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International Council for the
Exploration of the Sea

C.M. 1966/H: 23
Herring Committee
Gadoid Committee

Attn. Comparative Fishing Committee
Hydrographic Committee

Preliminary Report
of the joint international 0-group fish survey in the
Barents Sea and adjacent waters August/Sept 1966.

1. Introduction

Following the recommendation of the 1964 meeting of the ICES Herring Committee, Soviet and Norwegian research vessels undertook joint surveys of the distribution of the early stages of herring in the eastern Norwegian Sea and in the Barents Sea. The first joint survey was carried out in 1965 and from the results it was concluded that the method used could give a reliable estimate of the distribution of 0-group herring, and that the survey could usefully be extended to include 0-group stages of other important species, e.g. cod, haddock, redfish (Anon 1965) ! In accordance with this enlarged scope of the survey the English research vessel was invited to participate in the survey reported here, which took place August 28th - September 10th 1966.

The vessels taking part, and the scientists in charge of each vessel were:

U.S.S.R.	R/V Akademik Knipovich	Yu. K. Benko
	R/V Fritjof Nansen	A.S. Seliverstov
Norway	R/V Johan Hjort	L.Midttun, P.T.Hognestad
	R/V G.O.Sars	O.Dragesund
England	R/V Ernest Holt	D.J.Garrood

The success of a survey of this kind depends upon close cooperation between scientists of different disciplines and a full list of those taking part is given in an appendix.

The preliminary programme for the 1966 survey was discussed at a meeting in Bergen in June 1966 and final arrangements were concluded in Murmansk on August 25th - 27th. When the survey had been completed a third meeting was held in Tromsø, Norway September 11th - 14th to analyse the data collected.

2. Programme and Methods

The survey track of the five vessels is shown in Figure 1. This is similar to the 1965 grid, but the participation of the additional vessel made it possible to survey the whole area in more detail, and to extend it further west into the Norwegian Sea.

The basic technique employed was echo-sounding of the pelagic scattering layer with periodic midwater trawl hauls to identify the traces (Dragesund and Olsen 1965). So far as possible the apparatus used was standardised between vessels, but to ensure comparability of the results a preliminary intership calibration experiment was carried out before the survey commenced.

During the survey a continuous record of the pelagic scattering layer was collected with trawl stations being placed at appropriate intervals and depths determined by the characteristics of the trace, but not more than 40 miles apart in areas where a scattering layer was being recorded. In addition some control trawl hauls were carried out on the sea bed to determine the presence of o-group fish that had already migrated out of the pelagic scattering layer.

Figure 1 also indicates the grid lines which were worked as hydrographic sections in order to relate the distribution of organisms in the scattering layer to the principal hydrographic features of the region.

3. General Outline of Results

The time available at Tromsø at the end of the survey was not sufficient to carry out a comprehensive analysis of the data. In particular it was not possible to complete the interpretation of the hydrographic data in the absence of salinity determinations, and in the fish samples there are evidently some very interesting variations in the development of the o-group stages between different areas. These aspects of the investigation will be reported at a later date and this preliminary report will only describe the distribution of temperature and of the o-group fish with comments on their abundance.

3. 1. Hydrography

On the hydrographic sections of the survey both temperature and salinity were recorded in order to determine the current and transport system which has carried the o-group fish from the spawning grounds up to their present localities. At present the salinity samples have not been analysed so it is only possible to discuss the temperature conditions which are presented as a series of horizontal and vertical sections in Figure 2, 3 and 4.

Even in the absence of the salinity measurements the general features of the current system are evident as tongue - shaped displacements of the isotherms, for example off West Spitsbergen and along the banks of Novaya Zemlya.

In the south western Barents Sea, up to approximately 37°E the temperature of 0-30 m layer was somewhat lower than average, and in the south eastern area it was considerably below the average for this time of year. Similarly the mean temperature of the 0-200 m layer of the North Cape - Bear Island section was 5.5°C (0.5°C below average) and in the Kola section across the Murman Current the anomaly of the 0-200 m layer amounted to $\pm 1.3^{\circ}\text{C}$ (0-50 m layer - 0.70°C and 50-200 m layer- 1.5°C). Slightly above average surface water temperatures were only found in a very narrow band off the Murman Coast.

These predominantly negative anomalies suggested that either there has been an increased level of thermal loss from the sea surface during the winter of 1965/66, or the volume transport within the current system is below average. However, it is not possible to reach a definite conclusion until the salinity determinations have been analysed.

3. 2. Distribution and abundance of o-group fish

A chart of variations in the density of the total pelagic recordings is presented in Figure 5. It can be seen that the most dense traces were obtained between North Cape and Bear Island, at Spitsbergen, and in the eastern Barents Sea, but as in previous surveys many other organisms besides the o-group fish have contributed to these traces. In general terms the o-group fish were most abundant in the west and central area of the Barents Sea. Elsewhere adult herring were present in the north-eastern Norwegian Sea ($73^{\circ}00'\text{N}$ - $75^{\circ}00'\text{N}$ and $05^{\circ}00'\text{E}$ - $15^{\circ}00'\text{E}$) and herring of the 1963 and 1964 year-classes were present off the East Finnmark coast southeastward to $40^{\circ}00'\text{E}$. Similarly adult blue whiting were found along the eastern boundary of the Norwegian Sea, and adult polar cod and capelin were widely distributed in the north-eastern Barents Sea from south east of Hope Island, east to Novaya Zemlya through the area where the pelagic scattering layer was almost entirely absent. Concentrations of adult polar cod also extended into the south eastern Barents Sea.

These larger echo scatterers gave a readily identifiable trace which could be excluded from the total survey trace in Figure 5. However, in addition, in the north-eastern Barents Sea, in a limited area near the Norwegian coast, and at Spitsbergen, the o-group fish were heavily mixed with larger invertebrate organisms, particularly Euphausiidae, Amphipodae and various medusae. Some allowance has been made for this in assessing the distribution and abundance of o-group fish of different species which are illustrated in Figures 6-11.

These distribution charts are plotted from a consideration of the density of echo-traces attributed to the various species according to the trawl hauls. These catches were also used to confirm the general level of abundance which has been assessed on a scale 1-4 with isolines enclosing areas with reliably distinct levels of trace density. It will be appreciated that these quantities are not precise, but close similarities between the catches of different vessels surveying the same area confirm the general levels shown in the charts.

In addition to the o-group fish of the species discussed below, o-group fish of other less important species were also recorded. For example o-group catfish were very widely, but sparsely distributed and o-group Lumpenus, Cottidae and Myctophidae were occasionally reported and a very few o-group greenland halibut were recorded west of Spitsbergen.

3. 2. 1. Herring (Figure 6)

The o-group herring were restricted to the Norwegian coastal belt with a slight extension northeastwards from North Cape. None were recorded north of $72^{\circ}00'N$ or east of $34^{\circ}00'E$. It appears that the o-group herring had not penetrated into the fjords at the time when the survey was carried out although they were present in the coastal waters. In 1965 the o-group herring had a more offshore distribution.

A very few scattered individuals were recorded along the West Spitsbergen current, but they did not form any identifiable recordary "patch". This distribution contrasts with the results of the 1965 survey which recorded two patches of approximately equal abundance, one midway between North Cape and Bear Island, and a second north west of Bear Island to Spitsbergen.

At that time the abundance of the 1965 year-class of herring was estimated to be very low compared to the more abundant, but still below average year-classes of 1963 and 1964. On this basis the present survey suggests that the 1966 year-class is also exceptionally low and this corresponds with the results of Norwegian and U.S.S.R. larval surveys carried out off the Norwegian Coast earlier this year.

3. 2. 2. Cod (Figure 7)

The distribution of o-group cod was broadly similar to that of herring, but extended further to the north east, towards Central Bank. Even within this area they were very scarce indeed. Only 20 individuals were caught and in view of this scarcity only the trawl stations where cod were taken have been shown in the chart: no isolines can be drawn. No o-group cod were found north of Bear Island and extensive bottom trawling in that area at varied depths, and elsewhere in the eastern Barents Sea, failed to locate any o-group fish on the sea-bed.

This confirms Baranenkova's opinion that o-group cod are still present in the pelagic scattering layers at the time of the survey (Baranenkova, Drobysheva and Ponomarenko 1964). Therefore the 1966 year-class of cod must be expected to be very poor indeed and this again confirms the results of larval surveys carried out earlier this year.

3. 2. 3. Haddock (Figure 7)

O-group haddock were even less numerous than the cod, only 8 specimens being caught during the survey. For this reason the data have been illustrated in the same way as for the cod and included in Fig.7. None were recorded as far north as Bear Island, but it is not possible to define their distribution accurately. However, it is clear that as for herring and cod the 1966 year-class must be extremely poor.

3. 2. 4. Saithe (Figure 7)

The o-group saithe have not yet been found in the scattering layer forming characteristic traces. This was also the case during the present survey, although a few specimens were taken in the trawl catches. The o-group saithe were found somewhat more westerly and northerly distributed than the cod and haddock (Figure 7).

3. 2. 5. Redfish (Figure 8)

O-group redfish were by far the most abundant pelagic echo scatterers in the western Barents Sea south of Bear Island between 15°00'E and 33°00E. The western boundary of this distribution corresponded closely with the edge of the continental shelf and spread north and eastward along the main branches of the oceanic currents, reaching as far north as Prince Charles Foreland off West Spitsbergen and to the Central Bank and Skolpen Bank in the east. However, in the West Spitsbergen current, the distribution of o-group redfish was very indistinct and only scattered individuals were present in trawl catches north of Bear Island. Within the main "patch" it was possible to distinguish a higher level of abundance which is indicated in the chart and which again reflects the orientation of the "patch" along the path of the most important water currents.

