

# Cod Spawning Grounds at Newfoundland During Periods of Low Abundance: 1978–91 Russian Survey Data

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## Abstract

This paper analyses survey data on distribution of prespawning cod (*Gadus morhua*) at different maturity stages in spring and summer in Div. 3KLNO. Under conditions of significant cod stock reductions observed in all the surveyed areas since 1970, mass cod spawning in Div. 3LNO was observed mainly on the Shelf, in the coastal areas of Newfoundland. It was concurrently observed that spawning on the Grand Bank slopes had diminished almost completely. In Div. 3K, cod spawning was observed both in the western coastal area, and in the eastern area Funk Island Bank. Based on these analyses recorded and literature data on prespawning cod distribution and their maturation dynamics, localization of cod spawning grounds on the Newfoundland Shelf in the period of sharp stock reduction is suggested.

*Key words:* atlantic cod, distribution, Newfoundland area, spawning

## Introduction

The present work should be considered as continuation of the discussion on spawning time and spawning grounds of Atlantic cod (*Gadus morhua* L.) off Labrador and Newfoundland. Essentially, the current discussions may be as summarized by Serebryakov (1967). Serebryakov (1967) presented data from 1957 to 1963 on prespawning cod off Labrador and Newfoundland and their subsequent egg and larvae distribution permitted him to conclude that the most intensive cod spawning was on the outer slopes of the Grand Bank, primarily on the Northern Labrador slope. There were also some cod spawning locations on the Shelf but spawning there was not intensive (Serebryakov, 1967). Other authors have also come to similar conclusions. The maps suggested by them emphasize the importance of slopes as spawning grounds much stronger than by Serebryakov (Fitzpatrick and Miller, 1979). However, a more recent generalization of data on distribution of prespawning cod and their maturity stages in 1946–92 showed the Shelf, mainly coastal Newfoundland, to be the main cod spawning area (Hutchings *et al.*, 1993).

In the present paper an attempt is made to analyze peculiarities of prespawning cod distribution in 1978–91, as well as to reveal possible reasons for the aforementioned differences in conclusions about the main spawning grounds of cod.

## Materials and Methods

The materials used on distribution of Atlantic cod and their gonad maturity were obtained during the spring and summer bottom assessment surveys conducted by Russian specialists in 1978–91 (Table 1).

Observations on cod gonad development were performed at sea, at the same time as the analysis of feeding and age composition of samples. Maturity stages were ranked using a 6-point scale developed by Sorokin (1957, 1960).

When drawing plots of prespawning cod distribution, four "conditions" characterizing fish in readiness to spawn were established:

1. females at maturity stages III–IV are present in the catch;
2. males at maturity stages V–VI are present in the catch;
3. females at maturity stages V–VI are present in the catch;
4. females at maturity stages V–VI constitute more than a half of total number of females in the catch.

Values of these "conditions" were plotted geographically onto a regular grid (15'W × 10'N) (Fig. 1). For every point of the regular grid, series of these condition values were made for the period

TABLE 1. Dates of research on bottom trawl surveys in NAFO Div. 3KLNO in 1978–91.

Year	Survey period		
	Div. 3NO	Div. 3L	Div. 3K
1978	10.06–25.06	3.05–10.06	2.07–14.07
1979	8.04–29.04	30.04–13.05	14.05–25.05
1980	8.05–1.06	5.05–8.05	13.06–21.06
1981	11.06–27.06	2.06–13.06	12.07–22.07
		8.06–10.06	
1982	3.05–25.05	27.06–11.07	21.06–1.07
		25.05–11.06	
1983	25.05–20.06	26.06–1.06	12.07–2.08
		1.07–12.07	
1984	30.04–30.05	6.06–22.06	23.06–12.07
1985	3.05–15.05	22.04–24.04	17.06–25.06
		17.05–19.05	
1986	19.04–10.05	4.06–17.06	22.05–15.06
		16.04–19.04	
1987	11.03–13.04	10.05–22.05	11.05–6.06
		26.04–11.05	
1988	17.03–6.04	7.04–23.04	24.04–8.05
1989	5.03–21.05	27.04–21.05	5.06–19.06
1990	5.04–26.04	26.04–23.05	1.06–18.06
1991	9.04–27.04	9.05–6.06	–

