International Council for the Exploration of the Sea

C.M.1989 / G:42
Demersal Fish Committee

ESTIMATES OF STOCK SIZE OF NORTHEAST ARCTIC COD AND HADDOCK, SEBASTES MENTELLA AND SEBASTES MARINUS FROM SURVEY DATA, WINTER 1989

by

Tore Jakobsen, Sigbjørn Mehl, Odd Nakken
Kjell Nedreaas and Knut Sunnanå

Institute of Marine Research
P.O.Box 1870 - Nordnes
5024 Bergen, Norway

ABSTRACT

The combined acoustic and bottom trawl survey in the Barents Sea in winter has been carried out since 1981. The target species are cod and haddock, but in recent years the redfish species Sebastes marinus and Sebastes mentella have also been included. Since 1982, an acoustic survey for spawning cod in the Lofoten area has been carried out immediately after the Barents Sea survey.

For cod, the acoustic survey gives a total estimate in numbers which is about 10% lower than in 1988, whereas the bottom trawl survey gives a reduction of about 40%. The difference between the surveys probably to some extent reflects a change in the vertical distribution. Poor recruitment is confirmed by both surveys.

A similar difference between the surveys is found for haddock, but the reduction in number is larger, about 30% and 60%, respectively, for the acoustic survey and the bottom trawl survey.

Abundance indices for redfish indicate that the stock situation is stabilizing for Sebastes marinus and Sebastes mentella, although at a low level.

The results of the Lofoten survey indicate that recruitment to the spawning population of cod is improving.

1. INTRODUCTION

Each year since 1975 a Norwegian acoustic survey has been carried out during the winter in the Barents Sea. The aim of the survey has been to estimate the number of cod and haddock by age group in the survey area. In recent years attempts to estimate the number of redfish have also been made, primarily the species Sebastes marinus and Sebastes mentella.

Since 1981 a stratified random bottom trawl survey has been carried out in the same area and at the same time as the acoustic survey. Preliminary results from both surveys are reported by Dalen et al. (1982, 1983, 1984), Hylen et al. (1985, 1986, 1988) and Godø et al. (1987).

After the Barents Sea survey, from 1982 onwards, an acoustic survey on spawning cod has been carried out, mainly in the Lofoten-Vesterålen area (Godø et al. 1982, 1983, 1984, 1985, 1987, Raknes and Sunnanå 1986, Hylen et al. 1988).

The present paper reports on the results of the surveys in the winter 1989.

2. MATERIAL AND METHODS

The Barents Sea surveys in 1989 were carried out in the period 27 January to 26 February, using the two research vessels "G.O.Sars" and "Michael Sars" and the hired commercial trawler "Anny Kræmer". The three vessels were equally equipped for bottom trawling, using a 1600 mesh shrimp trawl with rockhopper gear, the latter for the first time in these surveys. The research vessels were also equipped with midwater trawls.

Figs 3.1 and 3.2 show the survey grid, the 149 hydrographical stations and the 149 trawl stations worked by the research vessels. The trawl stations include 33 taken with midwater trawl. Stations included in the bottom trawl survey were stratified on the areas shown on Fig. 3.3. Of the 203 stations, which are shown on Fig. 3.4., 130 were taken by the trawler. These stations were also included in the final calculations of the acoustic survey together with the additional trawl hauls taken by the two research vessels.

The survey for mature cod on the spawning grounds off northern Norway (mainly the Lofoten-Vesterålen area) was conducted in the period 24 February - 26 March 1989. The area was first covered by R/V "Michael Sars" 24 February - 5 March. R/V "G.O.Sars" covered the area 3-6 March and 19-26 March.

2.1. The Acoustic Surveys

The acoustic surveys were carried out as in 1988, using the method described by Dalen et al. (1982) and Dalen and Smedstad (1979, 1983). The acoustic equipment used was:

"G.O.Sars": Simrad EK 400, 38kHz hull mounted 5^0 x 5.5^0 echosounder and towed echosounder.

"Michael Sars": Simrad EK-S, 38kHz hull mounted echosounder.

Both ships used a digital echo integrator system developed at the

Institute of Marine Research, run on NORD 10 computers (Blindheim et al. 1982). The acoustic systems are calibrated using the method described by Foote et al. (1983).

All the echo integrator systems produce output in units of reflecting surface per square nautical mile (m^2/nm^2). The factor used to convert this to number of cod and haddock per square nautical mile is set to $C = 2.49 \times 10^6 \times L^{2.18}$. This factor equals a target strength $TS = 10 \log (\sigma/4\pi) = 21.8 \log L - 74.9$ where L is the length of the fish and σ is the back scattering surface of a single fish of that length. For redfish the formula $C = 5.2 \times 10^5 \times L^2$ was used, corresponding to $TS = 20 \log L - 67.87$.

2.2. The Bottom Trawl Survey

Fig. 3.3 shows the survey area with the strata used in the bottom trawl survey, and also the division into the four sub-areas for which the bottom trawl indices are given (which are identical to the four sub-areas used in the acoustic survey). The distribution of the 203 bottom trawl stations included in the calculations are shown in Fig. 3.4. The survey design described by Dalen et al. (1982) was used. The trawl used in the bottom trawl surveys is a shrimp trawl (Campelen, 1800 meshes, with rubber bobbins and 35 mm meshes in the codend). The sweep wires are 40 m. The otter boards used are V-doors for the trawler and pelagic doors modified for bottom trawling on the research vessels. The method used to calculate the abundance indices is based on the stratified swept-area considerations described by Dalen et al. (1983) using 25 m as the sweeping-width of the trawl. The introduction of the rockhopper gear which means that relatively more of the small individuals are caught, has been corrected for by relationships based on field experiments. Table 3.1 gives the number of stations in each stratum.

3. THE BARENTS SEA SURVEYS

3.1. Hydrography

Fig. 3.5 shows the temperature distribution in the Barents Sea in the winter 1989 at the surface (A), at 100 m depth (B), and at the bottom (C). In 1989 the temperature in the central survey area had increased somewhat compared to 1988.

3.2. Geographical Distribution of Cod and Haddock

Fig. 3.6 shows the distribution of the total echo abundance of cod and haddock combined in 1989. The geographical distribution was still westerly, but there has been some movement of fish to the northeast.

Fig. 3.7 shows the echo abundance in the 10 m layer above the bottom. The highest values were generally found in the areas with highest total echo abundance and made up the same relatively high proportion of the total as in 1988. This is also seen in Table 3.2 which shows the echo abundance of cod/haddock 1981-1989, total and in the bottom layer, and the percentage found near the bottom.

Fig. 3.8 shows the distribution of the echo abundance of cod alone (note that this plot is cruder and on a different scale than the combined cod/haddock plot). The haddock (Fig. 3.9) as usual had a more easterly distribution than the cod.

3.3. Acoustic Abundance Estimates of Cod and Haddock

Table 3.3 shows the acoustic abundance estimates of cod in 1989 by age and sub-area. About one third of the fish are found in each of the offshore sub-areas A (northwest) and D (northeast).

Table 3.4 shows the full time series 1977-1989 of acoustic abundance estimates of cod by age group. The total number in 1989 was 89% of the 1988 estimate. The recruiting year classes appear to be poor.

The acoustic abundance estimates by age and sub-area for haddock are given in Table 3.5. The highest proportion (41%) was found in sub-area D. Compared to 1988 there had been a substantial reduction in sub-area A, both in relative and absolute terms.

The time series (Table 3.6) shows a reduction in total number, the 1989 estimate being 76% of the 1988 estimate. Also for haddock the recruitment appears to be poor.

3.4. Bottom Trawl Survey Indices of Cod and Haddock

Table 3.7 gives abundance indices from the bottom trawl survey for each age group of cod by sub-area. The distribution was similar to the one shown by the acoustic estimates.

Indices, total and by age group, for the full time series 1981-1989 are given in Table 3.8. The total index in 1989 was reduced by 47% from 1988, which is much more than in the acoustic survey.

The area distribution of haddock in the bottom trawl survey (Table 3.9) showed relatively more fish in sub-area D than the distribution from the acoustic survey.

As for cod, the bottom trawl survey shows a much higher reduction of total indices of haddock than the acoustic survey (Table 3.10), and the 1989 index was only 40% of the 1988 estimate.

