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Method of forecasting the stock condition and catches of cod in the Labrador and Newfoundland Bank areas

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A B S T R A C T

Using the long - time average factor of fluctuations in the abundance of a cod year - class when fish pass over from one year-class to the other, data on the age composition and the number of fish at different age in the mean catch per hour trawling, one could determine the factors of the Labrador cod abundance and biomass for I978 an I979.

In I978, the Labrador cod biomass will be 2.I times as much, and in I979 - 2.7 times as much compared to the cod biomass in I977.

INTRODUCTION

Cod of the Labrador stock are distributed in the Labrador areas (North, Central and South, i.e. in Divisions 2 G, 2 H and 2 J), the North Newfoundland Bank (3 K) and the northern part of the Grand Newfoundland Bank (the northern part of Div. 3 L), (Postolaky, I962, I963; Templeman, I962).

During the first half of the year, cod inhabit seawards shelf zones of the above mentioned areas at depths 280 m - 450 m. The greatest part of the fish stock is feeding along the shore of Newfoundland and off the South Labrador in the summer and winter periods (Postolaky, I966). The South Labrador and the North Newfoundland Bank are the most important areas of habitation of the Labrador

cod. The annual catch from this area makes 80 percent of the total yield of the Labrador cod.

In the first half of the year, the fishing vessels almost do not work due to the hard ice conditions in the North and the Central Labrador.

MATERIAL AND METHOD

Some statistical data on the commercial effort and the total cod catch from the South Labrador Area.(Statistical Bulletin, volumes II - 26, I96I - I976), data on the age composition of cod from the trawl catches, the long - time average factor (K) characterizing the fluctuations in the abundance of some year - class of cod from one year of their life to the other one were used by the author of the report. The actual and the forecasting factors of the Labrador cod number and the biomass were calculated for the Murmansk vessels, type BMRT.

Discussion of the results obtained.

In I968, the maximum catch of cod (607 thousand tons) was taken in the Labrador and the North Newfoundland Bank Areas, in I969, the catch was somewhat less, namely, 555 thousand tons. In the following years, the total catch of cod was always decreasing in these areas, its maximum level was registered in I976 (I42 thousand tons).

In I974 - I976, the decrease in the cod catches from the Labrador and the North Newfoundland Bank areas was caused by very hard ice conditions in the first half of the year. Usually, the most productive period of the trawl fishery in the South Labrador is the first half of the year. The cod fishery is based there on the wintering, pre - spawning and post - spawning concentrations.

As result of investigations conducted, one can suppose that the factor of the total mortality (Z) is not higher than 0.74 during the last years that corresponds to the total annual loss not higher than 50%. The fishery mortality factor (F) is not higher than 0.45

(or 35% of the annual loss). The average value and the factor of the natural mortality was 0.22. One of the factors characterizing the stock condition is the mean catch per unit of the commercial effort.

Since I96I through I977, the mean catch per hour trawling (twenty - four hours of the catch) fluctuated significantly by years (Table I). One of the reasons causing the fluctuations in the mean catch per unit of commercial effort is an uneven annual recruitment of the commercial part of the stock.

The decrease in the efficiency of the trawl fishery in I967 is caused by the fact that the I958, I959 and I960 year - classes, not so rich in their number, appeared just after a strong I956 and I957 generations.

The higher efficiency of the fishery in I968 and I969 was due to the entry into the commercial stock of three rich year - classes of I96I, I962 and I963. In I972, the increase in the efficiency of the fishery was due to the entering into the stock of a rich I967 year - class. In I973 and I974, the commercial stock included only a rich I967 year - class that could not already ensure a high efficiency in the fishery. The I969, I970 and I97I year - classes were poor, but the I972 and I973 ones might be related to the rich ones (Table 2). In I977, the commercial part of the Labrador stock was intensively recruited by fish of these year - classes. In I977, the efficiency of the fishery increased due to this fact in the South Labrador area as well (Table I).

