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Report of the International Acoustic Survey on
Blue Whiting in the Norwegian Sea, August 1983

ABSTRACT

A total of eight research vessels from the five countries, USSR, Norway, The Faroes, Iceland and G.D.R. participated in the survey which covered the area from Skagerak to Svalbard.

Integrator values were standardized by use of instrument constants obtained from calibration against standard target.

The best recordings of blue whiting were made in the southern part of the area, i.e. across the Norwegian Sea between Iceland and western Norway. Here the dominating 1982-year class appeared as small and dense schools. Over the rest of the area investigated blue whiting were found mostly as very scattered recordings.

The acoustic estimate, based on a fish length-dependent density coefficient, resulted in 2.8 mill tonnes of blue whiting observed. Of this only 1.1 mill tonnes were found to belong to the adult stock.

RÉSUMÉ

Un total de huit bateaux de recherche provenant de cinq pays, l'URSS, le Norvège, les Iles Féroés, l'Islande et la République Démocratique Allemande ont participé dans une campagne qui s'est déroulée entre le Skagerrak et Svalbard.

Le valeurs d'intégration ont été standardisés en utilisant les constantes des instruments obtenus par la calibration contre des standards blancs.

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Les meilleurs enregistrements de merlan bleu ont été obtenus au sud de la zone étudiée, c'est à dire, en travers de la Mer Norvégienne, entre Islande et le Norvège de l'Ouest. Ici, la classe d'âge de 1982 était dominante et apparaît dans des petits et denses bancs.

Le reste de la zone étudiée a montré seulement des enregistrements dispersés de merlan bleu.

L'évaluation acoustique, qui était basée sur un coefficient dépendant de la densité et la longueur des poissons, a donné 2.8 million tonnes de merlan bleu observé. De ce résultat, seulement 1.1 million de tonnes appartenaient au stock adulte.

INTRODUCTION

Acoustic assessment surveys on blue whiting have been conducted yearly during the last decade. These surveys, however, have mainly been carried out in the area west of the British Isles and around the Faroes in the spawning and post-spawning season, and hence only parts of the total "northern" stock have been covered (Anon., 1982).

To obtain estimate of the total stock, greater areas had to be surveyed. This could be done in the summer half of the year when the stock is spread over greater parts of the Norwegian Sea and adjacent waters.

In August 1980 and 1981, three and two Norwegian research vessels respectively, surveying the Norwegian Sea, showed that it was quite feasible to have the main part of the blue whiting stock covered with a reasonable period of time.

After recommendation by the Blue Whiting Working Group, an international acoustic assessment survey coordinated by ICES took place in August 1982. Eight vessels from five nations participated. It resulted in an abundance estimate of 4.6 million tonnes blue whiting.

Again for the summer season of 1983, the Working Group recommended a similar survey to take place in the Norwegian Sea and adjacent areas to estimate the abundance of blue whiting in the northern areas.

The terms of reference were set by ICES' resolution passed at its 70th Statutory Meeting, with a planning group established to coordinate the survey and finish the report (C.Res.1982/2:27).

- (i) the Coordinating Group for the Blue Whiting Survey in the Norwegian Sea should meet on 2 and 3 March 1983, after the Saithe Working Group, under the Chairmanship of Mr T Monstad (Norway) at ICES headquarters to draw up plans for the acoustic survey in 1983,
- (ii) a combined report on the 1983 acoustic survey should be prepared by the participating countries after the survey at a 2 days' meeting immediately prior to the meeting of the Blue Whiting Assessment Working Group.

The planning group met in Copenhagen 2 and 3 March 1983 to discuss the survey plans and practical procedures at sea (Anon., 1983). The present report was finalized at a meeting on 13 and 14 September at ICES headquarters.

The second ICES coordinated international acoustic survey on blue whiting in the Norwegian Sea, was then conducted in the period from 27 July to 30 August 1983.

MATERIAL AND METHODS

Eight research vessels from five nations participated in the survey. They were:

Vessel	Nation	Period	Instrument constant, $C_T \times 10$
"Eisbaer"	GDR	27 July-20 August	2.20
"Persey III"	USSR	1-20 August	1.75
"Eldjarn"	Norway	1-20 August	1.00
"Michael Sars"	Norway	1-20 August	0.83
"G.O.Sars"	Norway	2-20 August	0.81
"Magnus Heinason"	Faroe Islands	6-30 August	1.06
"Arni Fridriksson"	Iceland	7-27 August	0.42
"Bjarni Sæmundsson"	Iceland	15-28 August	-

Names of the institutes and the scientific staff of the different vessels are given in Appendix.

The area to be surveyed was divided between the various vessels, but with great overlapping in areas expected to have high concentrations of blue whiting. The planned cruise tracks were taken as guidelines and adjusted in accordance with the time schedule and the day to day situation.

Fig. 1 shows the cruise tracks of the various vessels and the trawl stations worked. In the area around Iceland the survey was combined with O-group fish investigations and in the area west and southwest of Jan Mayen with capelin investigations.

All vessels were equipped with echo integrators. The acoustic system of each vessel were calibrated for standardizing the integrator values into comparable units, either prior to the cruise or immediately after. Standard target copperspheres (Cu 60 mm) were used for this, except in one case where the acoustic system was measured by use of hydrophone. The instrument constant, C_I , was calculated for each vessel following the method given in Appendix II of last year's report, (Anon., 1982). They are presented in the above text-table, except for the vessel not observing any blue whiting in its area west and north of Iceland. The echo intensity recorded was expressed as number of square metres reflected per square nautical mile. The echo intensity was integrated and recorded as average value per nautical mile for each five nautical mile sailed. Identification of the recordings and collection of biological samples were made mainly by use of pelagic trawls. The Norwegian vessels used several pelagic trawls with vertical openings of 16, 20, 30 and 60 m, the Icelandic vessels had trawls with 12 m opening and the Faroese, the USSR and German Democratic Republic vessels used a trawl vertical opening of approximately 40 m. In a few cases sampling by bottom trawl was used. By use of the catch compositions together with analysis of the echo readings, the integrator values were apportioned on species or groups.

During the survey a great number of hydrographical stations were worked, by use of either bathythermograph, CTD-sonde or "Nansen-bottles" with reversing thermometer (Fig. 2).

As far as possible there was a daily radio-communication between the vessels for exchange of reports and to give information of recordings, stations and samples to the central vessel ("Eldjarn"). To make this task as easy and rapid as possible, standard forms were used. The data from all the vessels were combined and put on working maps as they were received.

Estimation of the biomass was done following the method used for the blue whiting acoustic surveys in August 1982 (Anon., 1982). The area surveyed was divided into rectangles of 1° latitude and $2^{\circ}30'$ longitude. In each of these rectangles the average integrator value was calculated, using combined values. Within each the distribution of blue whiting was calculated according to the zero-line.

