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Pelagic Fish Committee
Ref. Fish Capture
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INTERNATIONAL ACOUSTIC SURVEY ON BLUE WHITING
IN THE NORWEGIAN SEA DURING SUMMER 1986

ABSTRACT

The fifth ICES-coordinated acoustic survey on blue whiting in the Norwegian Sea and adjacent waters was conducted from the end of July to the beginning of September 1986. All together eight research vessels from USSR, Norway, Faroe Islands, GDR, Iceland and Denmark participated.

The area from Skagerrak/Kattegat to the Barents Sea was surveyed, and blue whiting was recorded over major part of the Norwegian Sea, the highest concentrations found more to the south than to the north.

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INTRODUCTION

In accordance with an ICES recommendation the first ICES-coordinated international acoustic survey on blue whiting in the Norwegian Sea took place in August 1982 (Anon. 1982), and similar surveys have been carried out since. (Anon. 1983a, 1984, 1985a).

The aim of the acoustic surveys in the Norwegian Sea during summer was to monitor the total "northern" blue whiting stock as a complement to the acoustic estimates of the spawning stock.

The fifth ICES-coordinated acoustic survey on blue whiting in the Norwegian Sea and adjacent waters was carried out from 22 July to 5 September 1986 (C.Res. 1985/2:3:21).

MATERIAL AND METHODS

Eight vessels from six countries took part in the survey:

Country	Research vessel	Survey period	Instrument constant C_I	Vertical opening of pel. trawl (m)
USSR	"Vilnius"	30 Jul - 18 Aug	1.09	50
Norway	"G.O. Sars"	22 Jul - 17 Aug	0.46	40, 20
Norway	"Eldjarn"	29 Jul - 18 Aug	0.56*	20
GDR	"Eisbaer"	10 - 31 August	4.38	20
Faroes	"Magnus Heinason"	7 - 19 August	1.49	40
Iceland	"Arni Fridriksson"	7 - 25 August	3.05	17
Iceland	"Bjarni Sæmundsson"	6 - 21 August	2.60	17
Denmark	"Dana"	12 - 26 August	-43.2**	18

* Raised to 1.02 from intercalibration with "G.O. Sars"

** Expressed in dB

Names of the institutes and the scientific staff participating in the survey are given in Appendix I.

Survey plans and tentative cruise tracks and area to cover were worked out by correspondence and telephone. The procedures at sea and the conveyance of data were the same as described in the Planning Group Report of 1983 (Anon. 1983b).

The cruise tracks with the trawlstations and the hydrographical stations are shown on Figs 1 and 2. For some of the vessels the survey had several objectives, of which collecting blue whiting data was only of minor importance. This was the case in the area around Iceland, west of Jan Mayen, from Jan Mayen to the Bear Island area and in the Skagerrak/Kattegat area.

All vessels used 38 kHz echo sounder connected to the echo integrator. The instrument constants (C_I) by vessels obtained by calibration against a 60 mm coppersphere standard target (Foote, 1981), are listed in the text-table above.

The spite of standardized integrator values based on standard-target calibration, a ship to ship-calibration between "G.O. Sars" and "Eldjarn" showed significant differences (Monstad, 1986). It is hard at present to explain this difference, but one reason might be due to the threshold effect which causes most vessels to have problems with single-fish integration at depths deeper than 100 m (Anon. 1985b). Using the blue whiting recordings obtained from the ship to ship-calibration, i.e., the recordings at depths between 200 and 500 m only, the relation "G.O. Sars"/"Eldjarn" = 1.82 was obtained (Monstad, loc. cit.). This figure was then used to raise the "Eldjarn"-values to the "G.O. Sars"-level. As no other ship to ship-calibration was performed, all other C_I -values were applied as provided.

The acoustic data from all vessels, but "Dana", were combined and treated as a whole. The blue whiting biomass and abundance were estimated using the same method as in previous years (Anon. 1984 and 1985a). The density coefficient (C_F) used for blue whiting is the same as has been used for young cod, corresponding to a target strength of -40,5 dB for a 30 cm fish (Anon. 1982 and 1985b)

$$C_F = 1.488 \cdot 10^6 \cdot L^{-2.18}$$

where L is fish length (Anon. 1985a).

The R.V. "Dana" which surveyed the Skagerrak/Kattegat area used a different estimation technique from the other vessels (Degnbol and Bangsborg, 1985). Hence the estimate from this area was made separately.

Almost all blue whiting samples were obtained by pelagic trawling. As in previous years the size of the trawl varied very much between the vessels, as shown by the trawl openings listed in the text-table above.

The length distributions, based on data from all vessels, were weighted by the abundance in the different areas, and the stock was divided into year-classes from age-length keys based on the Norwegian samples.

A great number of hydrographical stations were worked, the vessels using either CTD-sonde, bathythermograph or Nansen water-bottles with reversing thermometer.

In addition to the acoustic survey, information on blue whiting as by-catch in bottom trawl were also received from a Norwegian research vessel which made shrimp investigations in the Svalbard area from mid July to mid August.

RESULTS

Hydrography

Temperature distributions at 0, 200 and 400 m depth are shown in Figs 3, 4 and 5. Compared with the years since 1980 the temperature in August 1986 were generally somewhat low. At the surface the sector east of Iceland was relatively warm, while the temperatures off the coast of Norway and in the area between Jan Mayen and northern Norway were relatively cool.

At 200 m the temperature in the East Iceland Current had not changed much since 1985, but the front extended relatively far to the east, to about 1°E . Off the coast of Norway the waters were rather cold. There were no temperatures above 7°C north of 65°N , while water with this temperature extended to $68\text{--}70^{\circ}\text{N}$ in the previous years.

At 400 m the year-to-year fluctuations are generally small, and the conditions in the East Iceland Current were not much different from the previous years. Off the coast of Norway the temperatures were relatively low.

Blue whiting

The distribution and the density values of blue whiting recorded during the survey are shown in Fig. 6. The over-all recordings were in general weaker than during the previous four years, but the distribution pattern very much the same. Scattered recordings of blue whiting were made over most areas of the Norwegian Sea, with the highest concentrations found in the southern part; in the Norwegian Deep, in an area along the 0-longitude at 64° latitude, in the polarfront-area between the Faroes and Iceland and in a small locality west of Iceland.

The area of distribution was well defined to the west, but not to the south and to the north. North of the area covered by the acoustic survey, in the Svalbard area, various numbers of blue whiting were caught in the bottom trawl catches during a Norwegian shrimp investigation from mid July to mid August (Fig. 7), (Øynes, not published). This showed that blue whiting were distributed at bottom along the slope north to 78°N , and in small numbers also at $79^{\circ}40'\text{N}$.

The total biomass of blue whiting recorded during the acoustic survey was estimated to 3.0 mill. tonnes, and the abundance to 28.0×10^9 individuals (Table 1). The 1981 year-class and older contributed together with 0.9 mill. tonnes, the 1982 year-class

with 1.0 mill. tonnes and the 1983 year-class with 0.7 mill. tonnes. The 1984 year-class was represented with 0.2 mill. tonnes and the -85 and -86 year-classes with 0.1 mill. tonnes each. The assessed biomass by rectangle is shown in Fig. 8, where also the different sub-areas used in the calculations are marked.

The total length and age compositions of the stock weighted by abundance are shown on Figs 9 and 10, and for the different sub-areas on Figs 11 and 12 respectively.

The 1986 year-class with length from 10 to 17 cm, was found in sub-area III and IV where it in numbers contributed with 45% and 88% of the observed blue whiting. In total, the contribution of the 1986 year-class was 20%, while the most numerous one, the 1982 year-class, contributed with 27% and the 1983 year-class with 22%.

While in north, in area V and IV, the year-classes 1981 and 1982 were most numerous, the year-classes 1982 and 1983 dominated in south, i.e. area I, II and VII.

The blue whiting caught in bottom trawl at the slope in the Svalbard region (Fig. 7) was mostly large fish with length between 33 and 40 cm (Fig. 13). The peak length of 37 cm was 10 cm more than found in the total distribution from the acoustic surveyed area in the Norwegian Sea (Fig. 9).