3.5. Acoustic Abundance Estimates of Redfish

Although the estimates are given as numbers of fish, they should be regarded as indices only. The surveyed area has been enlarged since 1986, and in order to make the numbers from different years comparable, the numbers presented for 1988 and 1989 are the results from exactly the same area as surveyed in 1987. Fig. 3.10 shows the combined distribution of Sebastes marinus, S.mentella and S.viviparus in 1989. As in previous years there is no acoustic registration of redfish east of 36^0-37^0E in winter-time. As in 1987 we observe concentrations of redfish in the northeastern part of the investigated area. This is early I-group redfish of 5-7 cm. The concentrations observed in the western part in 1988 are only to a much smaller extent observed in 1989.

Reliable comparable results for redfish from these investigations only excist back to 1987, so the time series are too short to tell whether the observed numbers are at a historical low or high level. Compared to the results for 1988 the estimates for S.marinus in 1989 increased for nearly all length groups (Table 3.11). The relatively high number in 1987 may be an artifact caused by wrong species identification of fish less than 25 cm, since fish from the strong 1982 yearclass of S.mentella were between 15 and 20 cm at that time. The size of

specimens from this strong 1982 yearclass were 20-25 cm in winter 1989. Generally, the estimates for S.mentella show a stabilizing trend (Table 3.12). The increase in numbers of specimens less than 15 cm is promising. The acoustic abundance estimates for S.viviparus show a decrease in numbers (Table 3.13).

3.6. Bottom Trawl Survey Indices of Redfish

During the winter survey in 1989 a new "rockhopper" gear was used on the bottom trawl. For cod and haddock a conversion factor has been found so that the results from using the more efficient "rockhopper" gear have been converted to "standard" gear results, making the results from different years comparable. Similar conversion factors are at the moment not available for the redfish species, and the results for 1989 can therefore not be directly compared with previous years.

Sebastes marinus. The total abundance indices show an increase in numbers from 1988 to 1989 (Table 3.14), which is mainly caused by a huge increase of fish less than 10 cm. However, there is some evidence that the time of occurrence of redfish of this size group near the bottom varies from year to year, and the bottom trawl indices are therefore not very reliable for the smallest individuals. Variable vertical migration may also influence estimates based on pure bottom trawling. For the other length groups it is difficult to tell whether the observed changes, compared to previous years, are caused by the new "rockhopper" gear or are the result of real changes in the stock.

Sebastes mentella. Also in 1989 we observed a great number of 5-9 cm fish (Table 3.15). We also notice a great variation from year to year in the number of fish bigger than 30 cm. A reason which immediately suggests itself is horizontal and vertical migration. We do not observe similar huge variation from year to year in the acoustic survey.

Sebastes viviparus. The total abundance index decreased from 1988 to 1989 (Table 3.16), but it is within the range observed in the period 1985-1988. Since the investigations cover only the northernmost part of the area where S.viviparus live, migration may influence the indices.

4. THE LOFOTEN-VESTERÅLEN SURVEY

Because priority was given to other tasks, the analysis of the Lofoten survey results has been delayed and the final results are yet not available. The distributions of cod/haddock during the two periods of acoustic coverage are shown in Figs 4.1 and 4.2.

The acoustic estimate of cod abundance was 24 million fish, compared to 16.5 million in 1988. For haddock there was a reduction from 23 million to 13 million fish.

REFERENCES

Blindheim, J., Eide, P. K., Knudsen, H. P. and Vestnes, G. 1982. A shipborne data logging and processing system for acoustic fish surveys. Fish. Res., 1 : 141-153.

Dalen, J., Hylen, A., Jakobsen, T., Nakken, O. and Randa, K. 1984. Preliminary report of the Norwegian investigations on young cod and haddock in the Barents Sea during the winter 1983.

Coun. Meet. int. Coun. Explor. Sea, 1984 (G:44) : 1-24.

Dalen, J., Hylen, A., Nakken, O., Randa, K. and Smedstad, O. M. 1982. Norwegian investigations on young cod and haddock in the Barents Sea during the winter 1982. Coun. Meet. int. Coun. Explor. Sea, 1982 (G:4) : 1-32.

Dalen, J., Hylen, A., Nakken, O., Randa, K. and Smedstad, O. M. 1983. Preliminary report of the Norwegian investigations on young cod and haddock in the Barents Sea during the winter 1983. Coun. Meet. int. Coun. Explor. Sea, 1983 (G:15) : 1-23.

Dalen, J. and Smedstad, O. M. 1979. Acoustic method for estimating absolute abundance of young cod and haddock in the Barents Sea. Coun. Meet. int. Coun. Explor. Sea, 1979 (G:51) : 1-24.

Dalen, J. and Smedstad, O. M. 1983. Abundance estimation of demersal fish in the Barents Sea by an extended acoustic method. In: Nakken, O. and Venema, S. C., eds. Symposium on fisheries acoustics. Bergen, Norway, 21-24 June 1982. FAO Fish. Rep., 300 : 232-239.

Foote, K. G., Knudsen, H. P. and Vestnes, G. 1983. Standard calibration of echo sounders and echo integrators with optimal copper spheres. FiskDir Skr. Ser. HavUnders., 17 : 335-346.

Godø, O. R., Nakken, O., Raknes, A. and Sunnanå, K. 1982. Acoustic estimates of spawning cod off Lofoten and Møre in 1982. Coun. Meet. int. Coun. Explor. Sea, 1982 (G:62) : 1-16.

Godø, O. R., Nakken, O., Raknes, A. and Sunnanå, K. 1983. Acoustic estimates of spawning cod off Lofoten and Møre in 1983. Coun. Meet. int. Coun. Explor. Sea, 1983 (G:37) : 1-24.

Godø, O.R., Nakken, O., Raknes, A. and Sunnanå, K. 1984. Acoustic estimates of spawning cod off Lofoten and Møre in 1984. Coun. Meet. int. Coun. Explor. Sea, 1984 (G:47) : 1-24.

Godø, O.R., Nakken, O., Raknes, A. and Sunnanå, K. 1985. Acoustic estimates of spawning cod off Lofoten and Møre in 1985. Coun. Meet. int. Coun. Explor. Sea, 1985 (G:66) : 1-14. (G:66) : 1-14.

Godø, O. R., Hylen, A., Jacobsen, J. A., Jakobsen, T., Mehl, S., Nedreaas, K. and Sunnanå, K. 1987. Estimates of stock size of Northeast Arctic Cod and Haddock from survey data 1986/1987. Coun. Meet. int. Coun. Explor. Sea, 1987 (G:37): 1-48.

Hylen, A., Jakobsen, T., Nakken, O. and Sunnanå, K. 1985. Preliminary report of the Norwegian investigations on young cod and young cod and haddock in the Barents Sea during the winter 1983. Coun. Meet. int. Coun. Explor. Sea, 1985 (G:68):1-28.

Hylen, A., Jakobsen, T., Nakken, O., Nedreaas, K. and Sunnanå, K. 1986. Preliminary report of the Norwegian investigations on young cod and haddock in the Barents Sea. Coun. Meet. int. Coun. Explor. Sea, 1986 (G:76) : 1-25.

Hylen, A., Jacobsen, J.A., Jakobsen, T., Mehl, S., Nedreaas, K. and Sunnanå, K. 1988. Estimates of stock size of Northeast Arctic cod and haddock, Sebastes mentella and Sebastes marinus from survey data, winter 1988. Coun. Meet. int. Coun. Explor. Sea, 1986 (G:43) : 1-29.

Raknes, A. and Sunnanå, K. 1986. Acoustic estimates of spawning cod off Lofoten in 1986. Coun. Meet. int. Coun. Explor. Sea, 1986 (G:79): 1-9.

Table 3.1. Trawl hauls taken in the bottom trawl survey 1989.

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

Table 3.2. Cod/Haddock. Total echo abundance and echo abundance in the 10 m layer above the bottom 1981-1989. (m^2 reflecting surface x 10^{-3}).

Echo Abundance	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989
Total	2097	686	597	2284	5187	5990	2676	1696	914
Bottom	799	311	169	604	736	820	608	579	308
Ratio bottom/total	.38	.45	.28	.26	.14	.14	.23	.34	.34

Table 3.3. Cod. Acoustic abundance estimates for each age group/year class in the surveyed areas in 1989. (Numbers in millions).

Area	Age (Year class) 1 (88)	2 (87)	3 (86)	4 (85)	5 (84)	6 (83)	7 (82)	8 (81)	9 (80)	10+ (79+)	Total
A	+	3	8	25	21	52	7	2	+	+	119
B	+	+	+	3	4	40	8	+	+	+	57
C	+	2	5	9	8	27	3	+	+	+	55
D	2	4	18	40	23	25	3	+	+	+	115
Total	3	9	31	77	56	145	21	3	+	+	346
%	0.8	2.5	8.9	22.4	16.3	41.9	6.0	1.0	0.2	0.1	100.0

Table 3.4. Cod. Estimates of year class abundance from acoustic surveys in the period 1977-1989. (Numbers in millions).