The one vessel that did not calibrate its instruments against a standard target, had its integrator values standardized by the regression $y = 2.0 \cdot x + 11.1$ ($r = 0.41$). This is based on mean values from 22 rectangles which the vessel and one or more of the other vessels had surveyed.

In contrast to last year when the mean length and the mean weight were established for each rectangle, the length- and weight distribution of the blue whiting were used. These were based on the trawl catches within the rectangle, and in some cases where only very small or no samples were available, it was made of a combination of the length and weight distributions in the neighbouring rectangles.

The echo intensity represented by the relative integrator values were then converted into biomass values using a length dependent density coefficient, the same C-value as used last year. The calculations were made by computer that gave the abundance of blue whiting in each length group for each of the rectangles, and summing it up for the total area.

RESULTS

Hydrography

The horizontal distribution of the temperatures at surface, 200 m and 400 m depths are given in Fig. 3, 4 and 5 respectively. The water masses were found somewhat colder than during the corresponding survey in 1982.

The vertical distribution of the temperatures are shown in a section from Halten (western Norway 64°N) to Jan Mayen (Fig. 6).

Blue Whiting

Blue whiting were found scatterly distributed over most of the area covered, i.e. from the Svalbard area in north to the Skagerak in south, between the coasts of Iceland and Norway. In Fig. 7 is shown the distribution of blue whiting recorded and the relative abundance.

As observed the two last years, the highest concentrations were found in the southern part of the investigated area, and mostly the blue whiting appeared as small dense shoals, but also as layers.

The total biomass of blue whiting observed was estimated to 2.8 mill tonnes representing 36.5×10^9 specimens. In Fig. 8 the biomass is given for each rectangle within the distribution area.

Juvenile blue whiting, mainly the 1982 yearclass, was predominated more or less over the whole area surveyed. The 0-group fish were found mainly at the southwestern Icelandic coast. Adult fish were spread all over the distribution area, but best recorded in north and far off the coasts. The total length distribution, weighted by the abundance is shown in Fig. 9, and divided into various sub-areas in Fig. 10. These sub-areas are shown in Fig. 11. The total length distribution shows clearly the 1983 and the 1982 yearclasses from the older age groups. From this it appears that 0-group fish

approximately range from 11 to 18 cm, I-group fish further up to 27.5 cm and older groups above that length. By use of this, the total abundance could be splitted, giving 0.2 mill tonnes of the 1983 yearclass, 1.5 mill tonnes of the 1982 yearclass, and 1.1 mill tonnes of blue whiting older than one year.

DISCUSSION

Compared to 1982 the survey in 1983 was extended to the Norwegian Deep and the areas south and east of the Faroes.

The stock size of 2.8 mill tonnes estimated in 1983 is significantly lower than the 4.6 mill tonnes found in a smaller area in 1982. Disregarding the very strong 1982 yearclass the difference is in the order of 3 mill tonnes of adult fish.

The survey in 1983 was conducted in the same way as in 1982 and the methods used for estimating the abundance the same, and it is hard to see any bias introduced by the general approach.

The following sources of error might, however, have introduced negative bias to the estimates of adult fish in 1983.

- 1) Blue whiting is a fast swimming fish and a bias might have been introduced by the trawls catching relatively better the younger fish. Due to the very numerous 1982 yearclass, the adult stock might thus have been underestimated.
- 2) Some small concentrations of adult fish heavily mixed with juveniles were found in the area between the Faroes and Iceland which were not recorded by the research vessels. These concentrations were, however, too small to substantiate a fishery.

- 3) The very low concentrations of adult fish found over the larger areas in the Norwegian Sea might occasionally have been below the integrator treshold values.
- 4) An underestimate might also have been introduced by blue whiting distributed very close to the bottom along the Norwegian shelfedge not being recorded.

These sources of error, however, cannot explain the high difference in the two estimates obtained in 1982 and 1983.

REFERENCE

- Anon., 1982. Report of international acoustic survey on blue whiting in the Norwegian Sea, July/August 1982. ICES, C.M.1982/H:5.
- Anon., 1983. Report of the blue whiting planning group for the coordinated acoustic survey 1983, Copenhagen, 2-3 March 1983. ICES, C.M.1983/H:4.

APPENDIX

<u>Survey period</u>	<u>Research vessel</u>	<u>Research Institute</u>	<u>Participants</u>
1-20 August	"Perseus III"	Polar Research Institute of Marine Fisheries and Oceanography - PINRO - Murmansk	S.V. Belikov, E.S. Demidenko, V.A. Khljupin, V.I. Shapovalov, M.V. Shkatova, N.G. Ushakov, A.D. Voloshin, N.V. Bryzgalova, P.V. Fedorov, L.N. Korol, Ju.F. Shevtsov, E.S. Shishkin, N.V. Vanjukhind
1-20 August	"Eldjarn"	Institute of Marine Research, Bergen	O. Alvheim, A. Johannessen, L. Løvheim, T. Monstad (coordinator), R. Pedersen, E. Sælen, Ø. Torgersen
1-20 August	"Michael Sars"	Institute of Marine Research, Bergen	J. Blindheim, S. Kolbeinson, J.H. Nilsen, J.E. Nygård, W. Løtvedt, I.M. Bech
1-20 August	"G.O.Sars"	Institute of Marine Research, Bergen	A. Asenjo, B. Brynildsen, K. Hestenes, K. Lauvås, A. Raknes, A. Roald, S. Tjelmeland, E. Østvedt, G. Sangolt
6-30 August	"Magnus Heinason"	Fiskirannsóknarstovan, Torshavn	H. i Jakupsstovu, B. Thomsen
7-27 August	"Arni Fridriksson"	Hafrannsóknastofnunin, Reykjavik	S. Sveinbjørnsson, T. Sigurgeirsson
15-28 August	"Bjarni Sæmundsson"	Hafrannsóknastofnunin, Reykjavik	H. Vilhjalmsón, P. Reynisson, A.Aa. Malmberg, O. Asthorsson
27 July-20 Aug	"Eisbaer"	Institut für Hochseefischerei und Fischverarbeitung, Rostock	N. Schultz, Ch. Nagel, H. Bremer-Rotbarth, J. Albrecht, R. Buck