The total weight/length relationship of blue whiting is plotted on Fig. 14.

DISCUSSION

The biomass and abundance by year-class estimated during the blue whiting surveys in the Norwegian Sea since 1983 are given in the text-table below.

1983			1984			1985			1986		
Age years	t·10 ⁻⁶	N·10 ⁻⁹	Age years	t·10 ⁻⁶	N·10 ⁻⁹	Age years	t·10 ⁻⁶	N·10 ⁻⁹	Age years	t·10 ⁻⁶	N·10 ⁻⁹
0	0.22	8.5	0	0.05	2.1	0	0.03	2.2	0	0.08	5.0
1	1.52	22.7	1	1.77	30.6	1	0.47	6.0	1	0.13	2.0
2+	1.09	5.3	2	1.56	14.6	2	2.40	24.0	2	0.17	2.1
			3+	0.41	1.9	3	1.58	12.5	3	0.71	5.9
						4+	0.46	2.4	4	1.05	7.9
									5+	0.87	5.1
Total	2.83	36.5		3.79	49.2		4.94	47.1		3.02	28.0

The estimate obtained in 1986 (3.0 mill. tonnes and 28.0×10^9 specimen) indicates a reduction both in biomass and in number of approximately 50% compared to the 1985 survey and back to a level close to the level found in 1984.

The Blue Whiting Assessment Working Group has considered all the ICES coordinated blue whiting surveys in the Norwegian Sea as underestimates for a number of reasons (Anon., 1986), and as the procedures and methods have not been changed, the estimates obtained in 1986 is most probably also an underestimate. During a Workshop in 1985 (Anon., 1985b) the problems were discussed in detail. One of the big problems identified by the Workshop was that most vessels were not able to detect or integrate single fish concentrations of blue whiting at the relevant depths. This means that a certain minimum concentration of blue whiting was needed in order to have a proper integration. This minimum concentration varied between vessels.

The threshold effect was clearly demonstrated by the intercalibration between "Eldjarn" and "G.O. Sars" in which the standard target corrigated values of "Eldjarn" had to be multiplied by 1.82 in order to be of the same levels as the "G.O. Sars" values (Monstad, 1986).

None of the vessels participating in the 1985 and 1986 surveys were able to integrate properly single fish concentration of blue whiting at depths larger than 133 m, and for this reason alone the estimate for large areas of the Norwegian Sea must be underestimated. With the present methodology it is not possible to adjust for this effect either.

A change in the migration routes into the Norwegian Sea has been demonstrated due to changes in the hydrographic conditions (Schevchenko, 1984, Schevchenko and Isaev, 1983 and 1985, and Monstad and Blindheim, 1986). In years with a strong influx from the East Icelandic current the cold water acts as a barrier for the post-spawners migrating north in the western part of the Norwegian Sea forcing them to follow a more eastern route. It is hard to quantify this effect on the assessment, if any. However, blue whiting migrating north in the eastern parts of the Norwegian Sea are dispersed over larger areas, and in this case the bias introduced by the threshold effect may be increased.

As mentioned above the methods used during the blue whiting surveys since 1982 has not been changed, and the C_F value used to convert integrator values into biomass has also been the same. It is, however, worth noting that the C_F value used for young cod, which previously was the same as used for blue whiting, has now been changed to a value almost 2 dB larger (Aglen *et al.*, 1985, Hysten *et al.*, 1986). Applying the new cod value on blue whiting would result in an almost 100% increase of the present assessment.

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Shevchenko, A.V. and Isaev, N.A. 1985. Peculiarities of blue whiting distribution in the Norwegian Sea in spring-summer 1983 and 1984 in relation to hydrographic conditions. ICES, C.M. 1985/H:14, 1-11 [Mimeo].

Table 1. Biomass (tonnes $\times 10^{-3}$), abundance ($N \times 10^{-6}$), size of distribution area (n.mile²), density (tonnes/n.mile² and $N \times 10^{-3}$ /n.mile²) of blue whiting by year-classes and areas in the Norwegian Sea. July/August 1986.

Area Year class	VII		I		II		III		IV		V		VI		Total	
	Biom.	N	Biom.	N	Biom.	N	Biom.	N	Biom.	N	Biom.	N	Biom.	N	Biom.	N
1986	-	-	-	-	0.1	3	42.2	3012	32.2	2003	-	-	-	-	74.5	5018
1985	6.5	72	33.4	627	60.1	825	10.4	146	0.1	1	7.2	89	14.8	248	132.5	2008
1984	50.0	658	17.5	262	70.5	833	21.5	214	0.5	4	4.0	42	5.3	68	169.3	2099
1983	99.9	887	80.8	738	290.1	2418	167.9	1290	10.2	68	28.0	197	37.3	278	714.2	5858
1982	284.0	2104	102.1	853	329.7	2594	189.7	1386	19.4	122	54.5	358	67.9	480	1047.3	7897
1981+	250.4	1299	77.3	498	175.5	1174	95.6	585	12.9	77	139.1	700	134.4	737	885.2	5070
Sum	690.8	5020	311.1	2978	926.0	7847	527.3	6633	75.3	2275	232.8	1386	259.7	1811	3023.0	27950
Area size	18003		35112		110876		58581		2586		69622		49486		344365	
Density	38.4	279	8.9	85	8.4	71	9.0	113	29.1	880	3.3	20	5.2	37	8.8	84

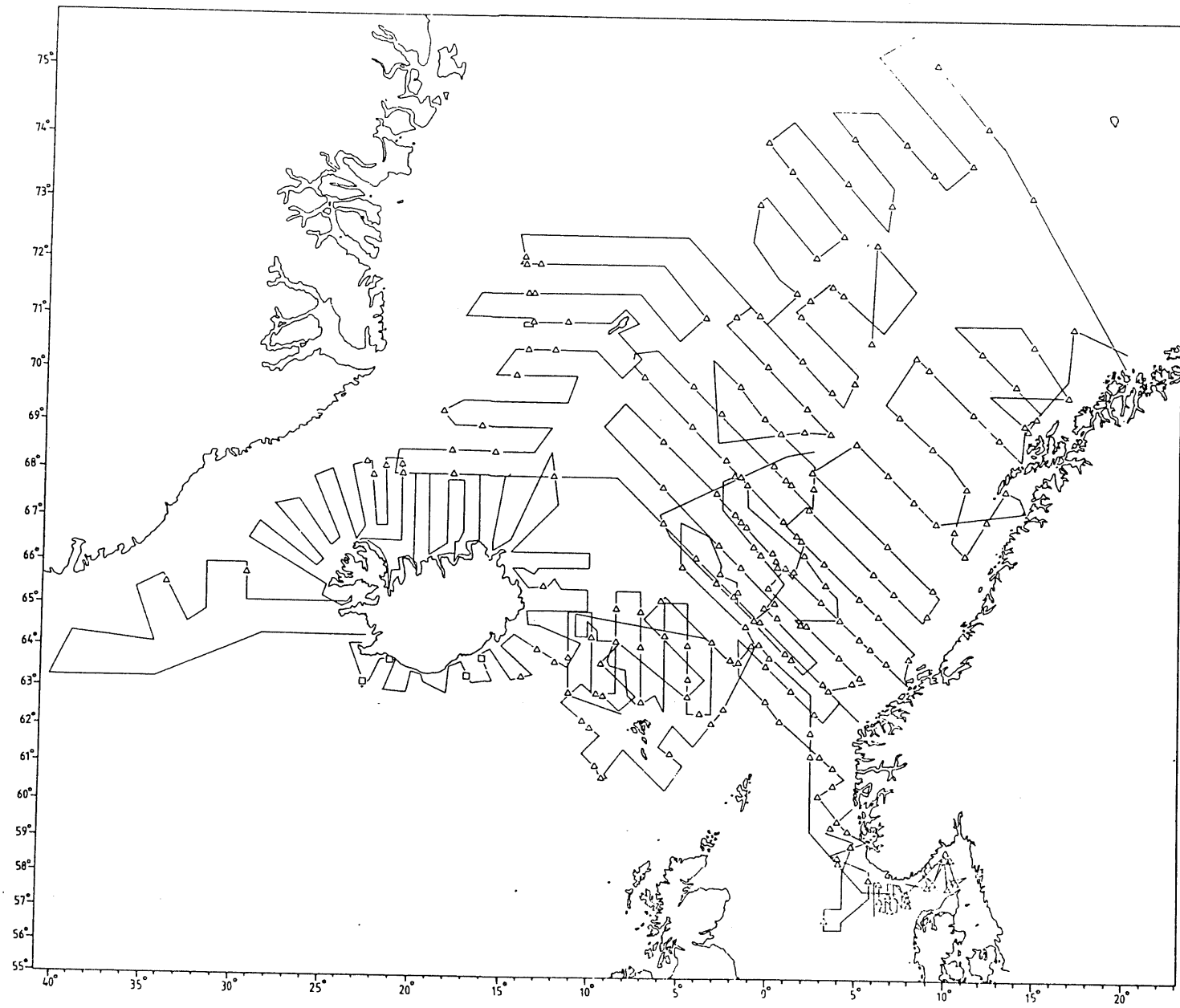


Fig. 1. Cruise tracks and trawl stations of the eight research vessels, August (22.07-31.08) 1986. Symbols: Triangle - pelagic trawl, square - bottom trawl.

