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The impact of water temperature on the fluctuations in the abundance of Flemish Cap Bank cod

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Flemish Cap Bank (Subarea 3 M of the ICNAF area) is an area of commercial fishing which is most convenient for studying and resolving general problems of fisheries and biology. The bank is inhabited by populations which are entirely isolated from the populations of the neighbouring regions. For example, the results of mass tagging show that cod never migrate from the Flemish-Cap Bank to the Grand Newfoundland Bank located in its vicinity, or in the opposite direction (Konstantinov, 1970).

The whole water area of the Flemish-Cap Bank is open to international fisheries, or to fisheries research since it is located outside the territorial sea and fishing zone. It is virtually never covered with ice, and it was only in spring 1973 that its north-western side was frozen for a short period.

Regular trawl fisheries on the Flemish-Cap Bank was started in autumn 1956. Since then biological data on commercial species have been constantly gathered there. Sufficiently ample catch statistics for the area is also available. Besides, Soviet fish biologists count juvenile cod and conduct total trawl surveys of bottom fish (commercial

and non-commercial species of mass or scarce abundance) every year in the area. The results of these studies are published in ICNAF publications (Bulatova, I973; Chekhova, I974). Finally, Soviet hydrologists keep a regular record of the water temperature on the Flemish-Cap Bank.

Taking the example of bottom fish of the Flemish-Cap Bank the impact of fishing on the status of stocks can be evaluated in quantitative terms and the effectiveness of various regulatory measures can be tested.

These factors make it possible to consider the Flemish-Cap Bank as a natural testing area suitable for various observations and experiments.

It goes without saying that a population which is intensively fished cannot always be taken as an example to illustrate the effect of fishery since the latter can be overtaken by very pronounced natural fluctuations. This was the case with cod in 3NO in I967-I968 (Pinhorn A. Wells, I970). About the same situation occurred on the Flemish-Cap Bank in I972 when a rich year class of I968 was recruited into and essentially enlarged the commercial stock of cod, the total catch of cod exceeding the levels of any preceeding year.

Therefore, in order to predict the status of stocks of commercial species we need to take into account both the impact of fishery and the natural fluctuations. The latter depend chiefly on the abiotic environment which determines the survival of deposited eggs, larvae and young.

In his previous papers the author (Konstantinov, I97I, I972) made it a point that in the southern Newfoundland

area the reproduction of cod is facilitated by the lower water temperature, versus the average for many years. Indeed, the Grand Bank is in fact the southern boundary of the fishing area of cod. Although this species does occur in the more southerly areas up to the coast of Northern Carolina (Wise, I958) it is not a leading object of the fishery there. Therefore, the temperate cooling of water masses in the south of the Grand Bank (rings) the environmental conditions for cod close to the optimum level, i.e. to the level which is typical of the central part of its fishing area. All this also pertains to the cod of the Flemish-Cap Bank.

Besides, as was ascertained by the researchers of the north-European seas, while diminishing the strength of year classes of cod of the northern populations the cooling of water temperatures has the opposite effect on the southern populations of cod (Dickson, Pope, Holden, I974). For example, in the North Sea the cooling of water masses in I950-I970 brought about a sharp rise in the strength of year classes of cod, in the abundance of its commercial stock, and in the total catch.

Like the southern slopes of the Grand Bank, the Flemish-Cap Bank is under the warming effect of the North-Atlantic current. The eastern part of the standard hydrographic section 6A located between 47°00′N, 46°40′2W and 47°00′N, 46°29′W (H_2) is representative enough for analysing the seasonal and yearly fluctuations of water temperature on the Flemish-Cap Bank.

The mean temperature at H_2 in late April and in May I969-I974, and the data of the count of yearling cod on

the Flemish-Cap Bank are collated in the table given below. All these materials were collected by Soviet scientists from the exploratory vessels "ROSSIA", "PERSEI-III", "PROTSION" and "GEMMA". April and May were chosen since it is the period when eggs and larvae of cod develop (and die in mass) in the upper layers of the Flemish-Cap Bank, mainly within 0-50 meters. In other words the strength of the successive year class is predetermined in this period.

Table I. Water temperature within 0-50 meters on the Flemish Cap Bank (part H_2 of the section 6-A) and the average number of cod yearlings per hour of trawling with a fish-recording trawl according to the records for the next calendar year.

Year	Date of measuring temperature	Temperature in the layer 0-50 m	Average number of cod yearlings of this year class caught per hour of trawling in the next calendar year
1969	April 26	5.36	6
1970	May 20	4.48	0
1971	April 30	1.35	16
1972	May 1	1.91	2
1973	April 27	0.86	219
1974	May 2	1.68	

As is shown in the table, the lower the water temperature is the stronger year classes of cod are formed on the Flemish Cap Bank. The unique abundance of yearlings of the 1973 year class is a remarkable fact. We can expect that in 1977-1978 the commercial stock of cod on the Flemish Cap Bank will go up sharply, and that the yearly catch catch limit can then be increased. It can also be suggested that the yearly class of 1974 will not be of poorer strength than the average for many years.

In conclusion, I would like to mention that the fluctuations in the hydrological regime in the south of the Grand Bank and on the Flemish-Cap Bank affect the abundance of commercial species not only in these areas but, after some time, in the north-European seas as well. This connection was described in detail by Tempelman (1965, 1972). Our estimates corroborate his views. We used quantitative data on the results of count of juvenile cod and haddock in the area of Newfoundland and in the Barents Sea. The greater power of the north-Atlantic current warms up the southern part of the Grand Bank and facilitates the reproduction of haddock in this area, though it has the opposite effect on the reproduction of cod on the Grand Bank and on the Flemish-Cap Bank. After about a year or eighteen months the warm wave reaches the north-European seas giving rise to the formation of strong year class . of the boreal commercial fish. For example, the water temperature was extremely high on the Flemish Cap Bank in 1969 (see Table 2). Next year an exceptionally abundant year class of cod appeared in the Barents Sea, which is being efficiently utilized by the fishery now.

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