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Distribution and Abundance of Cod on the Flemish Cap, 1977-83

by

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Introduction

Regular groundfish surveys of the Flemish Cap were initiated by Canada in 1977 as part of the Flemish Cap Project. The distribution and abundance of cod, especially mature cod (as measured by availability to the trawl) may well influence the size of subsequent yearclasses.

Materials and Methods

In January-February of each year in the period 1977-83, a survey cruise was conducted on the Flemish Cap using the random-stratified sampling design. The sampling grid is shown in Doubleday (1982). Large geographical areas (strata) were arbitrarily defined and subdivided into units (Fig. 1). The area so defined extends to the 400 fath contour. The shallowest part of the bank is somewhat less than 80 fath. The charts used for stratification were numbers D2 8012 and D2 8013, published by the Canadian Hydrographic Service. The area of a single unit is, on average, 3.4 square nautical miles. Each unit in a stratum is numbered. Groups of 10 units, although often of quite irregular shape, are termed rectangles.

Fishing stations are selected prior to sailing. The total number of sets likely to be completed during the cruise is estimated. The number of sets planned for each stratum is proportional to its area. Stations are selected for each stratum by drawing from a random numbers table, numbers corresponding to unit numbers of the stratum. The position of the midpoint of the unit is the position to be fished. As an aid in distributing fishing stations more widely within a stratum, no more than one station is selected from a particular rectangle.

Tows were made in 1977 by the A. T. CAMERON, a side trawler of 750 t and in 1983 by the GADUS ATLATNICA, a stern trawler of 1500 t. The nets used were the Yankee 41-5 and Engels high rise, respectively. Both nets were fitted with a 1/8" liner in the codend. Tows were of 30-minute duration. In cases where the duration of the tow was somewhat less but the tow was otherwise normal, the catch was adjusted proportionately. Towing speed was 3.5 knots. The depth of tow was kept relatively constant by following bottom contours in areas on the slope.

All cod caught were weighed in basket lots onboard ship by means of a spring balance. All cod were measured except that on one cruise, 204 kg were inadvertantly discarded before measurement. The number measured, in this case, was adjusted proportionately to catch.

Both the Yankee 41-5 net and the Engels net were considered to have a wing spread of 45' (13.72 m). The trawl is considered to have travelled 1.8 nautical miles after 30 minutes at 3.5 knots and, therefore, the area swept by the trawl is about 0.01332 square nautical miles. The area of the bank, 10554.5 square nautical miles, is sufficient for about 792,000 non-overlapping tows (Table 1).

An estimate of the number of cod available to the trawl is derived after Groslein (1966) by multiplying the average catch per tow in each stratum by the total number of tows possible in the entire area of stratum, and adding such estimates for all strata.

Results

The catch per tow by stratum (Table 2) shows that the distribution of cod in the January-February period varies considerably but that cod were not found in quantity in strata 16-19 in any year. Further, cod were found in relative abundance in strata 12-15 only in 1977, 1978,

and 1979. These groups of strata comprise depth ranges 300-400 and 200-300 fath, respectively (Table 3). The distribution of cod within the other strata and depth zones varies considerably from year to year (Fig. 2).

It is clear from Table 4 that the gear does not adequately sample cod of ages 1 and 2. The number of 3 year-olds are also likely consistently to be underestimated. All estimates of any age may be expected to be coarse because of sampling variation. It is humbling to consider that the hundred or so sets completed on an average survey cruise is only about one ten-thousandth of the total possible.

The age compositions, nevertheless, show a fair degree of consistency in the progression of dominant year-classes throughout the years. For the period 1978-83, the numbers of cod at age 4 and older and ages 5 and older (Table 4) are compared to arrive at estimates of total mortality Z. Also for the same period, the numbers of cod in the 1973 year-class and older, in successive years, are compared to arrive at estimates of total mortality Z_2 for this group of year-classes. The results were:

Year		Z	1			Z ₂
1978		1.0	55			1.90
1979		0.	70	•		0.76
1980		0.0	56			0.63
1981		2.0	55			2.22
1982		-0.	16			-0.03
Average		1.	10			1.10

It is apparent that over the past 6 years or so, only about 1/3 of cod survive from one year to the next.