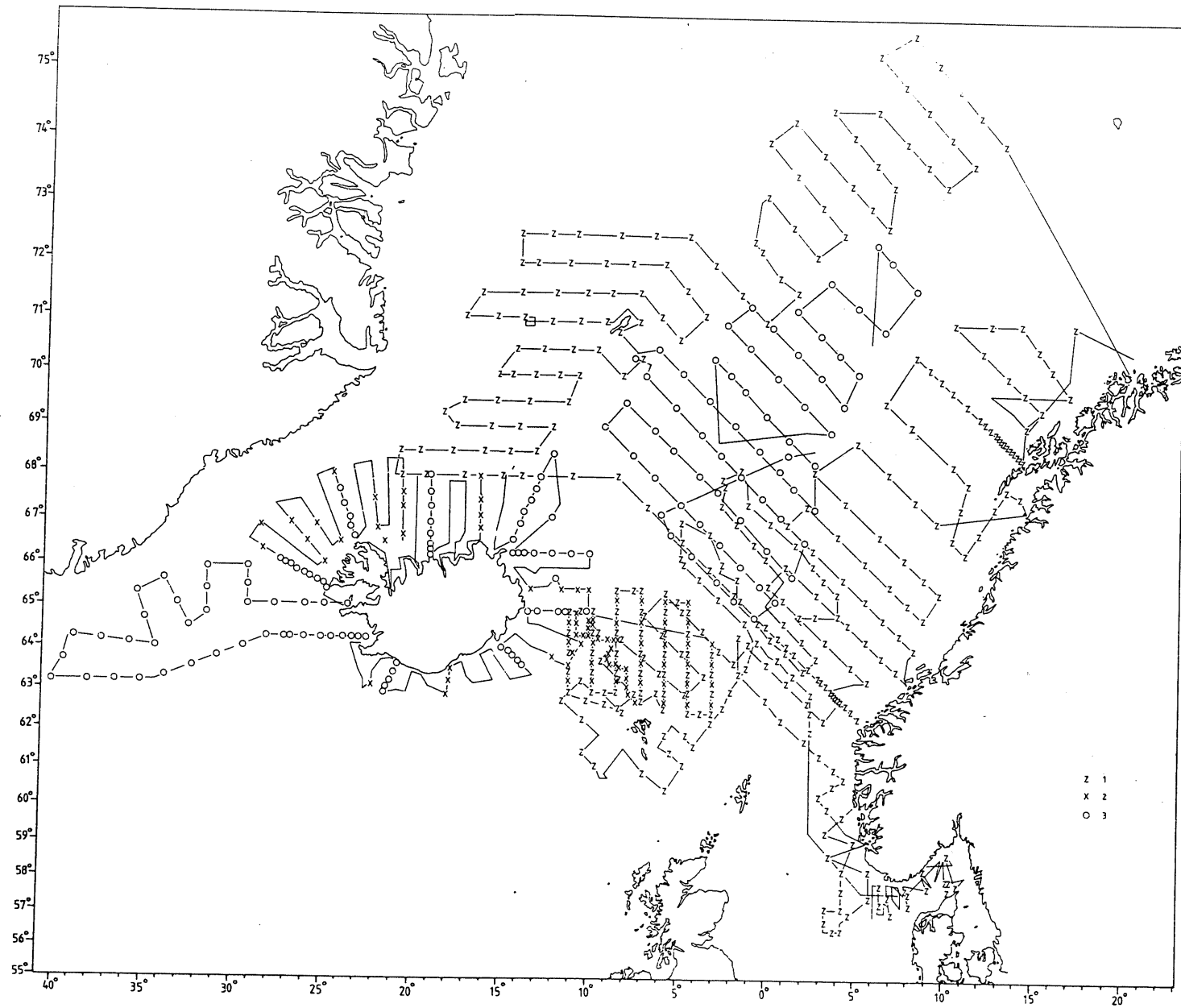


Fig. 2. Cruise tracks and hydrographical stations, August 1986. Symbols: 1) CTD-sonde, 2) bathythermograph, 3) Nansen water-bottles with reversing thermometer.

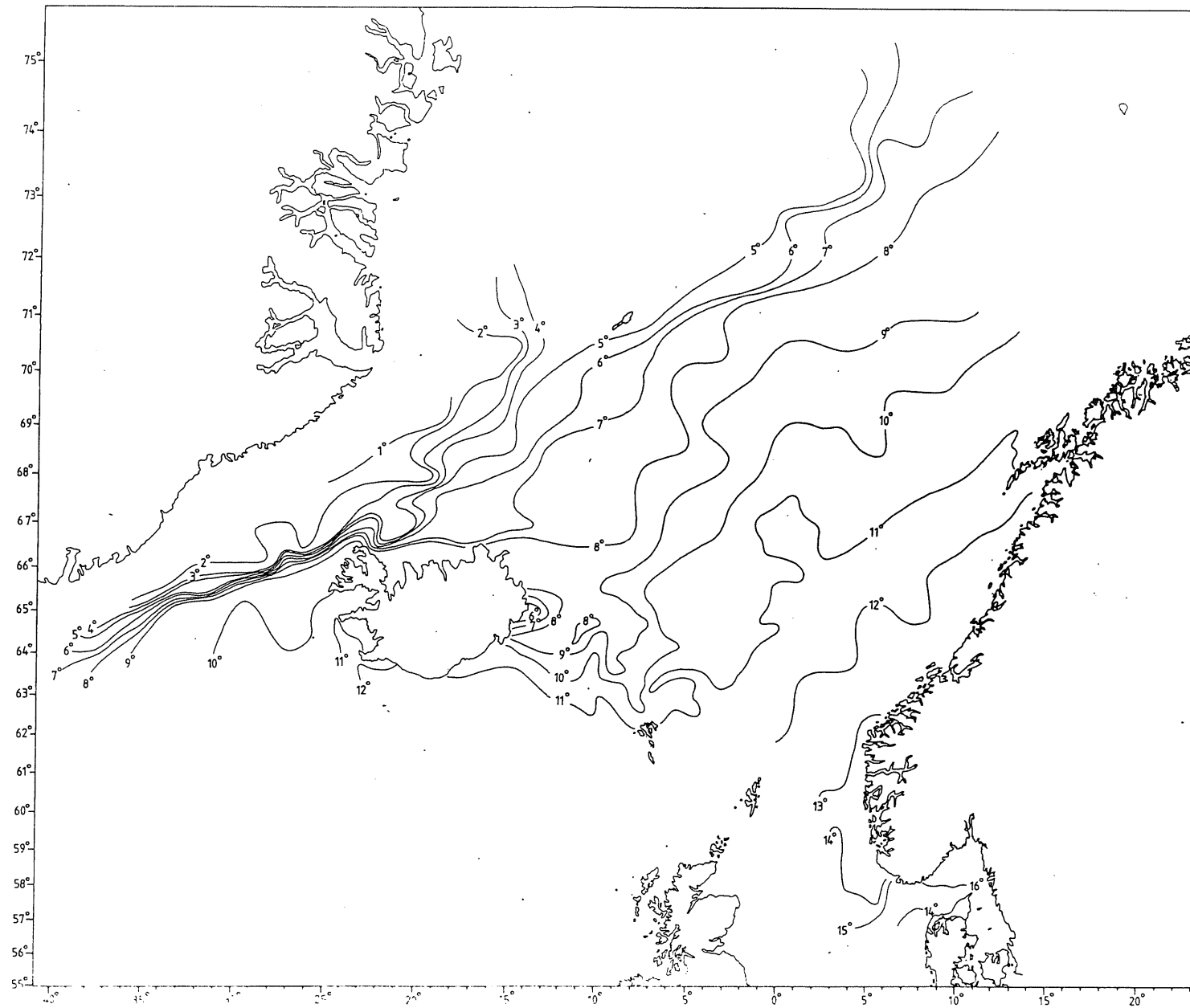


Fig. 3. Temperature ($t^{\circ}\text{C}$) at sea surface, August 1986.

