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PRELIMINARY REPORT OF THE NORWEGIAN INVESTIGATIONS ON YOUNG COD AND HADDOCK IN THE BARENTS SEA DURING THE WINTER 1983

by

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ABSTRACT

An acoustic survey and a bottom trawl survey for cod and haddock were carried out in the Barents Sea during the winter 1983. The two surveys gave different results. The acoustic survey showed a 50 % reduction from 1982 for the Barents Sea stock of young cod. The largest reductions were found for the 1977-1975 year-classes. For haddock the reduction in the total stock of young fish was about 40% with the largest reductions found for the 1978-1975 year-classes. The bottom trawl survey showed no such reductions of young fish. In this survey the indices for the younger age-groups (2-5) were higher in 1983 than in 1982 for both cod and haddock.

In both surveys the amount of older fish (6-10+) was significantly lower in 1983 than in 1982, mainly because the abundant 1975 year-class had reached maturity and had migrated out of the investigated area.

The 1982 year-class for cod is more numerous than the poor 1980 and 1981 year-classes, but at present it is not possible to estimate its absolute size. The 1982 year-class for haddock is probably a strong one as one year old haddock was caught in high numbers in most of the surveyed area.

INTRODUCTION

Each year since 1975 a Norwegian acoustic survey has been carried out during the winter in the Barents Sea. The aim of these surveys have been to estimate the absolute number of cod and haddock within the surveyed area. The results from these surveys can be found in Dalen and Smedstad (1979, 1982) and in Dalen et al. (1982).

Since 1981 a stratified random trawl survey has been carried out in the same area and at the same time of the year as the acoustic survey. Preliminary results from these surveys are reported by Dalen et al. (1982).

MATERIAL AND METHODS

General

The surveys were carried out in the period 19 January to 5 March 1983 by three vessels. RV "G.O. Sars" was used in the acoustic survey and the two commercial trawlers MT "Hagbart Kræmer" and MT "Stallo" carried out the bottom trawl survey. RV "G.O. Sars" bottom trawl stations east of 35°E (23 in number) are included in the bottom trawl survey.

Totally 357 trawl stations were taken. MT "Hagbart Kræmer" worked 135 bottom trawl stations, MT "Stallo" 131 and RV "G.O. Sars" carried out 65 bottom trawl stations, 7 pelagic trawl stations and 200 hydrographical stations.

The acoustic investigations

The acoustic investigations were carried out as described in Dalen et al. (1982). A new echosounder (SIMRAD EK 400-38 kHz) replaced the old one (EK 38 S); otherwise the integration system was as in previous years. The performance of the system was thus significantly improved, and according to the calibration results on the standard target (Foote et al. 1981, 1982) the integrator conversion factors, C, were changed. Below are given the values used in 1983 and in previous years:

	Cod	Haddock
Previous values of C:	$5.25 \cdot 10^6 \cdot l^{-2.18}$	$1.72 \cdot 10^6 \cdot l^{-1.69}$
1983 values of C:	$1.87 \cdot 10^6 \cdot l^{-2.18}$	$6.10 \cdot 10^5 \cdot l^{-1.69}$

where l is the length of the fish in cm.

Figs 1 and 2 show the survey tracks, hydrographical stations and trawl stations worked by RV "G.O. Sars".

Bottom trawl survey

A total of 279 trawl stations were taken as a part of the bottom trawl survey. Another 18 stations (8 by RV "G.O. Sars") were taken as part of an experiment for controlling the fishing power of the three vessels. The survey design and all the computatins were carried out as described by Dalen et al. (1982). The final indices given this year are somewhat different from those given last year by Dalen et al. (1982). In that report the stratified mean catch in number (X_{st}) was used. In this report the final index is calculated as $I=X_{st} \cdot A \cdot 10^{-6}/SA$ where X_{st} is the stratified mean catch in numbers for a given area A, and SA is the area swept by a single standard trawl haul of 3 nautical mile, assuming that the trawl has an effective fishing width of 25 meters. It should be noted that these figures should be considered as indices only and not as estimates of numbers of fish in the area. The advantage of such an index is that it may suppose to be proportional to the number

of fish in the area. The confidence limits of this index is calculated as

$$CI=(\bar{X}_{st}\pm S_{\bar{X}_{st}}\cdot t)\cdot A\cdot 10^{-6}/SA$$

where $S_{\bar{X}_{st}}$ is the standard error of the stratified mean catch in number and t is the 95% quartile of a Student's t-distribution.

Fig. 3 shows the trawl stations taken by MT "Hagbart Kræmer" and MT "Stallo" and the bottom trawl stations taken by RV "G.O. Sars" east of 35°E. Table 1 gives the number of trawl stations in each strata, and Fig. 4 shows the locations of the strata used and the four subareas used for dividing the total area in smaller areas.

RESULTS

Hydrography

Fig. 5 shows the distribution of temperature on the surface, in 100 meters depth and at the bottom. The temperatures were significantly higher than in the previous years, and between 1.0° and 2.0° higher than last winter (Dalen et al. 1982) in the central parts of the area.

Distribution of cod and haddock

Fig. 6 shows the distribution of echo abundance for cod and haddock. As in the previous years the highest concentrations were found in the western part of the Barents Sea and close to the Norwegian coast. East of 35°E only one year old cod was found. Figs 7-12 show the distribution of the age-groups 2-7+ for cod. Except for the two year old fish all age-groups were distributed close to the Norwegian coast. Figs 13-18 show the distribution of age-groups 2-7+ for haddock. As for cod also the main concentrations of haddock were found in the western part of the area and close to the Norwegian coast.

For both cod and haddock the 1-year old fish is excluded from the computations of the acoustic estimates. This is done since the 1-group fish due to small size (low target strength) and scattered deep water distribution will contribute very little to the echo abundance. However, since they are caught in high numbers by the trawl they would have a large influence on the final estimates of the other year-classes if included in the computations.

Acoustic abundance estimates for cod and haddock

Cod

Tables 2 and 3 give the number of cod of the different year-classes in the different subareas and in the total area compared to estimates from the previous surveys.

The figures in Table 2 demonstrate clearly the geographical distribution mentioned previously; most of the fish was observed in the areas close to the Norwegian coast (subareas B and C) while the abundances were less in the offshore parts (subareas A and D).

Except for the 1980 and 1981 year-classes all year-classes were reduced in numbers from 1982 to 1983, resulting in a dramatic reduction from about 400 million specimens in 1982 to 200 million specimens in 1983 of the total Barents Sea stock (Table 3). For the older age-groups (7-8) a significant part of this reduction is caused by the fish being outside the investigation area undertaking the spawning migration.

Although the 1980 and 1981 year-classes were found in higher numbers this year than in 1982, the total numbers of these year-classes are low and the results thus confirm previous years findings indicating that these year-classes are very poor.

Considering the year-classes 1977, 1978 and 1979 which made up the bulk of the stock it seems that the reduction in numbers

from 1982 to 1983 (Table 3) are within reasonable limits when taking total mortality into account.

Haddock

Tables 4 and 5 give the total number of fish of the different year-classes in the different subareas and in the total area. Table 4 shows that also for haddock most of the fish is found in the western and coastal subareas B and C. This is true for all age-groups except the 2 years old fish where half of the total estimated stock was found in subarea D. Table 5 shows that there has been a reduction in the total estimate from 80 mill. fish in 1982 to 50 mill. fish in 1983. The reduction is greatest for the 5-7+ year old fish. A part of this reduction is due to a spawning migration out of the investigated area of the year-classes 1977-1975. Table 5 also shows that the 1979-1981 year-classes are very poor compared to earlier year-classes of the same age.

Bottom trawl survey

Cod

Table 6 gives the indices from the bottom trawl survey for the different year-classes in each subarea and Table 7 gives the indices for the total area in 1981-1983. The age distribution is very similar to the one found in the acoustic survey (Table 2) because much the same age and length samples are used in both surveys.

Table 7 shows that there is no consistency in the estimates of the same year-classes for the three years. There has been an increase in the abundance indices for 2-5 years old fish for all three years. The total indices for 2-10+ years old fish (Table 7) do not show the large reductions experienced in the results from the acoustic surveys, instead they indicate a more or less stable population.

The two surveys also show different distribution patterns for fish 2-10+ years old. As mentioned earlier, most of the fish was found in subareas B and C in the acoustic survey. Table 6 shows that nearly two thirds of the fish was found in subareas A and D in the bottom trawl survey.

These large differences in distribution and abundance indices between the two surveys are difficult to explain, but a part of it may be explained by the fish behaviour in the survey period and in the fishing performance of the trawl. During the survey period much cod is found above bottom feeding on capelin. Such a pelagic distribution of cod makes only a portion of the stock available for bottom trawling, but is favourable for the acoustic method. It is thus quite possible that the ratio between the trawlable part of the stock and the total stock may change within the survey area and from year to year, so that the indices from the bottom trawl survey do not fully reflect the variations in stock size. On the other hand the fish which are situated close to the bottom will not be recorded by the acoustic instruments. If this portion varies from area to area and year to year this will cause a varying bias to the acoustic estimates which is difficult to assess. Data on the vertical distribution of the echo abundance for cod and haddock along the ships tracks (Fig. 1) are available, but remain to be analyzed.