The main concentration of o-group redfish corresponds very closely with the distribution recorded in the previous years, but its northerly extension to West Spitsbergen was very poorly represented compared to the results of the 1965 survey.

On the other hand the complete survey suggests that in 1966 o-group redfish are significantly more abundant than in 1964 and 1965 although these two year-classes were also considered to be above average strength. Consequently this holds a good prospect for the redfish fishery in future years.

3. 2. 6. Capelin (Figure 9)

O-group capelin were found over a very wide area, but once again in contrast to the 1965 survey they were poorly represented along the West Spitsbergen current with only a slight trace being recorded between Bear Island and the South Cape of Spitsbergen. The main patch was situated slightly further to the east than the concentration of o-group redfish, with a western boundary at about $23^{\circ}00'E$ and extending far to the north-east to the latitude of Hope Island and south-east to the edge of the survey area. It will be evident from the chart that the distribution of o-group capelin tended to be discontinuous within this whole area, but it is possible to say that the main concentration lay between $71^{\circ}00'N$ and $74^{\circ}00'N$. o-group capelin were not found close to the Murman and East Finnmark Coast although spawning is known to have taken place in the latter area during 1966.

The distribution is centered further north and east than the o-group capelin recorded in 1965 and they are considered to more abundant this year.

3. 2. 7. Long rough dab (Figure 10)

The distribution of long rough dab overlapped that of o-group capelin over a wide area, but it extended further to the northwest beyond Bear Island to Spitsbergen and it had a particularly marked northeastward extension past Hope Island and beyond the limit of the survey. Long rough dab do not give such a well defined echo as other species so that it was not possible to form a reliable estimate of the varying abundance of fish within the whole area. However, the trawl catches indicate that there was an area of greater abundance in the southwestern half of the total distribution, between $72^{\circ}00'N$ to $74^{\circ}00'N$, and $17^{\circ}00'E$ to $35^{\circ}00'E$. This is very similar to the results of previous surveys.

3. 2. 8. Polar cod (Figure 11)

This year it has come desirable to consider the distribution of polar cod because for the first time o-group fish of this species were found in significant quantities. Figure 11 shows the great difference between the distribution of polar cod and that of the other species. Two concentrations were found, one in the southeastern Barents Sea, from $40^{\circ}00'E$, east and northeast beyond the limit of the survey area. A second dense patch covered the banks west and south of Spitsbergen with a "tongue" extending as far south as Bear Island. Here again the northerly limit of the distribution could not be defined within the survey area.

4. Length Compositions (Figure 12)

Figure 12 shows the length composition of o-group redfish, capelin, long rough dab and polar cod, as taken from the total catches of each species by the U.S.S.R. and Norwegian research vessels. The numbers of o-group herring, cod and haddock were not considered adequate to construct an accurate length composition. It is not possible at this stage of the investigation to comment on the comparison with the length composition recorded in 1965, or on the possible variations in length recorded in different parts of the area surveyed.

5. Discussion

There are a number of marked contrasts between the distributions recorded in 1966 and those of 1965. In particular the herring had a very much more coastal distribution than in 1965; although further east, both o-group capelin and long rough dab were absent from the coastal waters off the Murman and East Finnmark coast. This second feature also occurred in 1965. Further north both o-group long rough dab and capelin had a very much more pronounced north easterly extension of their distribution than in 1965 and both species and also o-group redfish were relatively poorly represented northwest of Bear Island. In contrast polar cod were very much more numerous than in 1965 and had the extension southward from Spitsbergen and Bear Island which has not been recorded in previous surveys.

The analysis of the hydrographic data has not yet been carried far enough to relate these differences in the distribution of o-group fish to any distinctive features of the distribution of the water masses. However, an attempt has been made to compare the distribution of o-group redfish and the isotherms in 50 m. Judging from Figure 13 it seems to be a fairly good correlation between the 4°C isotherm and the border of the redfish distribution. This fact indicates that the transport of postlarval fish takes place along the path of the most important water currents and consequently it will be of great importance to relate differences in distribution of o-group fish with any variations in the hydrographic condition.

Investigations carried out by U.S.S.R. earlier in the year have suggested that water transport to the Bear Island area has been weaker than usual (Kislyakov - verbal communication). It is also worth noting that the distribution of o-group capelin lay further to the east than the distribution of o-group redfish and this must be related to differences in either the time or area where spawning takes place.

6. Recommendations

1) The scientists participating in the survey consider that the results are of sufficient interest, that the work should be continued at least until such time as wider fluctuation in year-class strength of the important species have been observed, and until separate assessments of the strength of these same year-classes can be deduced from the commercial fisheries. It will then be possible to evaluate the accuracy of the method for determining year-class strength and will provide further information on the distribution of mortality of young fish during the first year of life.

2) The survey should be maintained in its present enlarged scope for the time being, with a further extension of the area, southwest along the Norwegian coast, to be surveyed before or after the main work as carried out this year.

3) Every effort should be made to improve the techniques and apparatus employed in the survey, particularly with respect to refining the quantitative assessment of the traces, and to identifying the echo-scatterers by new methods in addition to the central midwater trawl hauls.

7. References

- Anon. 1965. Preliminary report of the joint Soviet-Norwegian investigations in the Barents Sea and adjacent waters, September 1965. ICES C.M. 1965, No. 161.
- Baranenkova, A.S., Drobysheva, S.S. and Ponomarenko, J.J. 1964. Vertical migrations and feeding of Cod Fry in the Barents Sea in September/October. Materialy Rybokhozyaistvennykh Issledovaniy Severnogo Basseina 2: 28-34
- Dragesund, O. and Olsen, S. 1965. On the possibility of estimating year-class strength by measuring echo-abundance of 0-group fish. Fisk. Dir. Skr. Havunders. 13(8):48-62.

Appendix

Scientific personnel

U.S.S.R.	R/V Akademik Knipovich.	Yu.K. Benko, A.G. Kislyakov, A.A.Chernyshevich, I.P.Penina, E.S. Demidenko, N.G.Zherebtsova.
	R/V Fritjof Nansen.	A.S.Seliverstov, A.I. Mukhin, R.N. Sarynina, L.Ya.Kaverina, A.I. Chukova, V.N.Dokuchaev,
Norway.	R/V. G.O.Sars.	O.Dragesund, I.Hoff, O.Martinsen, B.Myrseth, O.Chruickshank, G. Sangolt, C.A. Lewis.
	R/V Johan Hjort.	L.Midttun, P.Hognestad, E.Brynildsen, O.Nakken, W.Lstvedt, H.E.Olsen,S.Agdestein, Sujatno Birowo.
England.	R/V Ernest Holt.	D.J.Garrood, R.R.Dickson, R.B.Mitson, J.E.Nicholls, B.K.Clarke.