The best factor characterizing the fish stock condition is the catch per unit of the commercial effort. If the value characterizing the fishery removal of the stock is higher than that one characterizing the recruitment, one can surely observe a negative correlation between the total annual catch and the mean catch per unit of the commercial effort (Parrish and Jones, I959; Zacharov and Konstantinov, I970). The statistical treatment of data on the annual catch of the Labrador cod and on the mean catch per hour trawling showed to the absence of a true relationship between these factors.

Thus, the fluctuations in the efficiency of the trawl fishery were caused mainly by some natural fluctuations in different cod year - classes. In order to forecast the fluctuations in the abundance of the Labrador cod stock for I978 - I979, the long - term average factor (K) of the fluctuations in the year - class abundance from one year to another was determined (Fig. I)[x/]. Using the factor of fluctuations in the abundance of the cod year - class from one age group to another, one could obtain the forecasting factors of the Labrador cod abundance and biomass for I978 and I979 (Table 3). The data given in Table 3 show that during the period from I973 to I976, the actual factors of the cod abundance and biomass decreased gradually that was caused by the absence of rich year - classes, In I977, the factors of the abundance and the biomass increased greatly versus those of I976 and reached the I973 level. This decrease was caused by the fact that two extremely rich year - classes - I972 and I973 - recruited the commercial part of the stock.

In I979, fish of these year - classes at age 6 - 7 years would increase greatly the abundance and the biomass of the commercial part of the Labrador cod stock. The total biomass of the fish stock as well as the efficiency of the trawl fishery would increase greatly due to this fact in the South Labrador area in the first half year of I979. In I979, the biomass of the commercial part of the stock would grow by 2.7 times compared to I977, and by I.3 time - compared to I978. The efficiency of the trawl fishery would also increase.

The efficiency of the trawl fishery depends not only on the abundance and the biomass of the fish sample ., but, also, on the peculiarities of it distribution and its behaviour which, on their turn, are closely connected to the environment conditions. Ice conditions effect greatly the fishery efficiency as well. Presently, it is difficult to foresee how much these factors effect the efficiency of the trawl fishery. But, taking into account the 3 - 4 year periodicity of the water temperatures fluctuations

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x/ To calculate (K), there were used data on the mean number of cod at different age in the catch per hour trawling of Murmansk fishery vessels BMRT type, I96I - I976.

(Burmakin, I972), one can suppose that in I979 the temperature conditions in the Labrador areas would be close to the long - term average rate (or, somewhat lower this rate), that would effect favourably the formation of the cod commercial stocks in these areas.

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Table 1. The efficiency of the cod fishery registered to the veesels of different nations for the first half year off the South Labrador area (in metric centners).

Year	Mean catch per hour trawling					Mean catch per day by GFR BMRT (3)
	USSR (2) BMRT (3)	Spain RT(4)	Portugal RT (3)	Portugal BMRT (4)	Poland BMRT (3)	
1960		22.5	35.5	-	-	-
1961	30.1	23.3	29.7	-	-	-
1962	34.1	30.1	32.4	-	-	-
1963	38.7	29.6	34.2	-	-	-
1964	42.2	24.8	24.5	-	-	-
1965	33.8	21.1	26.4	-	26.6	314
1966	33.5	18.7	24.0	-	28.1	298
1967	24.1	18.2	24.0	34.2	23.0	245
1968	36.2	20.3	26.4	48.0	35.0	357
1969	29.6	24.9	31.1	48.9	30.2	342
1970	26.9	22.7	23.9	29.2	30.2	427
1971	22.3	15.1	16.5	21.4	19.6	330
1972	28.6	-	15.3	17.0	24.5	332
1973	23.1	7.4	9.8	12.9	11.5	189
1974	21.4	16.7	13.3	25.9	18.7	267
1975	17.5	19.1	14.6	21.0	11.9	316.4
1976[1/]	-	-	8.2	-	15.0	242.6
1977	28.0					

1. In 1976, Murmansk BMRT conducted no special cod fishery.
2. The efficiency is calculated for Murmansk BMRT.
3. Tonnage class 2000 over, bottom otter trawl (stern).
4. Tonnage class 1000-1999.9, bottom otter trawl (side).