In Dalen et al. (1982) the bottom trawl survey indices were corrected using the average proportion of the total echo abundance to the echo abundance found between ten meters above bottom to the surface. The underlying assumption was that the bottom trawl only caught fish between bottom and ten meters above bottom. These correction factors were very coarse and if applied on the 1983 results they would have given an estimate of the total stock which was four times higher than the one given in Table 6.

Table 6 gives an index for the 1982 year-class of 44.6. About 90% of the 1 year old fish was found in the eastern subarea D. It is difficult to assess the strength of this year-class from

this single value, but compared to the indices of the 1980 and 1981 year-classes as one year old fish (Table 7) the 1982 year-class is far more numerous than the average of these two very poor year-classes.

Haddock

Table 8 gives the indices from the bottom trawl survey for the different year-classes in each subarea and Table 9 gives the indices for the total area in 1981-1983. As for cod more than 50% of the fish are found in subareas A and D in the bottom trawl survey. Table 9 shows that also for haddock, the bottom trawl survey does not show the reduction found in the acoustic survey. This is problably caused by similar difficulties as for cod in interpreting the results from this survey because only a unknown and varying proportion of the total population is sampled in this survey.

Table 8 gives an index of 314.5 for the 1982 year-class. This very high index indicate that the 1982 year-class is a strong one.

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Table 1. The number of trawl hauls taken in the bottom trawl survey 1983.

Strata number	1	2	3	4	5a	5b	6	7	8	9	10	11	12	13	14	15	16	17
Number of hauls	0	1	4	1	4	0	1	6	3	3	7	19	4	4	10	14	24	7
Strata number	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	
Number of hauls	9	11	17	11	24	4	2	3	11	20	5	13	5	4	6	16	6	

Table 2. Cod. Acoustic abundance estimates for each age-group/year-class in the surveyed areas in 1983. (Numbers in millions).

	Age (Year-class)									
AREA	2 (81)	3 (80)	4 (79)	5 (78)	6 (77)	7 (76)	8 (75)	9 (74)	10+ (73+)	TOTAL
A	1	1	8	12	6	2	1	+	+	32
B	1	2	7	20	17	10	6	1	+	64
C	2	6	22	22	11	4	2	1	+	70
D	11	8	8	11	4	1	1	+	+	44
TOTAL	15	17	45	65	38	17	10	2	1	210
%	7.1	8.1	21.4	31.0	18.1	8.1	4.8	1.0	0.5	

Table 3. Cod. Estimates of year-class abundance from acoustic surveys in the period 1977-1983. (Numbers in millions).

	Year-class												
Year of investigation	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970+	TOTAL
1977						45	882	104	315	139	52	59	1596
1978					28	235	797	153	172	25	14	18	1442
1979				16	14	109	502	77	45	14	4	2	783
1980	Malfunction of the acoustic instruments												
1981		3	73	58	124	243	270	41	8	3	4		827
1982	1	4	71	86	93	73	74	5	1				408
1983	15	17	45	65	38	17	10	2	1				210

Table 4. Haddock. Acoustic abundance estimates for each age-group/ year-class in the surveyed area. (Numbers in millions).

	Age (Year-class)							
AREA	2 (81)	3 (80)	4 (79)	5 (78)	6 (77)	7 (76)	8+ (75+)	TOTAL
A	2	+	+	+	+	1	1	4
B	1	2	3	2	3	7	3	21
C	2	3	4	2	1	2	1	14
D	5	2	2	1	+	+	+	10
TOTAL	10	7	9	5	4	10	5	49
%	20.4	14.3	18.4	10.2	8.2	20.4	10.2	

Table 5. Haddock. Estimates of year-class abundance from acoustic surveys in the period 1977-1983. (Numbers in millions).

	Year-class											
Year of investigation	1981	1980	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970+	TOTAL
1977						267	755	198	60	10	9	29	1328
1978					111	149	737	55	1				1053
1979				17	11	181	251	13	+	2			475
1980	Malfunction of the acoustic instruments												
1981		2	25	14	66	160	50	2	1				320
1982	3	4	7	10	12	29	14	1					80
1983	10	7	9	5	4	10	5						50

Table 6. Cod. Abundance indices with confidence limits from the bottom trawl survey for each year-class in the different areas in 1983.

AREA	Age (Year-class) 1 (82)	2 (81)	3 (80)	4 (79)	5 (78)	6 (77)	7 (76)	8 (75)	9 (74)	10+ (73+)	TOTAL 2-10+
A	(0.8±0.5)	0.5±0.2	1.5±0.5	10.6±3.8	11.6±3.2	5.2±1.3	1.4±0.5	0.8±0.4	0.2±0.1	+	31.8±10.0
B	(0.5±0.2)	0.1±0.04	0.4±0.2	2.2±1.4	4.7±1.9	3.5±1.1	1.8±0.3	1.1±0.3	0.2±0.04	+	14.0±5.3
C	(1.3±0.8)	0.7±0.3	2.7±2.9	8.6±10.3	6.1±4.0	2.8±1.2	0.8±0.3	0.5±0.3	0.1±0.1	+	22.3±19.4
D	(41.9±14.6)	4.6±1.5	6.2±2.8	7.4±2.8	9.8±5.0	2.8±1.3	0.7±0.2	0.6±0.3	0.1±0.1	+	32.2±13.9
TOTAL AREA	(44.6±14.9)	5.9±1.3	10.8±4.0	28.0±11.4	31.9±7.0	14.3±2.6	4.7±0.9	3.0±0.4	0.6±0.2	+	99.2±27.6

Table 7. Cod. Abundance indices for each year-class from the bottom trawl surveys 1981-1983.

Year of investigation	Year-class 1981	1980	1979	1978	1977	1976	1975	1974	1973	1972+	Total
1981		0.7	11.0	8.6	16.9	34.1	37.9	4.8	1.0	0.3	115.3
1982	0.1	0.9	16.1	20.4	21.4	16.0	15.8	1.4	0.2		92.3
1983	5.9	10.8	28.0	31.9	14.3	4.7	3.0	0.6			99.2

Table 8. Haddock. Abundance indices with confidence limits from the bottom trawl survey for each year-class in the different areas in 1983.

AREA	Age (Year-class) 1 (82)	2 (81)	3 (80)	4 (79)	5 (78)	6 (77)	7 (76)	8+ (75+)	TOTAL 2-8+
A	(61.5±22.4)	0.5±0.1	0.3±0.1	0.4±0.2	0.5±0.4	0.6±0.5	1.6±1.7	0.7±0.7	4.6±3.7
B	(6.9±2.9)	0.2±0.1	0.4±0.2	0.4±0.2	0.4±0.1	0.4±0.1	1.1±0.4	0.5±0.2	3.4±1.3
C	(46.6±19.0)	2.9±4.6	2.1±1.7	1.5±0.6	0.4±0.1	0.3±0.1	0.5±0.2	0.2±0.1	7.9±7.4
D	(199.8±55.1)	2.1±1.3	2.0±1.8	1.6±1.0	0.6±0.5	0.9±1.3	0.7±0.7	0.2±0.4	8.1±7.0
TOTAL AREA	(314.5±62.3)	5.7±4.8	4.1±1.7	3.6±0.9	1.9±0.4	2.3±1.4	3.9±1.7	1.6±0.9	23.1±11.8

Table 9. Haddock. Abundance indices for each year-class from the bottom trawl surveys in 1981-1983.

Year of investigation	Year-class 1981	1980	1979	1978	1977	1976	1975	1974	1973	Total
1981		0.3	4.8	2.3	9.5	2.0	6.1	0.5	0.2	25.7
1982	0.5	0.9	1.8	2.1	2.2	5.5	2.7	0.2		15.9
1983	5.7	4.1	3.6	1.9	2.3	3.9	1.6			23.1

