International Commission for the Northwest Atlantic Fisheries

Serial No. 5468

ICNAF Res. Doc. 79/VI/103

ANNUAL MEETING - JUNE 1979

Abundance and biomass of Greenland halibut in ICNAF Divisions 2J and 3K in November-December 1978

by

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Abstract

The results of the trawl assessment of abundance and biomass of Greenland halibut inhabiting Divisions 2J and 3K of the ICNAF area are considered in this paper. A specified catchability coefficient of the fish-counting bottom trawl with a small-meshed netting in the codend is given here.

The highest abundance and biomass of Greenland halibut is found in Division 3K (119 thou. tons). The mean specific biomass in Division 3K on the whole is 1.6 times as high as that in the Southern Labrador area (2J). The Greenland halibut biomass is distributed almost evenly on the shelf and the continental slope of the Southern Labrador area. In Division 3K nearly 90% of all biomass is concentrated on the shelf. In both Divisions the abundance prevails on the shelf, in the Southern Labrador area it makes up 82.1%, in Division 3K - 95.9% (as compared with the continental slope).

The data on size composition of Greenland halibut inhabiting the shelf and the continental slope are given in this paper.

For more rational exploitation of the stock it is recommended while preserving the total size of fishing withdrawal to reduce the fishing intensity in Division 3K and to increase fishing in the areas of the continental slope farther to the north.

Introduction

The aim of this work is to test the method and to obtain preliminary data on abundance, biomass and rate of exploitation

of Greenland halibut on the shelf and the continental slope in Divisions 2J and 3K.

The assessment of the Greenland halibut abundance and biomass includes only the southern part of the range of population, where mainly immature growing specimens dwell.

Since the seasonal migrations of Greenland halibut from area to area are insignificant, this estimate may be used as tentative calculations for working-out the recommendations for organizing rational fishery in the area under investigations.

Materials and methods

The results of the trawl survey of the Greenland halibut stocks carried out by the FRV "Persey-III" on the shelf and the continental slope in Divisions 3K and 2J were used as the material for this paper. The investigations on the catchability of the bottom fish-counting trawl with a small-meshed netting (10 mm) inserted in the codend were carried on during the cruise alongside with the trawl survey of the Greenland halibut stocks.

94 control trawlings were carried out in Divisions 3K and 2J from November 20 to December 27, 1978. The trawlings were made at depths from 160 m to 1,000 m. After the completion of the trawl survey in Divisions 3K and 2J a series of experimental trawlings the main object of which was to obtain the data on specific abundance and specific biomass at the depths most accessible for trawling was performed by the single-warp scheme at depths from 1,000 to 1,000 m on the continental slope. When conducting deep-water trawlings the same fish-counting trawl was used, but with different special rigging designed in PINRO.

While estimating the Greenland halibut stocks we limited ourselves to the 1,500 m isobath, though during the same experimental trawlings several Greenland halibut specimens were fished out at a depth of 1,860 m in cruise 14 of the FRV "Persey-III".

The averaged data on specific abundance and specific biomass of Greenland halibut in Division 3K at the depths of 1,000-1,500 m were extrapolated at the same depths of the Southern Labrador (2J)

where trawlings at great depths were not carried out. It is necessary to point out that the continental slope is very steep and the total area with depths of 1,000-1,500 m is insignificant in Division 2J; it gives the ground to believe that the error is negligible while extrapolating.

All specimens in the catch were meazured and, if possible, were let out into the sea alive (the vessel was prohibited to store fish with commercial purposes). Mass tagging of Greenland halibut, cod, various species of flounder and wolffish was made during the trawl survey. Age samples were taken recurrently out of catches, mass meazuring with dissection of Greenland halibut specimens separately by sex and field analysis of feeding were performed.

The total weight of the catch and the mean weight of one Greenland halibut specimen were determined on the basis of length frequency and size - and - weight key. The total number of fish (N) in the fished off area was defined on the basis of the Greenland halibut abundance in the catch (n) and the catchability coefficient (K).

$$N = \frac{n \cdot 100}{K}$$

The catchability coefficient of the fish-counting trawl relative to Greenland halibut was determined as a result of long-term special investigations (Chumakov and Serebrov, 1978), carried out in cruises 17,19 and 21 of the FRV "Persey-III" in 1976-1978, and was taken equal to 12.2% ± 1.49.

The fished off area (S) was taken equal to the product of the horizontal opening of the trawl (B), i.e. the distance between the boards multiplied by the distance covered by the trawl (L):

$$S = B \cdot L$$

To determine the opening of the trawl between the boards the opening between the ends of the netting wings was meazured first, and then the sine of the angle of attack of the warps and the opening of the trawl between the boards were defined with the

help of the table of elements of a catenary curve by the ratio of the horizontal opening and the line length.

