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Change in Cod Distribution in the Labrador Area

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The general pattern of cod migrations in the Labrador area is described by many ichthyologists; among Soviet investigators A. Postolaky (1966) accomplished it in considerable detail. In the first half of the year the densest cod concentrations keep to the continental slope at depths of 250-400 m. In summer cod migrate to coastal shallow waters of the Labrador Peninsula where they are exploited by Canadian fishermen. Statistical data of their catches are of special interest due to the fact that they probably reflect the level of cod stocks. Actually, operations of inshore fishermen in summer and autumn are not impeded by either meteorological or ice conditions; fishing gears (traps, gill nets, rods, long lines) did not essentially change in recent years. Periods and areas of coastal fishing remain rather invariable. Thus, the average annual catch per fisherman may be an appropriate characteristic of the level of cod stocks.

Hodder (1965) reports that, since 1954 to 1963, the average catch per Canadian fisherman in the Labrador area decreased from 23 t to 17 t or by 26%; in other words it decreased, on the average, about 3% annually. This continuous and gradual fall could not be caused by natural fluctuations of year-classes abundance. According to the data from Soviet investigations on regular quantitative analyses of small Labrador cod, the abundance of their year-classes changes insignificantly (Konstantinov and Noskov, 1967). One can characterize the strength of the Labrador cod year-class by the average number of the young caught with a special trawl per one hour-trawling. The abundance of good Labrador cod year-classes is not more than 2.5 times greater than that of poor year-classes whereas in the Barents Sea the abundance of rich year-classes is 10 times higher than the poor brood years (Table 1).

The relative stability of annual increase of Labrador cod is partly explained by the transport of their eggs and larvae southward (whereas eggs and larvae of the Barents Sea cod and West Greenland are brought to the north in areas where they can probably meet Arctic water masses).

Thus, a gradual decrease of cod stocks in the Labrador area is not caused by fluctuations but by the regular intensive fishery, primarily the trawl fishery, in offshore waters. The change in the length-age composition of trawl cod catches (Konstantinov & Noskov, 1967) and also a continuous decrease of a portion of the largest and oldest fishes should be considered as a result of the intensive fishery. The gradual reduction of Labrador cod stocks is also explained by May (1967) as a result of this intensive exploitation in the open sea.

If the trawl fishing efficiency in offshore waters is directly and strictly proportional to cod stocks (as it is evidently observed during the summer-autumn coastal fishery) then the catches taken by large European trawlers per hour-trawling should decrease continuously and regularly from year to year. However, in fact there is no direct and close relationship between the level of Labrador cod stocks and trawl fishing intensity. Not only the cod stocks but also features of the fish distribution affect the results of trawl fisheries in offshore waters. For instance, it is known that the eastern distribution of cod in the Barents Sea caused by hydrological conditions favourably influences upon the Soviet trawl fishing efficiency (Konstantinov, 1964, 1967a). There are reasons to believe that the southern cod distribution in the Labrador area results in the successful fishery which is carried out by European trawlers. This is shown by comparing operational conditions for the trawling fleet in the central and south Labrador divisions of ICNAF. In the central Labrador area the ground very often damages bottom trawls; the ice and meteorological

conditions are very difficult. The continental shelf in south Labrador is wider and is seldom covered with ice completely. The grounds in south Labrador are more favourable for trawling and meteorological conditions are somewhat milder compared to those in central Labrador. Consequently, the farther the cod concentrations move southward in winter and spring, the more favourable are the conditions observed for trawler operations.

Therefore, from the practical point of view, methods for predicting the Labrador cod distribution in winter and spring would be very useful.

Pre-spawning specimens are dominant in cod concentrations near Labrador. It is a well known fact that pre-spawning fish are very sensitive to even insignificant variations of water temperature; the chilling or warming of the sea can change fish migration paths and displace main spawning grounds. For instance, when the water temperatures are low, the Barents Sea capelin spawn more westerly than when water temperatures are higher. Thus, hydrological conditions registered early in winter make it possible to determine an area of spring concentrations of capelin and "capelin" cod (Konstantinov, 1961, 1964, 1965a, 1967b, 1967c; Prokhorov, 1965; Midttun, 1965).

It is natural to suppose that low water temperatures in the Labrador area result in a more southerly cod distribution and high temperatures contribute to a more northerly distribution. The temperature on the International hydrological section 8A between 53°40'N, 55°44'W and 54°51'N, 54°32'W in the 50-200 m layer in the period before the beginning of cod trawl fishery can be taken as an index of the thermal sea condition in the Labrador area. Table 2 shows that, in 1965 and 1966, a comparatively high water temperature was observed in the Labrador area. The warming of the sea was due to slackening of the cold Labrador Current. It should be noted that, in 1965 and 1966, evidently many permanent currents of the Northwest Atlantic including the North Atlantic Current were somewhat slackened. According to Templeman (1965), the slackening of the North Atlantic Current was responsible for the low abundance of haddock in the southern part of the Grand Bank and also the extreme low abundance of year-classes of cod, haddock and herring in the Barents and Norwegian Seas. About the middle of 1967 the intensity of the main currents increased; water temperatures increased in the warm North Cape Current and decreased in the cold East Icelandic, East Greenland and Labrador Currents.

In autumn 1967 on hydrological section 8A in the Labrador area the water temperature was lower than in autumn 1965 and 1966. The paper by Burmakin (1968) reports this fact in some detail.

Table 2 indicates that the lower the temperature on section 8A in October (or November), the more southerly the large Soviet trawlers (BMRT) begin their operations. It should be noted that hydrological conditions predetermine the distribution of fish (and parallel with this the dislocation of the fishing fleet) in both December and following months.

As mentioned above, the southern distribution of cod contributes to successful fishery by the fleet. For example, in January and February 1967, the average catch taken by large Soviet vessels (BMRT) per one hour-trawling was 2.44 t but during the same period 1968 it amounted to 4.05 t.

So observing hydrological conditions in the Labrador area one can predict, several months in advance, peculiarities of the cod distribution, future dislocation of the trawling fleet and probable fishing efficiency.

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Table 1. Number of young cod caught by a special trawl per one hour-trawling. (The average catch of young cod taken per one hour-trawling and calculated for Division 3K by species at age 2+ and 3+; for the Barents Sea at age 1+ and 2+)

Year-class	Labrador Cod stock (caught in Division 3K)	the southern Barents Sea	the Bear Island-Spitsbergen area
1958	-	10	20
1959	18	12	13
1960	11	6	13
1961	22	2	2
1962	20	6	5
1963	26	14	84
1964	-	51	39

Table 2. Water temperature on hydrological section 8A and the area off Labrador where Soviet trawlers (BMRT) started fishing, 1964/1967.

Year	Date	Water temperature (50-200 m layer)	Location	
			Lat N	Long W
		°C		
1964	23-24 October	-0,22	54°50'	54°15'
1965	12-13 November	1,49	56°30'	58°15'
1966	16-17 October	0,98	55°30'	57°00'
1967	21-22 October	0,66	55°10'	55°45'