Year of investigation	Year class 1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973+	Total
1977													45	882	104	565	1596
1978												28	235	797	153	229	1442
1979											16	14	109	502	77	65	783
1980										Malfunction of the acoustic instruments							
1981									3	73	58	124	243	270	41	15	827
1982								1	4	71	86	93	73	74	5	1	408
1983								15	17	45	65	38	17	10	2	1	210
1984						2382	506	174	80	63	46	16	1	+	+		3269
1985					69	878	550	510	109	48	20	2	1	1			2187
1986				625	578	1246	424	225	27	8	1	+	+				3136
1987			1	47	126	506	128	37	4	2	1						852
1988		1	23	79	74	179	26	6	+	+							389
1989	3	9	31	77	56	145	21	3	+	+							

Table 3.5. Haddock. Acoustic abundance estimates for each age group/year class in the surveyed areas in 1989. (Numbers in millions).

Area	Age (Year class) 1 (88)	2 (87)	3 (86)	4 (85)	5 (84)	6 (83)	7 (82)	8+ (81+)	Total
A	5	+	2	3	7	12	1	0	32
B	9	5	6	2	8	21	2	0	52
C	3	+	5	6	11	17	+	0	42
D	4	2	7	23	35	15	1	0	87
Total	20	8	19	34	61	64	6	0	213
%	9.6	3.5	9.1	16.0	28.8	30.3	2.6	0.0	100.0

Table 3.6. Haddock. Estimates of year class abundance from acoustic surveys in the period 1977-1989. (Numbers in millions).

Year of investigation	Year class 1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975	1974	1973+	Total
1977													267	755	198	79	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
1984						2148	1002	53	15	7	2	2	2				3231
1985					1034	1972	1187	33	2	1	1	1	1	1			4233
1986				346	502	1720	751	2	1	1	+	+	+				3323
1987			37	29	175	640	166	+	+	+		+					1049
1988		8	7	20	70	150	23	+			+						279
1989	20	8	19	34	61	64	6			+							213

Table 3.7. Cod. Abundance indices from the bottom trawl survey for each age group/year class in the different areas in 1989.

Area	Age (Year class) 1 (88)	2 (87)	3 (86)	4 (85)	5 (84)	6 (83)	7 (82)	8 (81)	9 (80)	10+ (79+)	Total
A	+	0.8	2.0	9.1	10.3	34.2	4.0	0.3	+	+	60.7
B	+	0.2	0.3	1.1	1.3	11.0	1.9	0.1	0.1	+	16.0
C	0.1	0.7	3.1	3.4	2.7	11.6	1.1	0.2	+	+	22.8
D	0.9	2.5	12.5	25.1	10.3	9.9	1.1	0.1	+	+	62.5
Total	1.1	4.1	17.9	38.7	24.5	66.7	8.1	0.6	0.1	+	161.9
%	0.7	2.5	11.1	23.9	15.1	41.2	5.0	0.4	0.1	0.0	100.0

Table 3.8. Cod. Abundance indices for each year class from the bottom trawl surveys 1981-1989.

Year of invest.	Year class 1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975+	Total
1981									0.7	11.0	8.6	16.9	34.1	44.0	115.3
1982								0.1	0.9	16.1	20.4	21.4	16.0	17.4	92.3
1983							44.6	5.9	10.8	28.0	31.9	14.3	4.7	3.6	143.8
1984						355.3	126.6	60.2	19.2	15.6	9.4	3.0	0.4	0.2	589.6
1985					7.3	168.9	90.3	78.1	15.7	6.3	2.5	0.2	+	0.1	369.4
1986				82.5	93.0	356.0	119.0	62.6	8.3	2.1	0.3	0.1	0.1		724.0
1987			4.5	89.3	95.8	229.0	42.0	11.4	1.3	0.4	+	+			437.7
1988		0.7	17.7	69.5	52.8	143.0	17.9	3.6	0.6	0.1					305.9
1989	1.1	4.1	17.9	38.7	24.5	66.7	8.1	0.6	0.1						161.9

Table 3.9. Haddock. Abundance indices from the bottom trawl survey for each age group/year class in the different areas in 1989.

Area	Age (Year class) 1 (88)	2 (87)	3 (86)	4 (85)	5 (84)	6 (83)	7 (82)	8+ (81+)	Total
A	4.2	0.5	1.0	1.7	5.5	10.7	1.4	-	24.9
B	2.4	1.4	1.6	0.6	2.7	6.8	0.6	-	16.0
C	0.8	0.1	1.5	1.7	3.3	5.9	0.5	-	14.0
D	2.1	1.0	4.0	13.0	21.2	9.3	0.8	-	51.5
Total	9.5	3.1	8.1	17.0	32.7	32.8	3.2	-	106.4
%	8.9	2.9	7.6	16.0	30.7	30.8	3.0	0.0	100.0

Table 3.10. Haddock. Abundance indices for each year class from the bottom trawl surveys 1981-1989.

Year of invest.	Year class 1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978	1977	1976	1975+	Total
1981									0.3	4.8	2.3	9.5	2.0	6.8	25.7
1982								0.5	0.9	1.8	2.1	2.2	5.5	2.9	15.9
1983							314.5	5.7	4.1	3.6	1.9	2.3	3.9	1.6	379.0
1984						663.2	355.8	15.2	1.6	0.7	0.2	0.3	0.4		1037.4
1985					167.8	616.2	380.2	7.2	0.4	0.2	0.3	0.3			1172.6
1986				77.9	135.0	314.0	123.0	0.4	0.1	0.1	0.2				651.5
1987			15.2	31.9	149.3	312.8	62.0	0.1	0.2	+					571.5
1988		5.0	8.3	23.9	72.5	134.1	19.0	0.2							263.0
1989	9.5	3.1	8.1	17.0	32.7	32.8	3.2								106.4

Table 3.11. Sebastes marinus. Acoustic abundance estimates for each length-group in the Barents Sea in winter 1987-1989 (numbers in millions). Only the area surveyed in 1987 has been included in the estimate for 1988 and 1989.

Area and year	Length-groups 5- 9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45+	TOTAL
1987	6	9	26	14	9	4	3	3	6	84
1988	1	2	2	5	5	4	2	2	4	30
1989	1	6	4	7	9	6	4	2	2	45

Table 3.12. Sebastes mentella. Acoustic abundance estimates for each length-group in the Barents Sea in winter 1987-1989 including unidentified Sebastes spp. (numbers in millions). Only the area surveyed in 1987 has been included in the estimate for 1988 and 1989.

Area and year	Length-groups 5- 9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45+	TOTAL
1987	138	26	236	94	43	13	6	3	+	563
1988	256	15	80	101	35	20	14	2	+	528
1989	888	40	13	124	51	16	15	2	+	1154

Table 3.13. Sebastes viviparus. Acoustic abundance estimates for each length-group in the Barents Sea in winter 1987-1989 (numbers in millions). Only the area surveyed in 1987 has been included in the estimate for 1988 and 1989.

Area and year	Length-groups 5- 9	10-14	15-19	20-24	25-29	30+	TOTAL
1987	+	+	+	5	1	+	7
1988	2	8	8	7	1	+	28
1989	2	3	5	5	1	0	19

Table 3.14. Sebastes marinus. Abundance indices from the bottom trawl survey for each length group in the Barents Sea in winter 1985-1989. Numbers in millions.

Year of investig.	Length group 5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45+	TOTAL
1985	6.4	169.9	52.4	81.9	69.4	52.8	68.8	13.9	5.3	521
1986	3.0	11.7	26.4	34.3	17.7	21.0	12.8	4.4	2.6	134
1987	7.7	12.7	32.8	7.7	6.4	3.4	3.8	3.8	4.2	83
1988	1.0	5.6	5.5	14.2	12.6	7.3	5.2	4.1	3.7	59
1989	48.7	4.9	4.3	11.8	15.9	12.2	6.6	4.8	3.0	114

Table 3.15. Sebastes mentella. Abundance indices from the bottom trawl survey for each length group in the Barents Sea in winter 1985-1989, incl. unidentified Sebastes spp. (mainly in the length groups 5-9 and 10-14 cm). Numbers in millions.