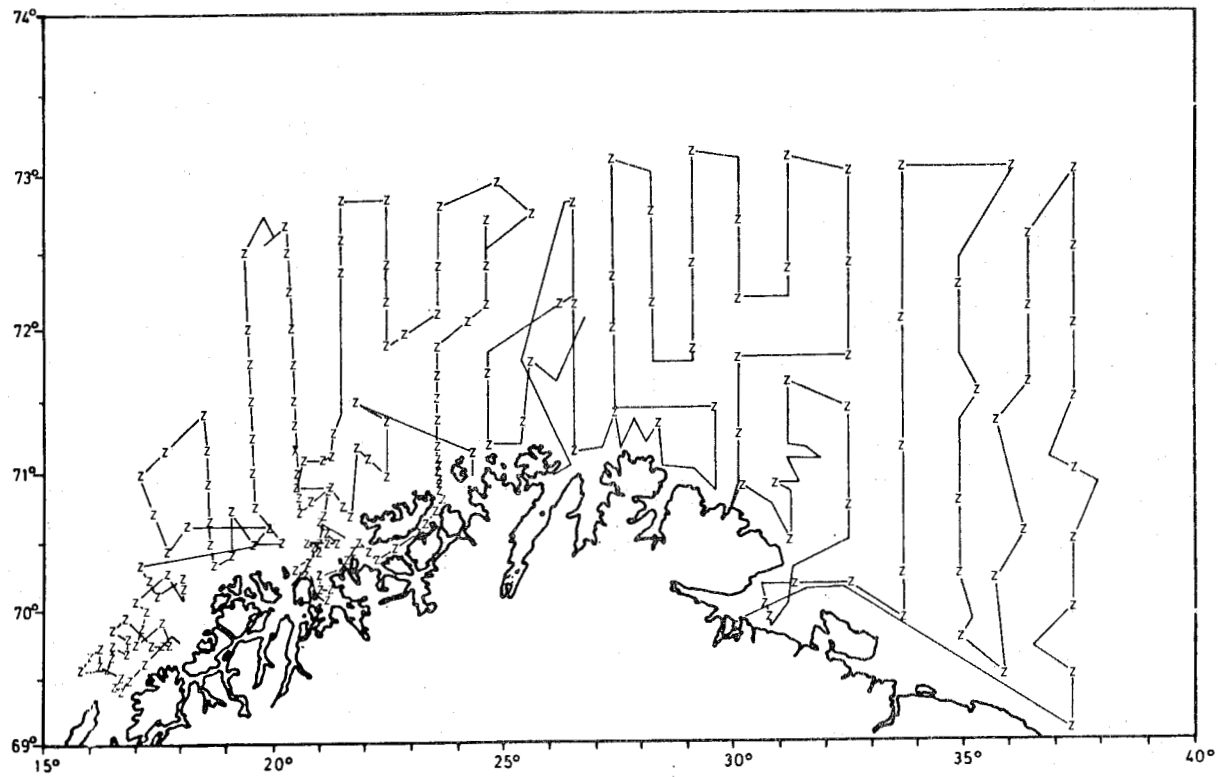

Fig. 1. Survey tracks and hydrographical stations taken by RV "G.O. Sars" 26.1.-5.3.1983.

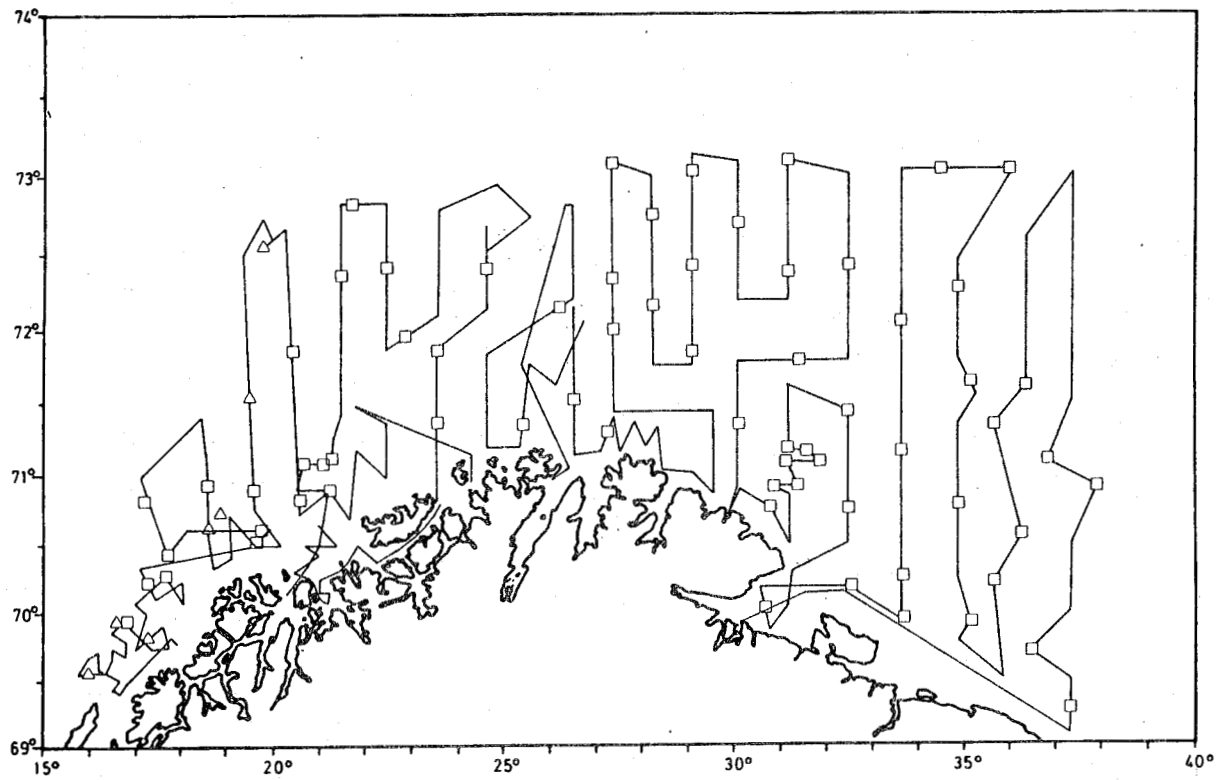

Fig. 2. Survey tracks and trawl stations taken by RV "G.O. Sars" 26.1.-5.3.1983. □ Bottom trawl. Δ Pelagic trawl.

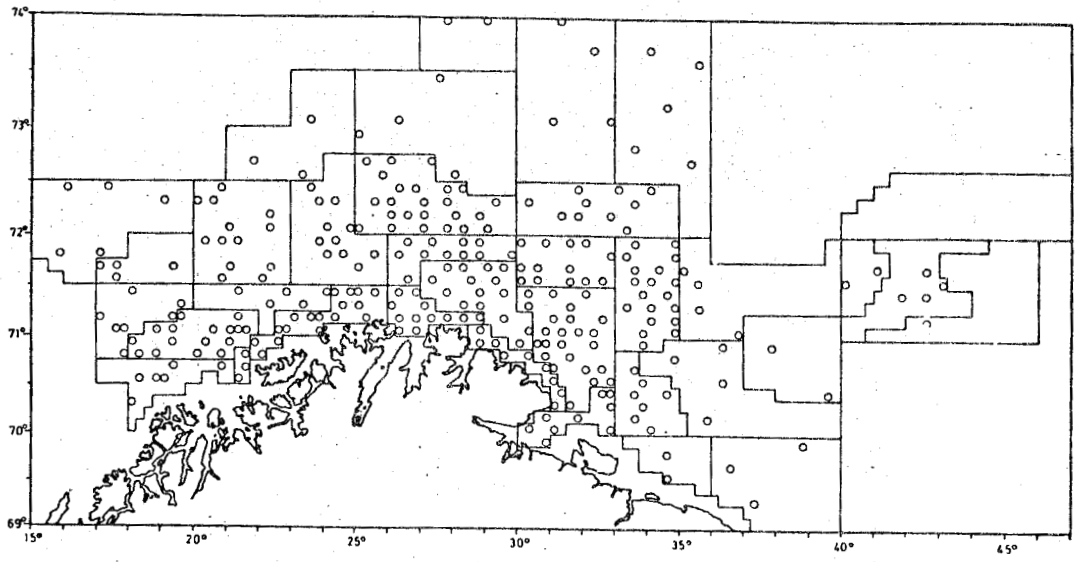

Fig. 3. Bottom trawl station taken by MT "Hagbart Kræmer" and MT "Stallo" 26.1.-26.2.1983, and bottom trawl stations east of 35°E taken by RV "G.O. Sars".

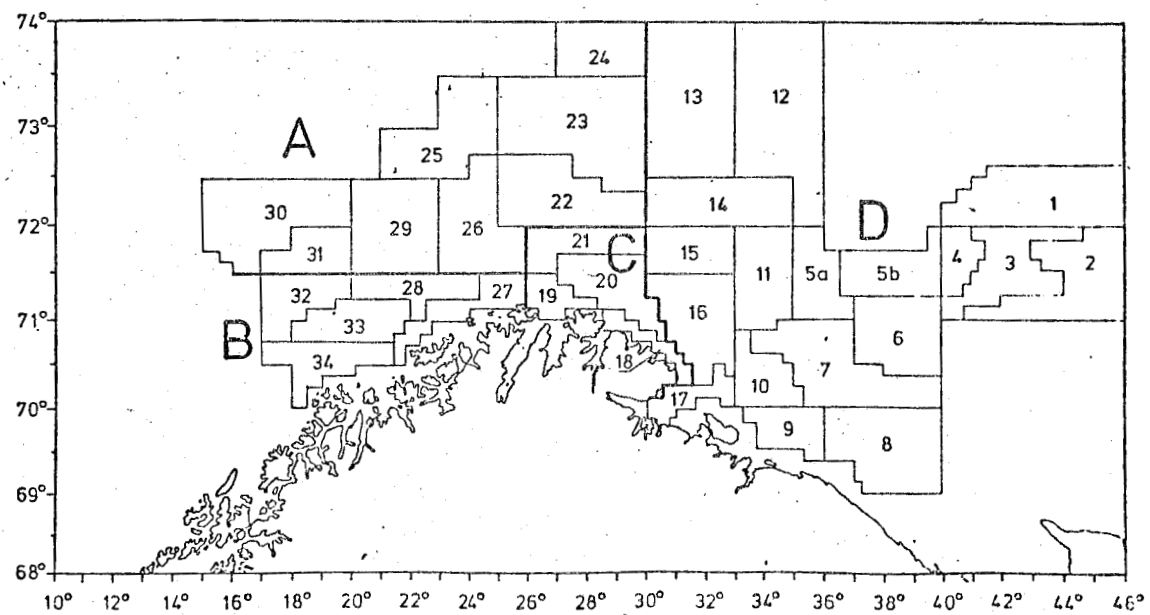

Fig. 4. The surveyed area with subareas (A,B,C,D) and strata used in the bottom trawl survey.