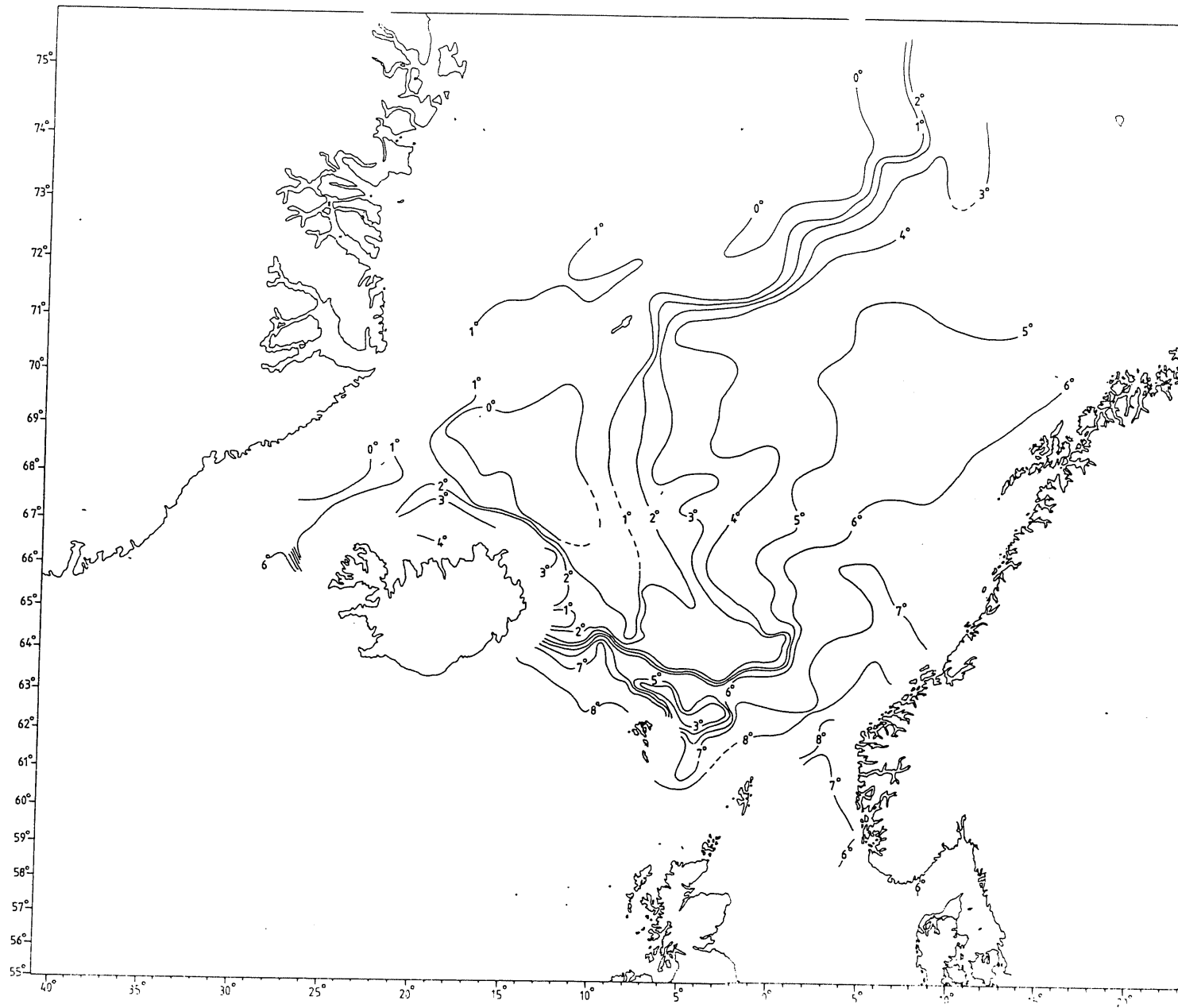


Fig. 4. Temperature ($t^{\circ}\text{C}$) at 200 m depth, August 1986.

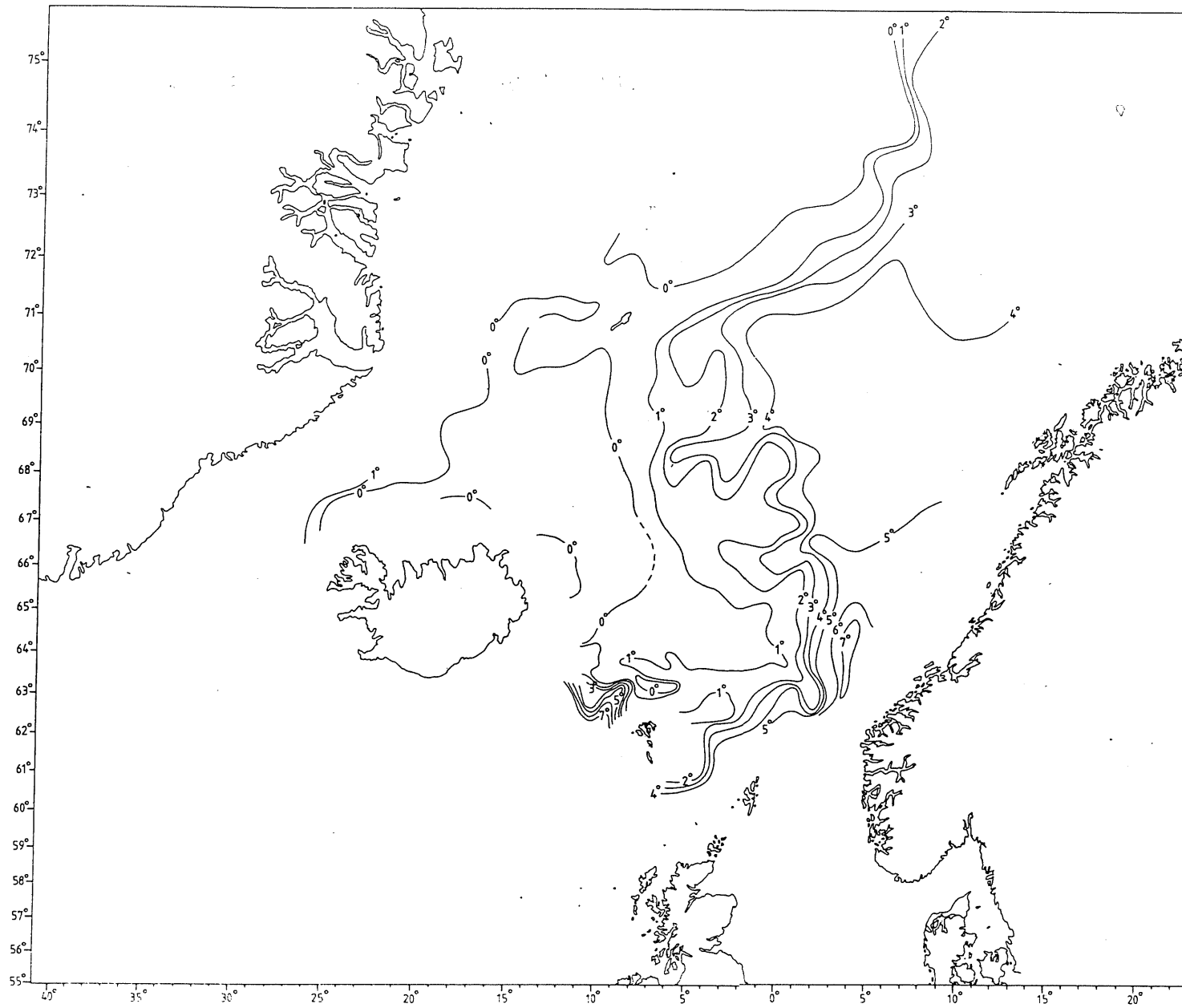


Fig. 5. Temperature ($t^{\circ}\text{C}$) at 400 m depth, August 1986.