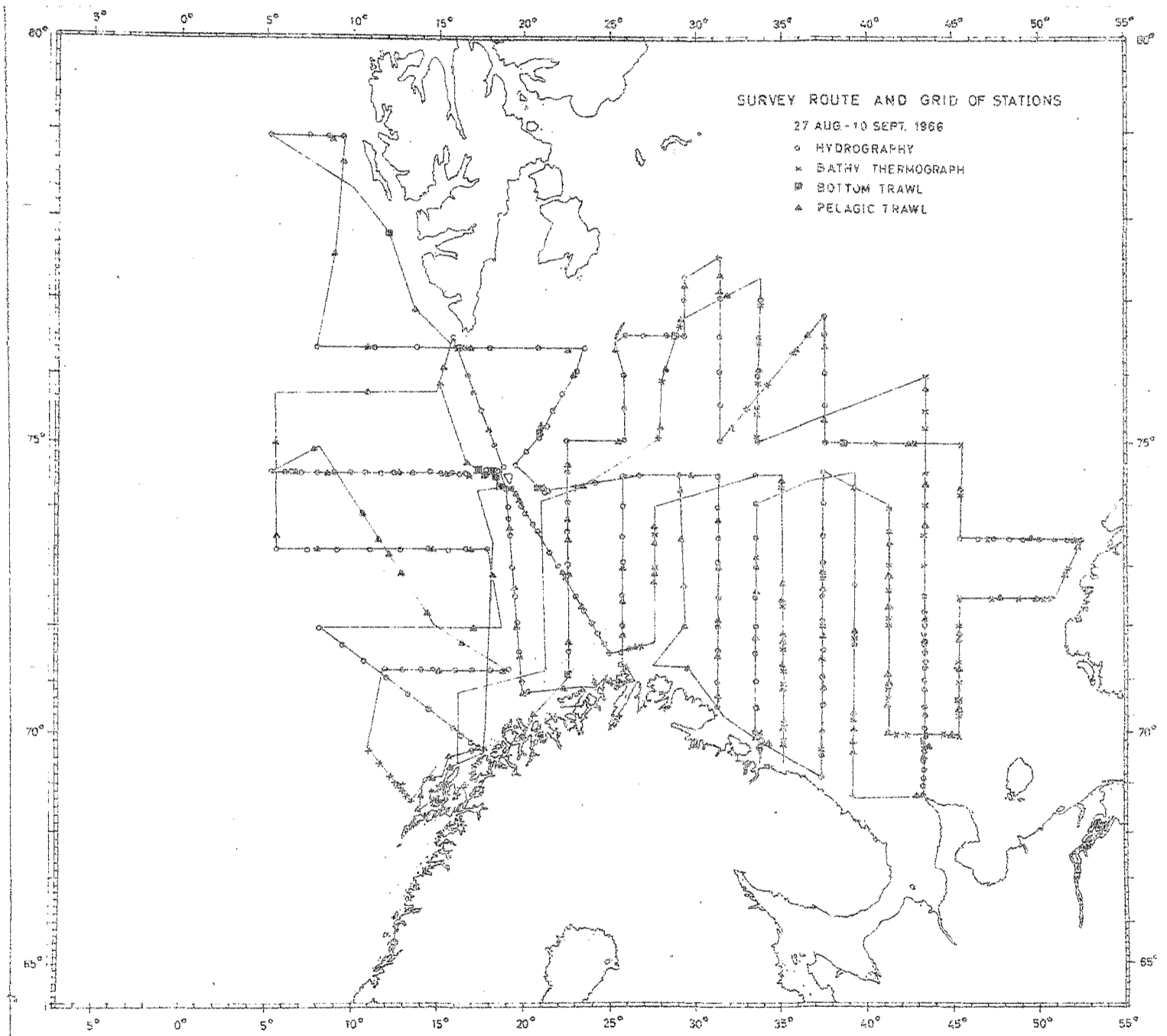


Fig. 1. Survey routes and grid of stations

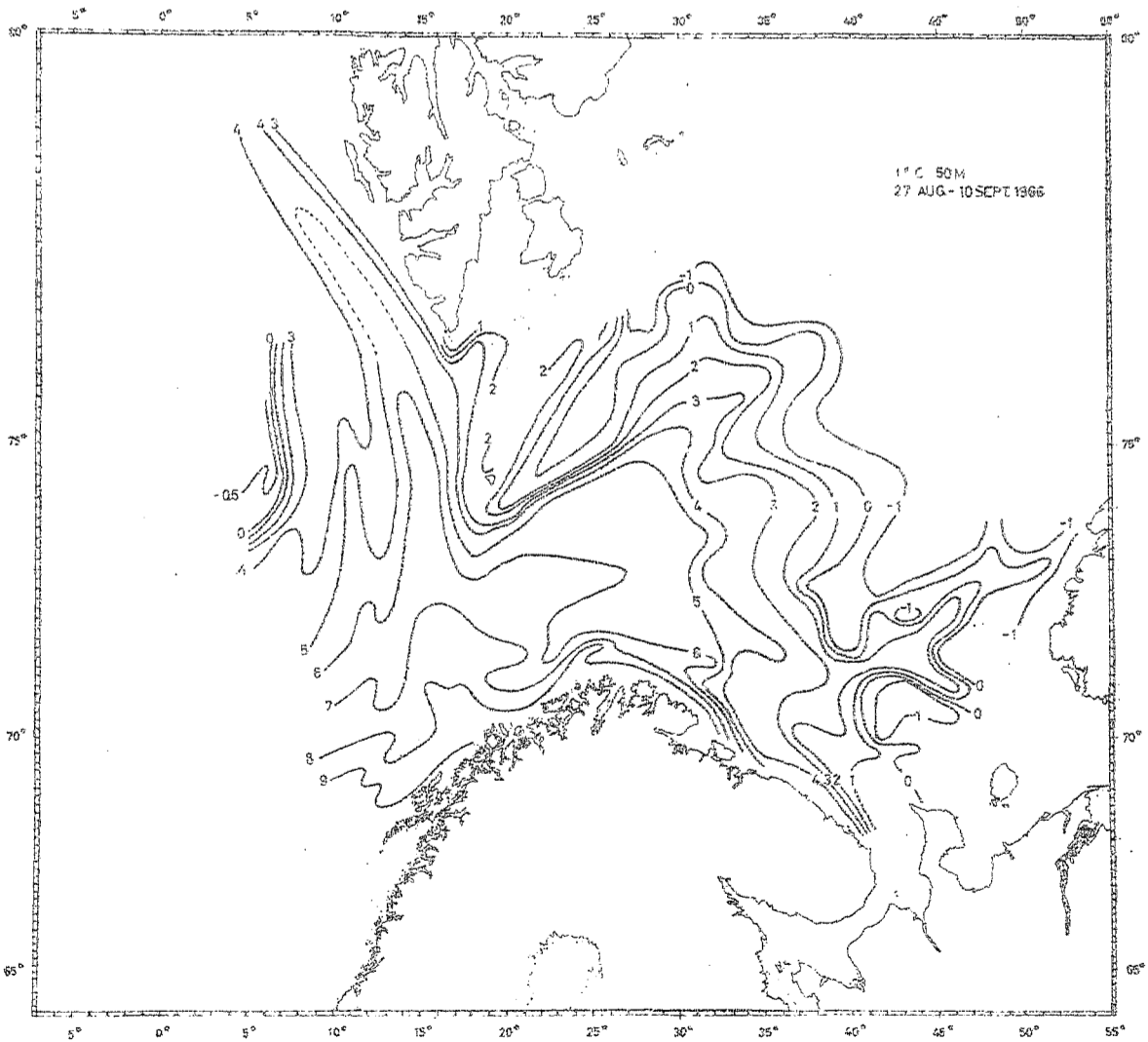
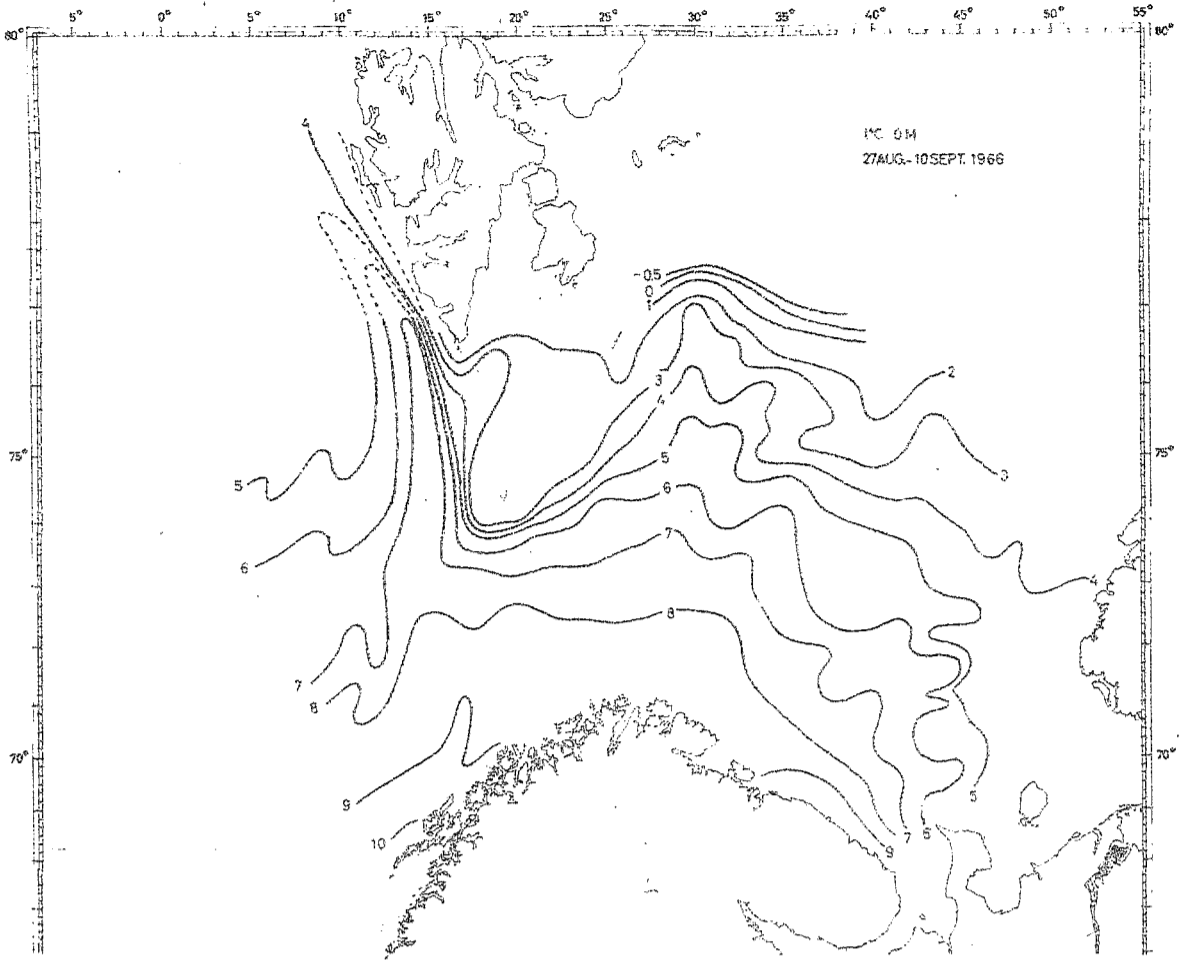