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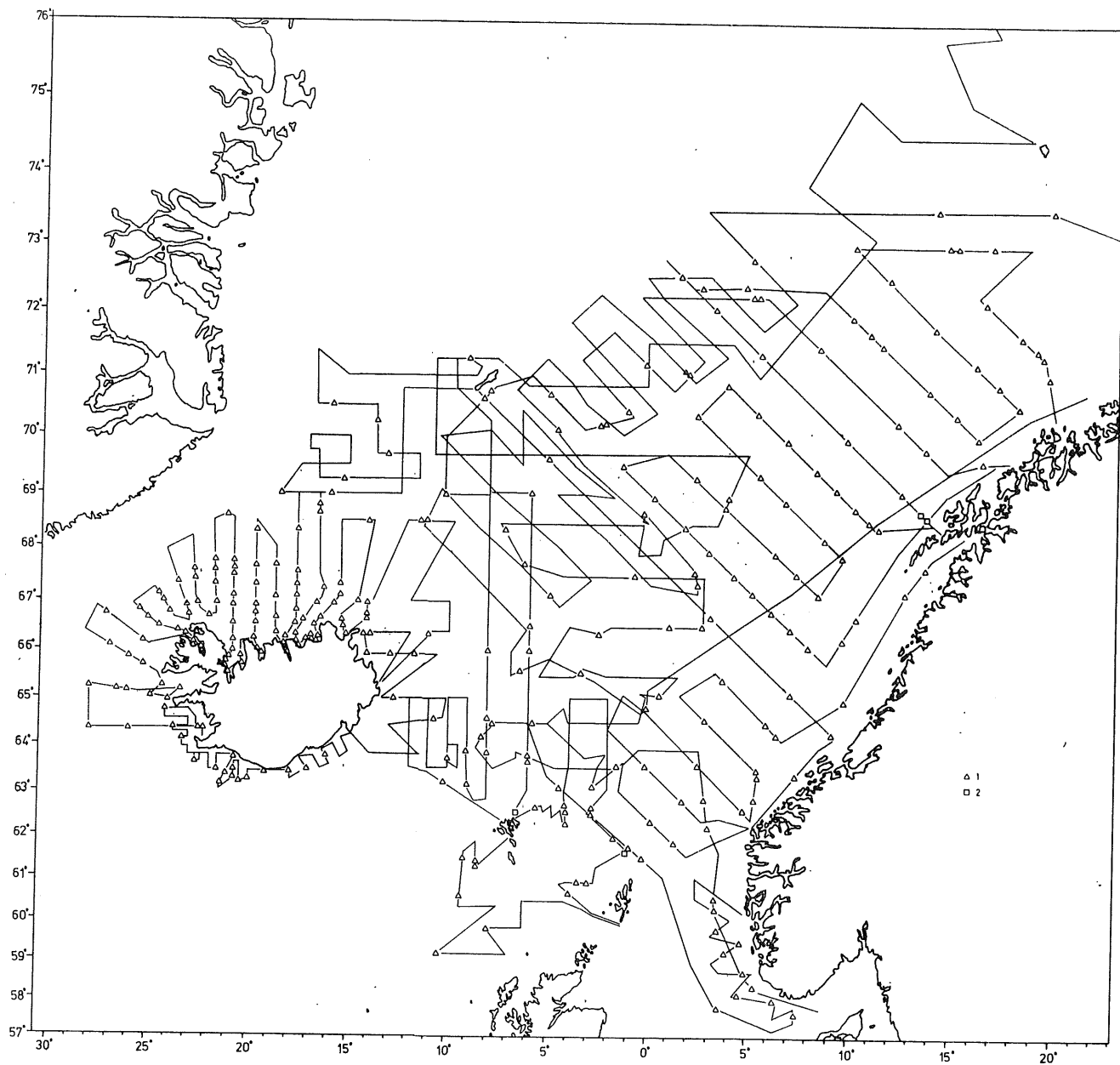


Fig. 1. Cruise tracks and trawl stations of the eight research vessels, April 1983.
1) Pelagic trawl, 2) bottom trawl.

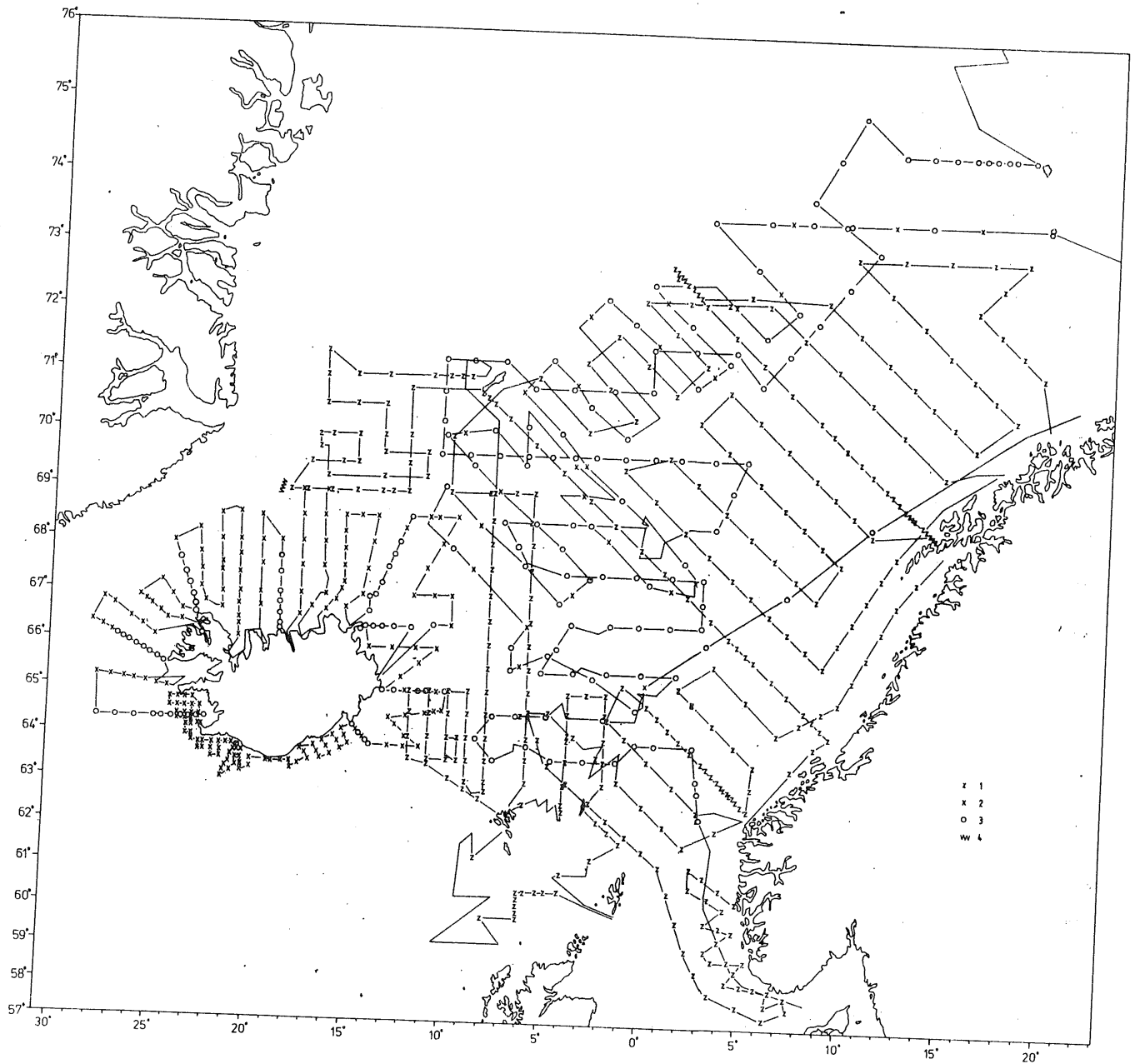


Fig. 2. Cruise tracks and hydrographical stations, August 1983.
1) CTD-sonde, 2) BT and XBT, 3) Water bottles with reversing thermometer, 4) Ice-border.