The distance covered by a trawl was determined by dead reckoning and observations at the beginning and at the end of trawling. According to the data of numerous meazurements the mean distance covered by the trawl for an hour of trawling is equal to 3.4 miles, the opening between the boards of the trawl is 69.2 m, and the fished off area makes up 0.127041 sq. miles.

After the initial processing of the data on each trawling the specific abundance of Greenland halibut was calculated in specimens per sq. mile, then the specific biomass of Greenland halibut (W) was obtained by the mean weight of one specimen in the trawl catch:

$$W = Q \quad P$$

where P is the mean weight of one specimen in the catch; Q is the specific abundance of Greenland halibut in spec. per sq. mile.

The data on the specific abundance and specific biomass were plotted on the chart following the coordinates of trawlings. The investigated area was divided into zones of density with approximately close values of specific abundance and specific biomass (Figs. 1-4). The area of zones was determined and the total abundance and biomass of Greenland halibut was calculated.

The additional calculations of biomass and abundance separately for the shelf and the continental slope were made considering the great difference in the mean weight of Greenland halibut inhabiting the shelf and the continental slope.

Results

The distribution of Greenland halibut in the area under investigations depends on many factors including the depth and bottom relief. We determined earlier (Chumakov, 1975) that Greenland halibut of a larger size keep mainly to the continental slope, and those of a small size - to the coastal shelf waters. The investigations conducted prove clearly the conclusion drawn earlier on the difference of size composition on the shelf and

the continental slope. As is seen from Fig.5 specimens 14 to 70 cm long were met in trawl catches on the shelf, and those 30 to 100 cm long - on the continental slope. Length curves of males and females are almost identical on the shelf. Females of a larger size prevail in the catches taken on the continental slope and specimens less than 30 cm long are nearly absent. A great number of small Greenland halibut specimens 14 to 35 cm long were met in the catches taken in shallow coastal areas. Especially many specimens of the same length were met in the catches in the south of the Newfoundland area. As a result, the length curves of males and females on the shelf have two peaks each. Specimens 24–25 cm and 42–43 cm long were met most often in the catches taken in Division 3K, while those 30–31 and 40–41 cm long - in Division 2J (Fig.5). The size composition of the Greenland halibut catches varies greatly according to the depth of trawling, of what the change of the mean length is indicative (Table 1).

The whole area is affected by the cold Labrador Current which, undoubtedly, influences the distribution of Greenland halibut size groups. Approaching the northern slopes of the Grand Bank the Labrador Current is divided into two independent streams: coastal and main. Waters of the coastal stream experiencing the constant influence of the shore flow-off, differ markedly in salinity from the waters of the main stream. The main stream carries waters of two different types and origins: arctic - with the temperature below -1° and relatively warm waters of the West-Greenland Current with the temperature from 3° to 4° (Buzdalin and Elizarov, 1962).

Numerous observations show that Greenland halibut of large size occur mainly at the near-bottom temperature from 2 to 4°, and small specimens - at a wider range of temperature - from 0.6 to 4°.

In this connection the areas of young and adult fish coinciding in a general way, have some distinctions. These distinctions

are clearly identified while considering the distribution of the Greenland halibut abundance and biomass in the investigated area. In particular, a rather high specific abundance of young Greenland halibut (density zone 4) is traced along the whole border of coastal waters at the depths of 160-300 m (Figs. 3,4). At the same time the specific biomass of Greenland halibut is comparatively low here (Figs. 1,2).

Relatively high specific abundance and specific biomass were observed in this period on the shelf in deep-water channels of the Southern Labrador and in Division 3K.

Our investigations showed that specific biomass depends mainly on the relief, ground conditions and depth, and to a smaller extent on near-bottom temperature. In November-December the greatest catches of Greenland halibut were taken at the depths of more than 300 m on the silty and silty-sandy ground at water temperature from 1.6 to 3.9°. Catches at the depths less than 200 m were small even if the optimum near-bottom temperature was observed.

To study the influence of temperature on the Greenland halibut distribution pattern by size composition we compared the near-bottom temperature of water at the depth of trawling with the mean length of Greenland halibut in the catch. There is a direct relationship between the mean length of Greenland halibut (L) in the catch and the near-bottom temperature (T). The correlation coefficient and its error are equal to 0.664 ± 0.042, the relation stability is 15.8; thus, the relation is undoubtedly stable. While checking the stability of the relation, even and uneven members of a sequence and also its first and second halves were analysed.

In our opinion, the regularity pointed out can be explained by greater mobility of adult Greenland halibut than that of young fish and their ability to avoid areas with cold Labrador waters.

The results of calculations of abundance and biomass of Green-

land halibut inhabiting Divisions 2J and 3K are given in Tables 2 and 3. The highest abundance and biomass of Greenland halibut is found in Division 3K (119 thou. tons), where the mean biomass is approximately 1.6 times as high as that in the Southern Labrador area (2J).