Fig. 2. Isotherms at 0 and 50 m

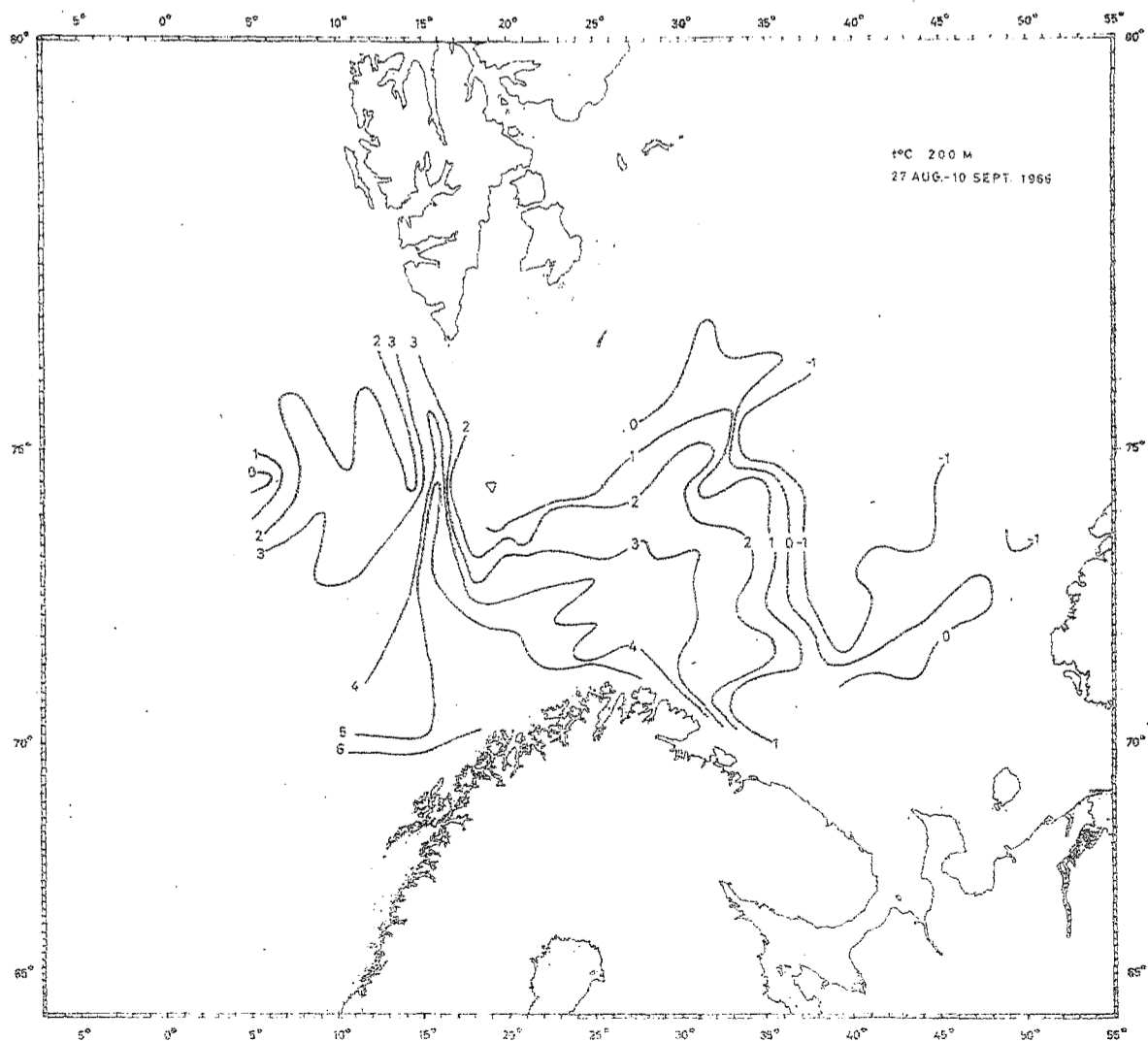
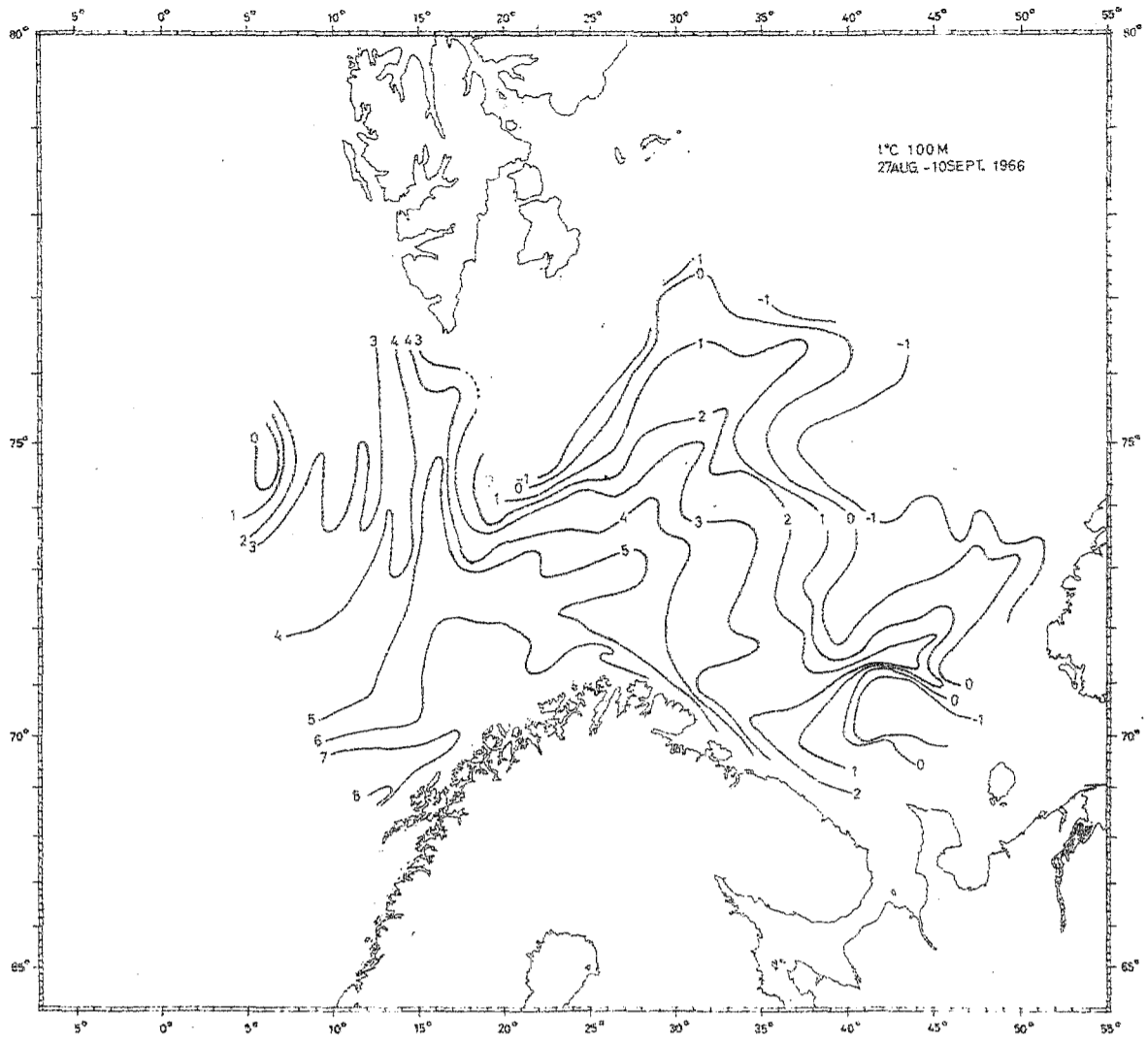