Year of investig.	Length group 5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45+	TOTAL
1985	55.5	380.5	42.3	70.1	39.1	18.1	7.9	2.3	0.6	622
1986	81.3	151.9	205.4	87.7	169.2	129.8	87.5	23.6	13.8	951
1987	71.8	25.1	227.4	56.1	34.6	11.4	5.3	1.1	0.1	433
1988	587.0	25.2	132.6	182.1	39.6	50.1	47.9	3.6	0.1	1070
1989	622.9	55.0	28.4	177.1	58.0	9.4	8.0	1.9	0.3	962

Table 3.16. Sebastes viviparus. Abundance indices from the bottom trawl survey for each length group in the Barents Sea in winter 1985-1989. Numbers in millions.

Year of investig.	Length group 5-9	10-14	15-19	20-24	25-29	30+	TOTAL
1985	1.9	8.9	5.6	3.1	1.2	0.2	21
1986	1.0	2.3	4.8	6.4	1.3	+	16
1987	+	0.5	4.4	8.0	1.9	0.2	15
1988	6.9	6.2	6.4	10.0	3.6	0.3	33
1989	3.7	7.8	6.3	4.3	0.9	0.0	23

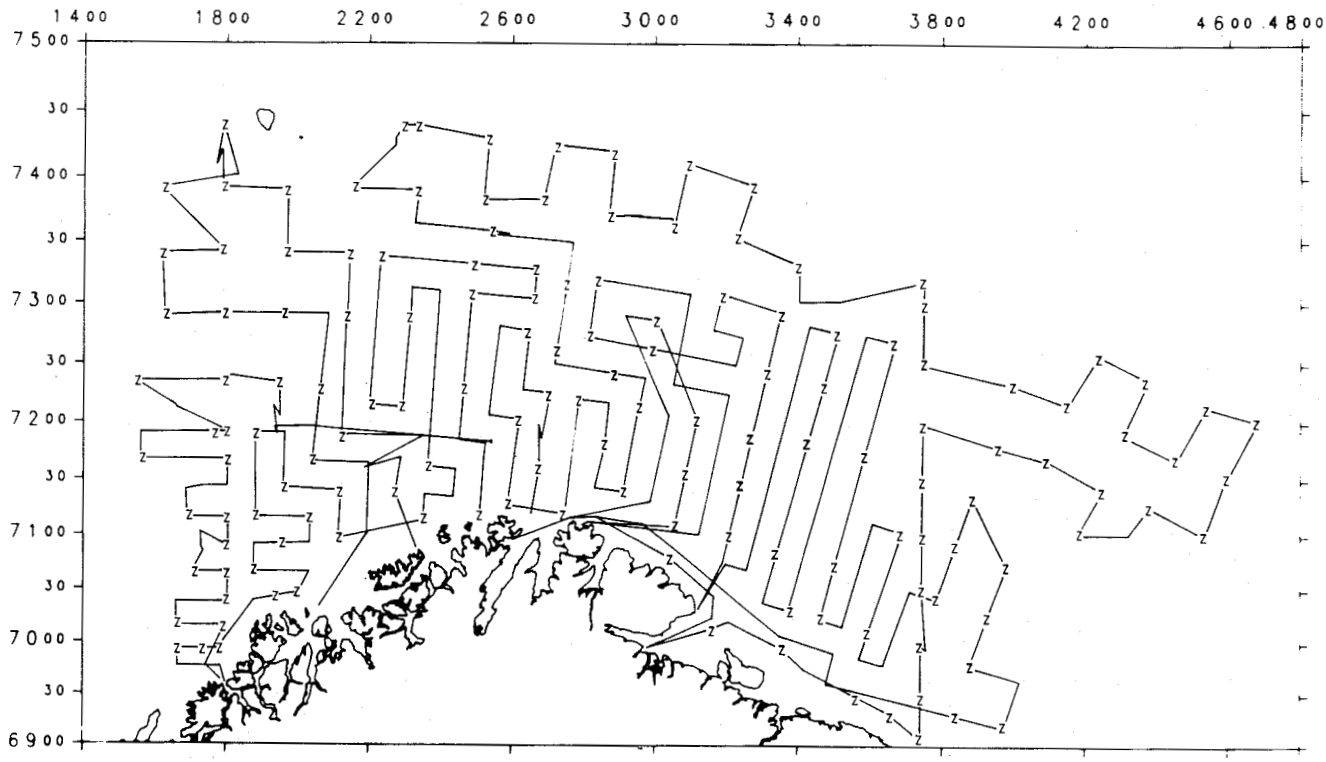

Fig. 3.1. Survey tracks and hydrographical stations; R/V "G.O.Sars" 10.1.-8.3. and R/V "Michael Sars" 27.1.-26.2.1989.

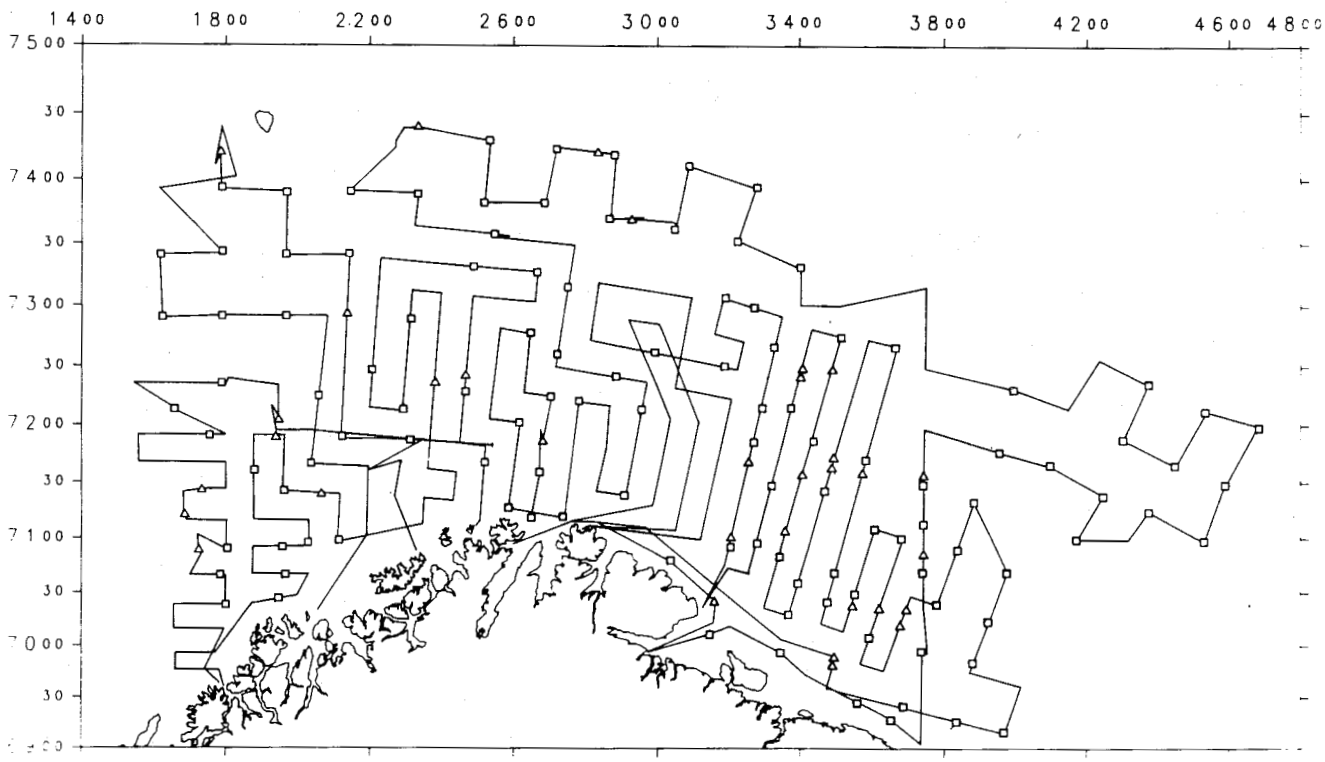

Fig. 3.2. Survey tracks and trawl stations; R/V "G.O.Sars" 10.1.-8.3. and R/V "Michael Sars" 27.1.-26.2.1989.