The analysis of the Greenland halibut size composition shows that the most rational withdrawal can be performed mainly on the continental slope and the adjacent parts of the shelf, where specimens of a larger size make up the bulk of the catches (Fig.6). The fishing mortality of large specimens will be less than that of small ones with the same weight of the catch there. In this connection we tried to calculate tentatively the Greenland halibut biomass and abundance separately on the shelf and the continental slope (Table 4).

Tentatively the Greenland halibut abundance and biomass on the shelf in Division 3K is 2.5 and 3.2 times respectively as high as those on the shelf of the Southern Labrador. In connection with the fact that Greenland halibut 14 to 30 cm long are not caught because of the selectivity of commercial trawls and large meshes in the fixed gill nets, it is clear that the part of the Greenland halibut biomass determined on the shelf is not accessible for fishery. Relatively low mean weight of one Greenland halibut specimen (670 and 522 g) on the shelf in Divisions 3K and 2J proves further the availability of a great number of young fish in this area. The mean weight of one Greenland halibut specimen on the continental slope is about 3 times as high as that on the shelf (Table 4).

The distribution of the Greenland halibut specific biomass on the continental slope is rather uneven, like that on the shelf. During the trawl survey the highest specific biomass of Greenland halibut was observed to the north of 52°N, i.e. almost entirely in the Southern Labrador area. The Greenland halibut biomass on the continental slope of the Southern Labrador was 2 times as high as that on the shelf, which is characterized

on the whole by a very high mean specific biomass (5.82 tons per sq. mile).

From our point of view the ratio of biomass and abundance on the shelf and continental slope in these Divisions is of interest. The Greenland halibut biomass is distributed almost evenly on the shelf and the continental slope in Division 2J. About 90% of the whole biomass is concentrated on the shelf in Division 3K. The Greenland halibut abundance in both Divisions is higher on the shelf than that on the slope: it makes up 82.1% on the shelf of the Southern Labrador, and in Division 3K - 95.9%.

The data on biomass conform rather well to the results of the Soviet fishery. In Division 3K Soviet vessels fish out Greenland halibut on the continental slope only as a by-catch in the fishery for roundnose grenadier and redfish. The specialized fishery for Greenland halibut is possible in separate seasons on the continental slope of the Southern Labrador.

The Greenland halibut fishery in these Divisions is carried out at present by fishermen from Canada, FRG, GDR, Poland and the USSR. The greatest quantity of Greenland halibut is taken on the shelf of Division 3K. The Greenland halibut fishery had been carried out mainly by Canadian fishermen by long-lines at the coast of the Newfoundland Island till 1960. During the last years they started using fixed single-thread gill-nets and are fishing in the open sea (Bowering, 1977) in the deep-water channels of the shelf. Fishery is of seasonal nature and is carried out from May till December.

Fishing vessels of other countries had been carrying out fishery for Greenland halibut in the Notre Dame Bay area practically all the year round before the economic zones were introduced. The most productive fishery was carried out in the winter-spring period in the deep-water channels of the shelf. Fishing of not mobile wintering concentrations in this area was hindered by unfavourable ice conditions observed constantly in this period.

In May-June, with warming up of coastal waters and migrations of Greenland halibut shoreward, they are taken mainly as a by-catch

in specialized fishery for grenadier, redfish, various species of flounder.

Vessels mostly from the USSR,Poland, GDR and FRG were carrying out the fishery for Greenland halibut in the Southern Labrador area all the year round and mainly on the continental slope.

With the development of the Soviet scouting and research works dense commercial concentrations of Greenland halibut were found at great depths on the continental slope of the Northern and Central Labrador, Baffin Land and on the Greenland-Canadian Threshold. The total catch increased sharply at the expense of fishery in new areas. Especially considerable catch of Greenland halibut was taken in 1975, when more than 20 thou. tons were caught only in the Greenland-Canadian Threshold area (IBC).

Despite the relatively high catch of Greenland halibut in the Davis Strait in those years, such peculiarities as stability of size-age composition, ratio of males and females, and also relatively low coefficients of fishing mortality testified to a good state of the commercial stock and probable increase in catch (Chumakov, Shafran and Tretyak, 1978).

The tendency to reduction of the Greenland halibut catch in the Northwest Atlantic was traced with introducing the 200-mile economic zones by the coastal countries. Especially significant decrease in the Greenland halibut catch took place in the north of the area in subareas 0 and 1. Thus, the Soviet fishery and investigations in the West Greenland area (1) have been completely stopped since 1977, and in the Baffin Land area (0) - since 1978.

The multi-age structure of the Greenland halibut stock and relatively weak fluctuations of the year-class strength (our unpublished data) give the reason to expect insignificant yearly change of the commercial stock. A relative yield in Divisions 2J and 3K during the last years may be estimated and the rate of exploitation in these areas may be compared tentatively on the basis of the total assessment of the Greenland halibut biomass in the above Divisions in November-December 1978 (Table 5).