Fig. 3. Isotherms at 100 and 200 m

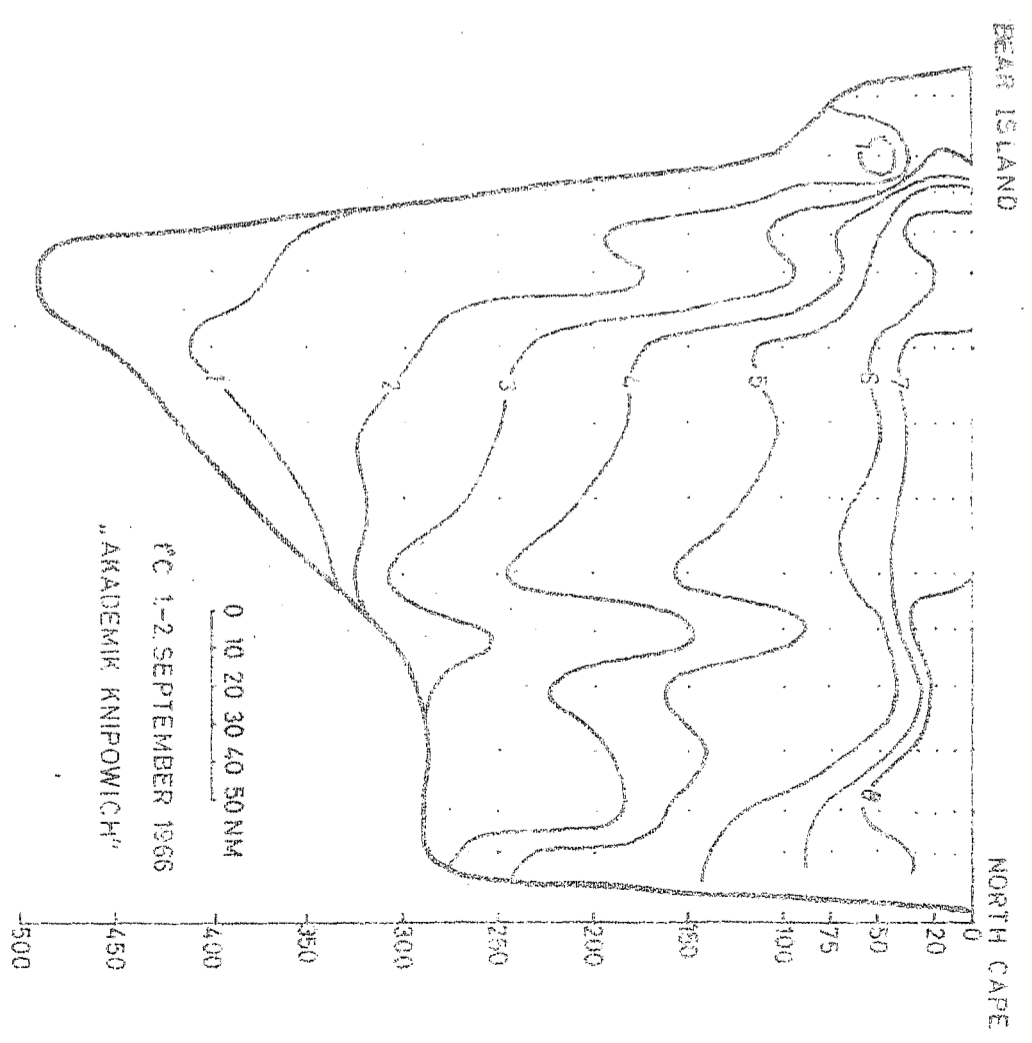
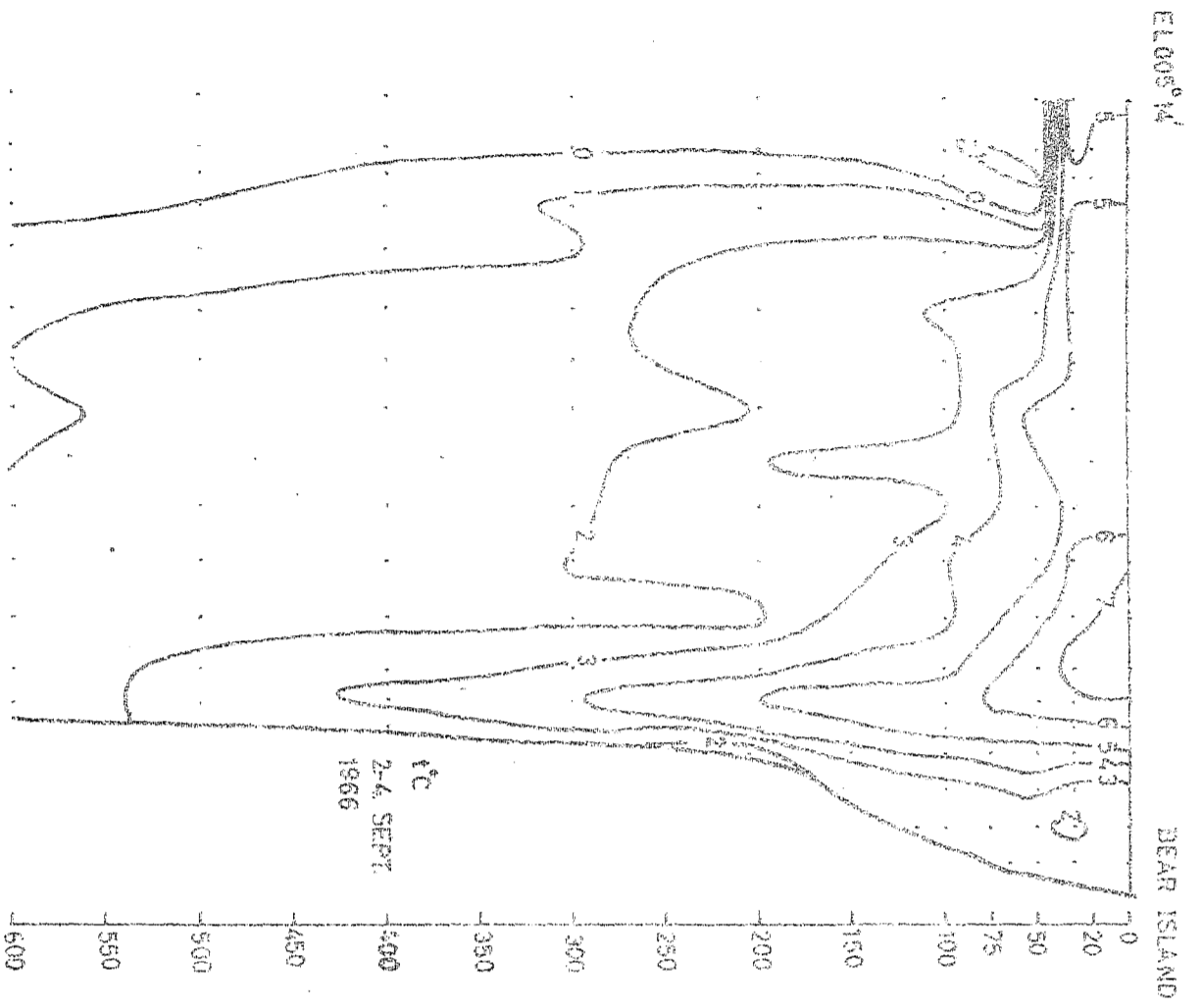


