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Distribution of cod on the Labrador-Newfoundland Shelf in the fishery zone of Canada and outside it

by

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ABSTRACT

Seasonal variations in cod distribution based on the results of spring-summer routine trawl surveys of 1967-1985 and the data obtained by the USSR commercial ships in 1962-1976 are discussed.

In winter-spring cod are concentrated on the continental slope or near it both in the fishery zone and outside it where they are fished periodically. In summer and autumn fish are distributed in the shallow and deep-water areas of the northern slope of the Grand Bank mainly within the fishery zone.

INTRODUCTION

Before introducing the fishery zone of Canada cod in the Labrador and Newfoundland areas were fished by ships from different countries mainly on the shelf, sometimes near the continental slope where fish form the densest concentrations in certain periods. After the fishery zone had been introduced fishing efforts either declined or were transferred from cod to other objects, time and areas of fishery being changed. Besides, there was observed the tendency of fishing for cod in some areas of the shelf and the continental slope outside the fishery zone. In this connection the studies into seasonal distribution of cod from different stocks in the Labrador and Newfoundland areas are of interest and represent the object of the paper.

On the Labrador-Newfoundland shelf cod form several local stocks. The Labrador, South Newfoundland, Flemish Cap stocks are the most abundant of them and the stock of the coastal cod near the Avalon Peninsula is the least abundant (Fleming, 1960; Templeman, 1974, 1981; Postolaky, 1978; Lear and Wells, 1982).

Ranges of the Labrador, South Newfoundland and coastal cod overlap in Div.3L particularly during their summer feeding migration. The Labrador cod dwell in the area from Div.2G to Div.3L and perform feeding and spawning migrations for more than 800 miles (Postolaky, 1978). They spawn in Divs.2G and 2H in February-March (Serebryakov, 1967). In April-June fish migrate south-westwards and southwards to the coast of the Labrador, North and East Newfoundland where they feed for capelin (Templeman, 1966; Postolaky, 1978). In late September alongside with cooling of waters in the coastal zone cod start migrating to deeper off-shore areas of the shelf. In October-November fish are scattered throughout a rather vast area. In December-January they form dense wintering and pre-spawning concentrations on the continental slope in depths of 220-400 m. In this period and in spring Div.2J where about 70% of the Labrador cod are withdrawn is the most important for fishery. In July-August when a great portion of large and equal-sized cod feed in the coastal waters of the Labrador and Newfoundland the fishery in the off-shore areas of Divs.2J and 3K ceases. At present cod from the above areas are fished only within the fishery zone of Canada.

Cod from the South Newfoundland stock are distributed on the southern slopes and the shallow of the Grand Bank (Divs. 3NOL). In Div.3L deeper than 100 m they mix with cod from the Labrador and coastal stocks (Templeman, 1974, 1981).

As far as the part of the eastern and southern shelf of the Grand Bank where cod concentrate is located outside the fishery zone the distribution of cod in Divs.3LNO is discussed in detail.

MATERIAL AND METHODS

To characterize the seasonal variations in cod distribution

the data on the average catches (t per trawling hour) taken by commercial ships in different parts of the Grand Bank in 1962-1976 were utilized. Owing to the fact that in different years cod fishery on the Bank was performed in different months and was limited by area the data for a number of years are pooled by months to reveal seasonal variations in fish distribution. These data are augmented by those on cod catches taken by research gears during trawl surveys made in February to July 1967-1985. Fig. 3 illustrates only the catches where the cod weight was 200 kg or more (per trawling hour).

The data on cod catches taken by all countries and the USSR in Divs.3L, 3N and 3O in 1967-1977 and 1978-1982 (Stat. Bull. ICNAF 1969-1980 and NAFO 1981-1984) are pooled by months and smoothed by the running mean method according to the formula: $B = \frac{a + 2B + c}{4}$ where a, b, c are the antecedent, middle, consequent terms of the series, B - the estimated one. Smoothing is performed to reveal the tendency in catch variation during the year. While plotting the chart the total catch like that of the USSR was taken equal to 100%.