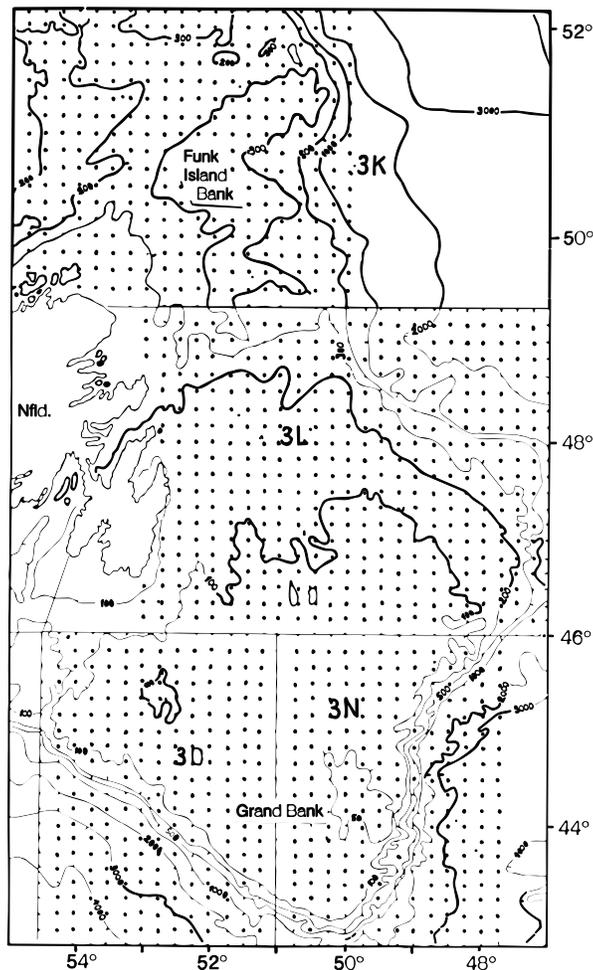


Fig. 1. NAFO Divisions 3KLNO and points of regular grid used to summarize data.