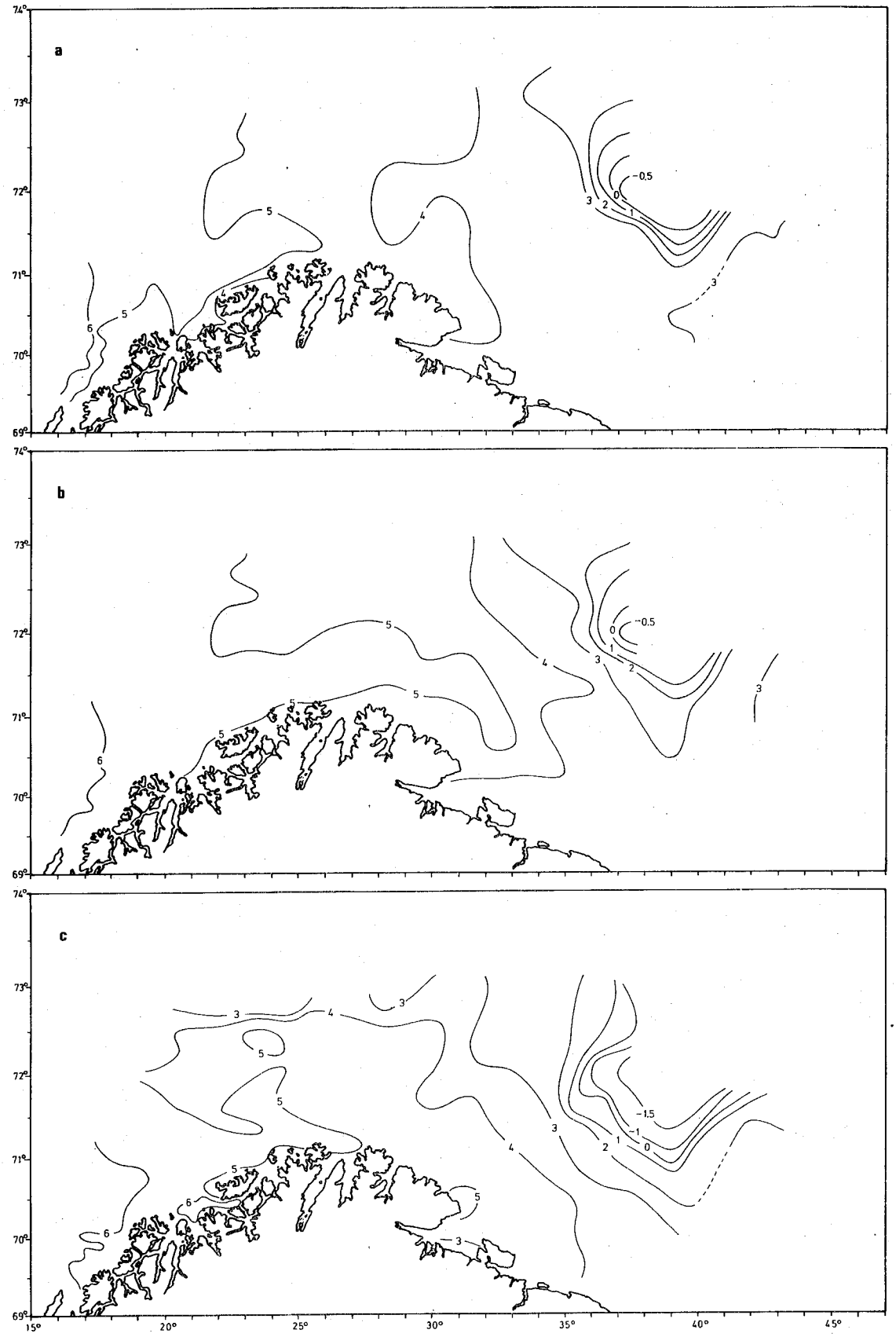

Fig. 5. The temperature distribution A) on the surface, B) 100 m depth and C) at the bottom.

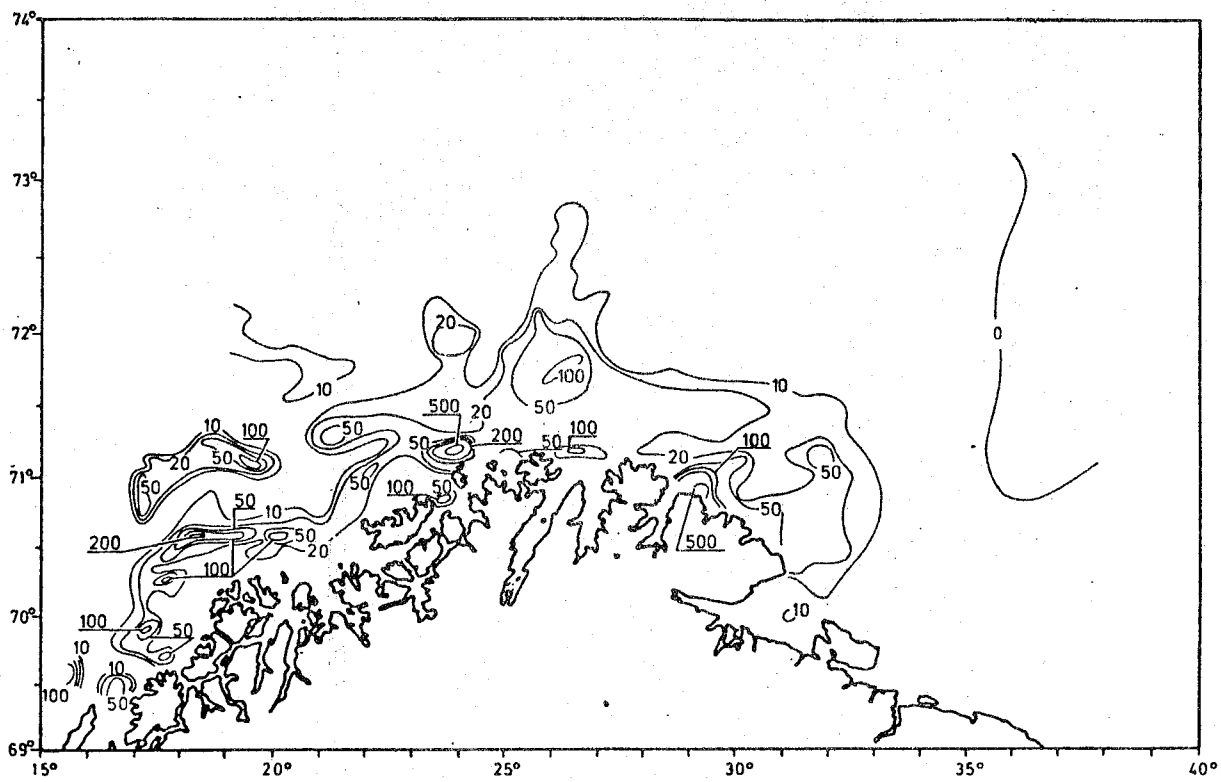

Fig. 6. The distribution of echo abundance (relative values) for cod and haddock, 26.1.-5.3.1983.

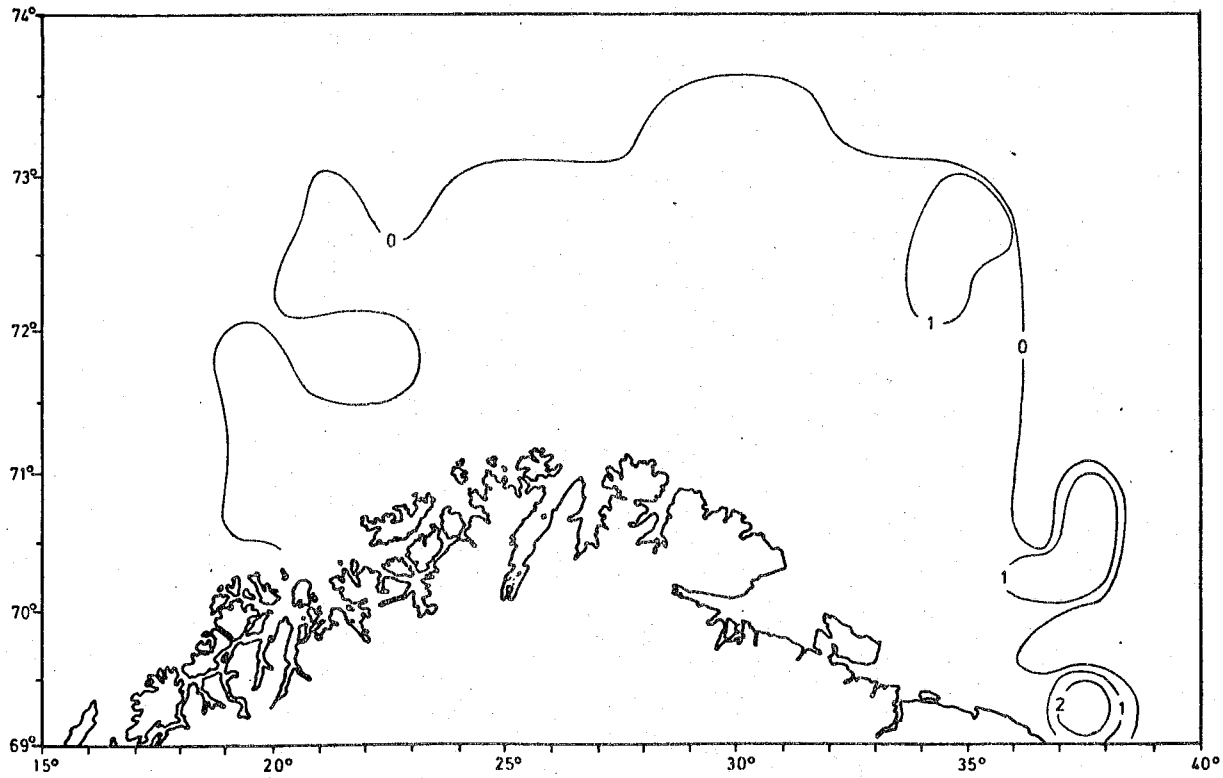

Fig. 7. The distribution of 2 years old cod 26.1.-5.3.1983. (1000 per n.m.^{2}).