As is seen from the given Table the greatest commercial with-

drawal in both Divisions was made in 1969 and 1970, it being maximal in Division 3K 16.1 and 16.9% respectively. The mean percentage of commercial withdrawal for 10 years of fishery in Division 3K is also somewhat higher than that in Division 2J. On the whole it may be concluded that the Greenland halibut catch in these Divisions is proportional to the stock and is carried out approximately with the same intensity. However, taking into consideration that in Division 3K the main fishery is carried out on the shelf where mainly small immature specimens of Greenland halibut dwell, the considerably greater fishing mortality in this Division than that in Division 2J may be stated. The mean weight of one Greenland halibut specimen in the catches on the shelf of Division 3K is almost three times as low as that on the continental slope of the Southern Labrador, hence the fishing mortality with the same weight of the catch will be approximately so many times higher on the shelf of Division 3K.

Thus, on the basis of the carried out investigations it may be concluded that the existing Greenland halibut fishery on the shelf of Division 3K is irrational. At the same time there is information about great commercial stocks of large Greenland halibut in the north of the area in subareas 2G, H, O and I, where the catch may be increased considerably (Zilanov et al., Ms, 1975). Undoubtedly it is untimely to increase TAC until there is sufficient information about the size of the spawning stock, about the yearly recruitment of the commercial part of the stock. To our mind, while preserving the total rate of exploitation at a level of the long-term mean in the nearest future, it is reasonable to reduce the intensity of fishery in Division 3K and to increase the catch in the areas situated further to the north of the continental slope.

The methods being applied for estimation of the Greenland halibut abundance and biomass make it possible to register only those specimens which are on the ground or in close proximity to it, not above the vertical opening of the trawl. It is

apparent that disregard of daily vertical migrations leads to underestimating the assessment of the Greenland halibut abundance and biomass in the investigated area.

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TABLE 1. The Greenland halibut mean length at different depths of the shelf and the continental slope of the Southern Labrador area (2J) and Division 3K in November-December 1978.

Depth, m	Shelf	Number of meazurements	Slope	Number of meazurements
101-200	29.79	241	-	-
201-300	37.22	788	-	-
301-400	38.75	2845	48.50	172
401-500	43.04	4084	50.53	1259
501-600	-	-	54.71	1824
601-700	-	-	60.65	724
701-800	-	-	58.61	938
801-900	-	-	62.91	354
901-1,000	-	-	67.03	245

TABLE 2. Abundance and biomass of Greenland halibut in the Southern Labrador area (2J) in November-December 1978.

Zone of density	Mean specific abundance, thou.spec. per sq. mile	Areas of specific abundance zones, sq. miles	Greenland halibut abundance, thou.spec.	Mean specific biomass, tons per sq. mile	Areas of specific biomass zones, sq. miles	Biomass, tons
I	0,25	3527,6	881,9	0,26	3971,3	1032,5
2	0,70	3878,8	2715,2	0,72	8511,8	6128,5
3	2,69	7378,5	19848,2	2,25	7203,9	16208,8
4	5,57	7185,6	40020,4	8,19	2330,8	19089,2
5	14,92	624,0	9310,0	21,67	583,4	12642,2
6	54,98	75,0	4123,5	59,11	68,4	4043,1
Total	3,39	22669,5	76899,2	2,60	22669,6	59144,3

TABLE 3. The Greenland halibut abundance and biomass in Division 3K in November-December 1978.

Zones of density	Mean specific abundance, thou. spec. per sq. mile	Areas of specific abundance zones, sq. miles	Greenland halibut abundance, thou.spec.	Mean specific biomass, tons per sq. mile	Areas of specific biomass zones, sq. miles	Greenland halibut biomass, tons
I	0,27	5897,0	1592,2	0,21	5155,0	1082,6
2	0,83	3667,9	3044,4	0,88	7249,4	6379,5
3	2,39	8864,9	21187,1	2,48	11440,2	28371,2
4	6,59	8428,0	55540,5	8,03	3098,3	24879,3
5	25,82	2737,3	70677,1	18,30	2652,2	48535,3
6	66,66	204,2	13612,0	53,57	204,2	10939,0
Total	5,56	29799,3	165653,3	4,20	29799,3	119206,9

TABLE 4. The Greenland halibut abundance and biomass on the shelf and the continental slope in Divisions 2J and 3K.