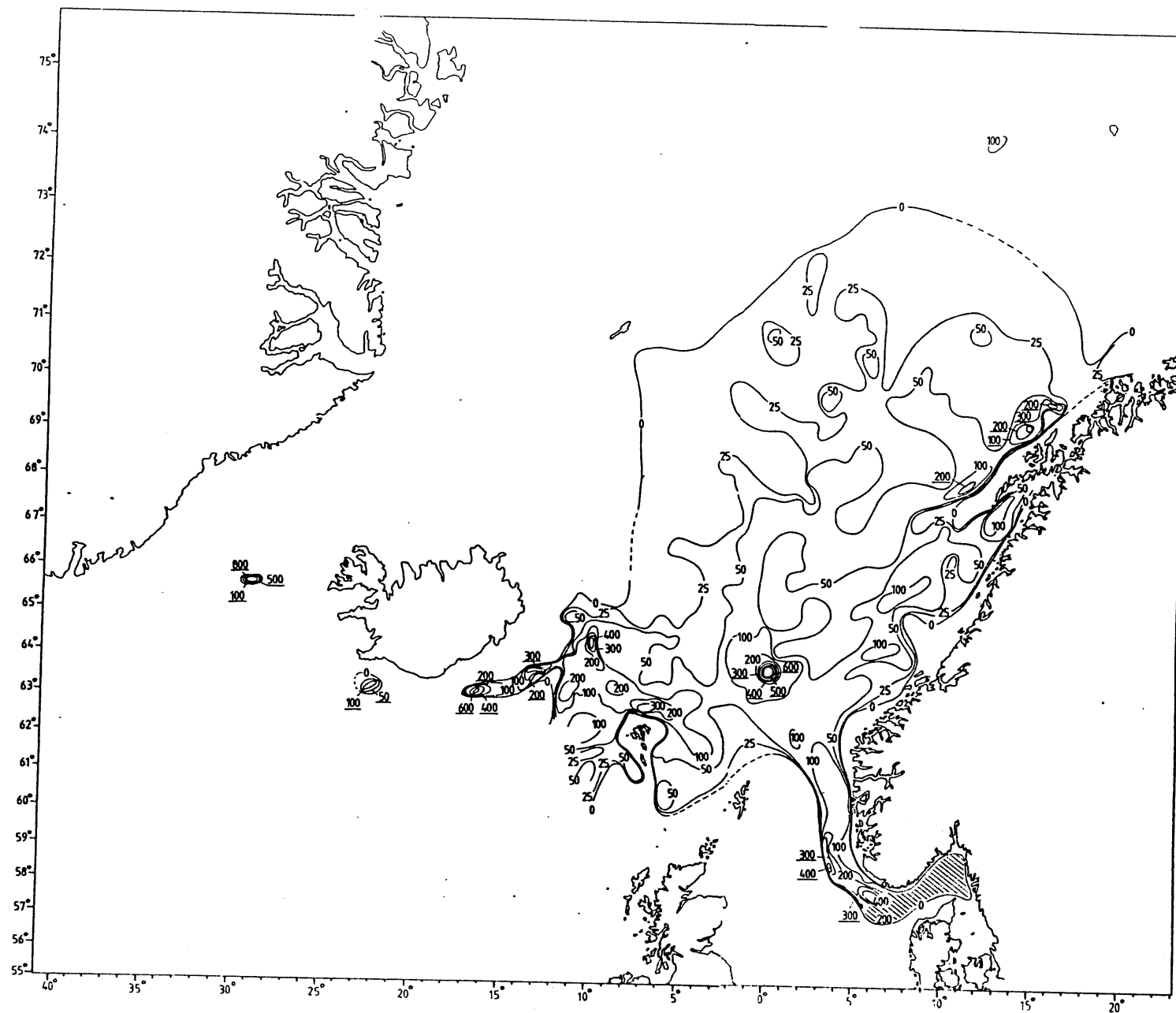


Fig. 6. Distribution and density values of blue whiting, August 1986. Echo intensity in $m^2/(n.mile)^2$. Hatched area in Skagerrak indicate distribution only.



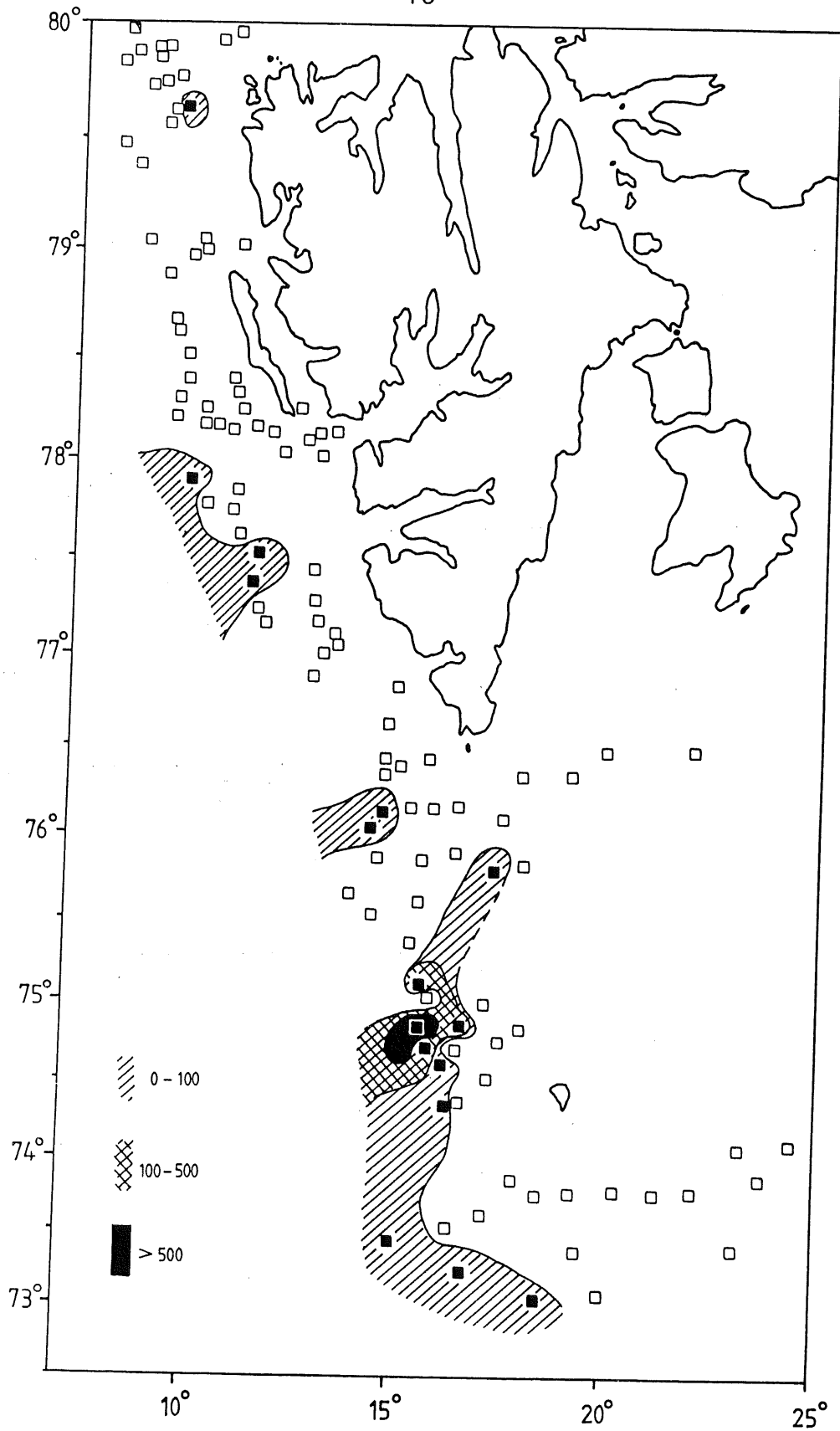


Fig. 7. Observations of blue whiting with R.V. "Michael Sars", 14 July - 15 August 1986. Symbols: Squares - bottom trawl stations, filled: with catch of blue whiting, open: without blue whiting. Different shaded areas indicate different numbers of blue whiting caught per hour of trawling (From Øynes, P., unpublished).