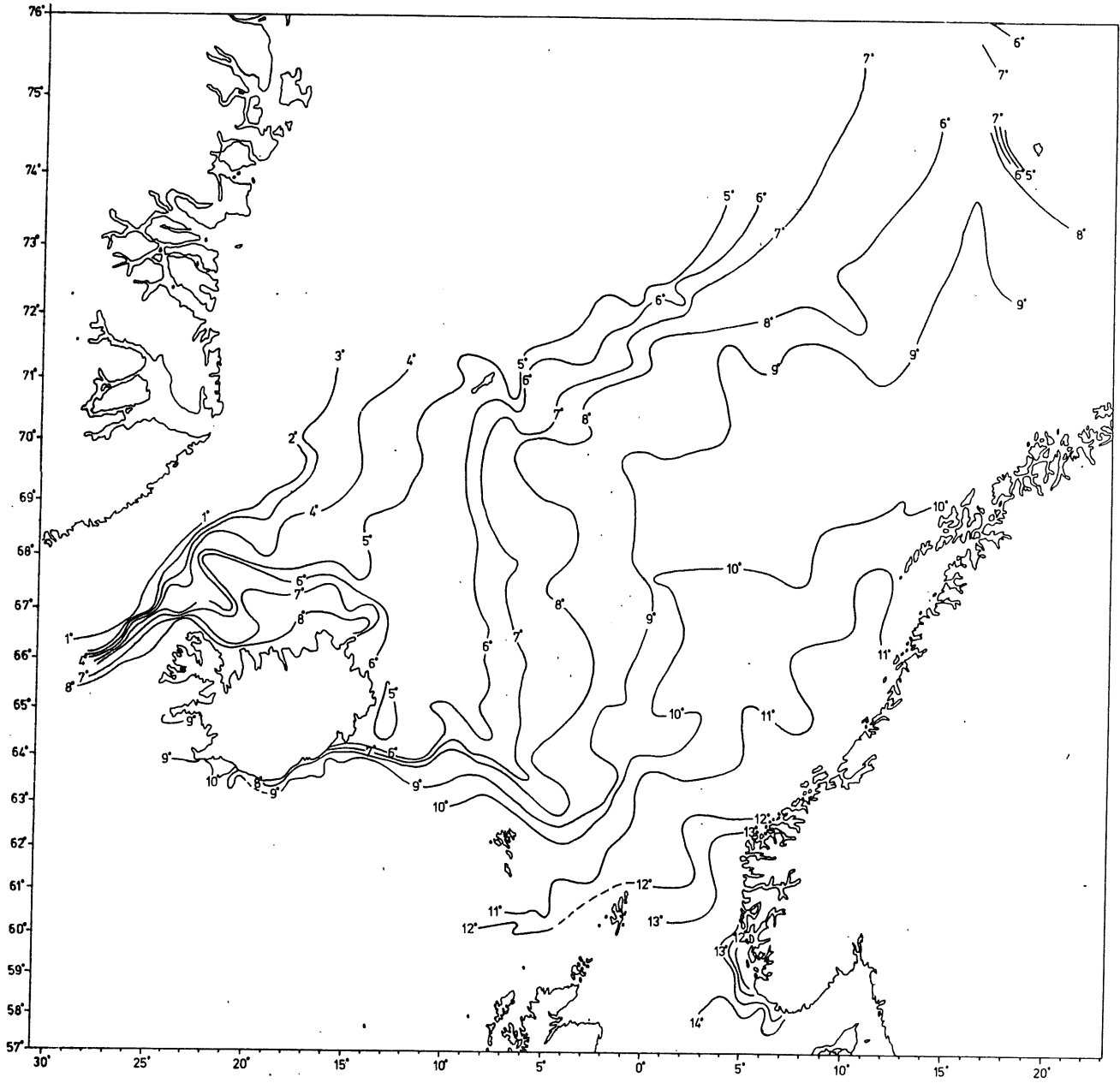


Fig. 3 Temperature ($t^{\circ}\text{C}$) at sea surface, August 1983.