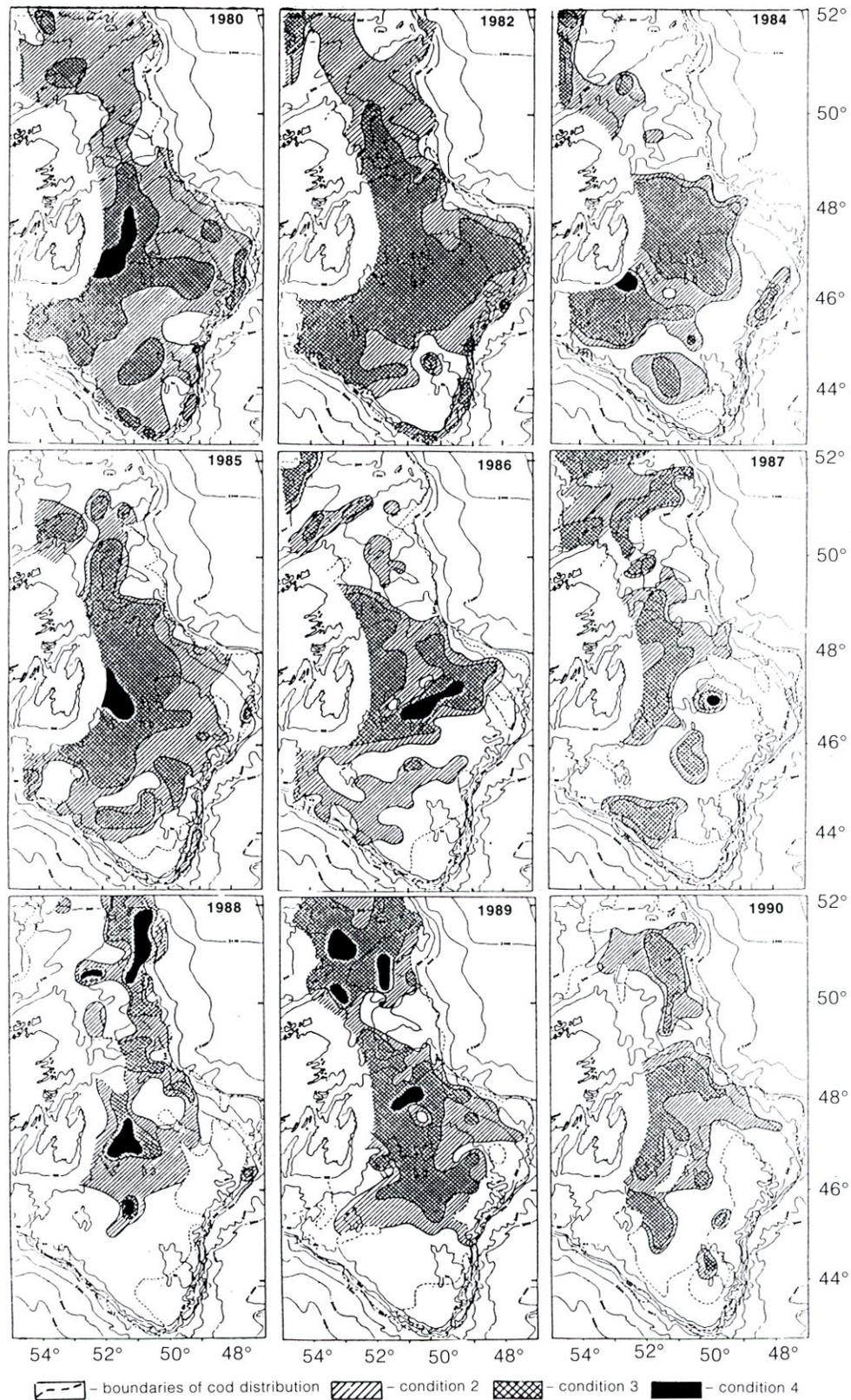


Fig. 2. Redistribution of mature cod with their maturation in Div. 3KLNO in spring and summer 1980-90.

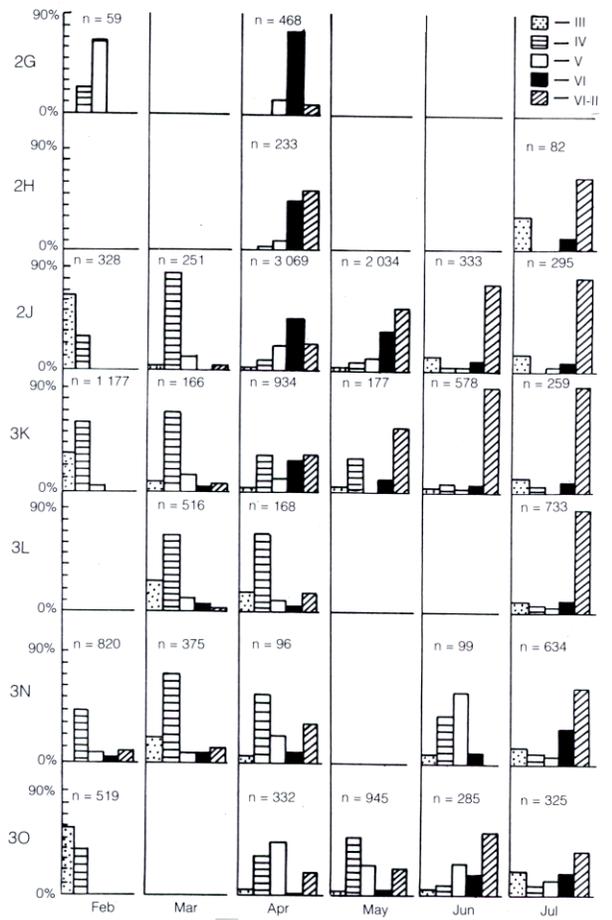


Fig. 3. Maturity stages of cod in Div. 2GHJ+3KLNO in 1957-63 (according to Serebryakov, 1967).

1978-91. Arithmetical means were used to draw a summarized plot of prespawning cod distribution.

When summarizing data in Div. 3K, results of 1978, 1981 and 1983 surveys were excluded from the analysis, because those surveys were conducted later in time of the year, when the main portion of mature cod became postspawning stage.

When histograms were constructed characterizing maturation dynamics of cod, only mature females were included. Intermediate maturity stages IV-V were combined with stage IV and that permitted a comparison of our results with results obtained by Serebryakov (1967).