RESULTS

The distribution of cod on the Grand Bank is closely connected with the peculiarities of the bottom relief of each of the three areas, the thermal state of waters, availability of these or other food objects. There may be found some areas with a higher density of concentrations observed from year to year. Thus, stable concentrations are formed on the north-eastern slope of the Bank between 48° and 49°N as well as between 46° and 47°40'N 180-350 m deep (Figs. 1, 2, 3). Both concentrations are conditioned by the availability of food objects - either capelin (in the north) or capelin and sand lance (in the south).

On the south-eastern slope of the Bank cod concentrate in the upper reaches of canyons 180-300 m deep (Table 1). Most of fish dwell in the waters with bottom temperature 0° to 3° under the layer of cold Labrador waters. When feeding for capelin cod may concentrate also at a slightly negative bottom temperature especially on the slope between 44° and 46°N (Table 2). These

data are similar to those obtained by Templeman (Templeman, 1965, 1966) and Lilly (Lilly, 1981).

On the south-western slope of the Bank influenced by warm waters of the North Atlantic Current cod dwell 80–180 m deep. Maximum stable concentrations are usually located at 51° - 52° W and between 54° - 54°30'W in the frontal zones at the border of waters from the Main and Coastal branches of the Labrador Current.

Figs. 1, 2 and 3 show that cod keep, mainly, on the continental slopes outside the shallow (excluding the southernmost shallow part of the bank). In separate years (for example, in the years highly abundant with fish or when stable frontal zones were available) cod form dense concentrations on the eastern slopes of the Bank and its southern extremity in this period. In Div. 3L outside the fishery zone at its border the catches of cod amounted to 2–3 tons per trawling hour in February-April 1968, 1973.

In February-March 1985 the catches of cod with the redfish by-catch taken in Div. 3N, on the slope south of 44°N in the depth 220–450 m amounted to 2 tons. In January-February 1967 the average catches ranged from 1 to 3 tons per haul taken at the southern extremity of the Bank at the border of Divs. 3N and 30 70–180 m deep.

Cod start migrating to the shallow from the slopes of the southern extremity of the Bank apparently in the second half of April under the pressure of warm waters of the North Atlantic Current. Primarily large fish migrate. In May cod form small schools on the shallow and at small depths along the slope in the south-western part of the Bank. The catches here vary from 0.3 to 0.5 t and to 1–3 tons per haul near the slope. In April-May in the south-west the formation of concentrations is generated by the schools of pre-spawning capelin migrating through the south-western shallow to the south-eastern one as well as by cod migrations to spawn (Bulatova, Turuk, 1979; Serebryakov, 1967; Kovalyov, Kudrin, 1973). In the second half of May - first half of July cod follow capelin to the south-eastern part of the shallow and by the spawning season of the latter they have

concentrated on capelin spawning grounds feeding on them. Here cod also go on spawning. Occasionally (in 1967, 1983) in the south-eastern part of the shallow concentrations are highly dense (catches amount to 3-4 t per trawling hour) and sometimes remain as long as till August-September (in 1967). In 1975 dense concentrations of two-year-olds were found here in June and September. In June a significant portion of cod mainly of commercial length migrate to Div. 3L - to the northern shallow part of the Bank. Cod move to the north of the shallow mainly in the waters with bottom temperature above 0°.

Cod dwelling on the eastern and south-eastern slopes under the layer of cold waters in winter-spring migrate along the eastern slopes to the north of the Bank into the fishery zone of Canada in late spring and summer.

The analysis of the length composition of fish captured on the south-eastern slope of the Bank north of 44° and southwards showed that in the northern part of the slope the percentage of fish with the commercial length (above 40 cm) is higher than in the southern area. When migrating to feed in Div. 3L large cod carry along some portion of three-year-old fish. Young fish remain on the slopes possibly throughout the year. Thus, in late June 1985 on the south-eastern slope of the Bank only in a single small catch from the area at 43°N the average length of cod was 45-47 cm. At the same time on the southern extremity of the Bank the catches of young fish 27-30 cm long ranged from 100 to 800 kg.

Thus, from May to, possibly, October cod are scattered in small schools over the vast shallow area and in deeper waters of the northern slope of the Bank. Feeding on capelin and sand lance they periodically form large concentrations on the south-eastern shallow, east of the Virgin Rocks, on the north-eastern slope between 48°30' - 49°N. Some fish migrate to feed at the coast (Templeman, 1974; Postolaky, Maleev, 1973).

