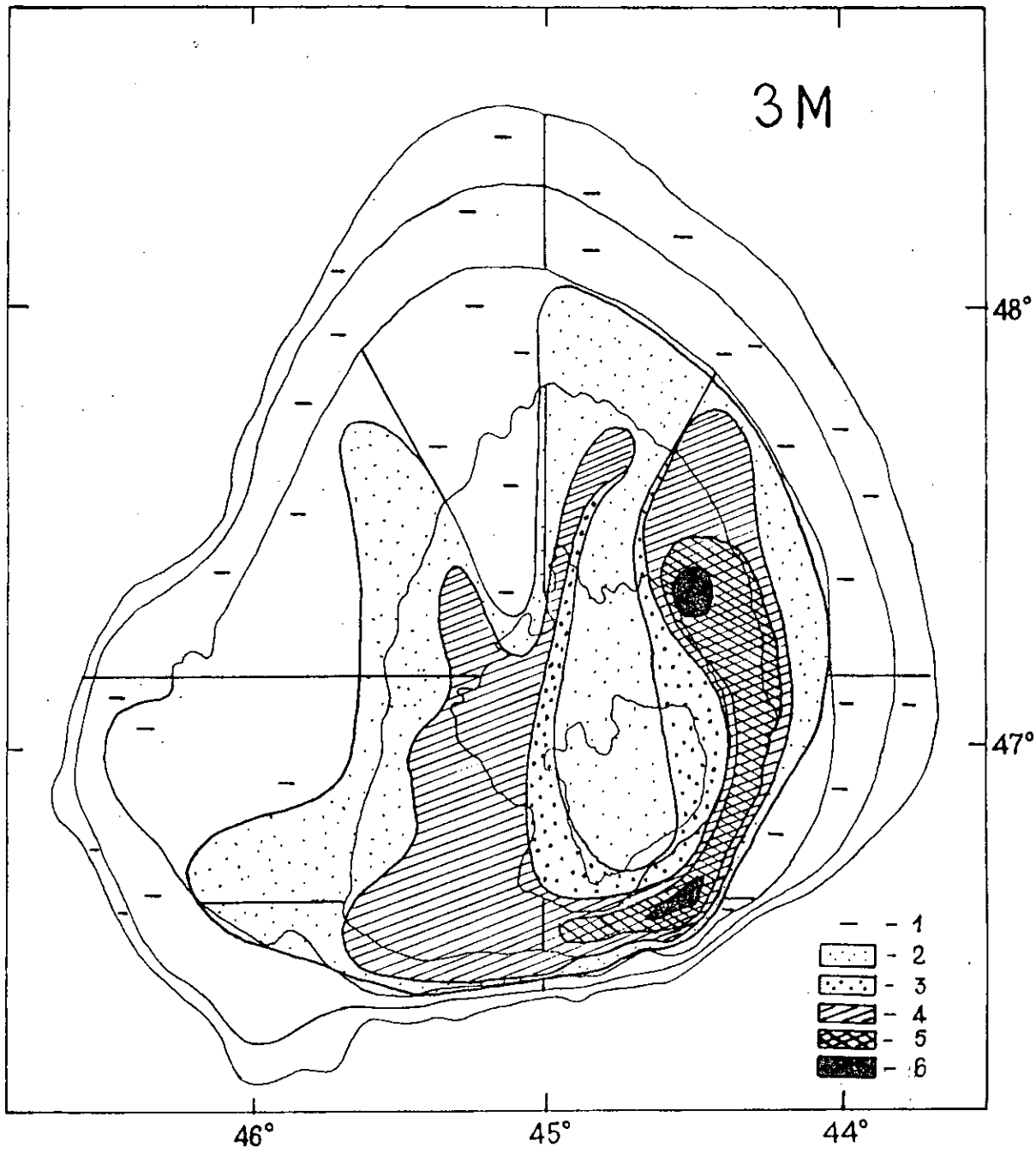

Fig.1. Distribution of cod catches per 30-min trawling on the Flemish Cap Bank in June-July 1993 from trawl survey data, fish:

1 - 0;
2 - 1-5 fish;
3 - 6-10 fish;
4 - 11-100 fish;
5 - 101-300 fish;
6 - over 301 fish