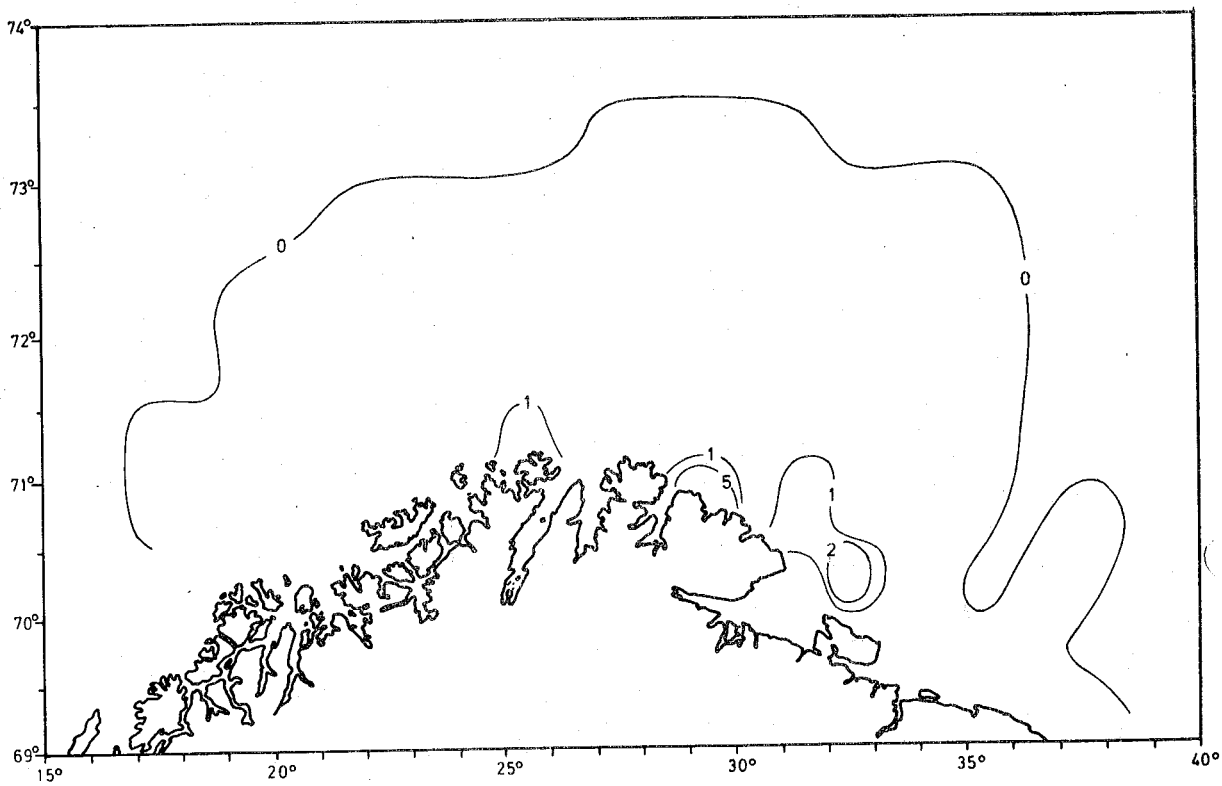

Fig. 8. The distribution of 3 years old cod 26.1.-5.3.1983. (1000 per n.m.^{2}).

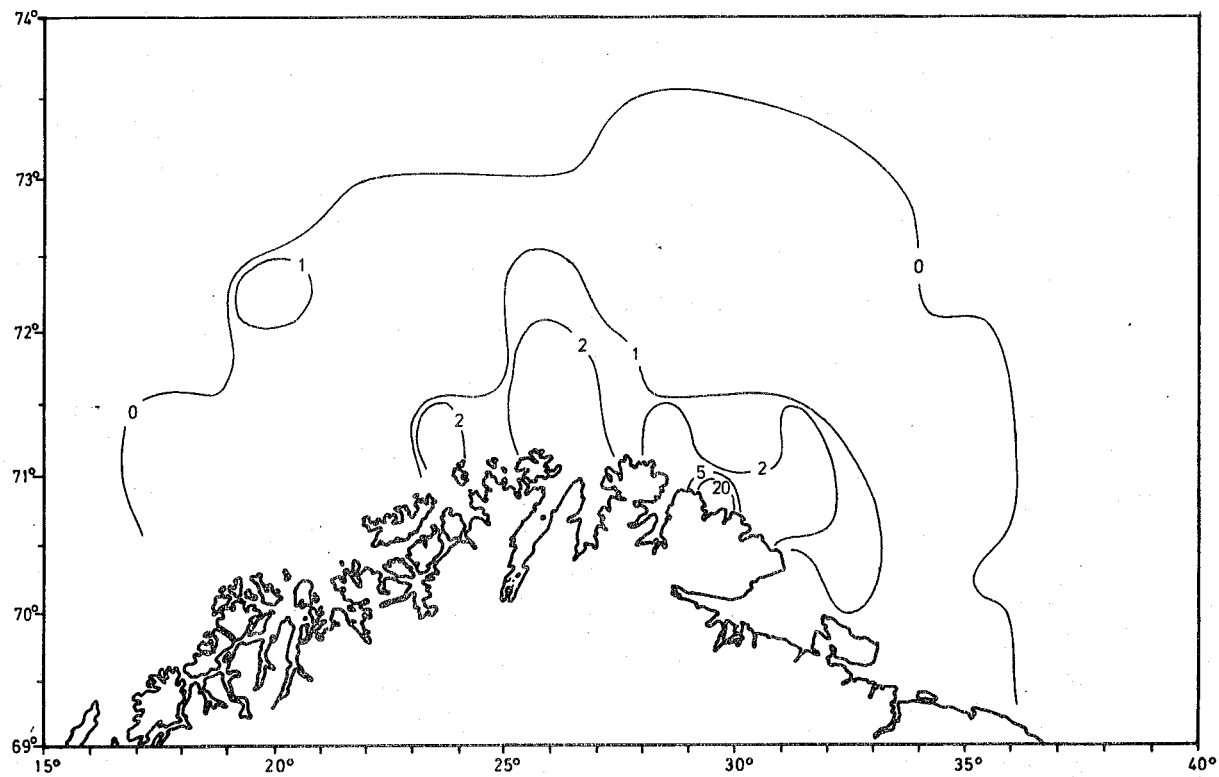

Fig. 9. The distribution of 4 years old cod 26.1.-5.3.1983. (1000 per n.m.^{2}).