**Results and Discussion**

The majority of distribution plots showed that in Div. 3LNO, a process where mature cod concentrations became prominent in the coastal Newfoundland area with the cod showing readiness

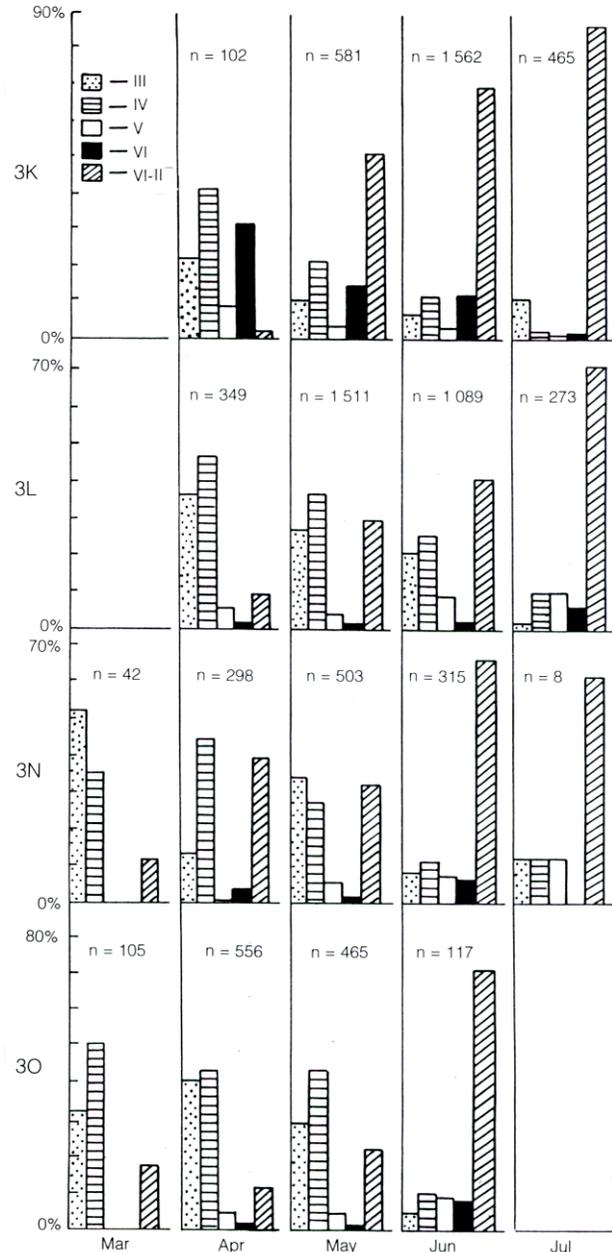


Fig. 4. Maturity stages of cod in Div. 3KLNO in 1978-91 (our data).

to spawn (Fig. 2). Only in single years, mainly in the first half of the study period, females at maturity stages V-VI were observed over the restricted areas of the slope. Comparison of the maps and time of surveys suggested that peak spawning in the coastal Grand Bank was reached in May-June.

A map by Serebryakov (1967) showed the Shelf of Div. 3L to be an area where cod spawning was not intensive. However, in that paper by

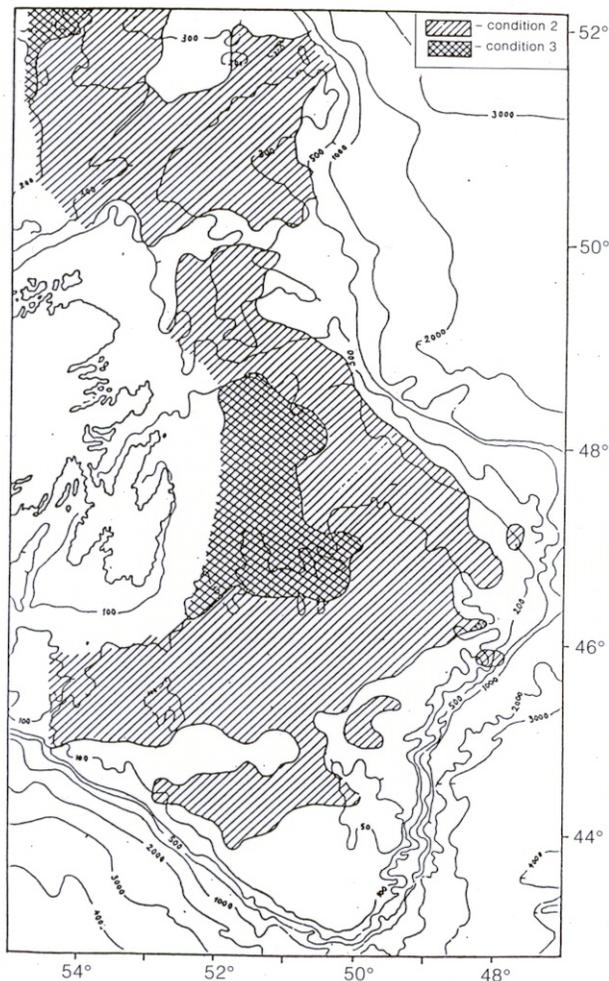


Fig. 5. Summarized plot of mature cod redistribution with their maturation in Div. 3KLNO (from 1978–91 data) (according to Serebryakov, 1967).