Division	Part	Area, sq. miles	Mean wt of one spec., g	Mean specific biomass, tons per sq. mile	Abundance, thou. spec.	Biomass, tons
2J	shelf	18,170.0	522	1.81	63,109.8	32,944.4
	slope	4,499.5	1,900	5.82	13,789.4	26,199.9
3K	shelf	24,740.0	670	4.30	158,815.4	106,515.7
	slope	5,059.3	1,856	2.51	6,837.9	12,691.2

TABLE 5. Commercial stock and catch of Greenland halibut in Divisions 2J and 3K in 1967-76.

Year	Southern Labrador (2J)			Division 3K		
	Commercial stock, tons	Catch, tons	Withdrawal, %	Commercial stock, tons	Catch, tons	Withdrawal, %
I967	59I44	II82	2,0	II9207	9237	7,7
I968	59I44	2266	3,8	II9207	I4344	I2,0
I969	59I44	8992	I5,2	II9207	I9248	I6,I
I970	59I44	8588	I4,5	II9207	20I3I	I6,9
I97I	59I44	2596	4,4	II9207	8828	7,4
I972	59I44	8465	I4,3	II9207	I2564	I0,5
I973	59I44	5964	I0,I	II9207	I0943	9,2
I974	59I44	8I65	I3,8	II9207	8326	7,0
I975	59I44	8I94	I3,8	II9207	II90I	I0,0
I976	59I44	3528	6,0	II9207	II2I2	9,4
	59I44	5794	9,8	II9207	I2673	I0,6

* Commercial stock is taken constant for all years of fishery on the basis of the Greenland halibut biomass during the period of survey in November-December 1978.

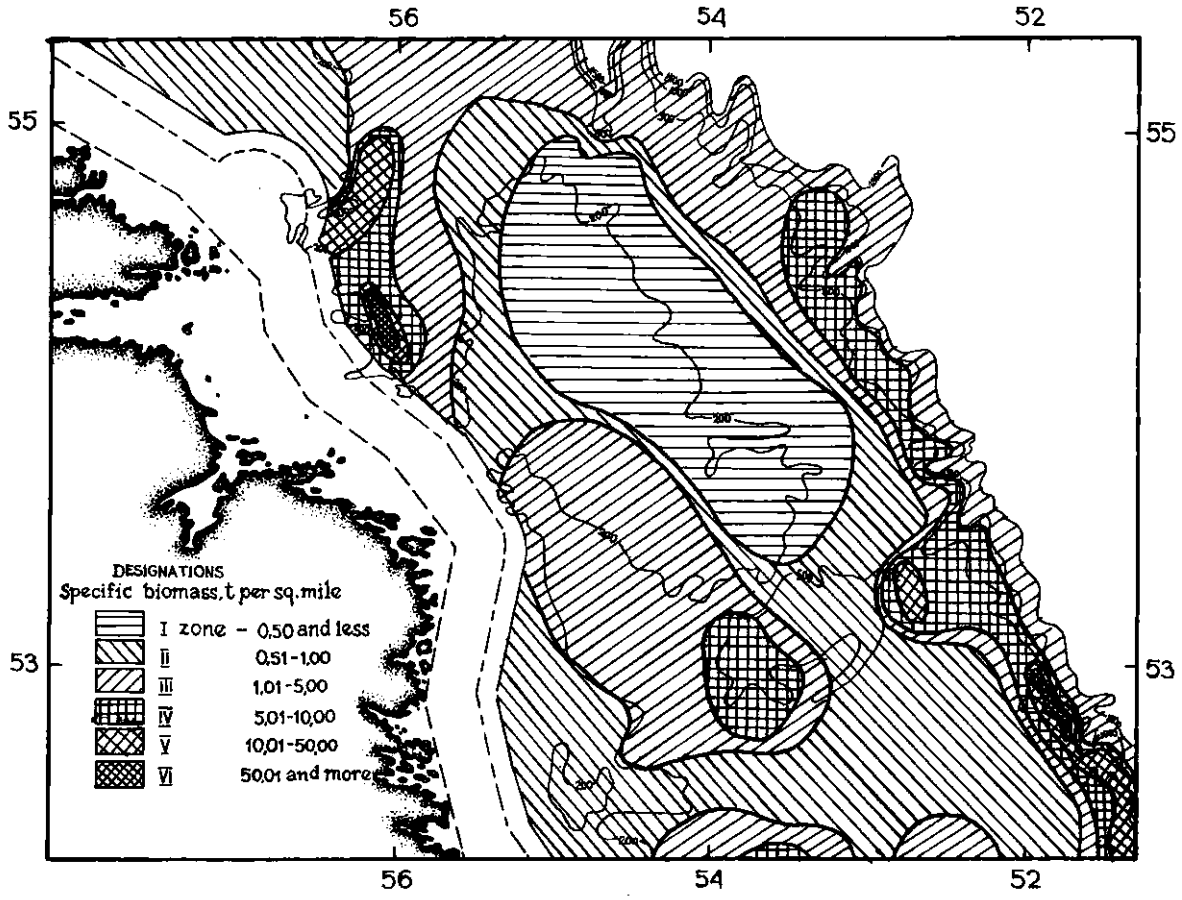

Fig. 1. Zones of the Greenland halibut specific biomass in the Southern Labrador area (2J).