Oceanographic conditions during each year produce a great effect on the start of fish migration. In June of the anomalously cold year 1985 cod remained on the southern slopes longer and entered the northern shallow part of Div.3L later as compared with

June 1984. As the trawl surveys showed the abundance and biomass of cod in Div. 3L in summer may change notably from year to year in relation to the approaches of the Labrador cod from the north and the South Newfoundland cod from the south. The relative biomass of estimated fish in Div. 3L amounted to 383 thou. tons in 1984, 177 thou. tons in 1985. In Divs. 3NO it was 262 and 458 thou. tons, respectively.

The estimation of fish biomass in depths of 55-91 m and 93-548 m showed that in summer in Div.3N no more than 6-8% of cod remain in the waters over the slope. Thus, more than 90% of cod are present in the fishery zone of Canada for a greater part of the year except a brief winter-spring period.

The NAFO statistics show that the fishery for cod is performed and their maximum catch in Divs. 3LNO is taken by all countries in summer (Fig. 4 - I). At the same time the USSR ships also fished for cod before introduction of the fishery zone (Fig. 4 - II). At present the USSR commercial ships fish for cod mainly from November to March.

Basing on the NAFO data from 1976 onwards the total catch of cod in Divs. 3NO ranged from 14 to 31 thou. tons. The USSR catch varied within 2-4 thou. tons in accordance with the quota. The analysis of the NAFO statistical data shows that the absolute cod catches taken by the USSR as well as the portion of the catch in relation to the total catch of cod declined greatly in the last years. Thus, from 1975 to 1982 the catch of cod reduced from 32 thou. t to 2 thou. t in the Labrador area and from 87 thou. t to 5 thou. t in the Newfoundland area. During this period the USSR catch declined from 36% to 2% in the Labrador area and from 28% to 2% - in the Newfoundland area.

Cod stock in the main fishing areas at the Canadian coast is in a good state and will still grow in the nearest future. The data from the Soviet and Canadian trawl surveys indicate the rise of the South Newfoundland cod stock. The Stock Assessment Committee gradually increases TAC from 17 thou. t in 1983 to 33 thou. t in 1985.

As far as the portion of the South Newfoundland and Labrador

cod stocks lies outside the fishery zone of Canada and may be exploited by different countries, it is reasonable to regulate the problems of stock exploitation through the NAFO.

CONCLUSIONS

1. Ranges of the Labrador and South Newfoundland cod overlap in Div.3L, their stocks being available for fishery in the areas of the shelf in Divs. 3LNO outside the fishery zone of Canada in January-March and October-December.

2. In winter-spring on the Grand Bank cod concentrate in deep waters near the continental slope (3LN) and at small depths (30) both in the fishery zone and outside it. In this period the catches of cod on the eastern and southern slopes of the bank outside the zone may average 1-3 t per trawling hour.

3. Cod start feeding and spawning migrations to the shallow in April-May. At that time fish concentrations on the shelf outside the fishery zone are unstable, fish are mobile thus not providing a high efficiency of fishery.

4. In summer-autumn more than 90% of cod (in biomass) are mainly in the fishery zone. Fishery outside the zone is low effective in this period.

5. Wintering concentrations of cod are formed on the slopes of the Grand Bank from November to March. In October-December fishery for this fish outside the fishery zone in Divs. 3LNO is possible but with a lower efficiency than in January-March.

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Table 1. Average catches of cod (kg per 30 min. of trawling) taken by a bottom trawl from different depths over the Grand Bank in May-July 1983-1985*

Depth, m	Area, year								
	3L			3N			3O		
	1983 July	1984 June	1985 June	1983 June	1984 Apr-May	1985 May-June	1983 June	1984 May	1985 June
55	-	-	-	305/10	36/11	124/7	-	-	-
56-91	126/13	189/16	80/16	50/22	101/23	235/24	63/20	144/31	85/25
93-182	52/18	192/37	38/24	32/12	57/11	27/11	9/16	29/15	312/16
184-273	45/18	215/20	124/19	94/7	102/11	220/13	1/4	7/10	5/10
275-364	183/22	45/18	74/20	71/12	114/12	197/10	1/10	0.2/11	1/10
366-546	42/15	2/10	2/12	33/9	3/10	4/11	0/10	0/9	0/9
546-728	0.1/8	1/8	0.1/11	1/8	0/9	0.1/8	0.1/4	0/9	0/8

* The average weight of fish is given in the numerator, a number of hauls at a given depth - in the denominator.