Serebryakov, there was no information on the cod gonad status in Div. 3L in May–June. It is possible that importance of the Shelf as a cod spawning ground was underestimated (Fig. 3). Our analysis of cod maturation dynamics showed that prespawning cod (maturity stages III–IV) or postspawning (VI–II maturity stages) were predominant in Div. 3L from April to July (Fig. 4). Abundance of cod with gonads at V–VI maturity stages were relatively low throughout all of the study months. It is therefore quite probable that the most intensive spawning on the Shelf could be taking place mainly within the coastal areas, in areas not covered by Russian surveys.

Localization of cod spawning grounds in Div. 3K required analysis in more detail. Surveys in that area were usually conducted not earlier than in May. In that period concentrations of prespawning cod

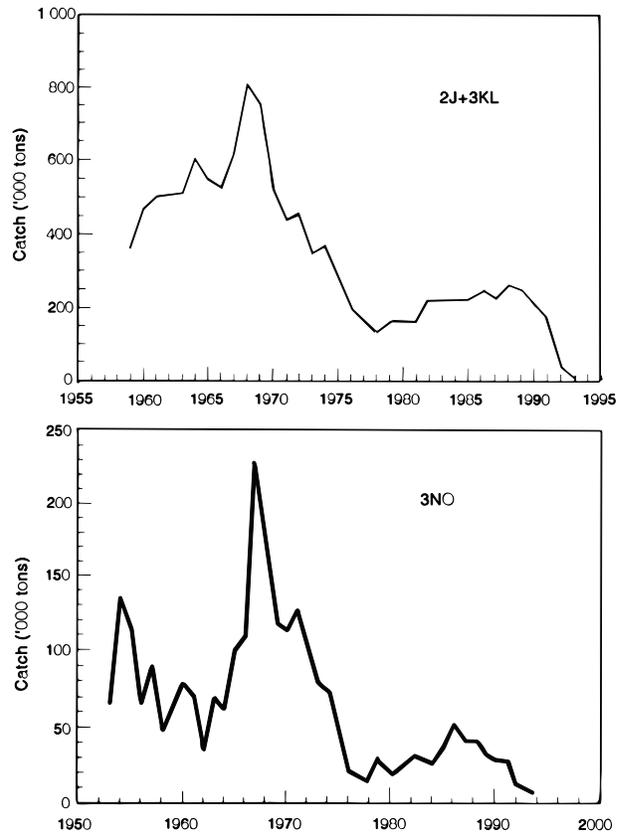


Fig. 6. Total catch of cod in 1955–94 (NAFO, 1994).

were regularly observed in the western part of the area. However, in some years, particularly in April–May 1988, concentrations of females at maturity stages V–VI were clearly recognized in the eastern part of the area, on the Funk Island Bank (Fig. 2).

According to Serebryakov (1967), the peak of cod spawning in the northern areas including Div. 3K was observed in March–April (Fig. 3). Our data indicated high abundance of females at maturity stage VI in April, May and June (Fig. 4). Comparison of time and areas of cod spawning in Div. 3K identified by Serebryakov (1967) and by us permitted to suggest that cod spawning here was observed twice: in March–April on the Funk Island Bank slopes and in May–June in the coastal Newfoundland area.