Table 2. Age composition of cod in the are of South Labrador for the first half year, 1961-1977 (data given), %.

Age, years	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
3	-	0.6	0.2	-	-	-	-	0.2	0.2	4.4	-	-	-	-	-	14.5	3.9
4	5.6	1.9	3.6	1.1	5.8	8.5	2.3	2.1	3.0	6.5	12.0	3.1	1.9	-	1.2	23.6	45.8
5	6.4	15.2	4.8	7.9	5.8	34.7	15.4	21.0	14.7	16.4	15.0	17.5	6.1	5.5	4.0	7.1	36.8
6	19.3	22.4	11.7	13.5	12.1	21.3	25.5	20.5	30.1	18.2	25.0	19.4	33.7	16.6	16.6	8.9	5.7
7	21.2	15.5	32.8	32.6	16.3	16.1	17.6	19.6	22.0	15.9	20.8	21.6	22.3	33.8	25.8	9.4	1.7
8	11.7	13.2	16.6	27.7	23.4	8.8	17.0	16.4	15.1	16.2	12.7	15.1	14.8	19.5	32.8	10.8	2.7
9	12.5	6.9	8.3	6.6	20.4	3.3	8.7	8.9	6.8	9.2	8.1	9.7	6.7	12.0	10.5	15.5	1.8
10	9.4	6.2	7.1	2.7	7.4	4.2	5.2	4.2	3.2	5.7	3.8	6.7	2.6	5.3	4.5	4.5	0.9
11	2.9	4.8	3.4	2.8	2.9	0.4	5.0	3.1	0.9	2.9	0.9	3.5	5.3	3.5	1.8	3.1	0.6
12	3.7	2.4	3.5	2.0	1.7	2.0	0.9	2.9	1.9	1.9	0.7	2.2	2.6	2.3	1.3	1.5	0.1
13	2.9	3.1	1.9	1.1	2.0	0.7	0.6	0.4	1.4	0.9	0.7	0.6	2.0	0.6	0.6	0.6	-
14	1.7	1.2	1.5	0.6	1.0	-	0.7	0.4	0.2	0.8	0.2	0.2	1.2	0.7	0.4	0.2	-
15	1.6	1.5	1.1	0.6	0.4	-	0.1	0.3	0.3	0.6	0.1	0.1	-	-	0.2	-	-
16	0.9	1.3	1.2	0.2	0.8	-	0.5	-	0.2	0.4	-	0.1	0.1	0.2	0.2	-	-
17	0.2	2.2	0.8	0.3	-	-	0.4	-	-	-	-	0.1	-	-	-	0.3	-
18	-	0.9	0.4	0.1	-	-	0.1	-	-	-	-	0.1	0.2	-	-	-	-
I9 and more	-	0.7	1.2	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-
Mean age, years	0.8	8.1	8.2	7.6	8.0	6.3	7.3	7.1	7.0	7.1	6.6	7.3	7.4	7.7	7.7	6.3	4.8
Average weight, g	1534	1522	1394	1357	1346	1067	1036	1390	1422	1169	1086	1295	1203	1435	1579	1040	713
Mean number of specimens per hour trawling	1874	1984	2733	2793	3167	2867	2[illegible]6	2756	2205	2335	2136	2115	2012	1700	1108	-	3938

Table 3. Actual (1973-1977) and forecasting (1978-1979) factors of biomass and the number of cod at age 5 - 13 in the mean catch per hour trawling for the first half year of Murmansk BMRT. The number of specimens is given in the numerator, the biomass (kg) - in the denominator.