The 1981 year-class appears quite strong. The estimate of 71 million at age 2 is largely the result of one very large set in the survey. If the result of this set were removed from the calculation of abundance, the year-class would be estimated at about 15 million. From Table 4, the 1975, 1976, 1977, and 1978 year-classes at age 4 were larger than at age 2 by factors of 2.6, 25.0, 3.3, and 1.6, respectively. Perhaps a factor of 2.5 would be reasonable. If this factor is applied to the estimates of 15 and 71 million at age 2, the size of the 1981 year-class at age 4 may be expected to be between 38 and 178 million. The 1973 year-class, estimated by Wells (1980) to have numbered 100 million at age 3, was estimated at 27 million at age 4 from the 1977 survey.

From the point of view of replenishing the stock biomass, it would be of benefit to reduce fishing mortality considerably for several years so as to enhance the survival of the apparently strong 1981 year-class. At current growth rates on the Flemish Cap (Wells 1983), this year-class would increase from an average weight of about 0.12 kg in February 1983 to about 0.90 in February 1985. In addition, the 1982 year-class at age 1 may well be quite strong (Table 4). Table 1. Number of tows possible in the area stratified and number of tows actually made on the Flemish Cap by Canadian research trawlers in 1977-83.

		Area								
	Depth	square	Number						а	
	range	nautical	of tows		N	umber	of tov	vs made	ə —	
Stratum	(fath)	miles	possible	1977	1978	1979	1980	1981	1982	1983
										· · ·
1	80	541.8	25,672	•	4	. 4	4	5	5	5
2	80-100	832.9	62,904	5	11	6	11	11	11	- 11
3	100-140	627.8	47,140	4	10	6	8	8	8	8
4	100-140	347.8	26,122	2	б	4	4	5	5	5
5	100-140	703.4	52,770	3	10	6	8	.9	9	9
6	100-140	496.1	37,232	3	8	6	6	7	7	7
7 • 1	140-200	821.8	61,703	2	8	6	10	11	11	11
8	140-200	646.1	48,491	4	9.0	6	8	9	9	. 9
9	140-200	314.3	23,570	2	4	4	4	4	4	4
10	140-200	951.3	71,386	4	14	6	12	13	13	13
11	140-200	806.1	60,502	4	11	6	10	11	11	11
12	200-300	670.4	50,293	-	5	6	8	9	4	9
13	200-300	248.6	18,691		4	4	3	- 3	3	3
14	200-300	602.0	45.189	2	8	6	7	8	8	8
15	200-300	665.7	49,993		7	4	. 8	9	-	9
16	300-400	634.1	47,591	· -	4	6	8	9	-	. 9
17	300-400	215.7	16.214		4	3	3	. 3	-	3
18	300-400	209.7	15 763	-	2	3	3	3	-	3
19	300-400	413.9	31,077	-	5	3	5	5	· •	5
Total		10554.5	792,303	35	134	95	130	142	108	142

^aNote: Small number of tows in which one only tow was made in a stratum not included here.