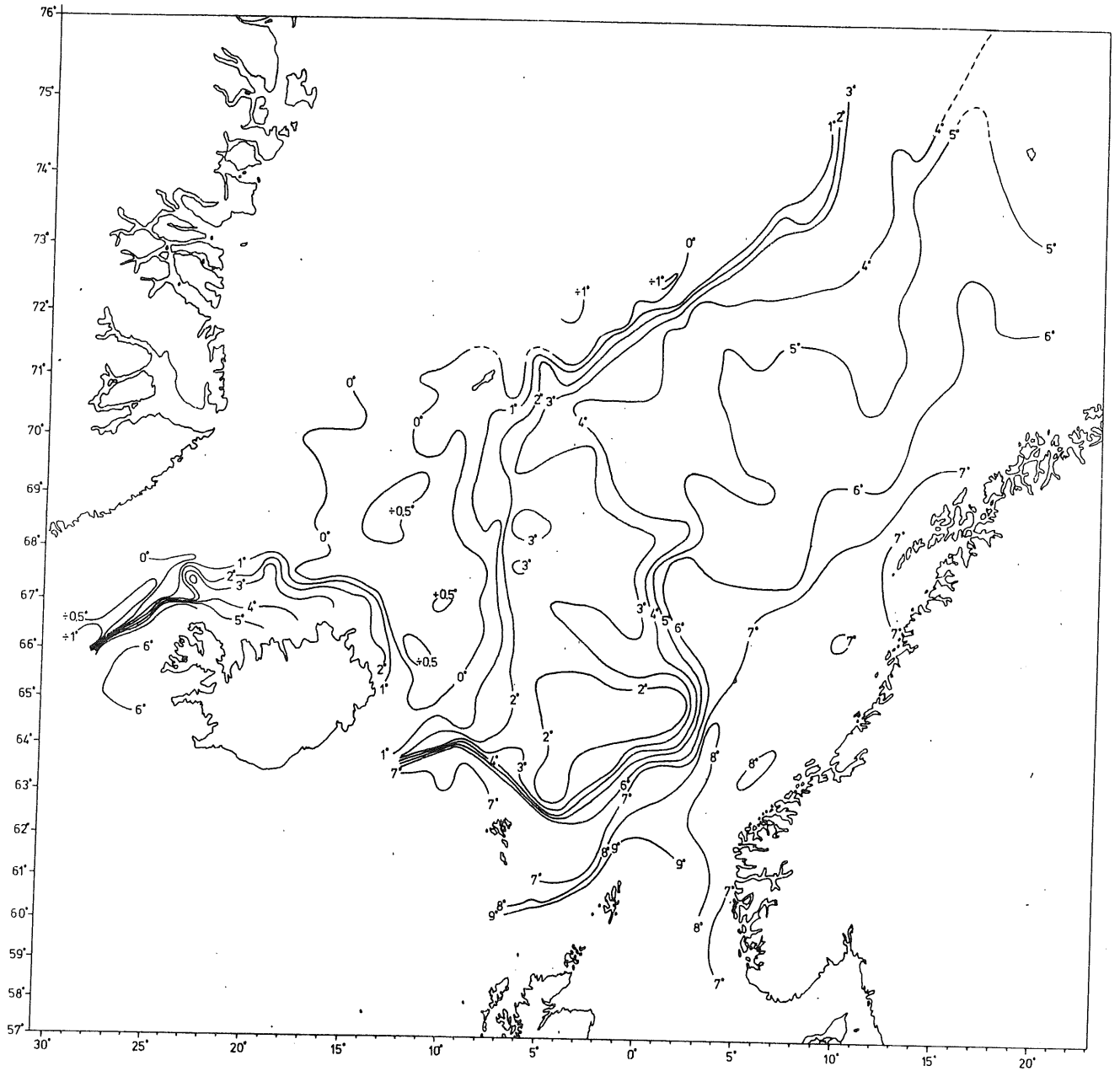


Fig. 4. Temperature ($t^{\circ}\text{C}$) at 200 m depth, August 1983.

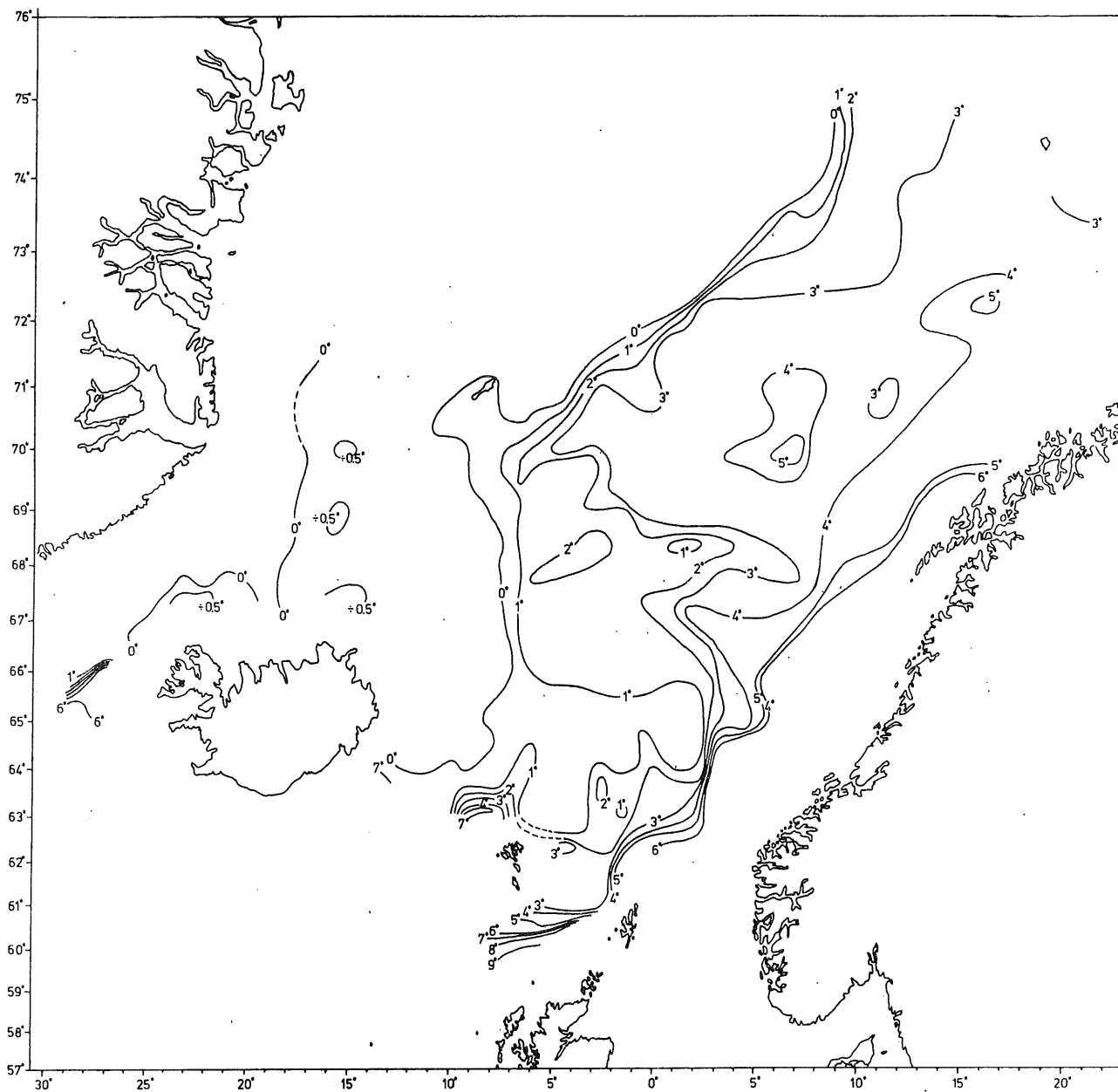


Fig. 5. Temperature ($t^{\circ}\text{C}$) at 400 m depth, August 1983.