Table 2. Average cod catches (kg/30 min haul) by bottom trawl in relation to bottom temperature in the South Newfoundland area in May-June 1985.

Temperature (C°)	Number of hauls	Average catch (kg/30 min)
-1.1 to -1.5	7	48.3
-0.6 to -1.0	7	92.2
-0.1 to -0.5	6	366.3
±0	1	578.1
0.1 to 0.5	4	377.0
0.6 to 1.0	13	192.6
1.1 to 1.5	6	141.3
1.6 to 2.0	8	126.0
2.1 to 2.5	3	128.4
2.6 to 3.0	3	11.7
3.1 to 3.5	4	5.9
3.6 to 4.0	2	1.4

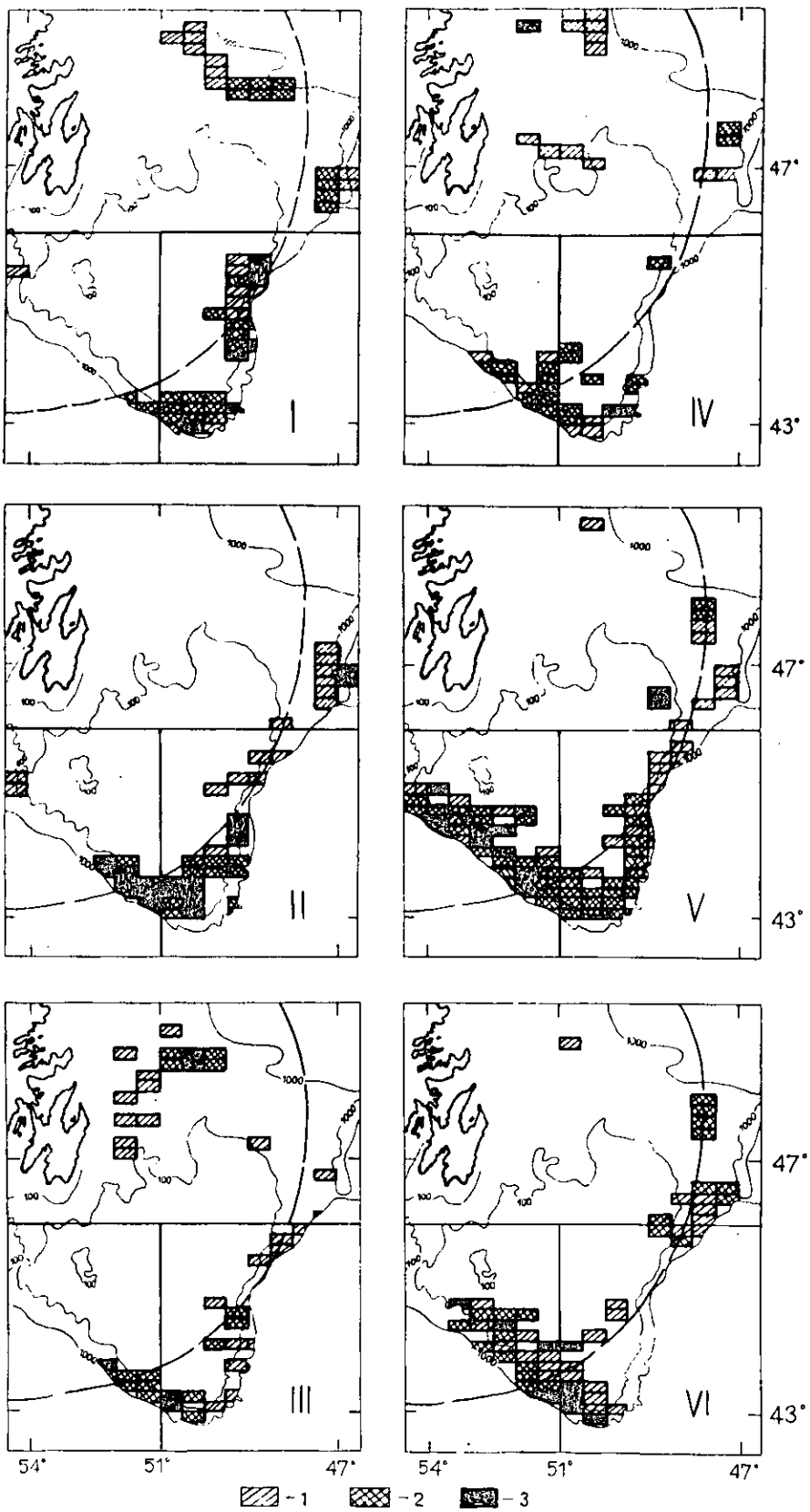

Fig. 1. Average catches of cod taken by commercial ships on the Grand Bank in January-June 1962-1976 (1- less than 1 t, 2 - less than 2 t, 3 - more than 2 t per trawling hour