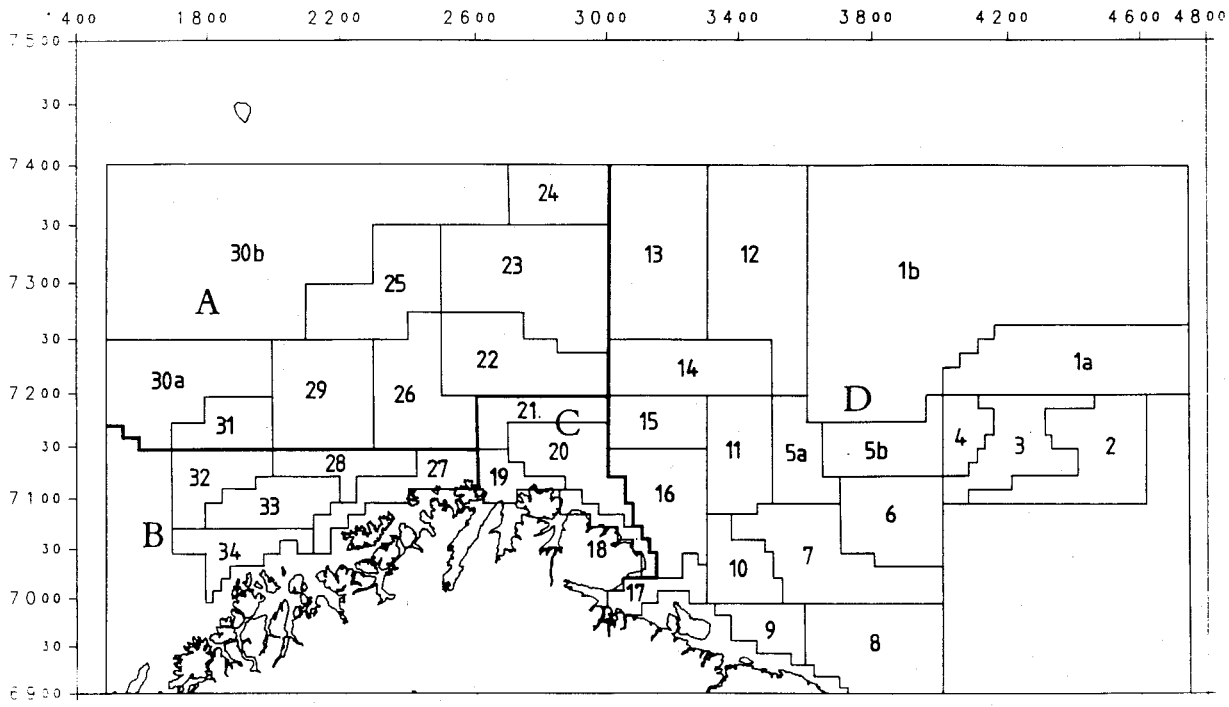

Fig. 3.3. The survey area with sub-areas (A - D) and strata used in the bottom trawl survey.

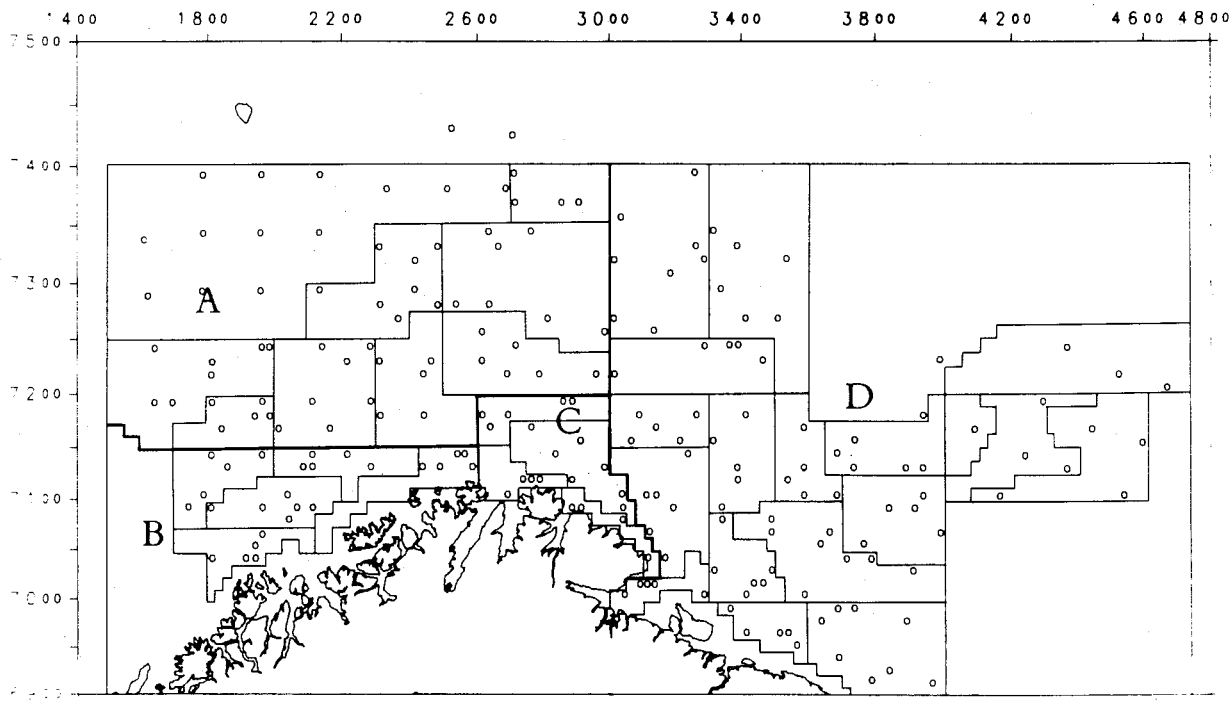

Fig. 3.4. Trawl stations taken in the bottom trawl survey by M/T "T.O.Senior" 28.1.-12.2., R/V "G.O.Sars" 10.1.-8.3. and R/V "Michael Sars" 27.1.-26.2.1989.

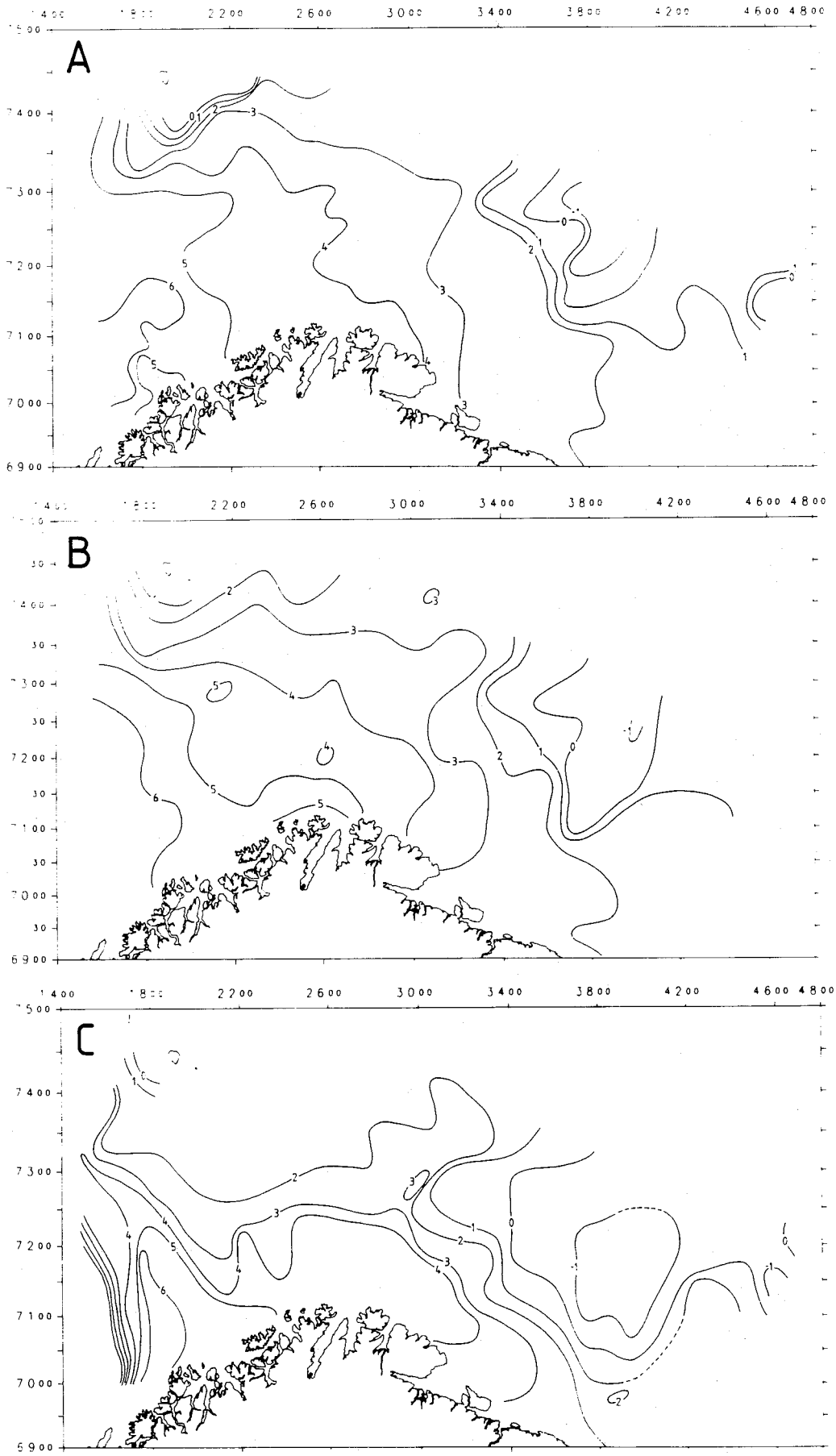

Fig. 3.5. Temperature distribution; R/V "G.O.Sars" 10.1.-8.3. and R/V "Michael Sars" 27.1.-26.2.1989. A) At the surface, B) at 100 m depth, C) at the bottom.