Fig. 4. Vertical temperature section North Cape - Bear Island and Bear Island -W

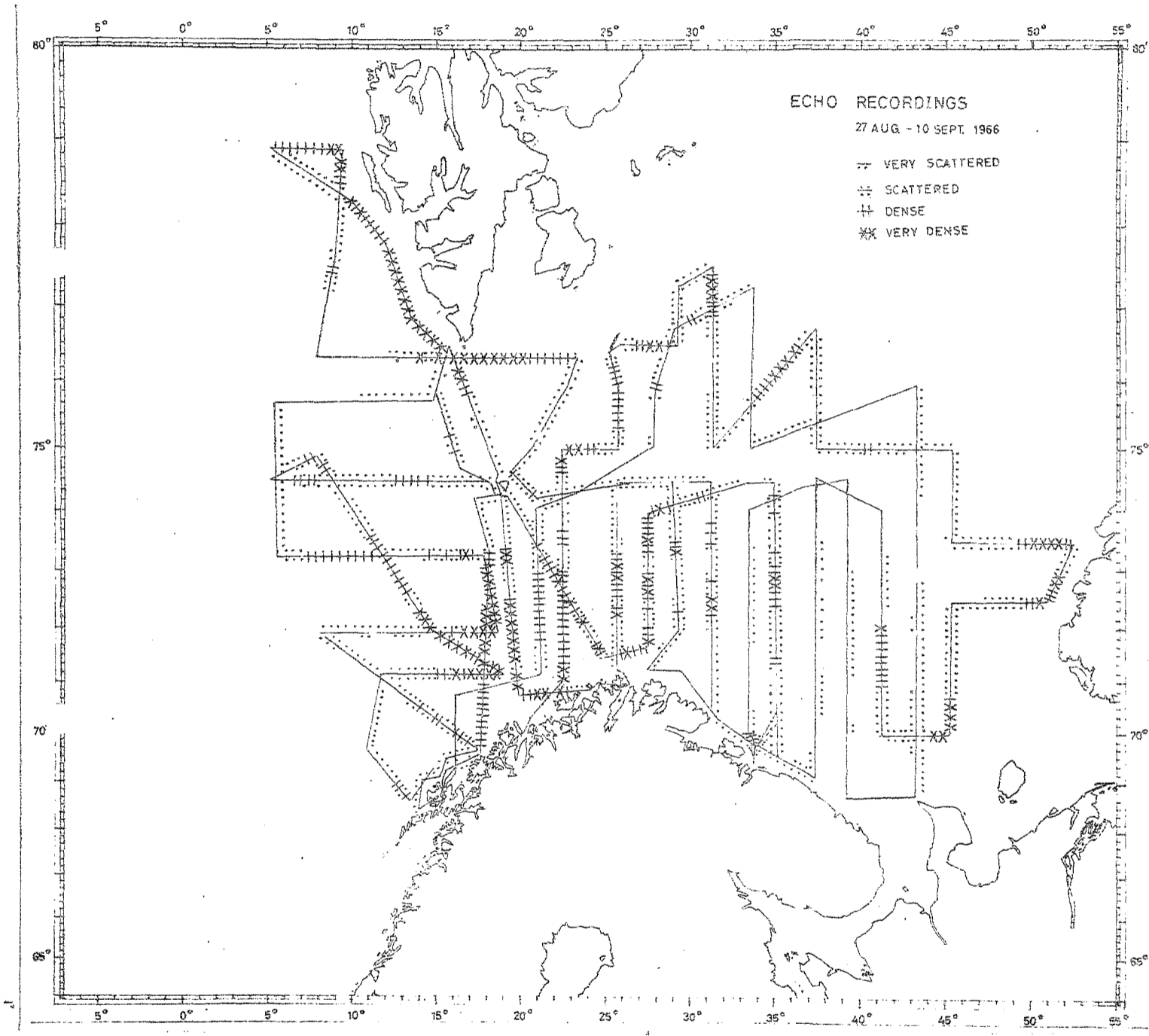


Fig. 5. Courses and echo recordings

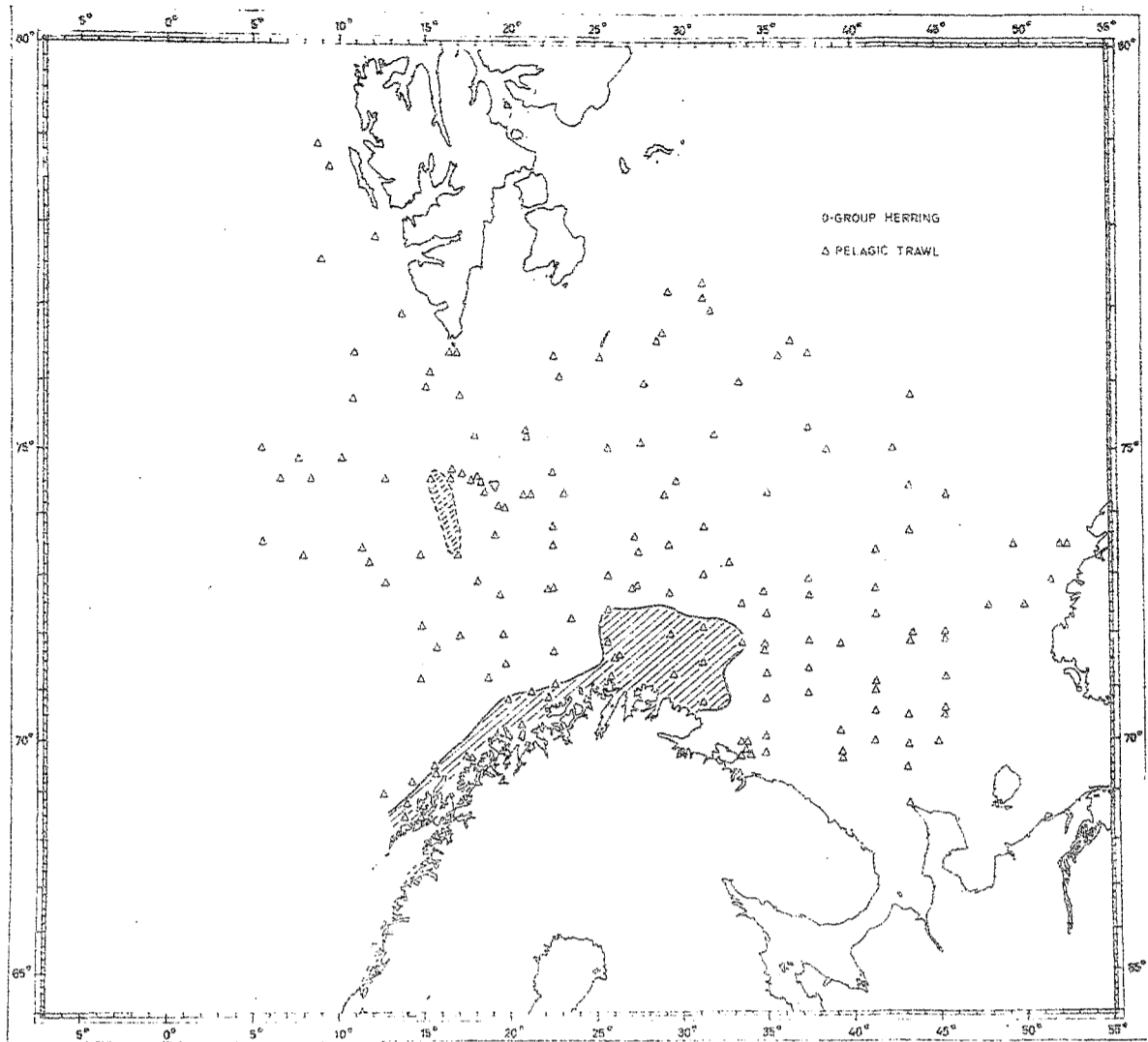


Fig. 6. Distribution of 0-group herring

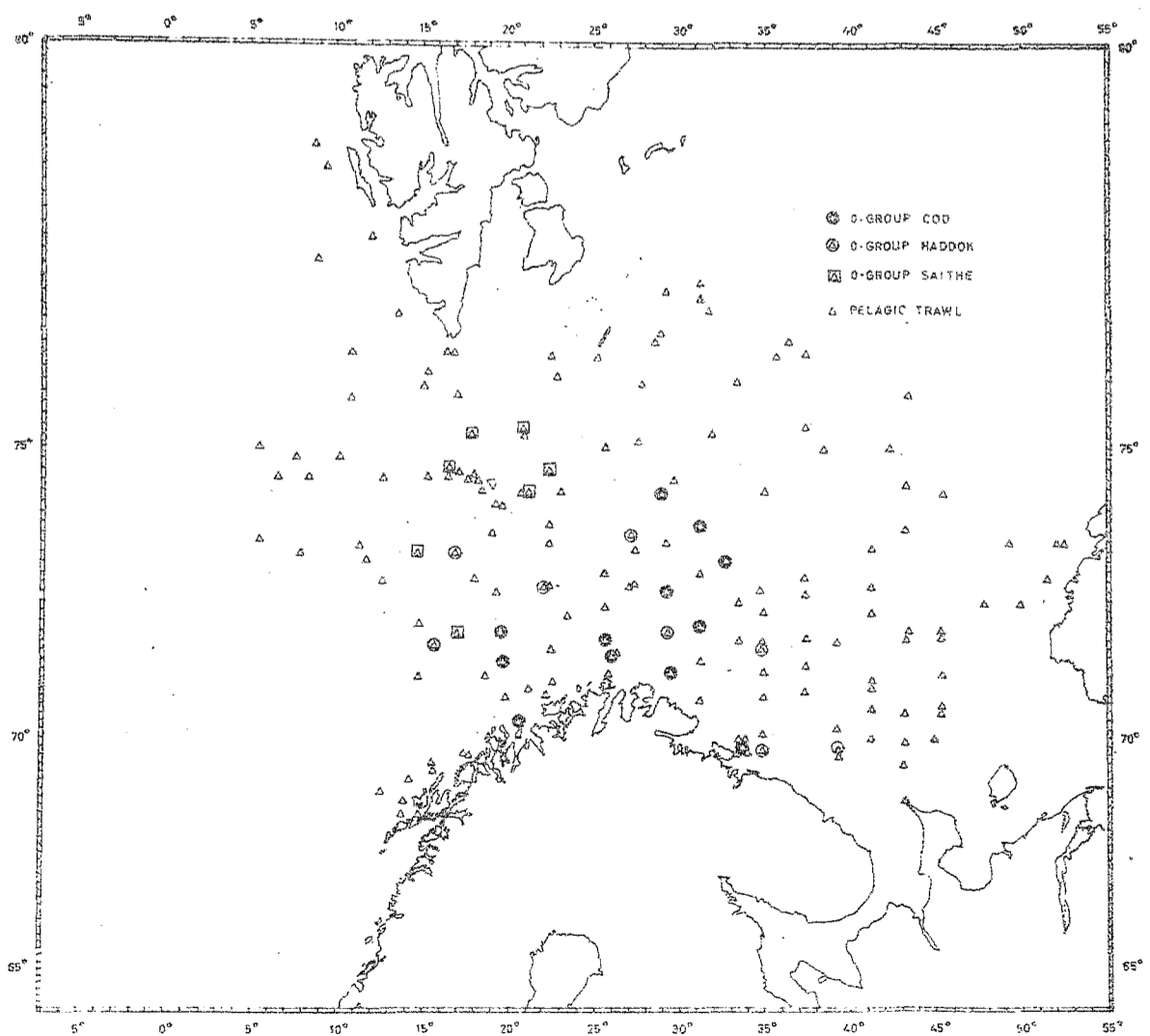


Fig. 7. Distribution of 0-group cod, haddock and saithe

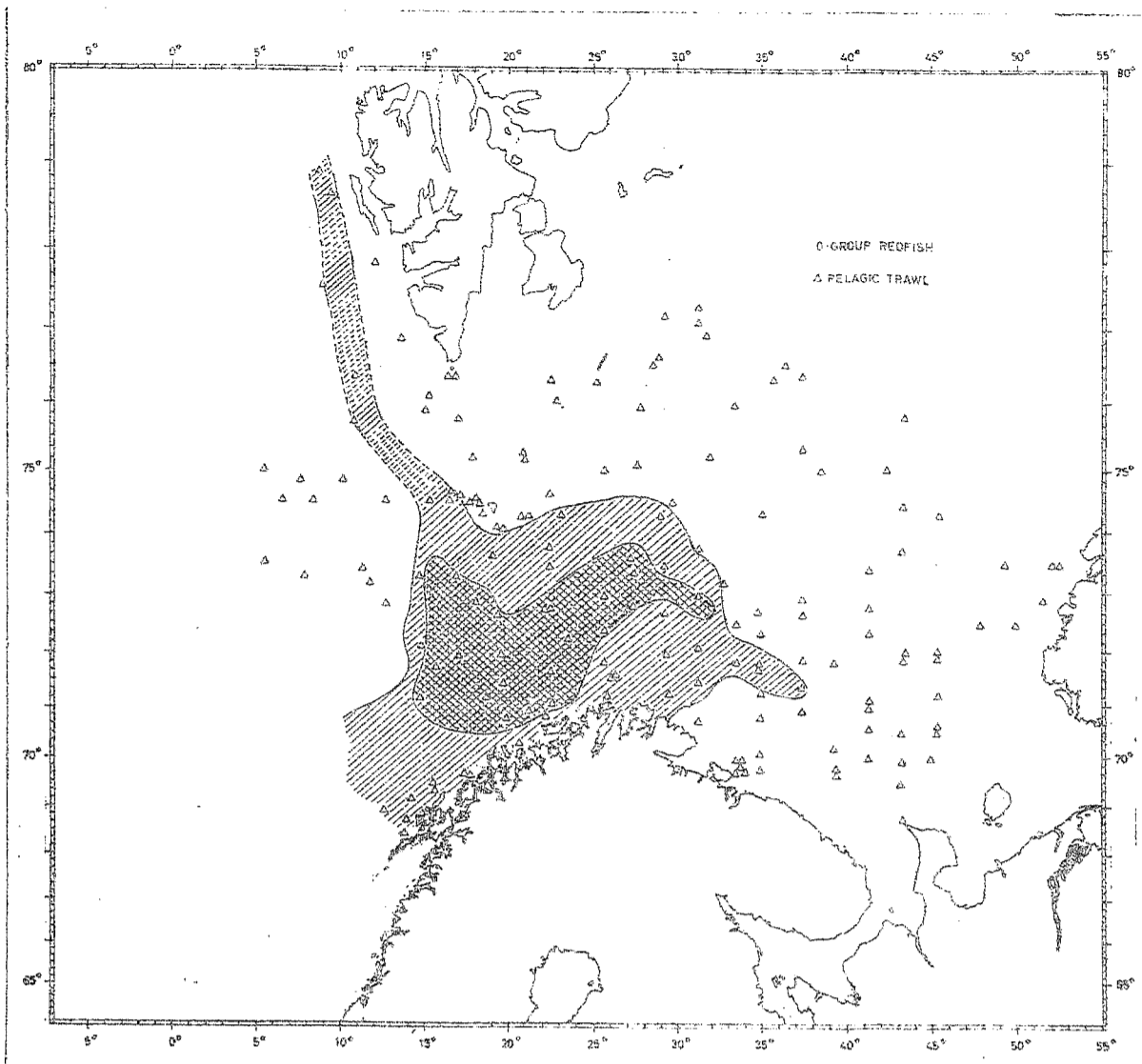


Fig. 8. Distribution of 0-group redfish.
The double hatching indicates the highest abundance