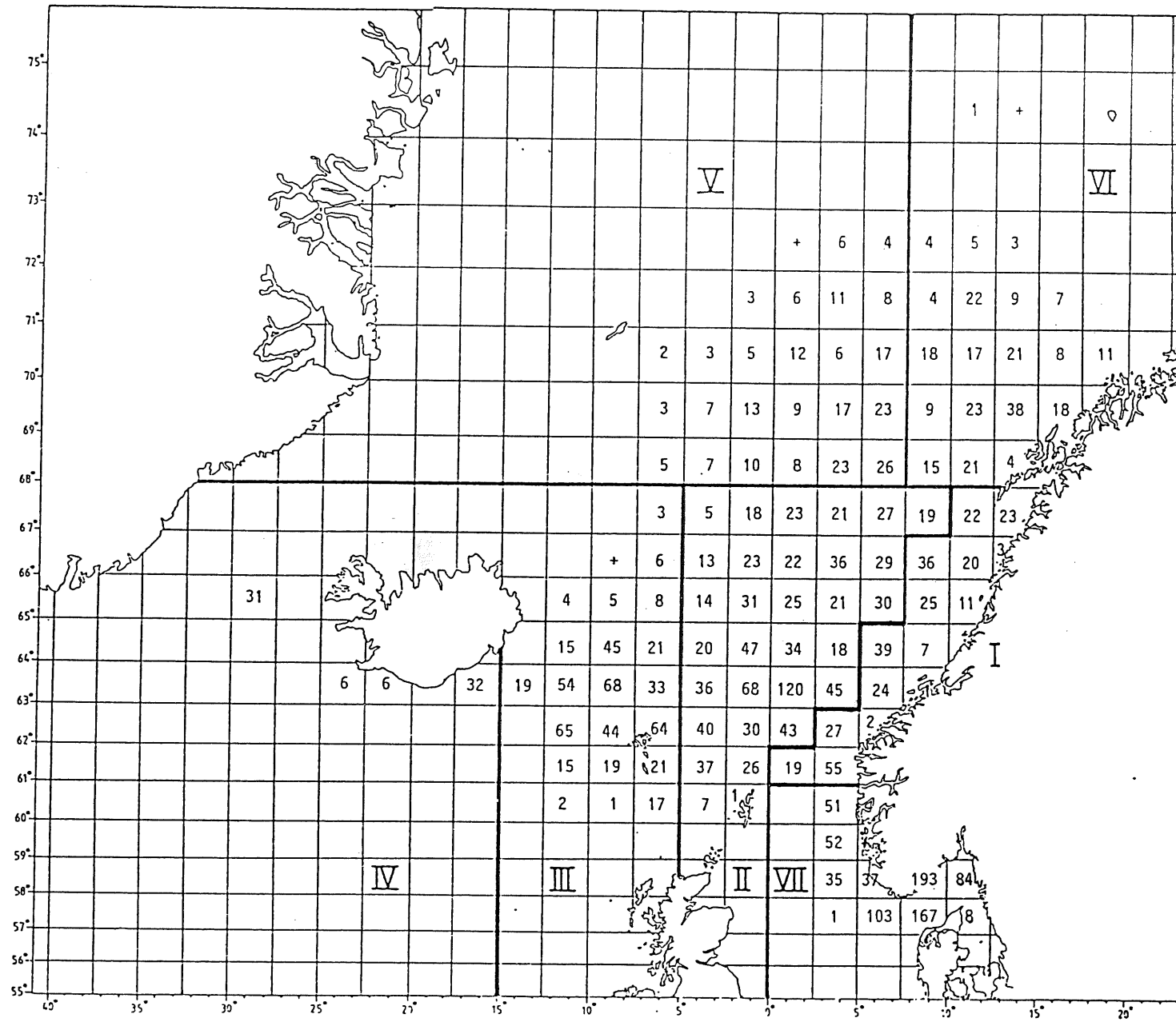


Fig. 8. Biomass of blue whiting (1000 tonnes) splitted on rectangles, August 1986. Markings of sub-areas I-VII.

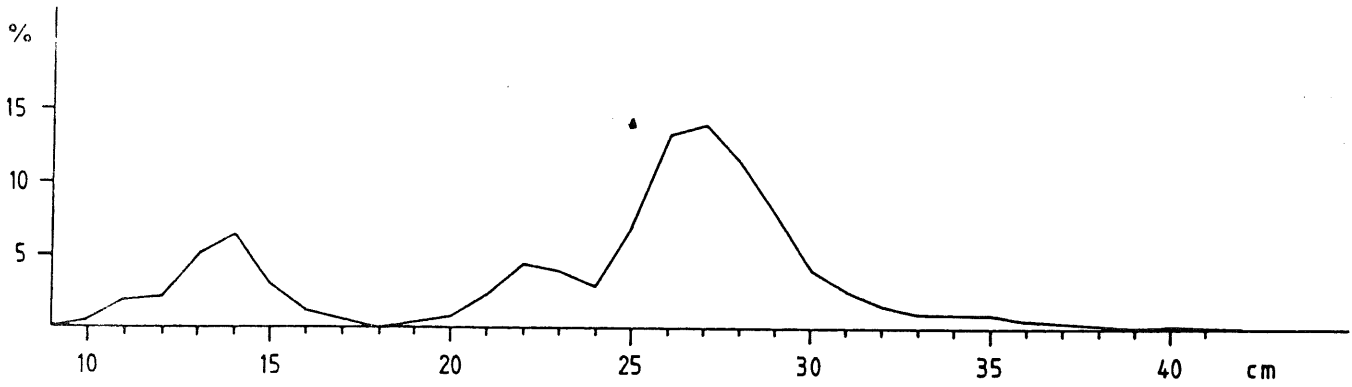


Fig. 9. Total length distribution of blue whiting weighted by abundance, Norwegian Sea, August 1986. N: 28.0×10^9 specimens.

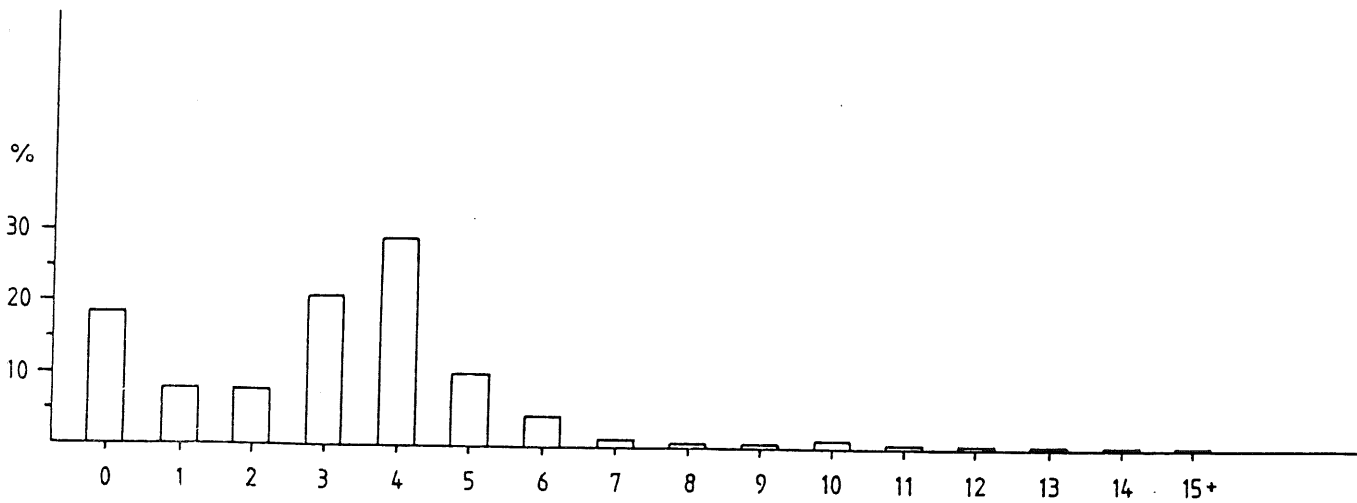


Fig. 10. Total age composition of blue whiting, Norwegian Sea, August 1986. N: 28.0×10^9 specimens.