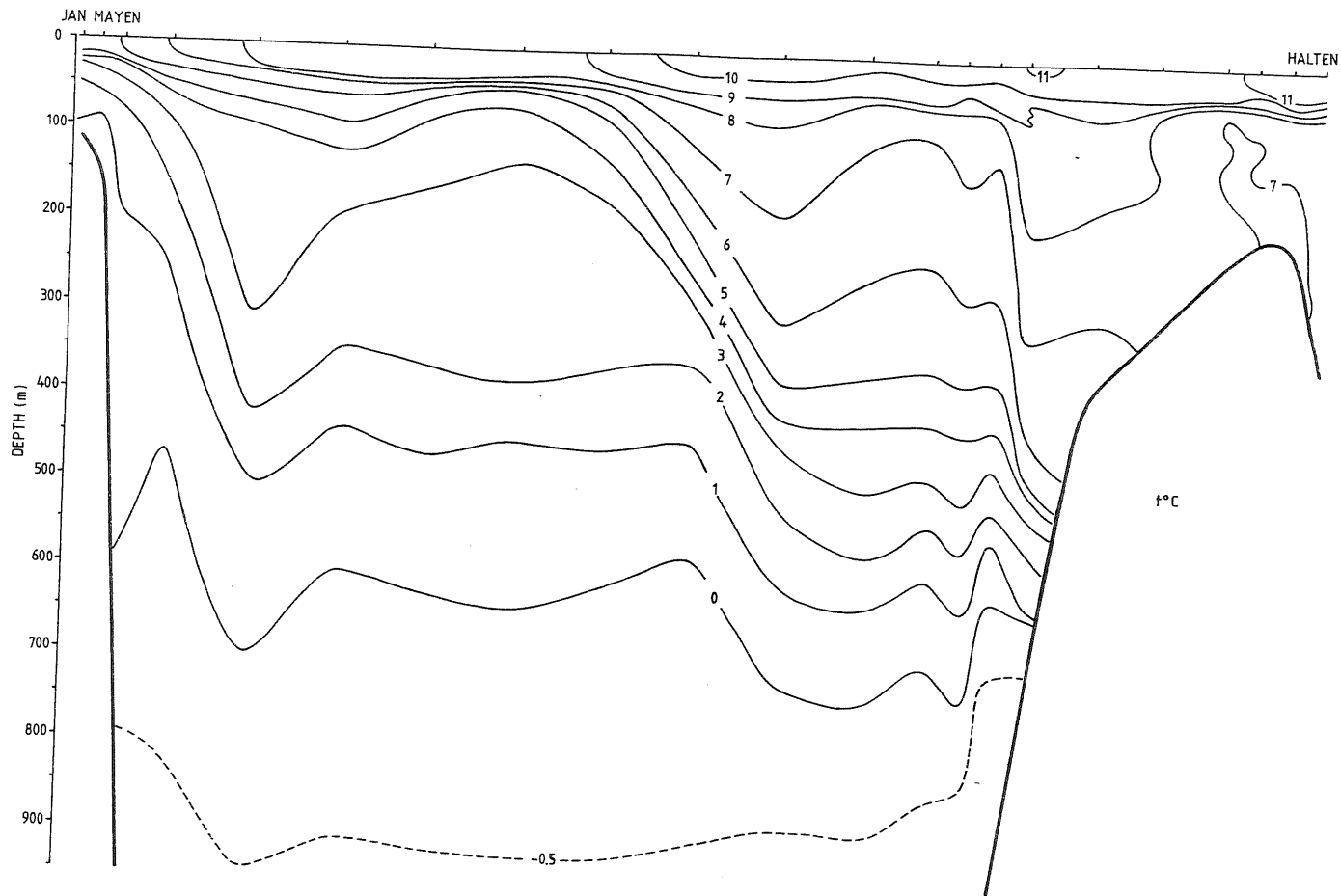


Fig. 6. Temperature ($t^{\circ}\text{C}$) in the section from Halten (Western Norway) to Jan Mayen, August 1983.

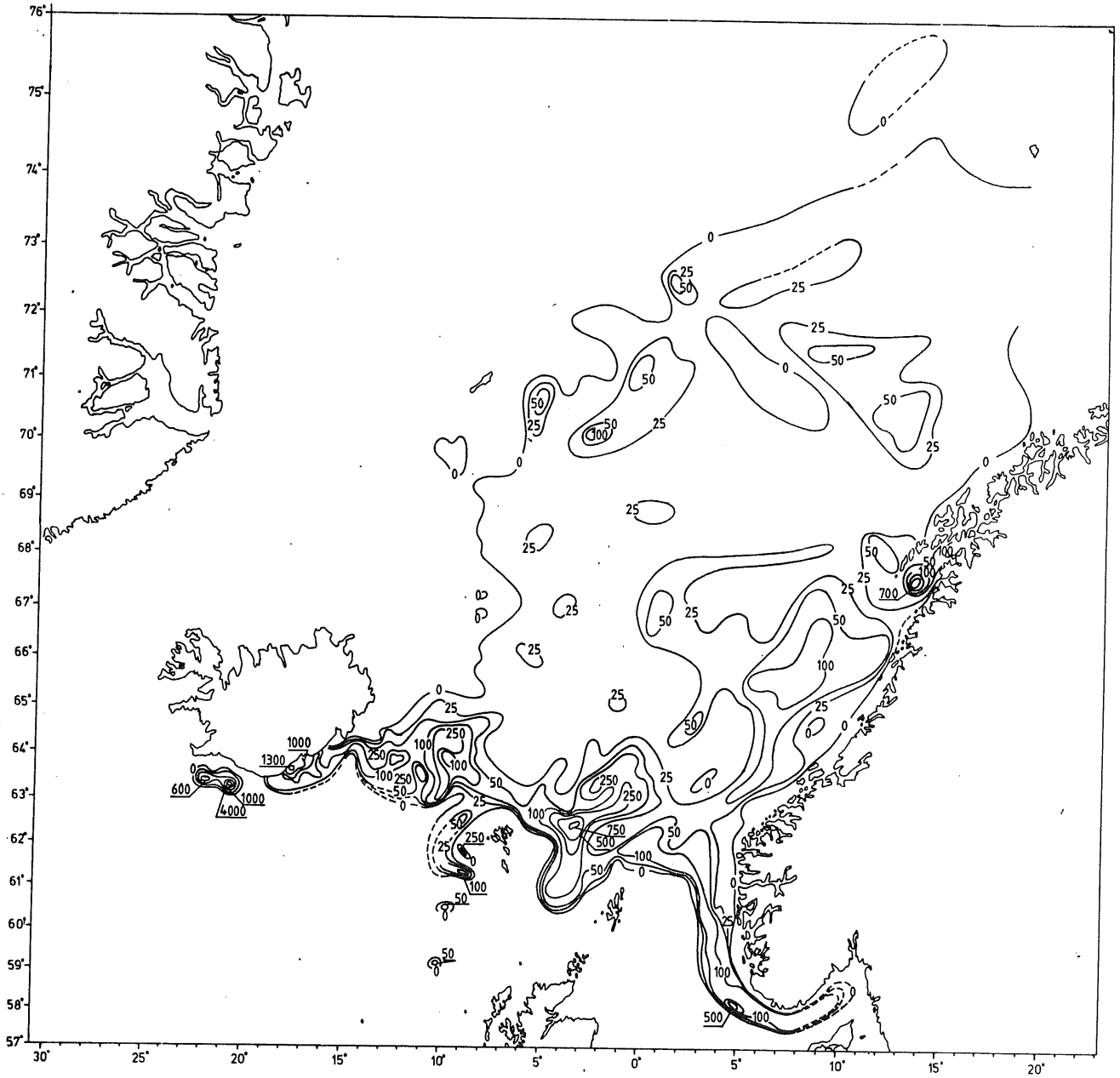


Fig. 7. Distribution and relative densities of blue whiting, August 1983. Echo intensity expressed as square m reflection per square nautical mile x10.