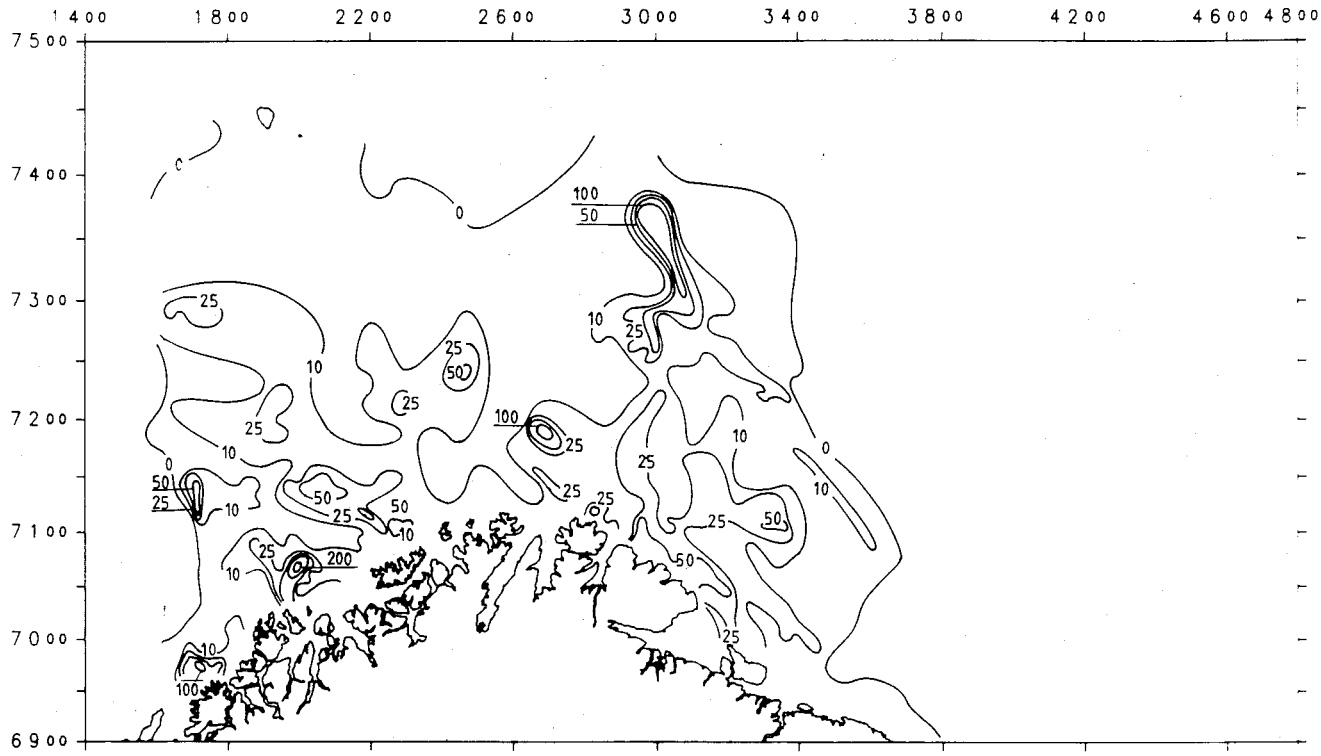

Fig. 3.6. Distribution of total echo abundance; cod and haddock. Units are integrated back scattering surface per square nautical mile $(m/n.mile)^2$.

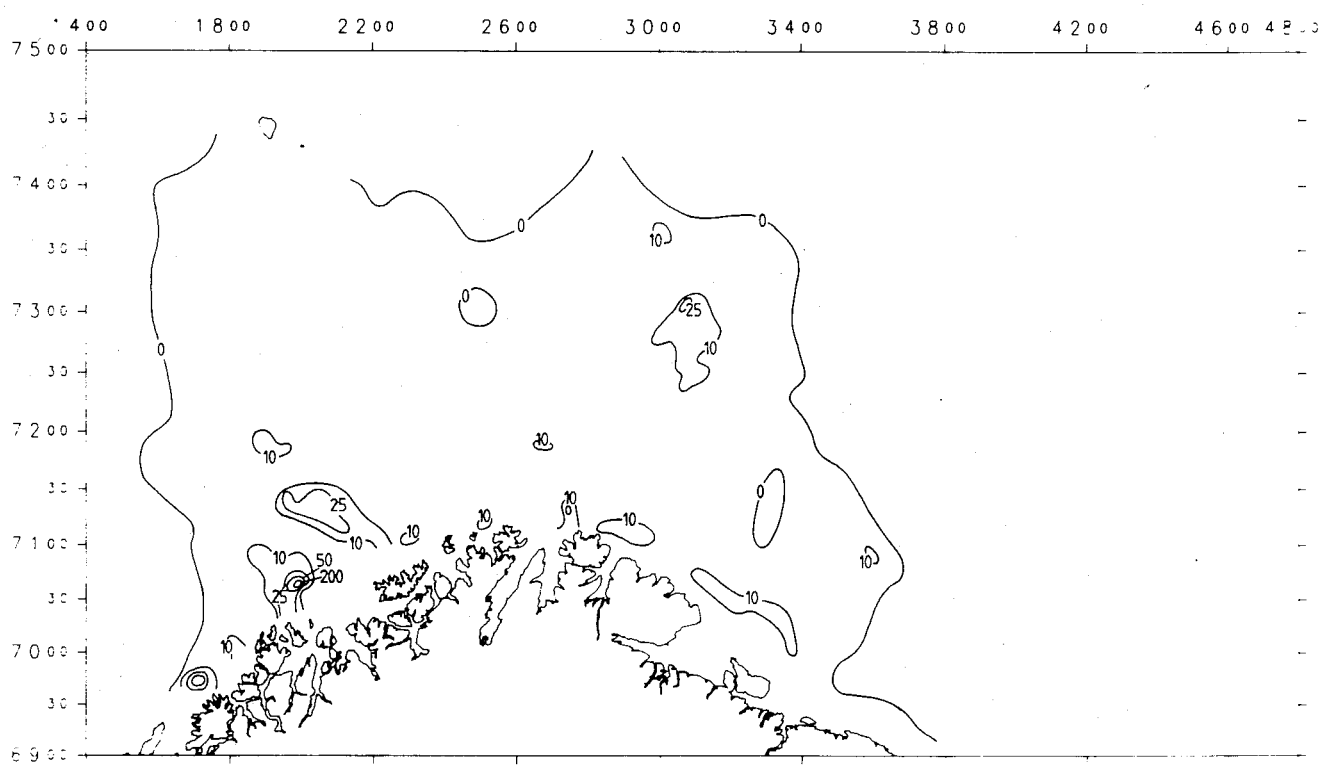

Fig. 3.7. Distribution of echo abundance in the 10 m layer above the bottom; cod and haddock. Units are integrated back scattering surface per square nautical mile $(m/n.mile)^2$.