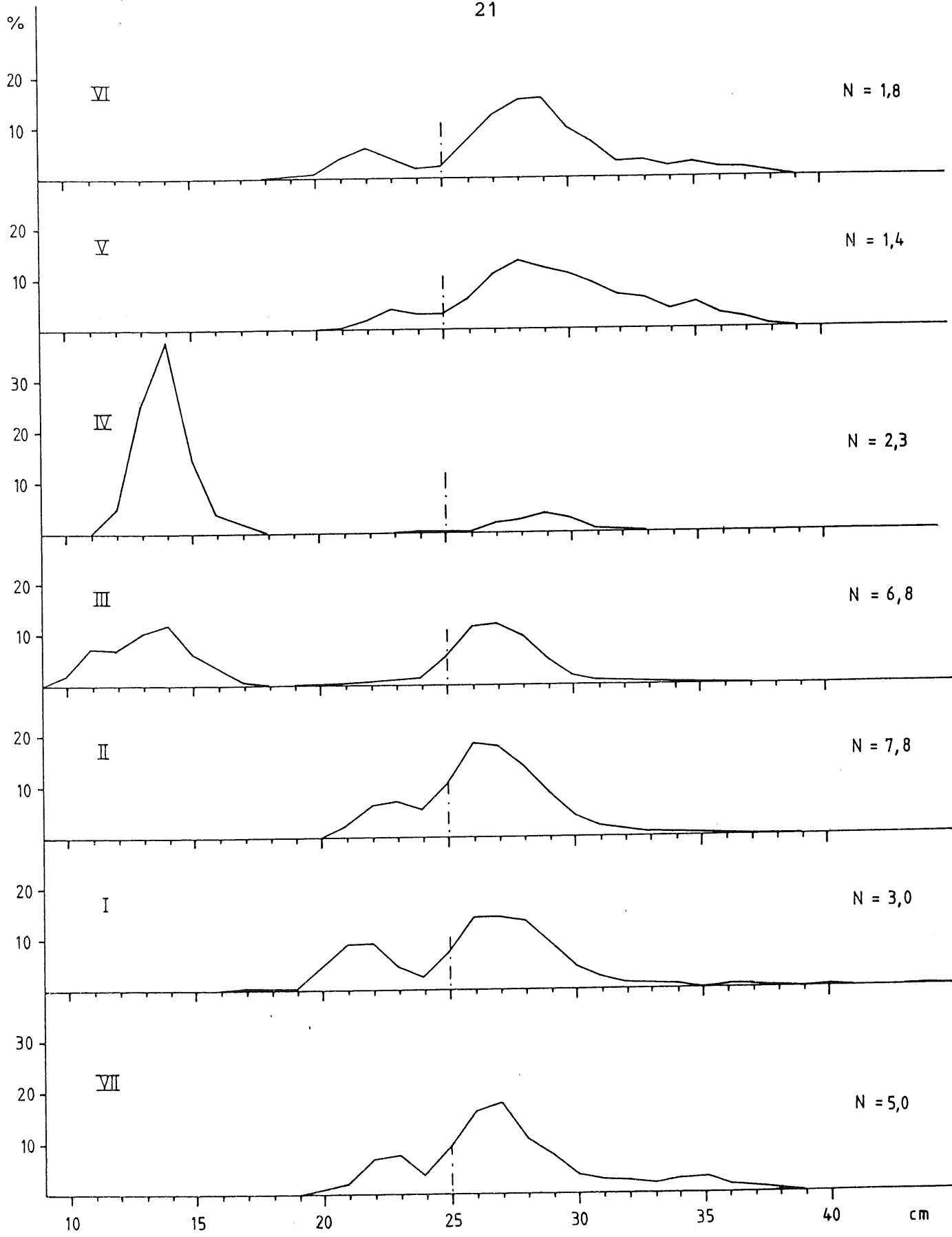


Fig. 11. Length distributions of blue whiting weighted by abundance in the different sub-areas (see Fig. 8). N: x 10⁹ specimens.

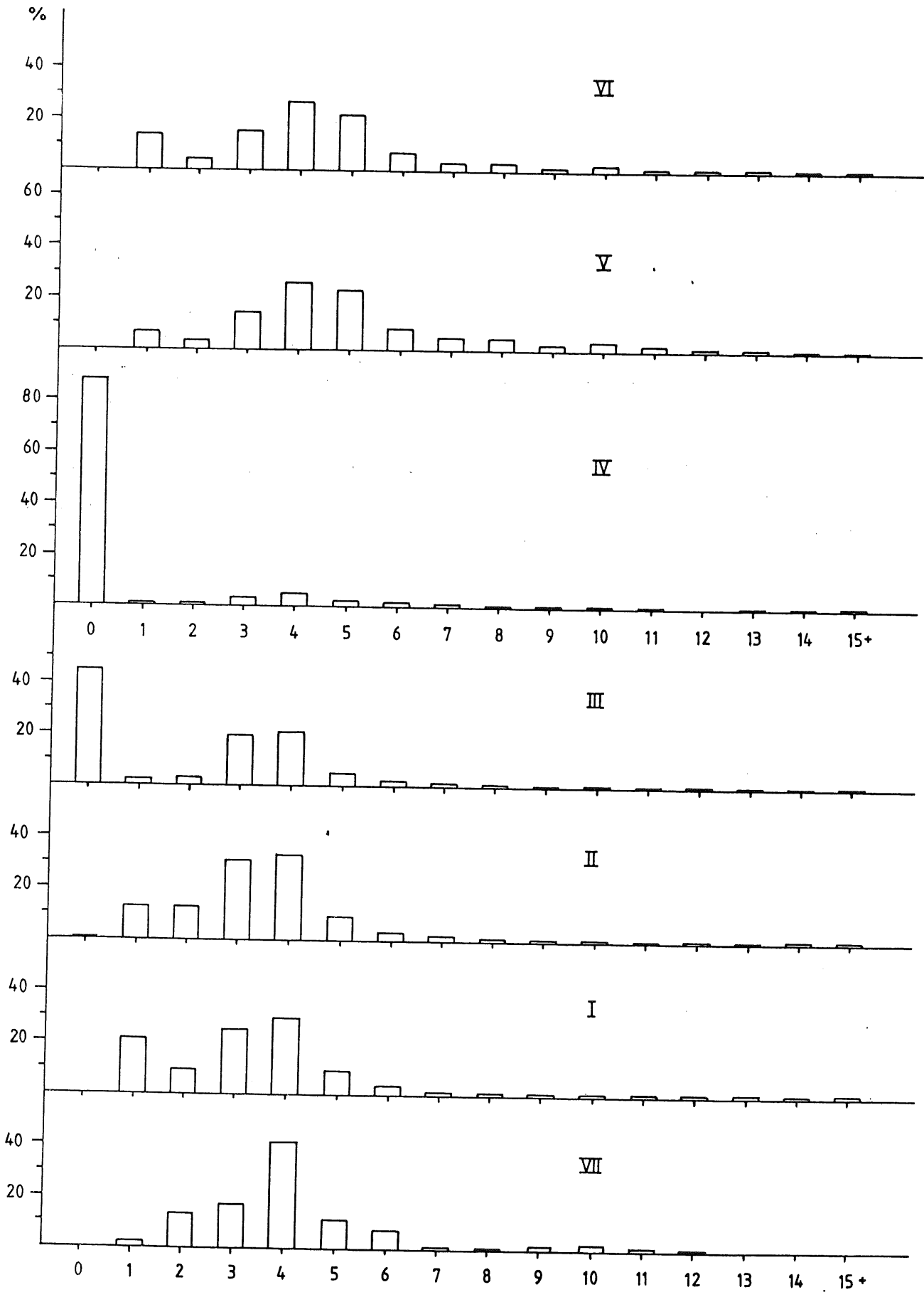


Fig. 12. Age compositions of blue whiting weighted by abundance in the different sub-areas (see Fig. 8). N: same as in Fig. 11.