The plots which summarized the redistribution of cod according to their readiness to spawn, proved the importance of the Newfoundland coastal areas as spawning grounds (Fig. 5) and this is consistent with the conclusions made by Hutchings *et al.* (1993). Obviously, at present, the Grand Bank slopes can not be considered as the main spawning areas of cod. Nevertheless, the above conclusion

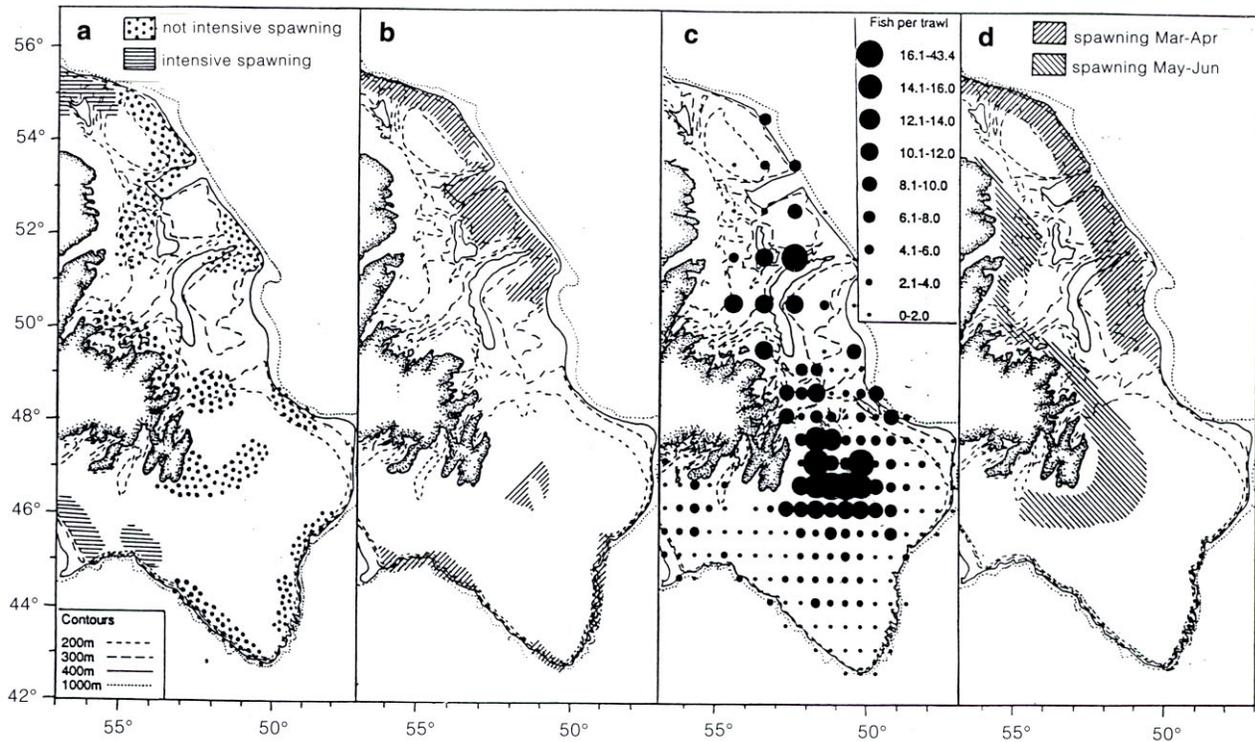


Fig. 7. Cod spawning areas according to different authors.

- a – according to Serebryakov (1967)
- b – according to Fitzpatrick and Miller, 1979;
- c – according to Hutchings *et al.*, 1993, rings – mean amount of spawners (both sex) in the catch per area unit in the most probable spawning period (from 1946–92 data)
- d – according to our data

in no way excludes the possibility that in the earlier study periods cod spawned on the Grand Bank slopes too. Spawning areas of cod can of course change their boundaries depending on climate and spawning stock size (Marti, 1980).

In conclusion, let us assume that dynamics of cod catches in Div. 3KLNO actually reflects their stock-size changes (Fig. 6). In this case, the work by Serebryakov (1967) would correspond to the period of total intensive growth of cod stock, which was evidently followed by expanding of both their dwelling area and spawning grounds. It is quite probable that in that period, cod spawning covered not only the Grand Bank northern slopes but also the southern ones (Fig. 7a). Later work devoted to that problem is referred to the period of maximum values of cod stock and their maximum spawning intensity on the slopes (Fitzpatrick and Miller, 1979) (Fig. 7b). In generalization of data for 47 years of observations, the pattern emerged that prespawning cod occurred both on the slope and on the Shelf, but on the Shelf their abundance was higher (Hutchings *et al.*, 1993) Fig. 7c). During our study period, the cod stock had sharply decreased

and stabilized on the low level. Obviously, this process has been followed by reduction of spawning grounds, mainly to the southern slopes of the Grand Bank (Fig. 7d).

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