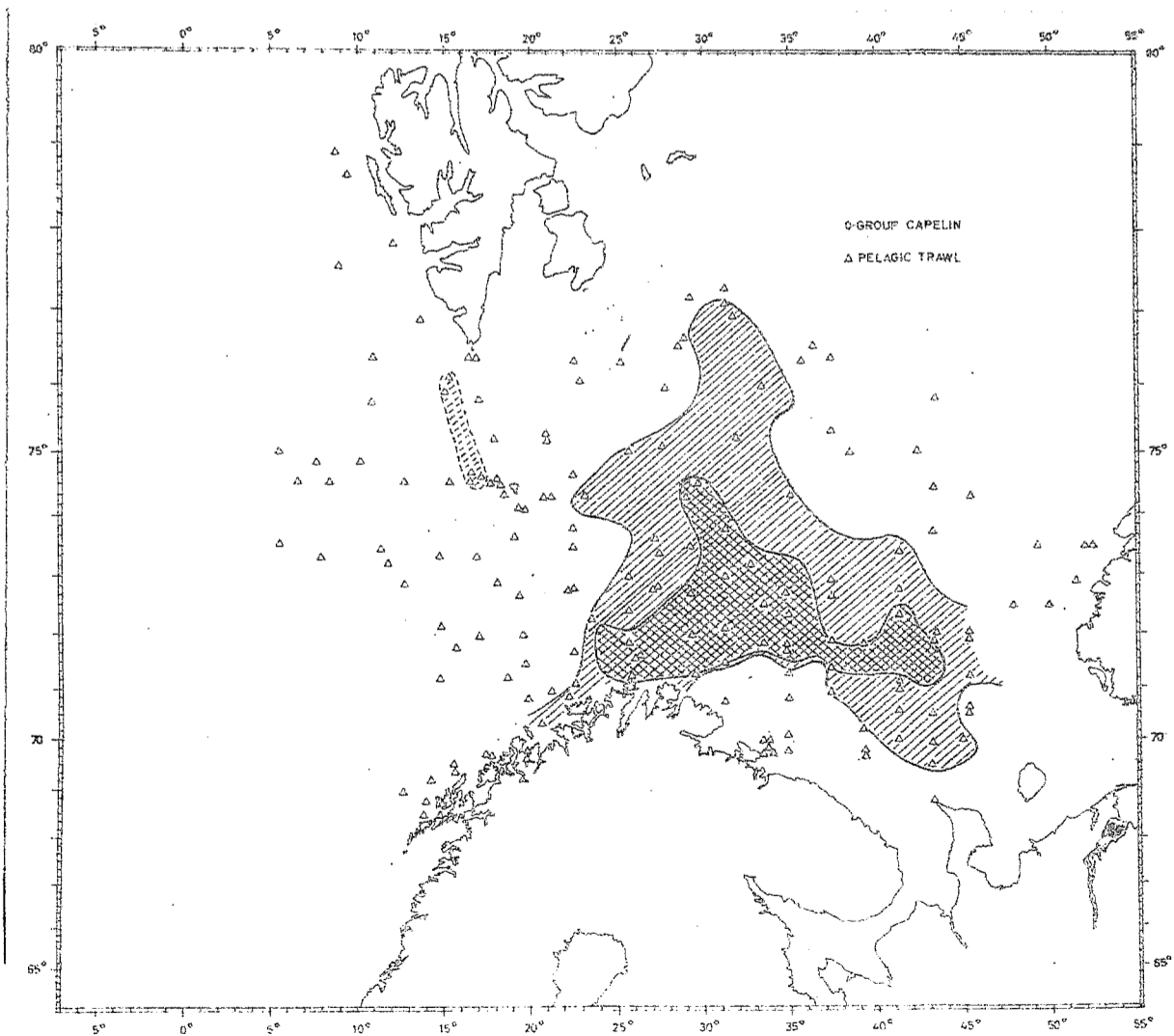


Fig. 9. Distribution of 0-group capelin.
The double hatching indicates the highest abundance

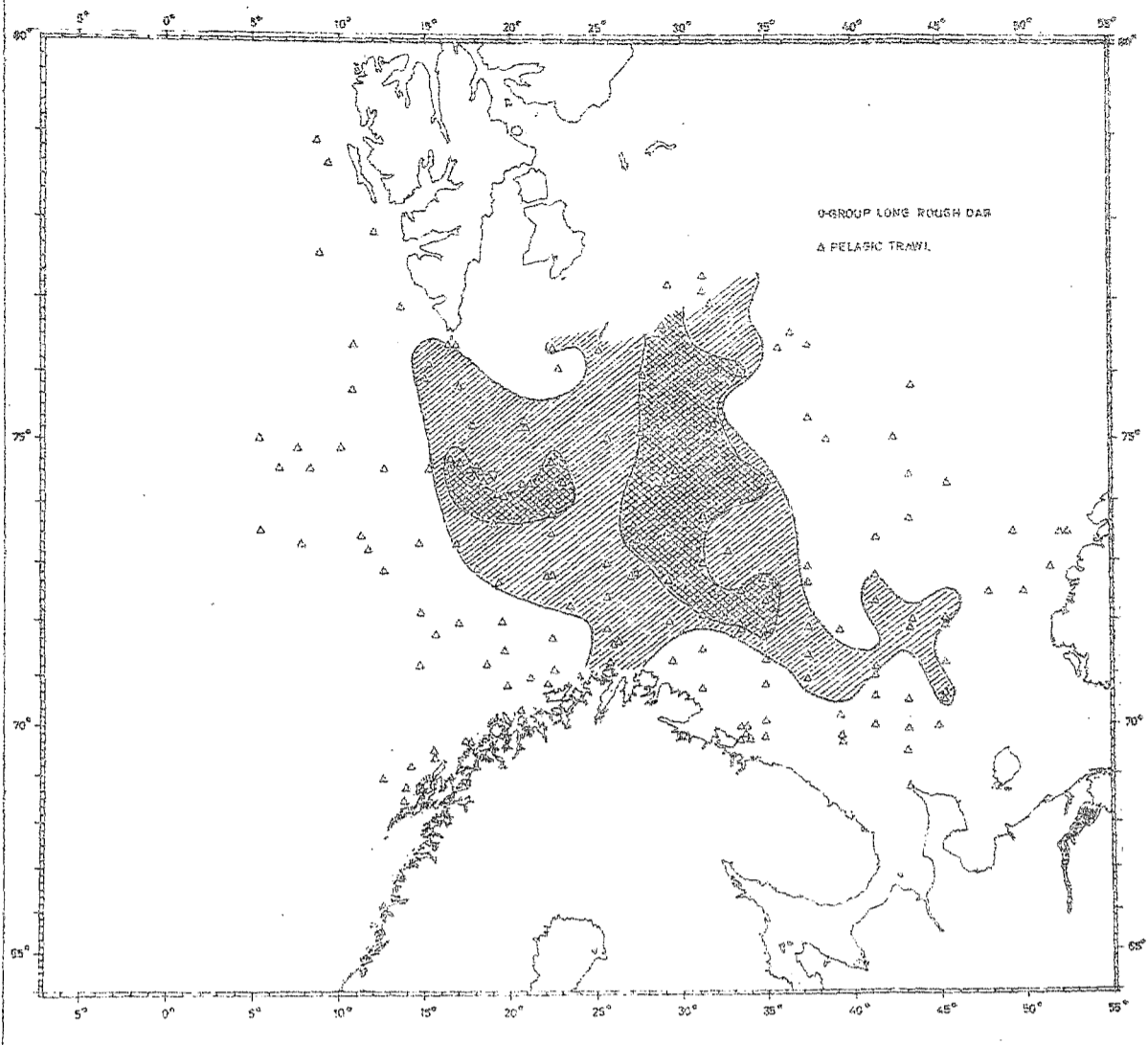


Fig. 10. Distribution of 0-group long rough dab.
The double hatching indicates the highest abundance