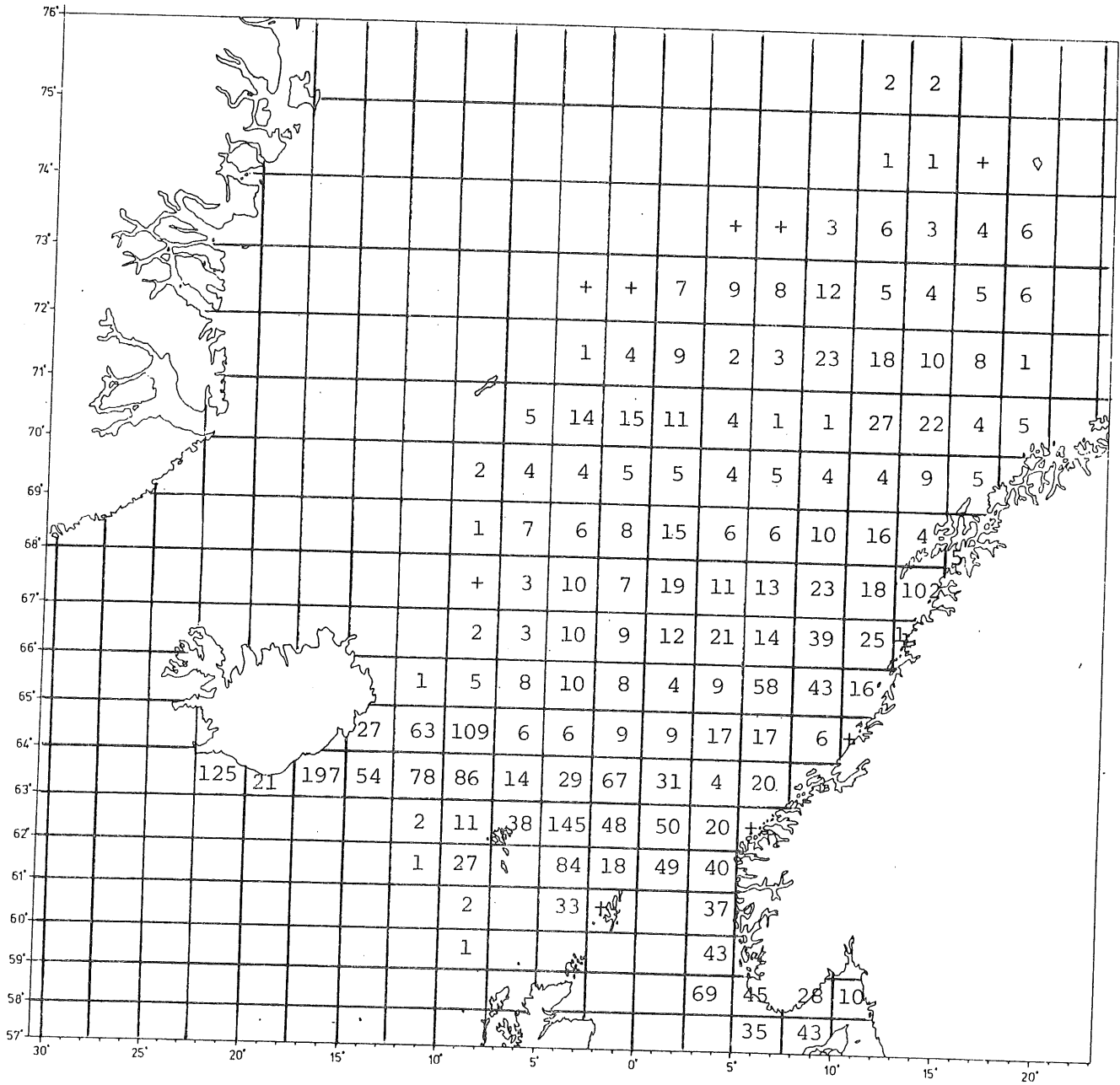


Fig. 8. Estimated blue whiting biomass (1 000 tonnes) in each of the rectangles, August 1983.

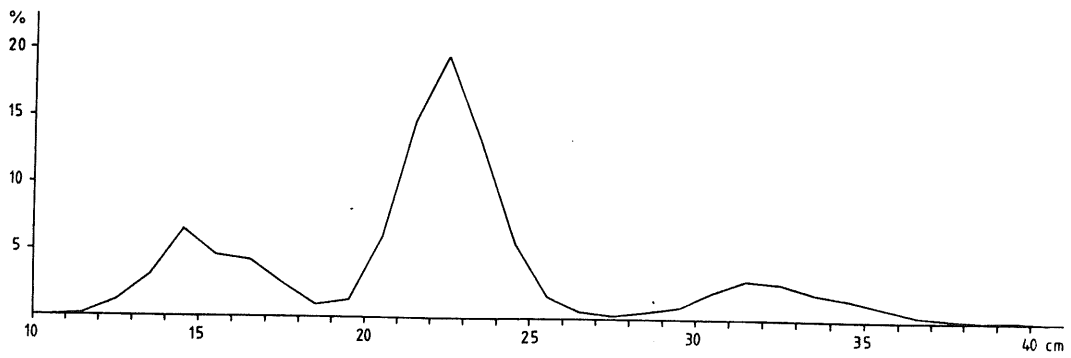


Fig. 9. Total length distribution of blue whiting weighted by abundance, in the Norwegian Sea, August 1983. N: 36.5×10^9 specimens.