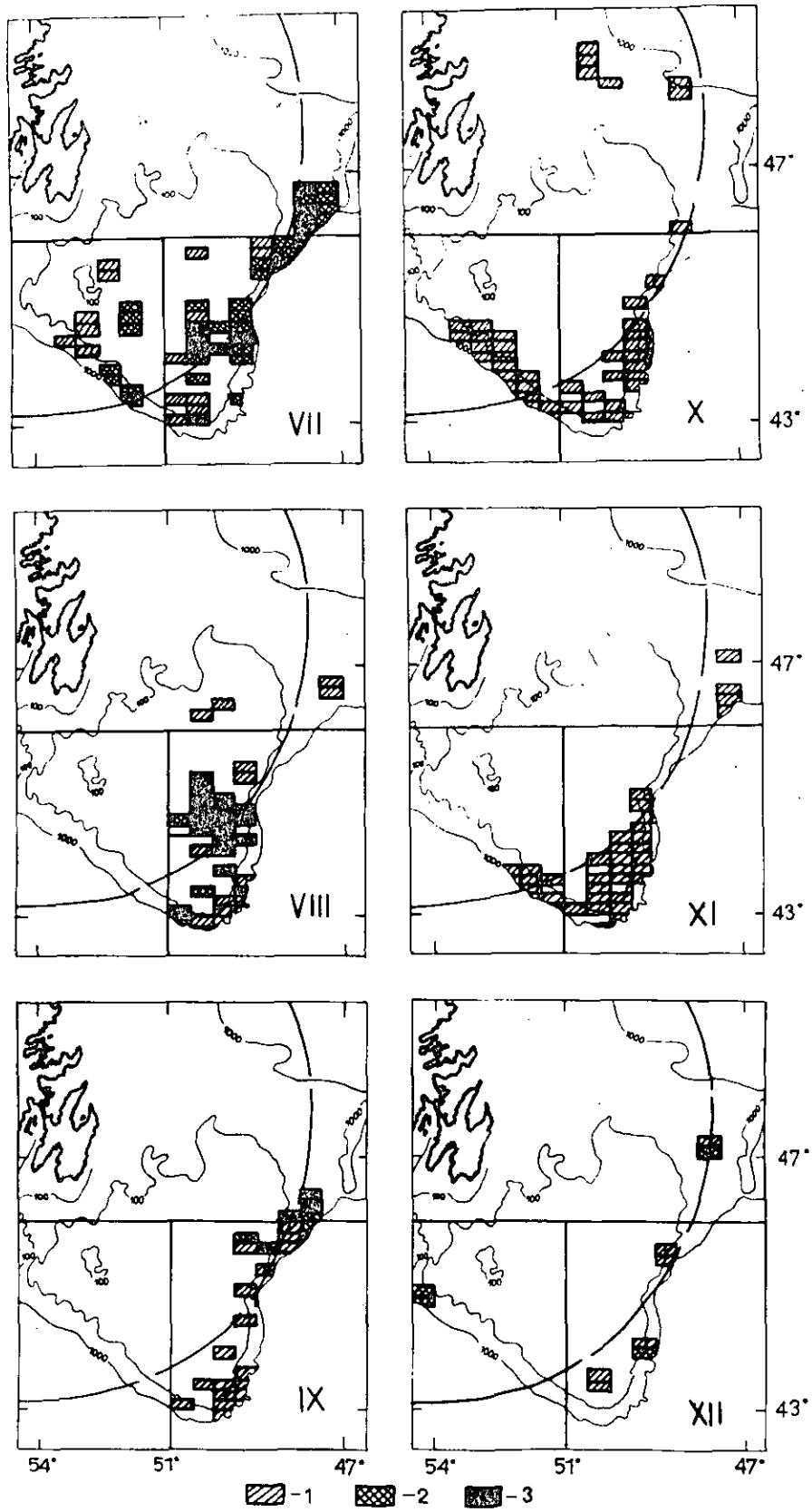

Fig. 2. Average catches of cod taken by commercial ships on the Grand Bank in July-December 1962-1976 (1-less than 1 t, 2 - less than 2 t , 3 - more than 2 t per trawling hour)