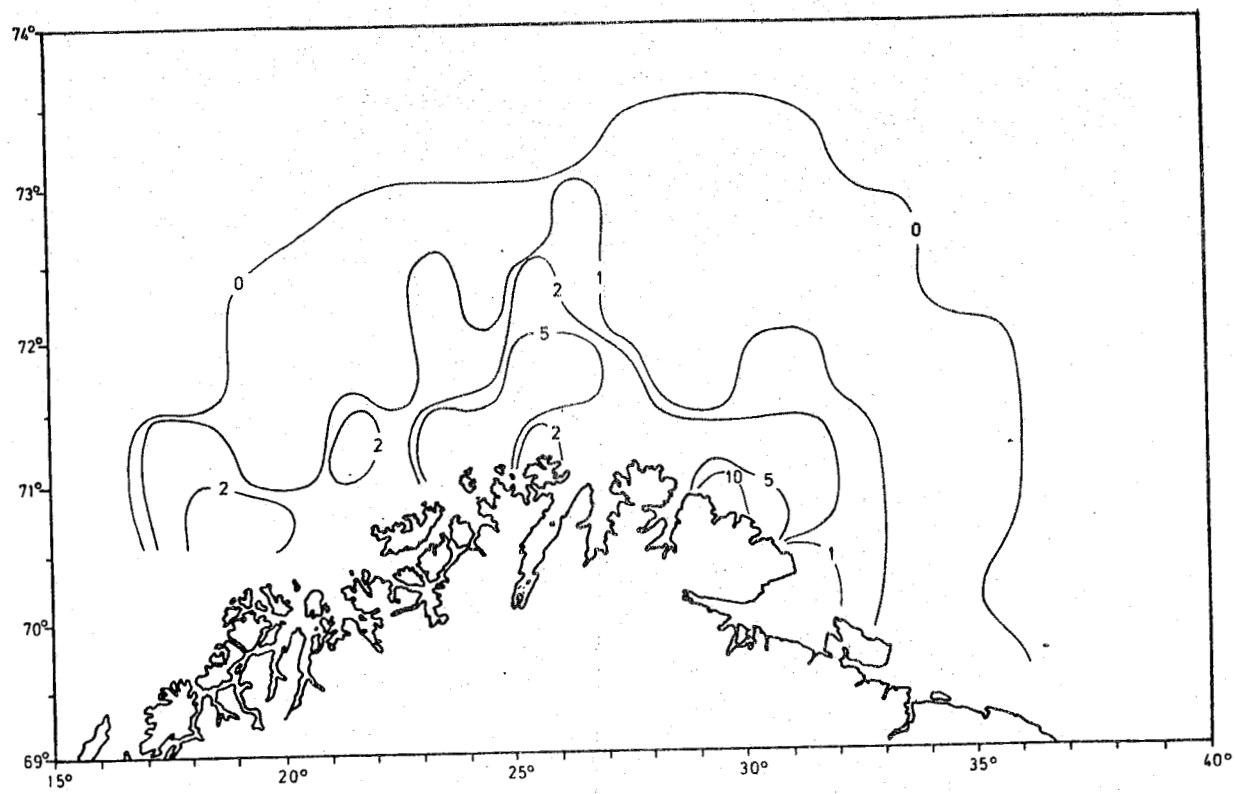

Fig. 10. The distribution of 5 years old cod 26.1.-5.3.1983. (1000 per n.m.^{2}).

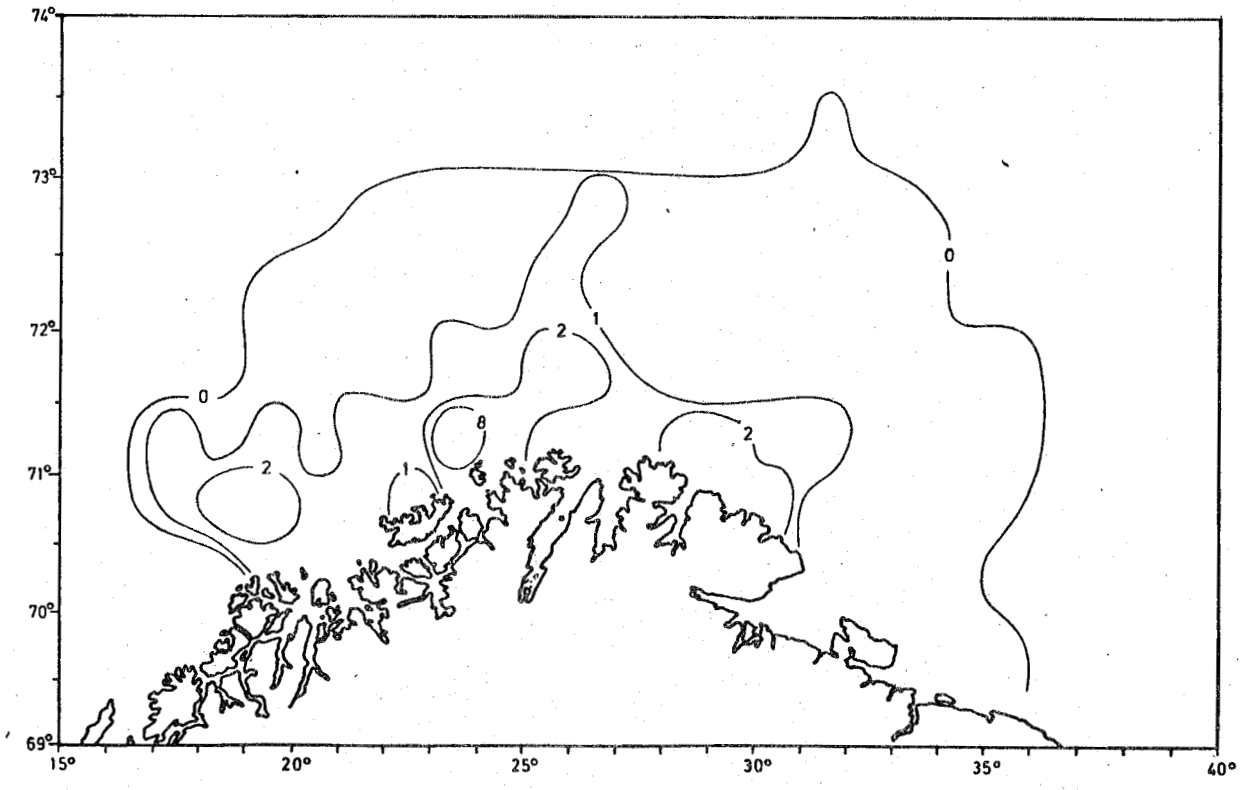

Fig. 11. The distribution of 6 years old cod 26.1.-5.3.1983. (1000 per n.m.^{2}).

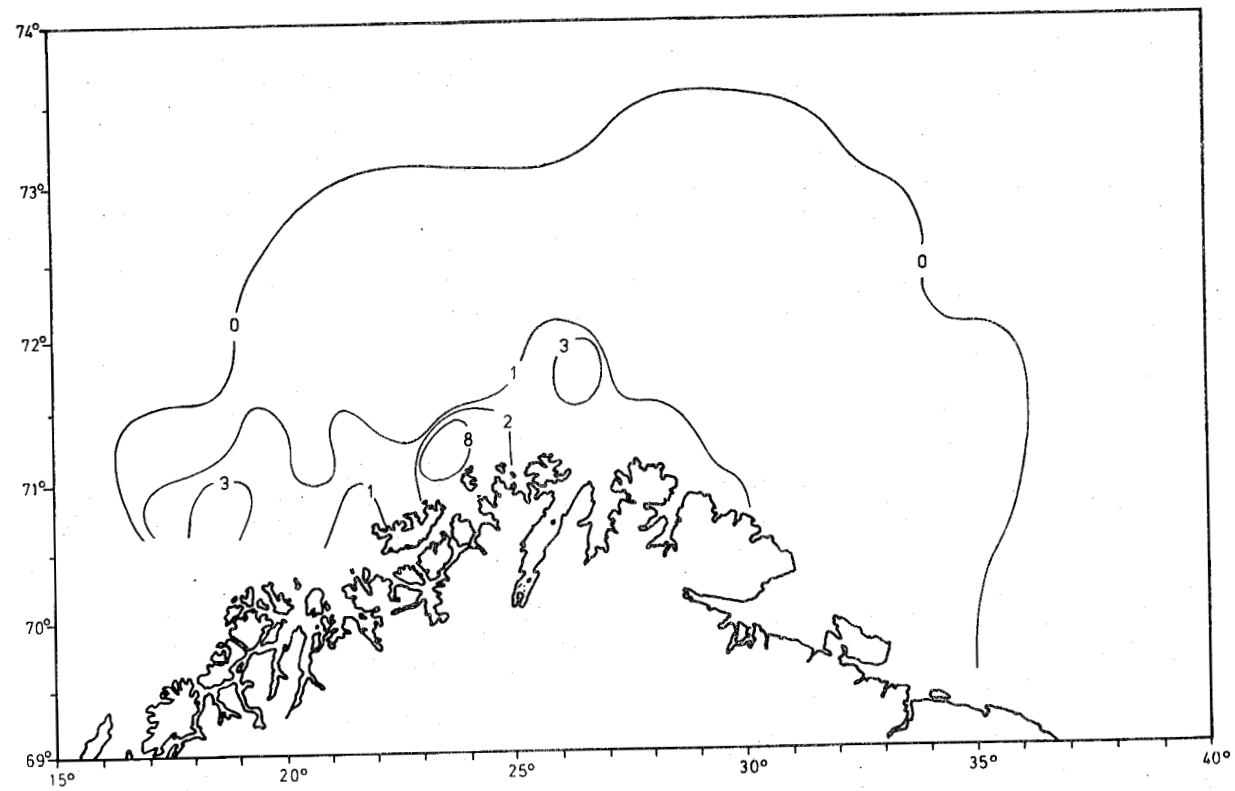

Fig. 12. The distribution of 7 years old and older cod 26.1.-5.3.1983. (1000 per n.m.^{2}).