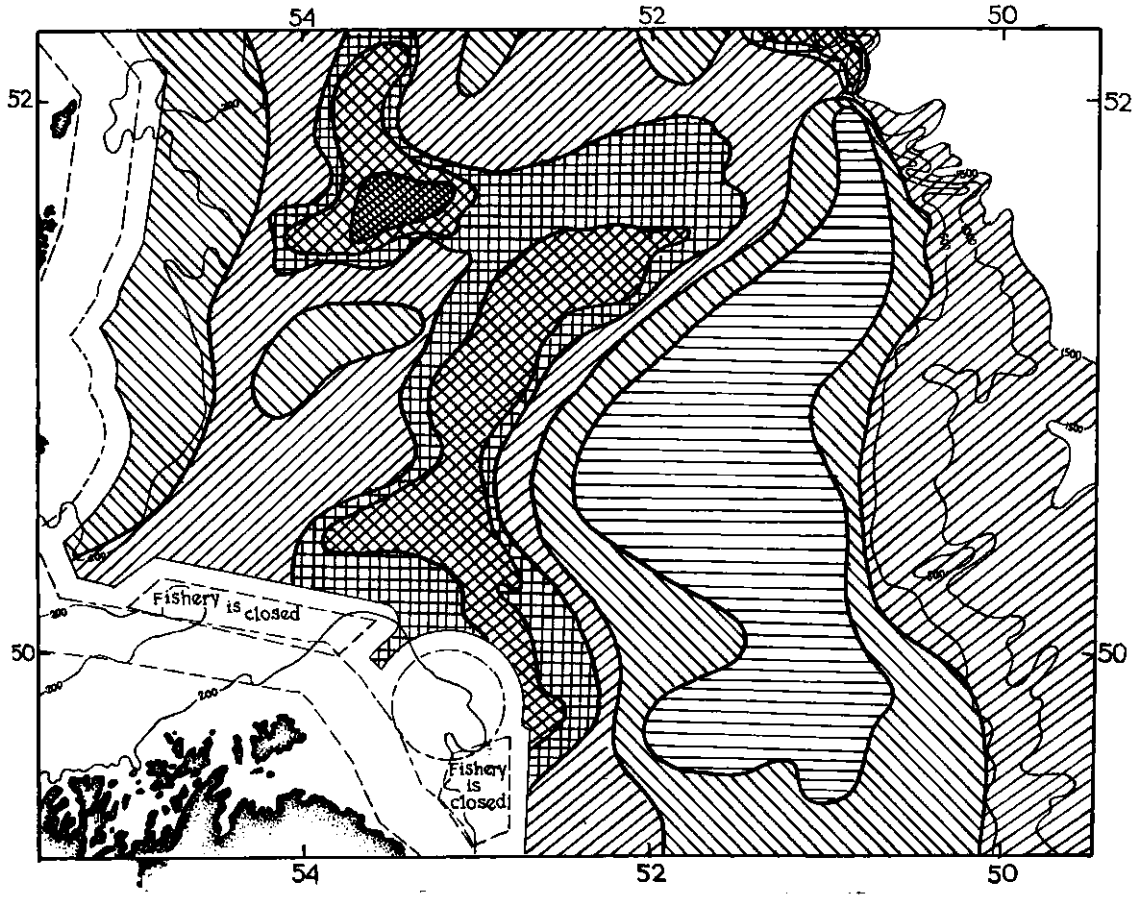

Fig. 2. Zones of the Greenland halibut specific biomass in Division 3K (conventional signs in Fig. 1).