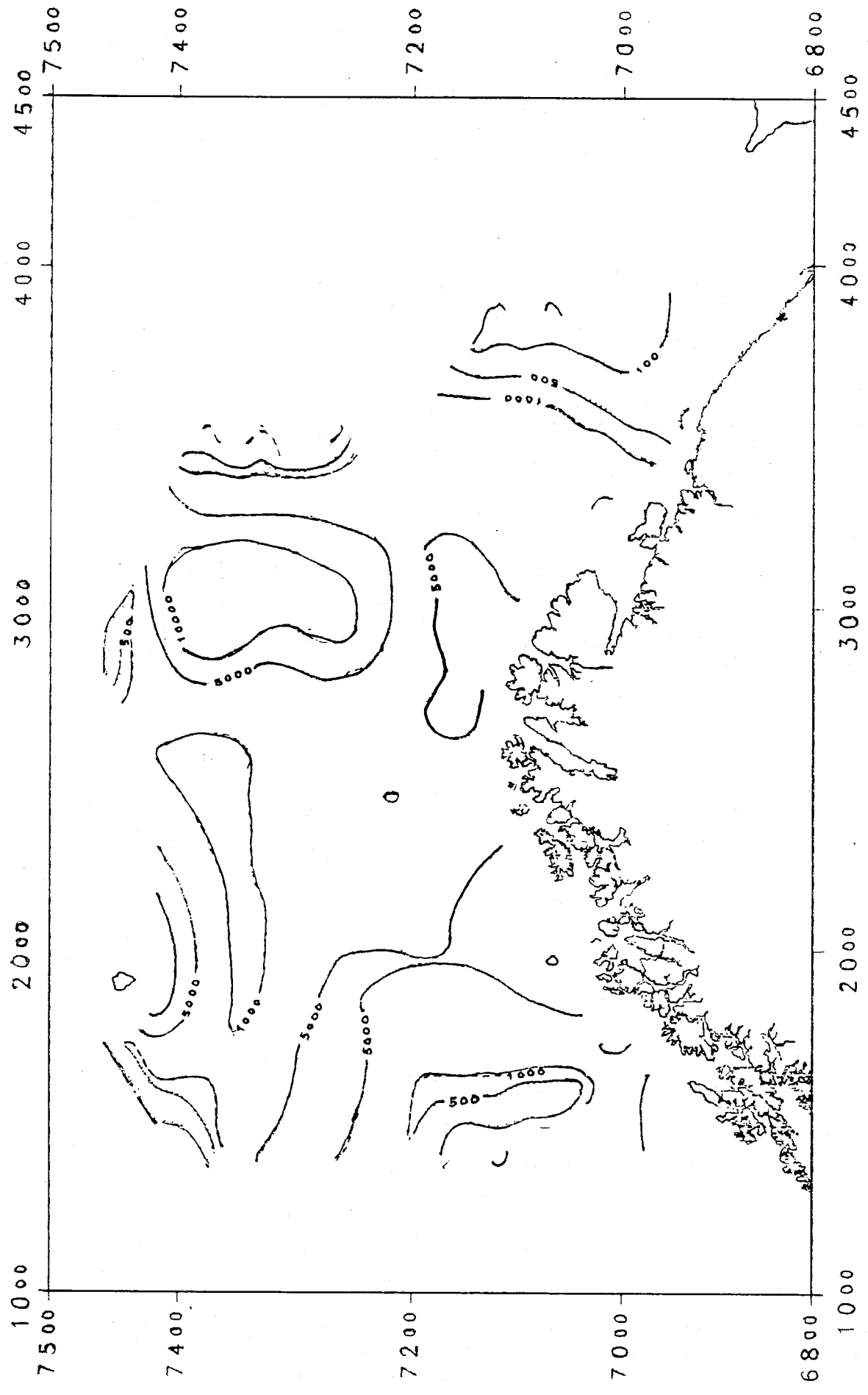

Fig. 3.8. Distribution of cod winter 1989. (Number of fish in 1000 per square nautical mile).

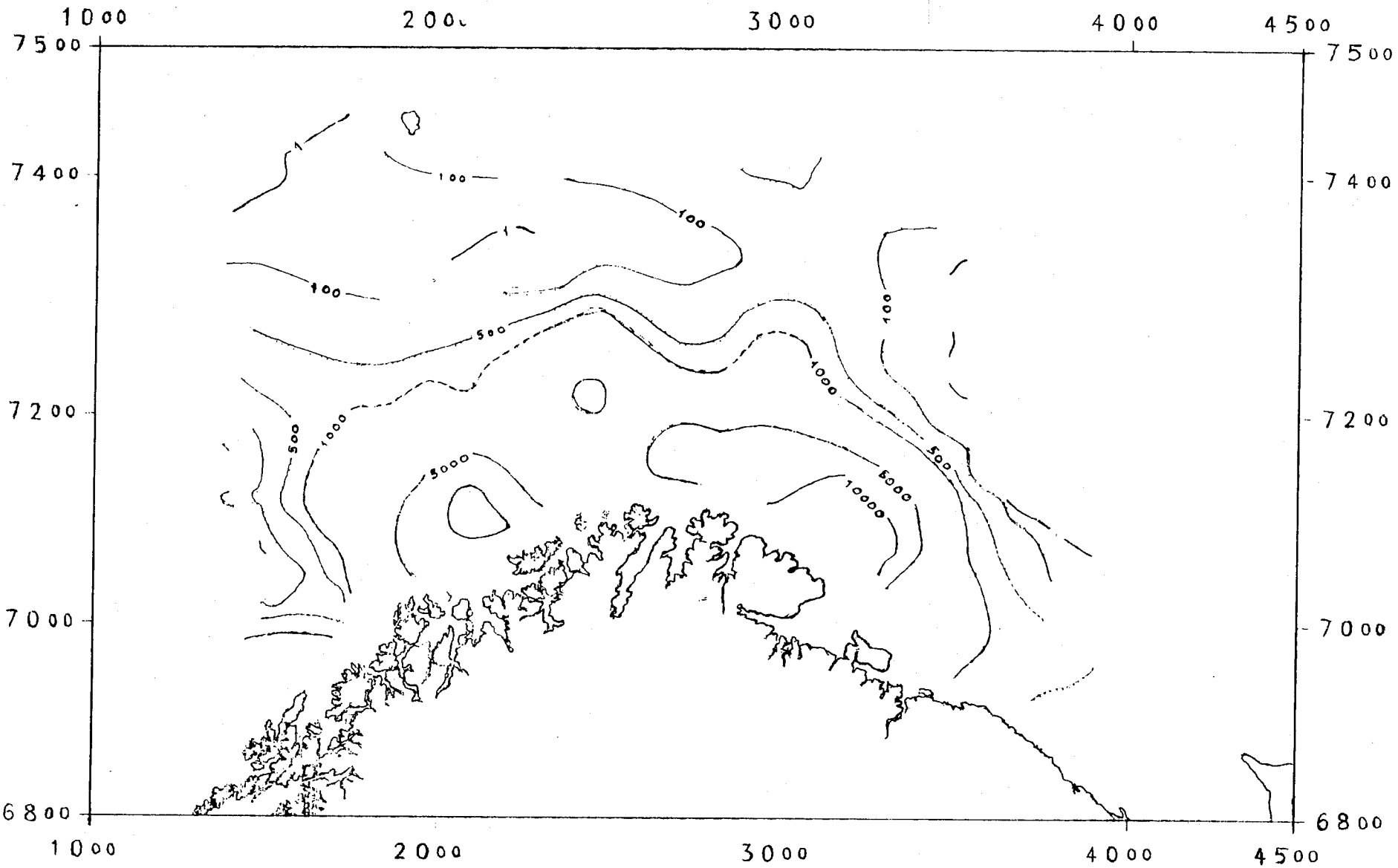

Fig. 3.9.Distribution of haddock winter 1989. (Number of fish in 1000 per square nautical mile)

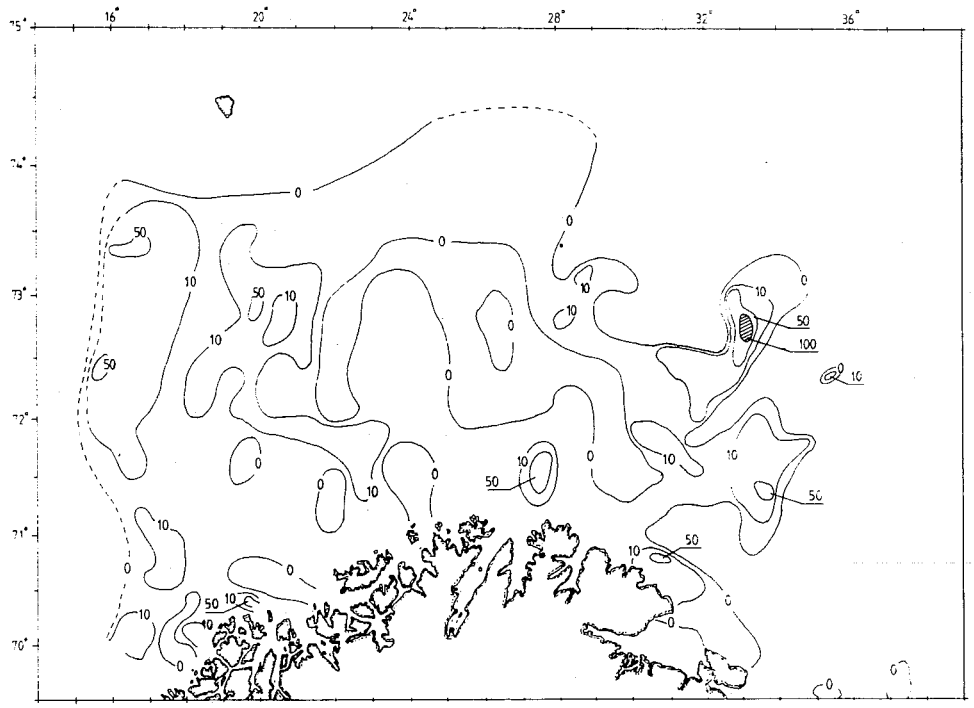

Fig. 3.10. Distribution of redfish in 1989. Units are integrated back scattering surface per square nautical mile, $m^2/(n.mile)^2$.