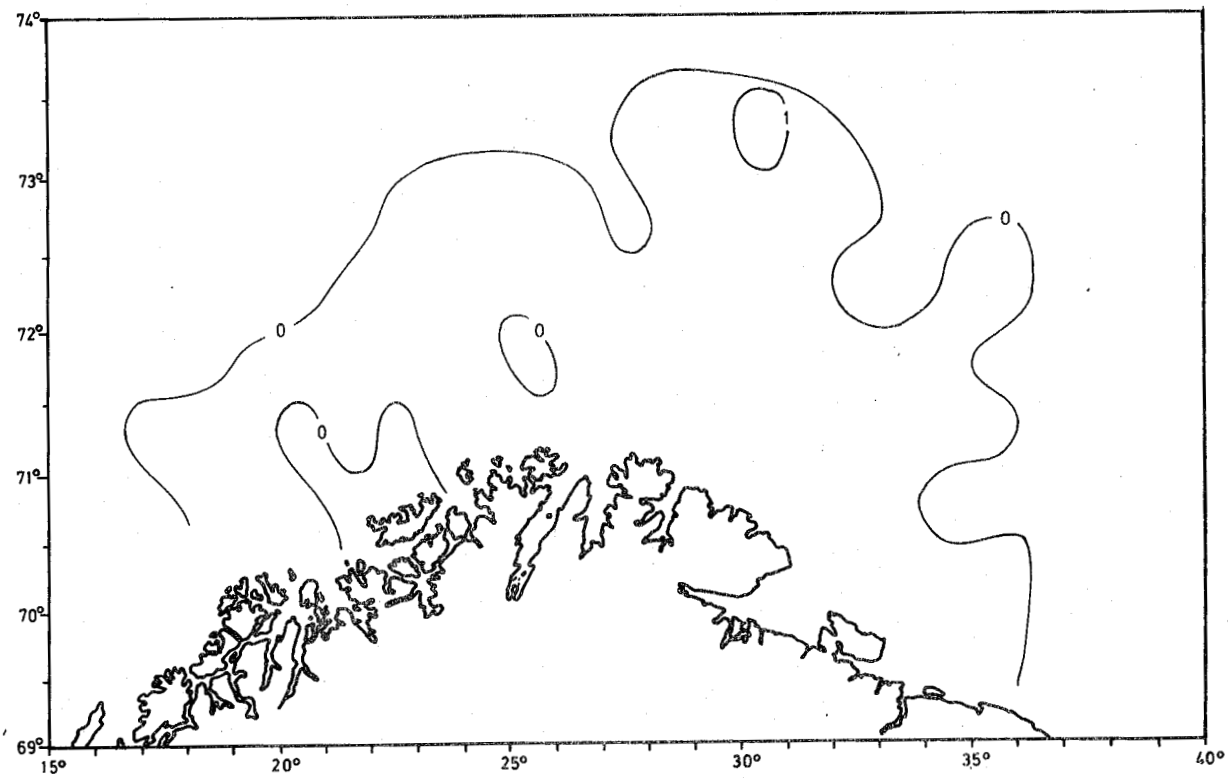

Fig. 13. The distribution of 2 years old haddock 26.1.-5.3.1983. (1000 per n.m.^{2}).

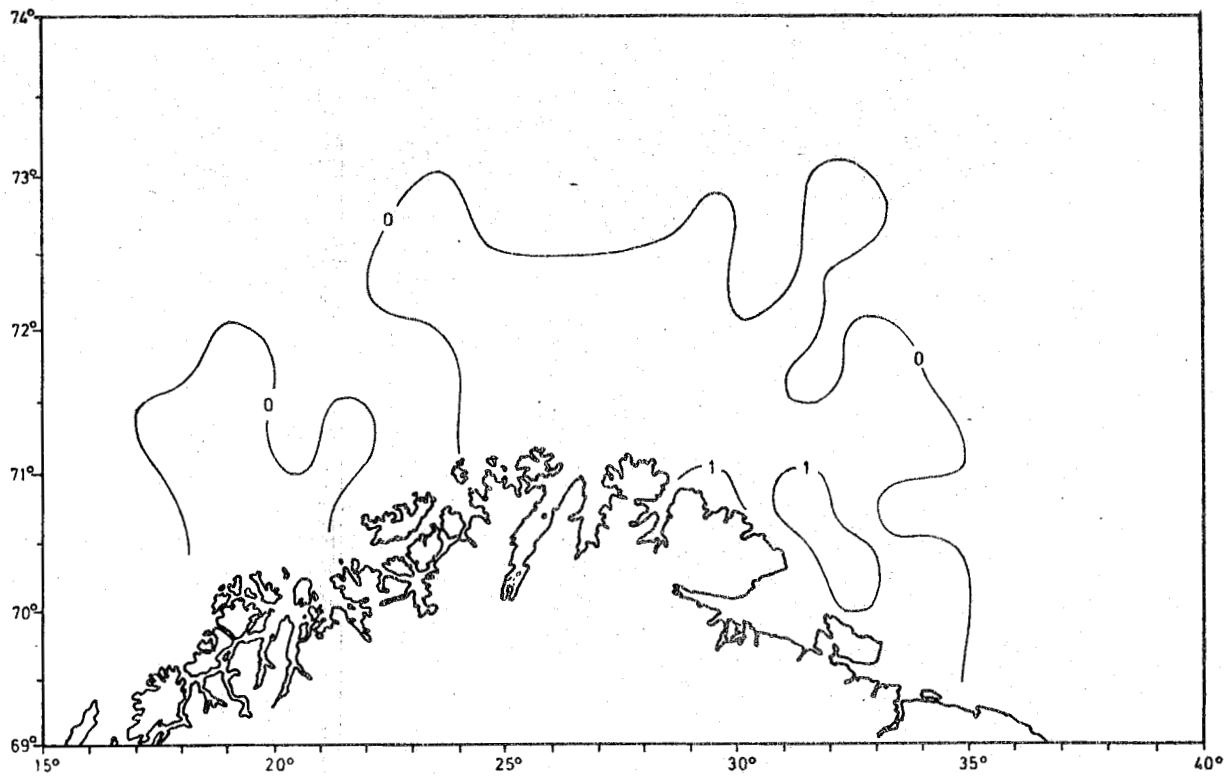

Fig. 14. The distribution of 3 years old haddock 26.1.-5.3.1983. (1000 per n.m.^{2}).

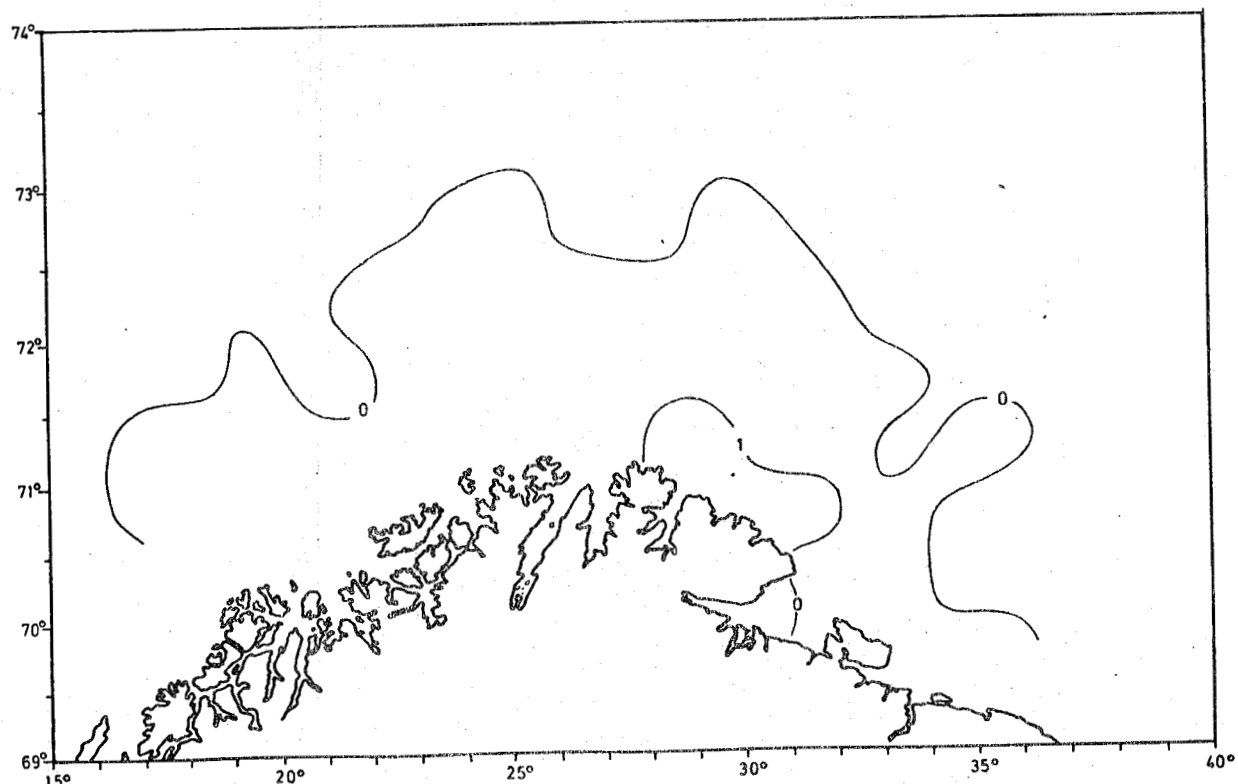

Fig. 15. The distribution of 4 years old haddock 26.1.-5.3.1983. (1000 per n.m.^{2}).