Year of the fishery	Age, years									Summary factors
	5	6	7	8	9	I0	II	I2	I3	
I973	183	678	459	298	135	52	107	52	40	1944
	88	650	554	416	223	98	217	119	92	2457
I974	94	285	590	335	206	91	60	39	I0	1700
	67	273	701	467	341	171	122	89	23	2254
I975	44	184	285	364	117	50	20	15	7	1036
	32	176	344	506	194	94	41	34	16	1437
I976	28	79	169	326	204	81	23	4	7	921
	20	75	204	455	338	152	47	9	16	1136
I977	1445	234	67	106	71	35	24	4	1	1987
	1035	224	61	148	117	66	49	9	2	1731
I978	1500	2023	211	54	64	36	14	10	2	3914
	1074	1938	255	75	106	68	28	23	5	3572
I979	70	2100	1821	169	32	32	14	6	4	4248
	50	2012	3200	236	53	60	28	14	9	4662
Mean weight of I cod specimen, kg	0.716	0.958	1.208	1.395	1.654	1.876	2.029	2.285	2.290	

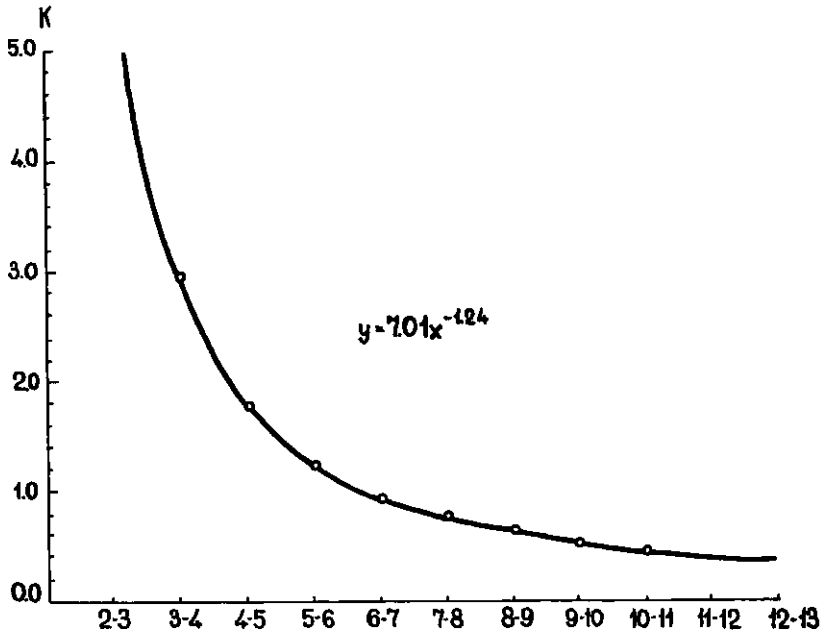

Fig. I. The variability factor of the Labrador cod abundance at the passing from one age group to the other one (the factor of the abundance of fish aged 5 - I3 years was determined by the long - time average factor (K) of the abundance fluctuations from one year of their life to the other; thus, K = 3.2 when fish pass from 3 year - old stage to 4 year - old one; K = 2.2 when fish pass from 4 year - old stage to 5 year - old one; K = I.4 when fish pass from 5 year - old stage to 6 year - old one; K = 0.9 (from 6 to 7); K = 0.8 (from 7 to 8); K = 0.6 (from 8 to 9); K = 0.5 (from 9 to I0); K = 0.4 (from I0 to II); K = 0.4 (from II to I2) and K = 0.4 (from I2 to I3); K = 7.0I x $^{-I.24}$, where "x" is the order number of an age froup: for example, I - corresponds to the fluctuations in the abundance of fish aged 2 - 3 years and 2 - of fish aged from 3 up to 4 years etc).
Let us consider an example: The catch of fish at age 3 (year - class I967) consisted of 48 spec. per hour trawling, the probable number of the same fish at age 4 will be 48 * x * 3.2 = I54 specimens per hour trawling, and that one of fish aged 5 - I54 * x * 2.2 = 338).