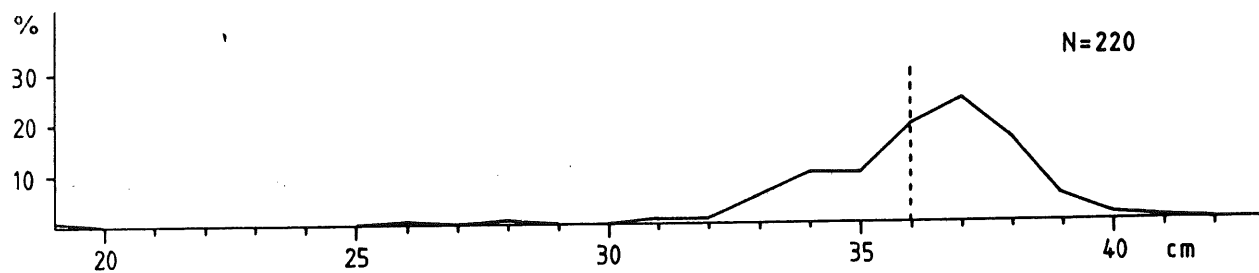


Fig. 13. Length distribution of blue whiting from bottom trawl catches in the Svalbard area, 14 July - 15 August 1986 (see Fig. 7). (From Øynes, P., unpublished).

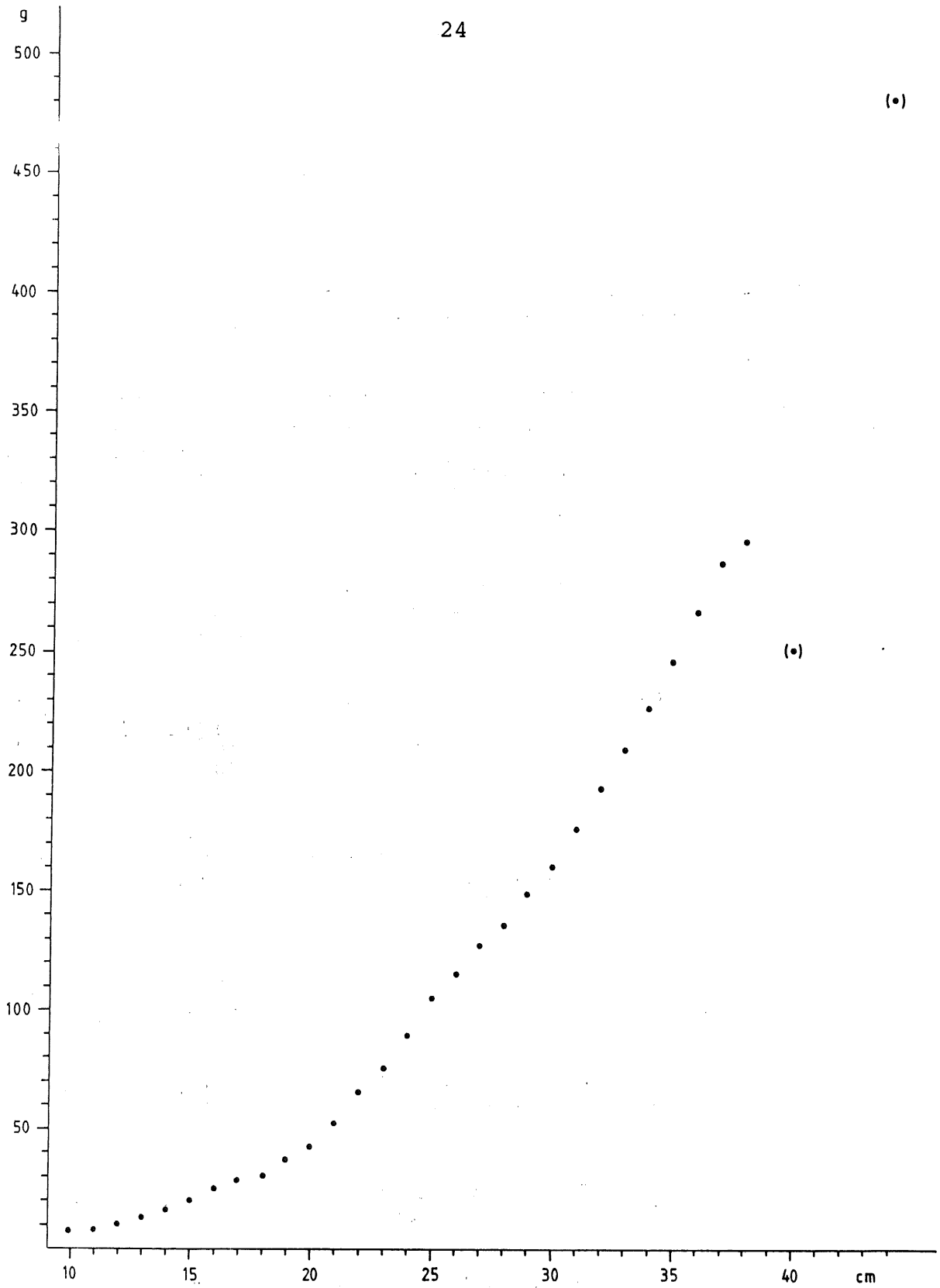


Fig. 14. Total length/weight relationship of blue whiting, Norwegian Sea, August 1986.

Appendix I

Blue whiting acoustic survey, Norwegian Sea, 1986.

Survey period	Research vessel	Institute	Scientific staff
30.07 - 18.08	"Vilnyus"	Polar Research Institute of Marine Fisheries and Oceanography - PINRO - Murmansk USSR	Vanjukhina N.V., Zubov V.I., Lovchikov A.L., Mamylov V.S. Pavljuchenko L.L., Semochkin A.I., Ustinov S.B. Ushakov N.G., Shabalin B.S.
29.07 - 18.08	"Eldjarn"	Havforskningsinstituttet Bergen, Norway	Blindheim J., Midttun O. Tangen Ø., Torgersen Ø. Valantine A., Østensen Ø.
23.07 - 17.08	"G.O. Sars"	Havforskningsinstituttet Bergen, Norway	Gullaksen O., <u>Monstad T. (co- ordinator)</u> , Sælen E., Wallevik M., Austgulen L., Abrahamsen H., Mørk T., Totland A.
10.08 - 31.08	"Eisbär"	Institut für Hochsee- fischerei und Fisch- verarbeitung, Rostock GDR	Vaske B., Gentzen B., Hamann K., Albrecht J., Buck W.
07.08 - 25.08	"Arni Fridriksson"	Hafrannsóknastofnunin Reykjavik, Iceland	Sveinbjörnsson S., Helgason V.
06.08 - 21.08	"Bjarni Sæmundsson"	Hafrannsóknastofnunin Reykjavik, Iceland	Vilhjalmsson H., Magnusson J.V., Malmberg S.A. Reynisson P., Astthorsson O.
07.08 - 19.08	"Magnus Heinason"	Fiskirannsóknarstovan Torshavn, Faroe Islands	Í Jákupsstovu S.H., Thomsen B. Kristiansen R.
12.08 - 26.08	"Dana"	Danmarks fiskeri- og havundersøgelser Hirtshals, Denmark	Ståhr K.J., Filt Jensen T., Degnbol P., Henriksen W., Jansen C., Hansen A.D., Kirkegaard E., Lewy P., Harr T., Dahlskov J., Palmen L.E.