Stratum	1977	1978	1979	1980	1981	1982	1983
A. Numbe	are						
1		141.90	53.50	72.25	33.40	27.60	16-80
2	72.60	53.82	20.50	50.64	89.55	11.91	924.00
3	118.75	56.60	29.50	18.25	29.88	1.75	215.62
4	43.50	49.33	21.00	76.00	37.40	5.00	60.80
5	33.00	99.60	56.67	273.37	171.11	2.33	25.89
6	67.67	225.25	191.00	45.67	29.29	21.00	33.14
7	66.50	137.75	36.17	14.80	9.91	12.55	23.27
8	50.00	172.44	25.50	12.25	65.11	6.78	105.33
9	33.50	426.65	26.75	13.25	45.75	5.25	7.50
10	50.25	103.64	27.33	72.00	23.69	8.49	23.77
11	299.50	112.64	41.50	18.40	19.00	15.27	21.55
12		47.00	14.33	3.25	1.78	1.50	6.56
13		57.50	6.50	1.33	0.0	1.67	0.0
14	48.50	77.38	14.50	2.00	1.75	4.25	4.13
15		122.29	16.00	7.50	3.33	-	1.00
16		3.00	0.0	0.0	0.0	—	0.0
17		10.20	0.67	0.0	0.0	-	0.0
18		1.00	0.0	0.0	0.0	-	0.0
19		1.60	1.33	0.20	0.0	1	0.0
Total	87.11	99.94	32.33	41.33	34.10	8.91	105.00
# Sets	35	134	95	130	142	109	142
B. Weigh	1†						
1		191.09	49.82	89.25	32.90	13.30	8.28
2	74.55	54.27	76.27	60.23	126.67	3.55	159.01
3	46.08	53.62	8.60	23.13	26.74	0.97	90.13
4	12.48	34.35	4.37	26.50	65.56	1.82	23.10
5	16.19	103.74	72.19	175.44	253.38	4.33	10.44
6	37.68	217.07	180.31	40.08	41.73	35.03	18.67
7	31.78	117.36	35.94	19.10	16.33	16.69	17.03
8	32.91	148.61	15.96	6.76	56.06	10.31	96.42
9	93.75	496.22	38.02	34.00	85.75	10.47	10.54
10	33.14	111.33	37.61	174.42	64.69	17.57	53.63
.11	367.97	94.93	48.20	15.65	39.95	27.47	23.70
12		73.73	25.65	8.63	6.13	2.47	7.67
13		97.61	14.87	2.83	0.0	8.17	0.0
14	54.48	104.19	26.18	6.86	6.25	18.01	24.88
15		150.01	28.15	11.81	15.64		3.96
16		5.22	0.0	0.0	0.0		0.0
17		13.56	0.38	0.0	0.0		0.0
18		1.13	0.0	0.0	0.0		0.0
19		2.00	2.42	0.60	0.0		0.0
Total	78.77	105.29	38.93	45.09	51.58	12.63	36.93

Table 2. Catch per standard 30 minute tow in numbers and in weight (kg) by stratum.

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th range	1977	19	78	1979	1980	198	1	1982	1983a
80		141	• 90	53.50	72.25	33.	40	27.60	16.8
80-100	72.60	53	.82	20.50	50.64	89.	55	11.91	924.0
00-140	72.08	3 107	• 65	79.41	111.96	74.	86	7.14	87.
40-200	112.44	153	.56	31.79	30.61	29.	06	10.38	36.
00-300	82.33	<u>80</u>	.83	13.15	4.00	2.	07	3.00	3.
00-400		4	.19	0.40	0.05	0 .	0		
Total	92.06	5 99	•87	33.16	40.53	33.	79	9.06	105.
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Table 4. Age 1 2 3 4 5 6 7 8 9 10 10	Numbers c 1977 12 2,134 10,272 27,208 5,958 768 165 13 177 40 50	of cod (000 95 4,757 15,531 45,688 12,135 476 181 65 154 169)) esti 4, 1, 5, 6, 1,	mated to 675 067 1 610 437 712 706 108 55 20 224	- 1,030 9,475 2,377 2,990 2,737 3,912 160 23 6 35	32 	628 1,781 21 1,663 978 32 150 137 219 11 11	293 71,001 7,824 319 2,357 958 45 84 68 237 11	

Table 3. Number of cod caught per standard 30-minute tow on the Flemish Cap, by depth zone (fathoms).

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Fig. I. Stratification chart of the Flemish Cap showing stratum unit boundaries.

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Fig. 2. Distribution and abundance of cod on the Flemish Cap in the period 1977-1983.



Fig. 2. (Cont'd)