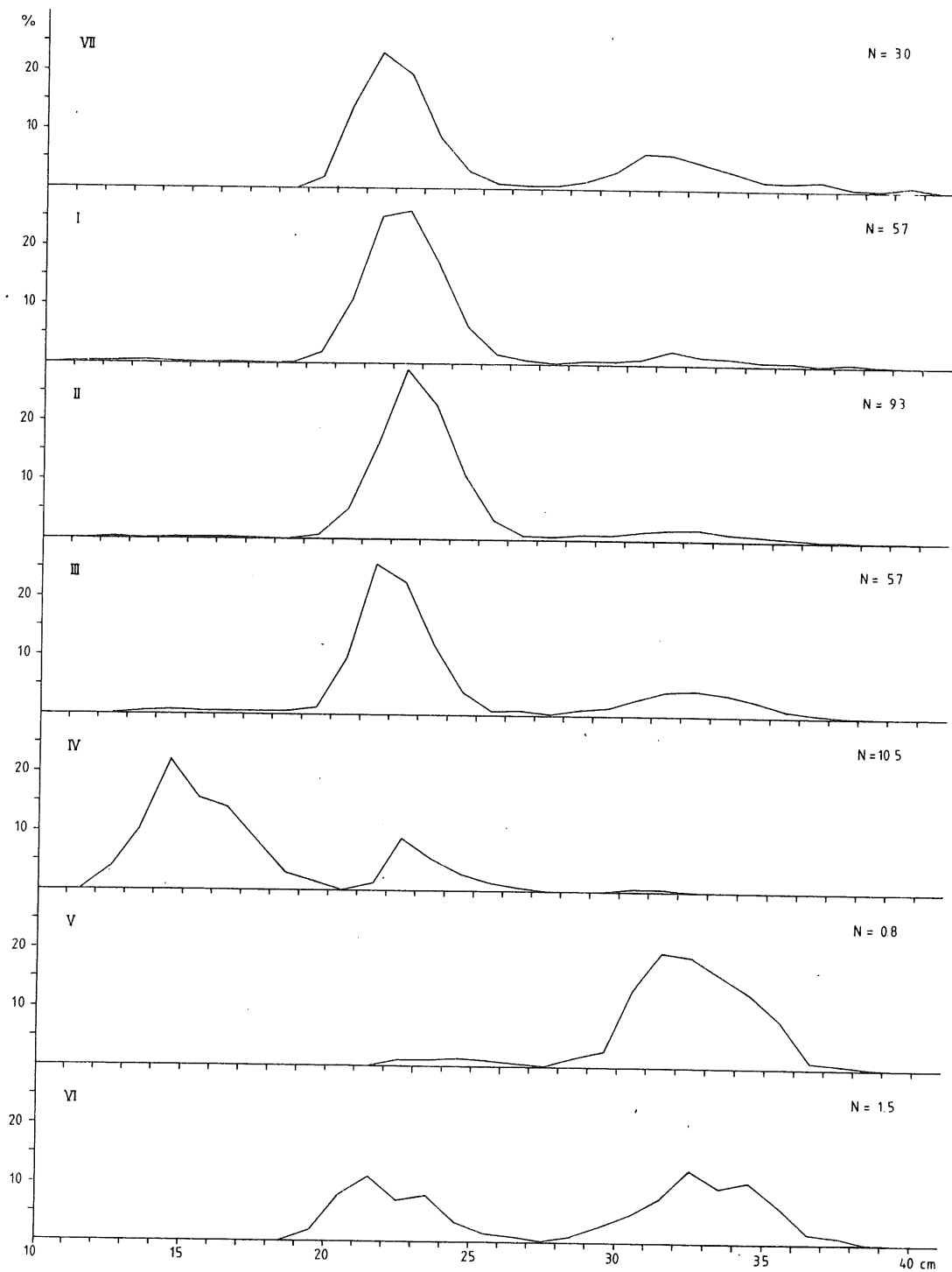


Fig. 10. Length distribution of blue whiting weighted by abundance in sub-areas I-VII. N is given in 10^9 specimen.

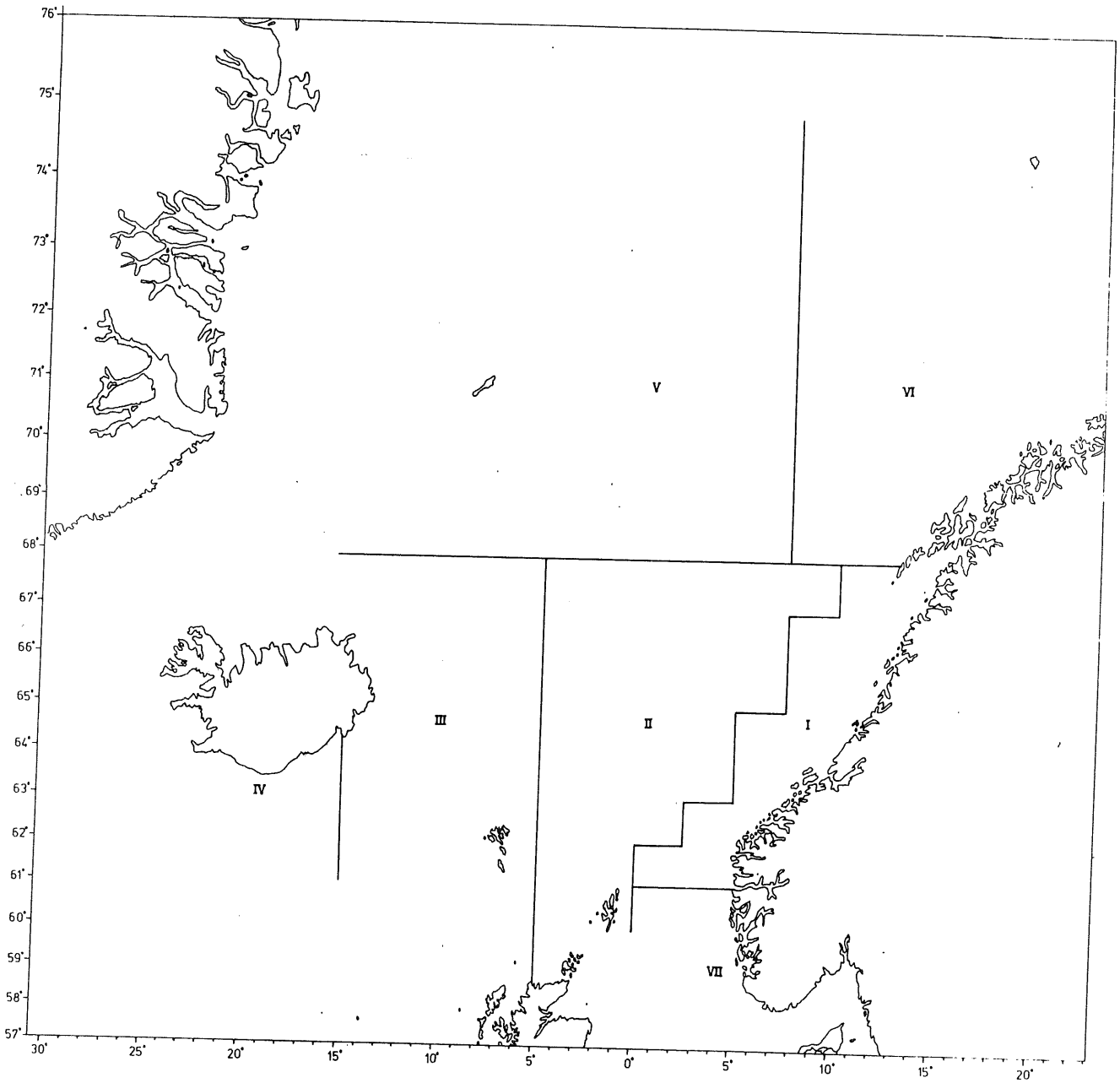


Fig. 11. Borders of sub-areas I-VII used for grouping of blue whiting samples, August 1983.