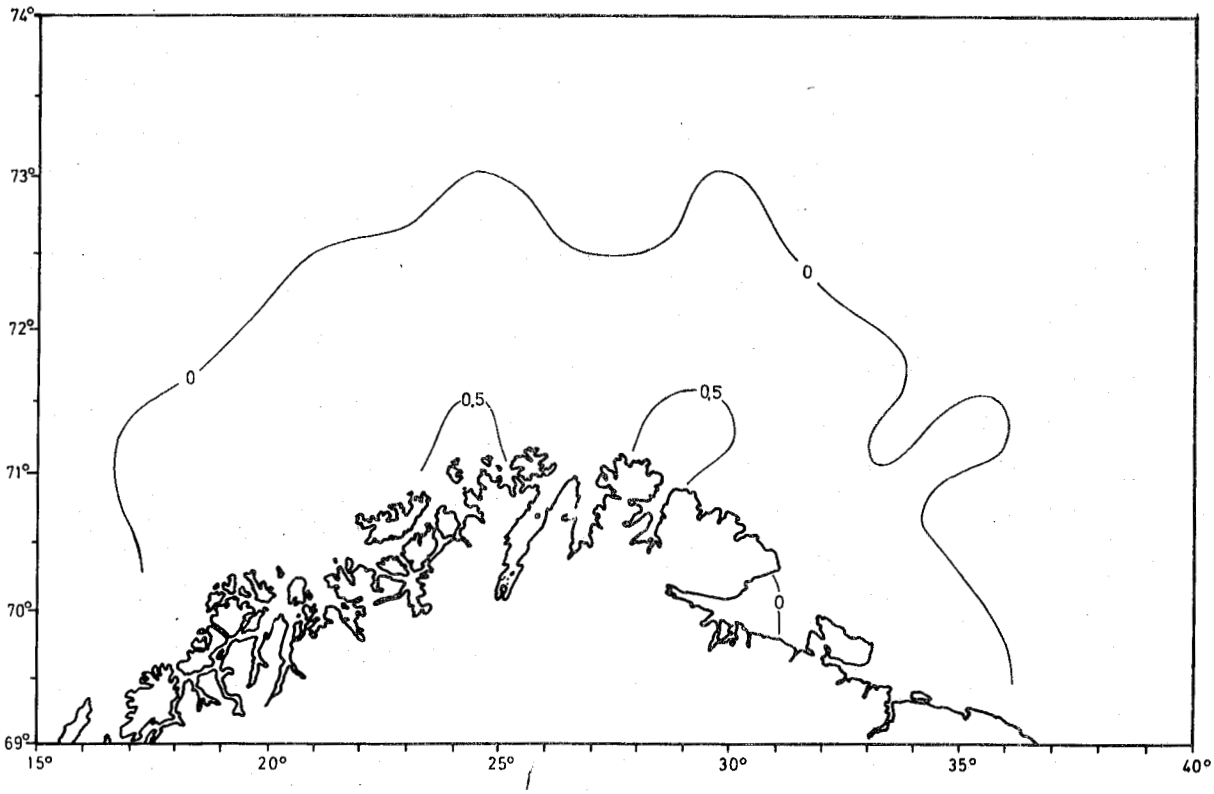

Fig. 16. The distribution of 5 years old haddock 26.1.-5.3.1983. (1000 per n.m.^{2}).

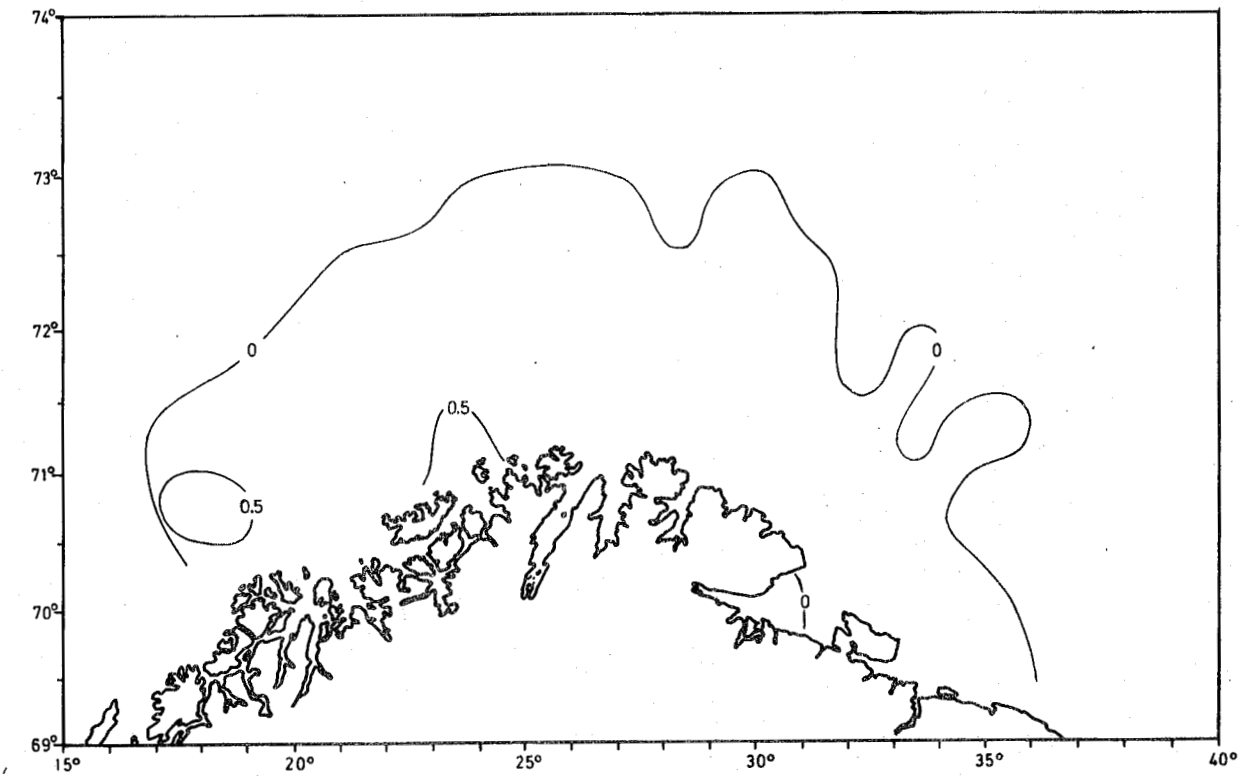

Fig. 17. The distribution of 6 years old haddock 26.1.-5.3.1983. (1000 per n.m.^{2}).

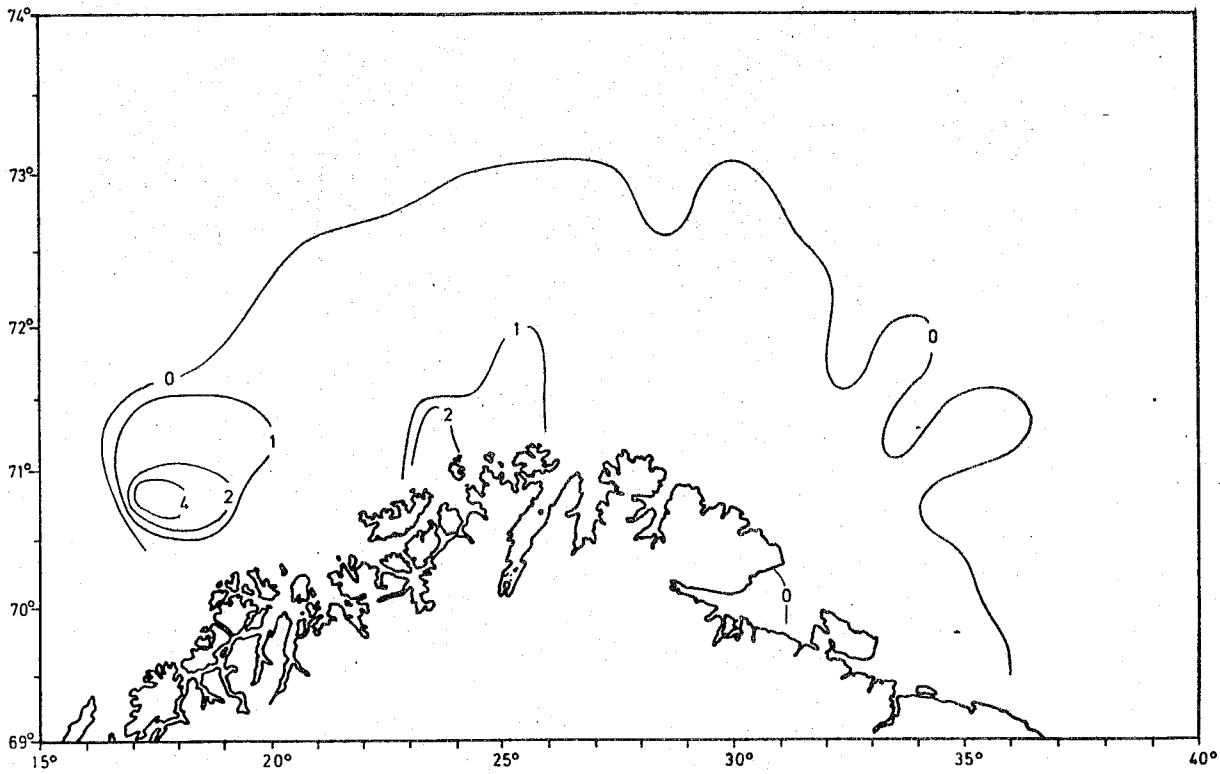

Fig. 18. The distribution of 7 years and older haddock 26.1.-5.3.1983. (1000 per n.m.^{2}).