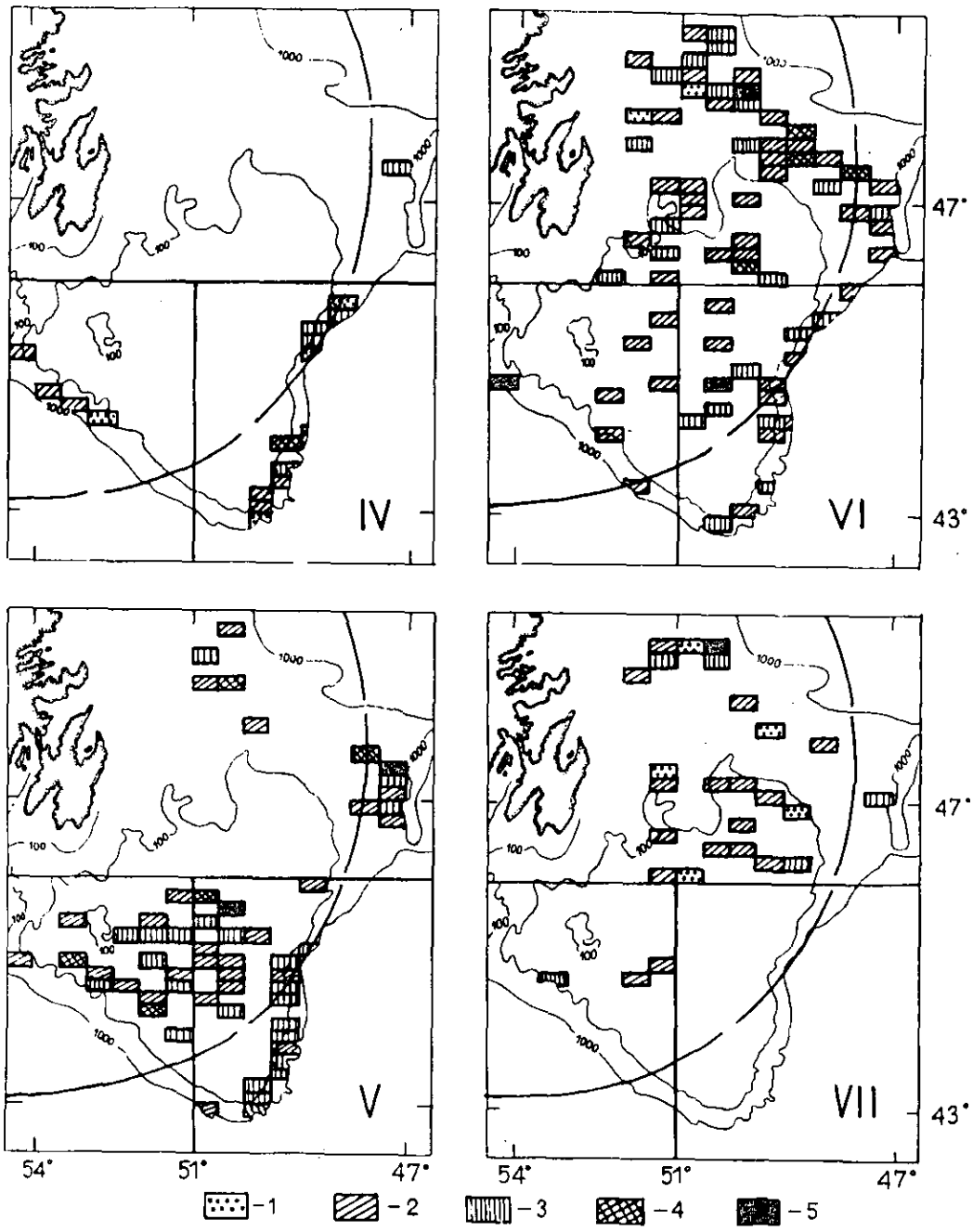

Fig. 3. The highest (0.2 t and more) catches of cod from the Grand Bank basing on the data of trawl surveys of 1967-1985 (1 - 0.2 t, 2 - 0.2 t, 3 - 0.5 t, 4 - 1.0-2.0 t, 5 - more than 2.0 t)