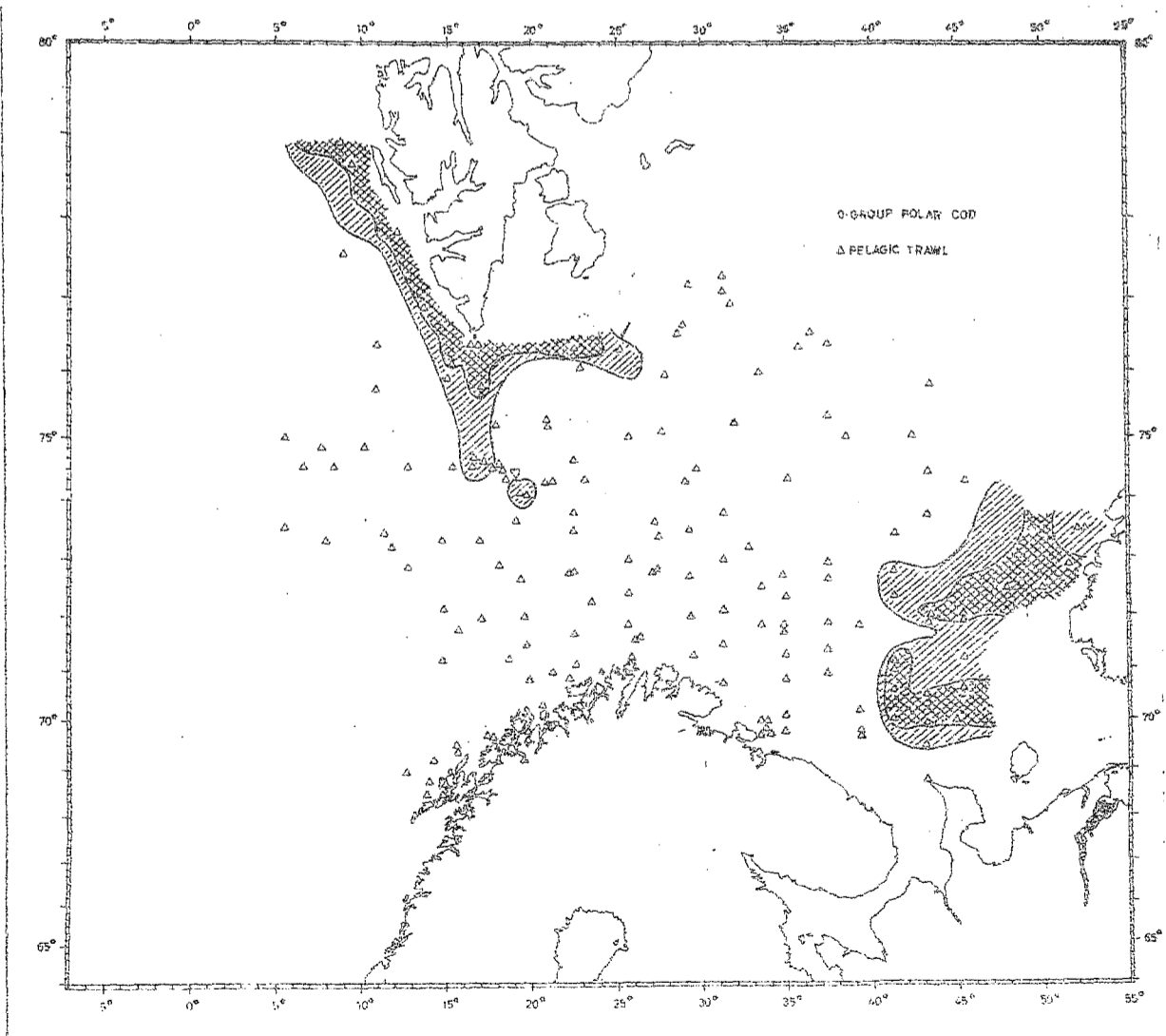


Fig. 11. Distribution of 0-group polar cod.
The double hatching indicates the highest abundance

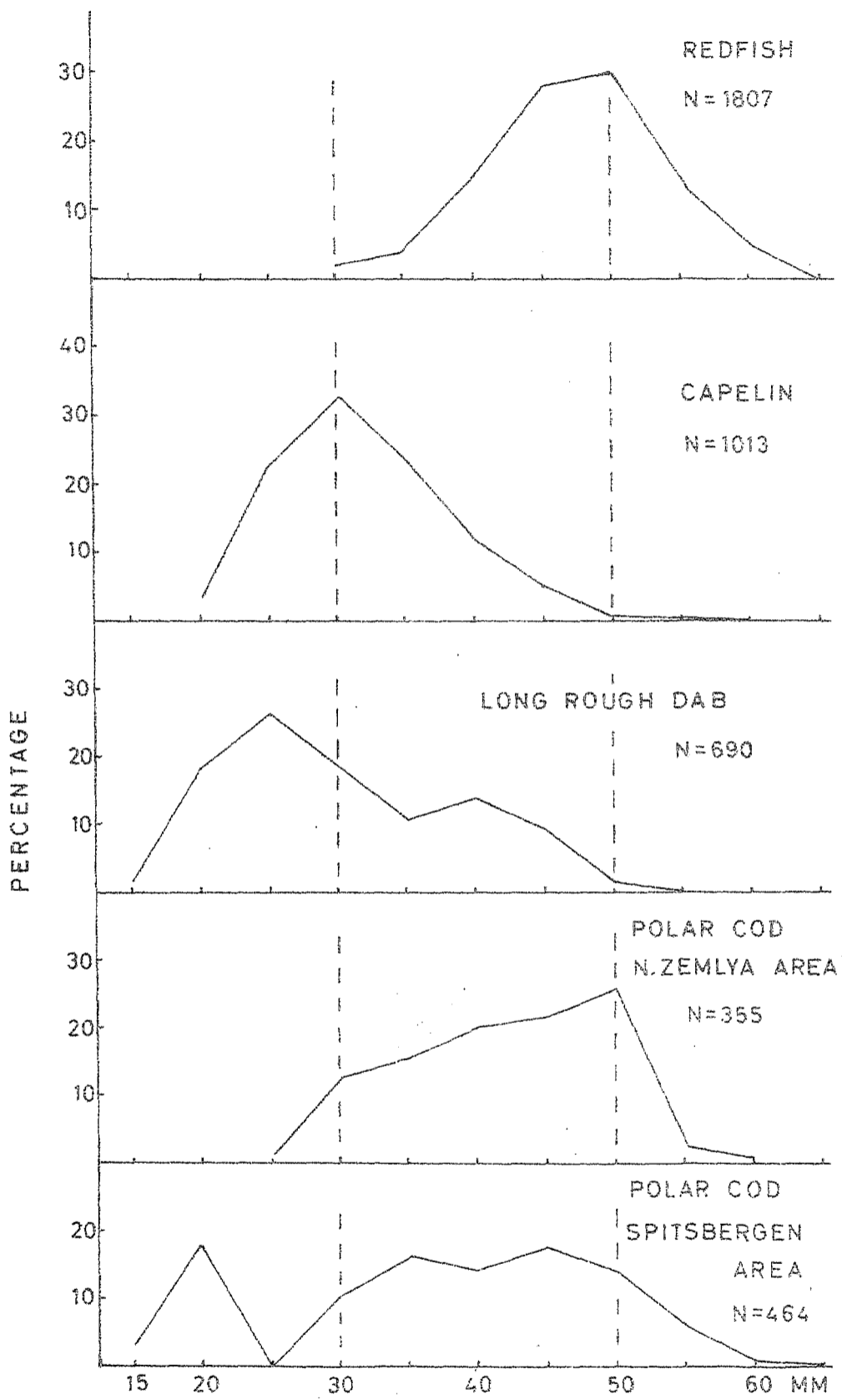


Fig. 12. Length composition

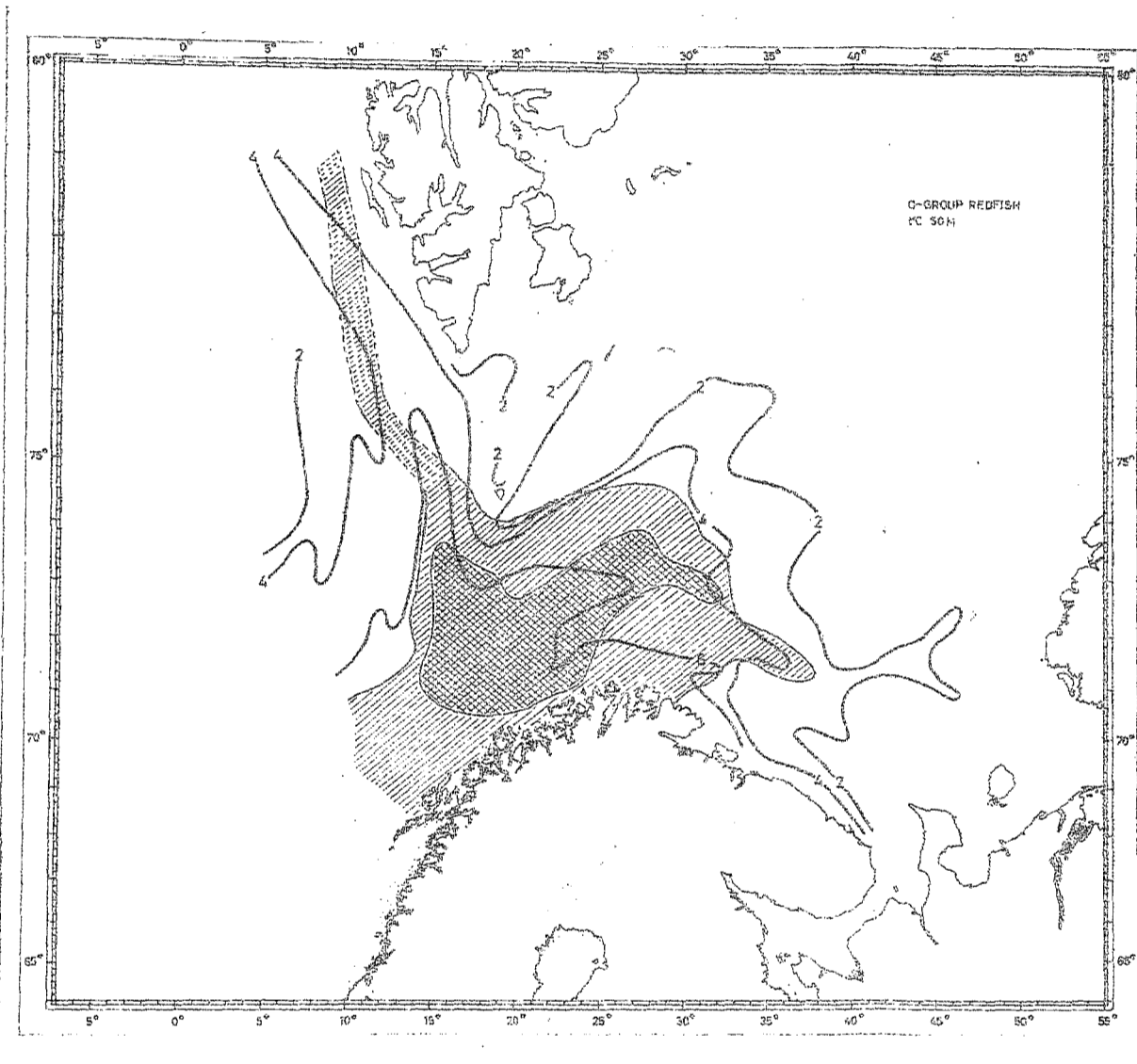


Fig. 13. Distribution of 0-group redfish compared with isotherms at 50 m