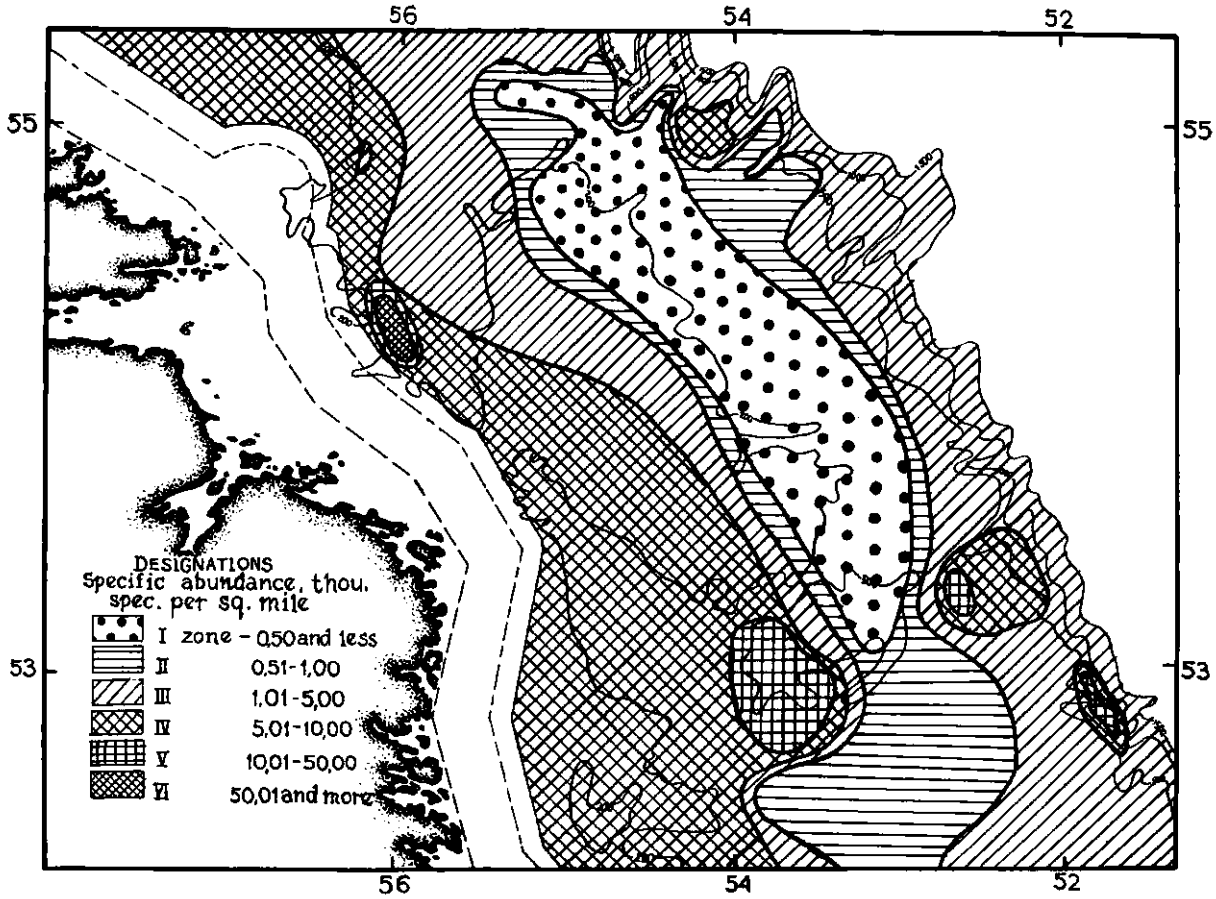

Fig. 3. Zones of the Greenland halibut specific abundance in the Southern Labrador area (2J).