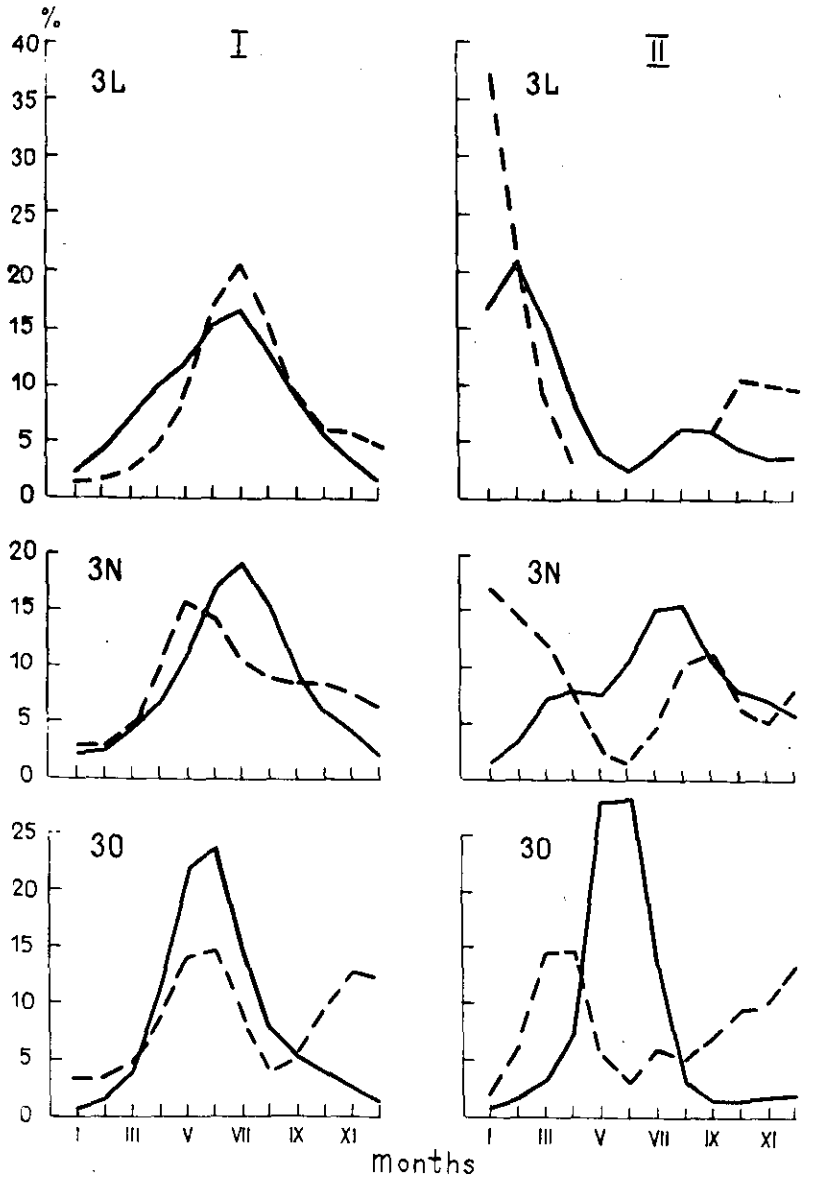

Fig. 4. The total catch of cod (I) and the catch taken by the USSR (II) in Divs. 3LNO pooled by months for 1967-1977 (solid line) and 1978-1982 (broken line), in %