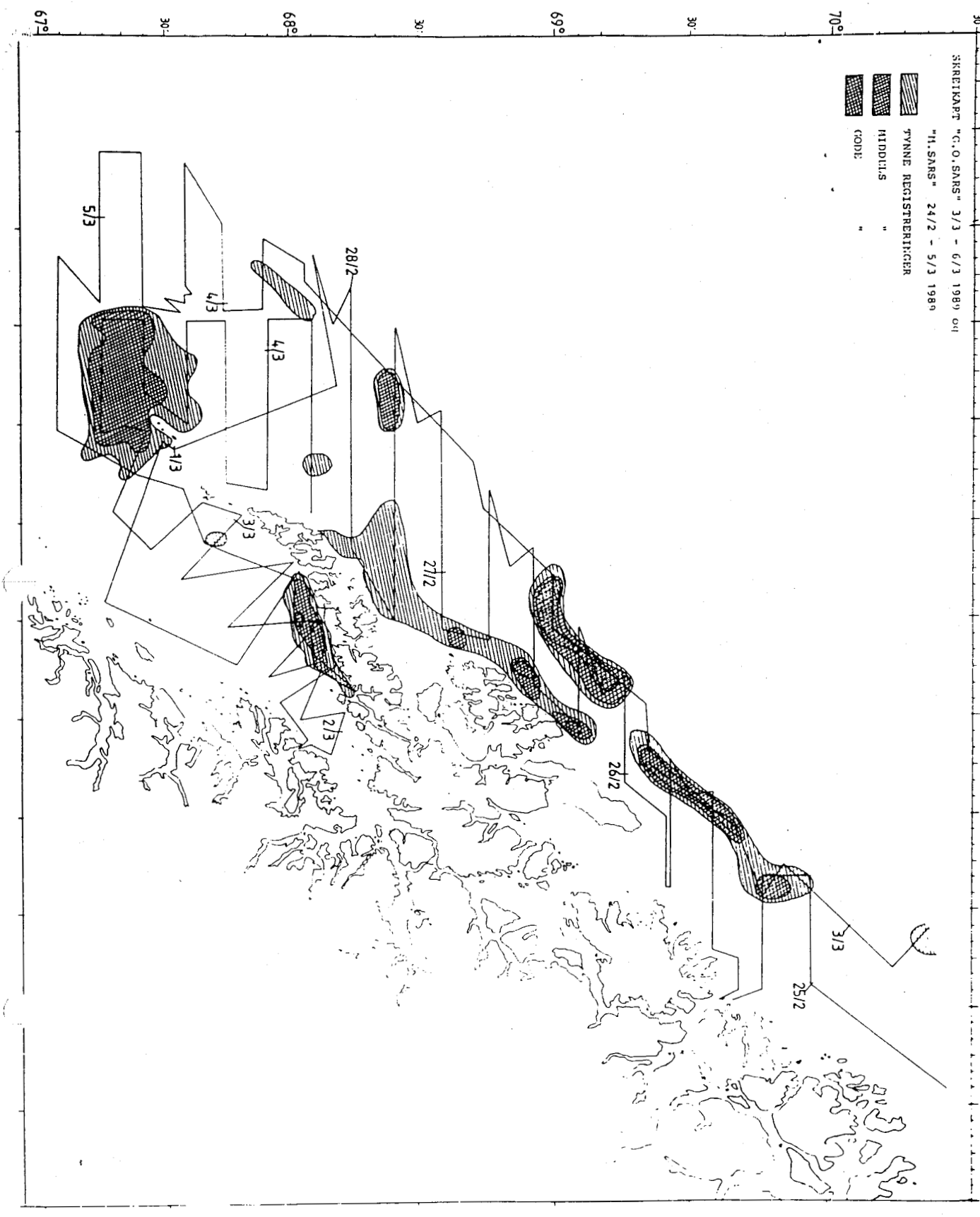

Fig. 4.1. Distribution of Cod and Haddock. R/V "G.O.Sars" 3-5 March 1989 and R/V "Michael Sars" 24 February-5 March 1989. Grading based on total echo abundance. Units are integrated back scattering surface per square nautical mile $(M/n.mile)^2$.

1 Very scattered

2 Scattered

3 Dense

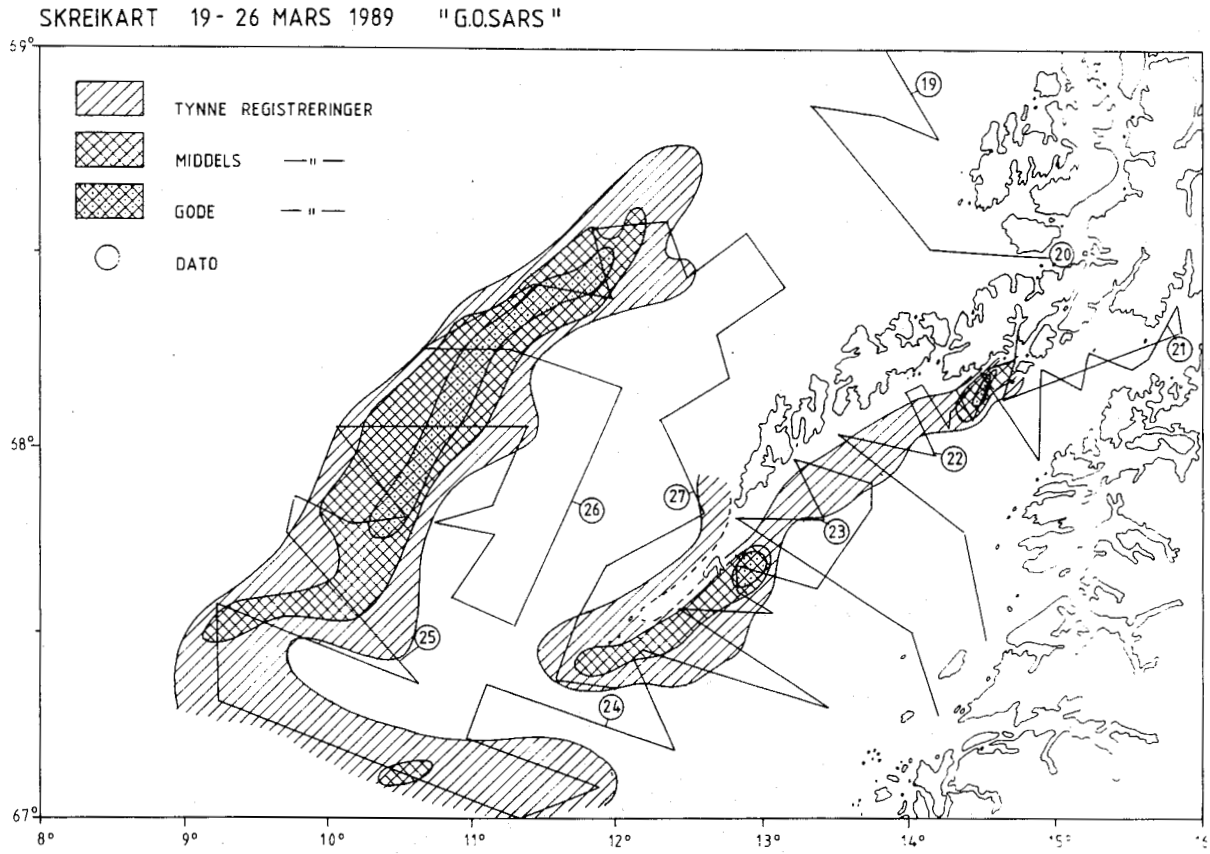

Fig. 4.2. Distribution of Cod and Haddock. R/V "G.O.Sars" 19-26 March. Grading based on total echo abundance. Units are integrated back scattering surface per square nautical mile $(M/n.mile)^2$.

1 Very scattered
2 Scattered
3 Dense