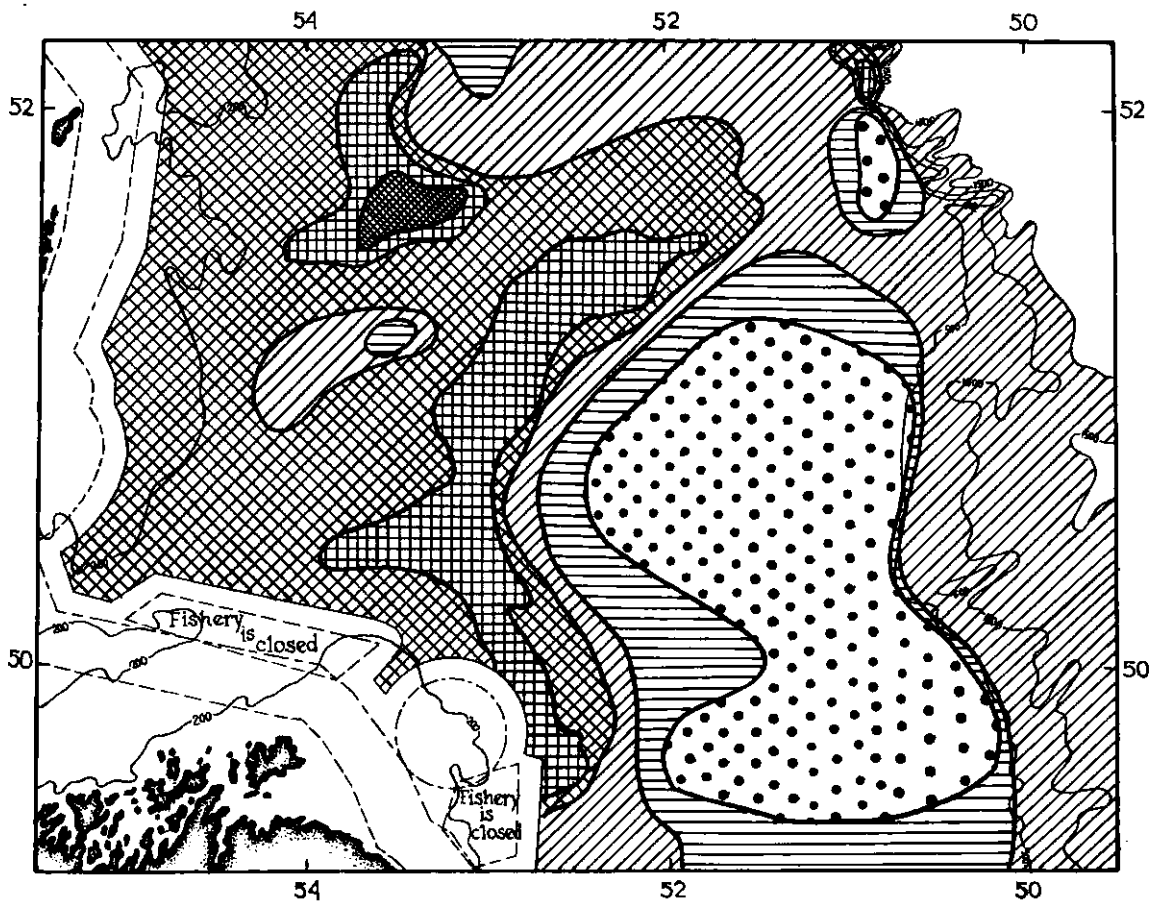

Fig. 4. Zones of the Greenland halibut specific abundance in Division 3K (conventional signs in Fig. 3).

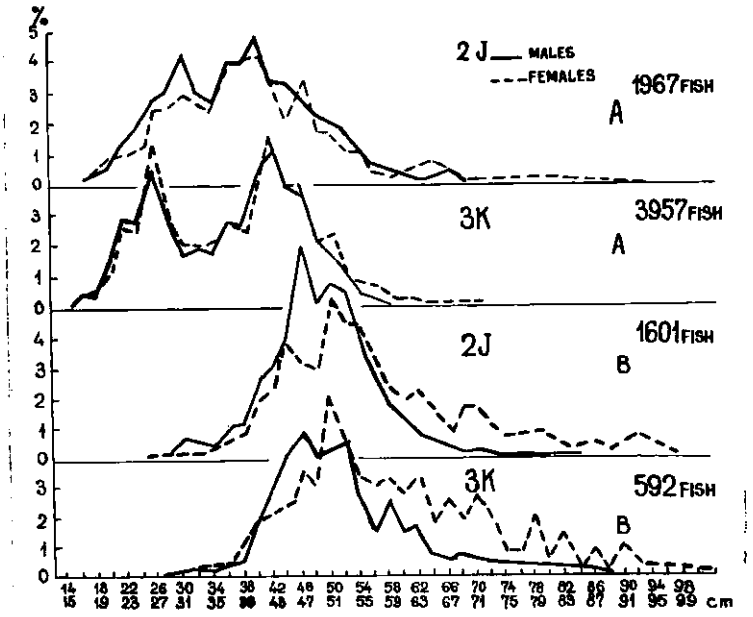

Fig. 5. Size composition of Greenland halibut on the shelf (A) and the continental slope (B) in Divisions 2J and 3K in November-December 1978.

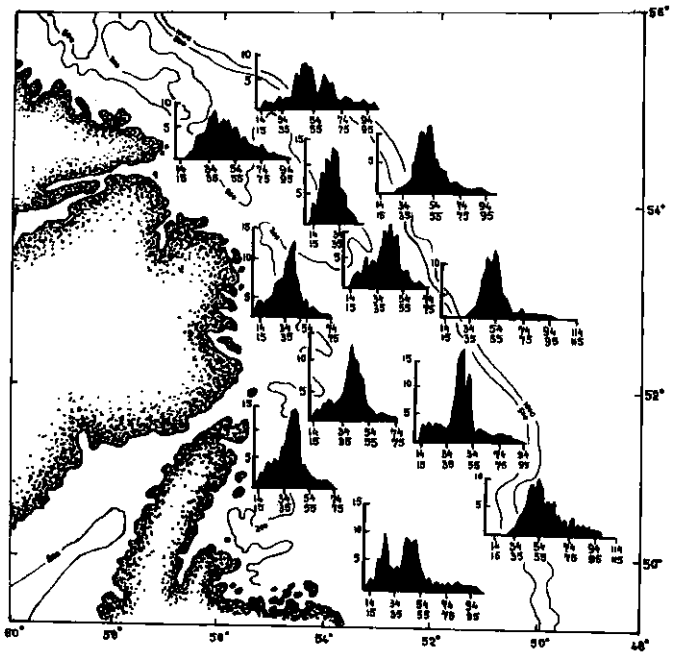

Fig. 6. The distribution of size composition in the area of Divisions 2J and 3K in November-December 1978.