

JOINT



REPORT

**PROCEEDINGS OF THE INTERNATIONAL
O-GROUP FISH SURVEY IN THE
BARENTS SEA AND ADJACENT WATERS
IN AUGUST-SEPTEMBER 1965-1997**



Joint IMR-PINRO report

**PROCEEDINGS OF THE INTERNATIONAL 0-GROUP FISH
SURVEY IN THE BARENTS SEA AND ADJACENT WATERS
IN AUGUST-SEPTEMBER 1965-1997**

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Preliminary Report
of the joint Soviet-Norwegian investigations in the
Barents Sea and adjacent waters September 1965

1. Introduction

At the 1964 meeting of ICES the Herring Committee made the following recommendation (B5):

"The Committee recommends strongly that Norwegian and Soviet research vessels should undertake joint surveys of the distribution of the early stages of herring in the eastern Norwegian Sea and the Barents Sea".

The general program for this survey was discussed between Soviet and Norwegian scientists at the third meeting of the Atlanto-Scandian Herring Working Group in Moscow in May 1965, and it was agreed that the aims of this survey were to investigate the distribution and abundance, not only of group herring, but also of other commercial species of fish and to make hydrographic observations.

Final agreement on the detailed program was reached at a meeting in Murmansk on September 2 and 3 1965, and the survey was conducted from the 4 to the 17 September with two Soviet and two Norwegian research vessels. From the 17 to the 19 of September a meeting was held in Tromsø for the purpose of combining the observations made and to prepare a preliminary report.

The participating vessels and the scientific and technical staff were:

R/V "Akademik Knipovich":	Yu.K. Benko, A.G. Kisliakov, A.A. Gankov, M.I. Gusnova, V.M. Naumov, K.A. Semina
R/V "Jastreb":	I.V. Packhorukov, A.S. Seliverstov, A.I. Muchin, O.E. Schatoba, E.I. Zajtsev
R/V "Johan Hjort":	P.T. Hognestad, S. Olsen, B. Brynildsen O. Cruickshank, W. Løtvedt, T. Monstad, H.E. Olsen, V. Rasmussen
R/V "G.O. Sars":	O. Dragesund, L. Midttun, K. Gran, I. Hoff. O. Martinsen, B. Myrseth, J. Parker, G. Sangolt

2. Program and methods

It was agreed that the four vessels were to operate in two pairs, consisting of one Norwegian and one Soviet vessel, steaming more or less parallel courses 30-40 miles apart.

As will appear from Fig. 1 one pair of ships covered the eastern and northeastern areas, whereas the other pair investigated the central and western parts.

The technique and methods applied was the same as that of previous Norwegian

surveys (Dragesund and Olsen in press), i.e. a combination of echo sounding and fishing experiments with pelagic trawl. In order to make the observations of each ship directly comparable, all four ships were equipped with the same type of echo sounder and the same type of trawl.

3. General outline of results

The time allotted for the meeting in Tromsø was of course not sufficient for a thorough analysis of the large material of data collected. The report prepared is therefore preliminary in its scope, but nevertheless some fairly definite conclusions were reached.

3.1. Hydrography

The aim of doing hydrographic observations in connection with the investigations of the distribution and abundance of 0-group fish, is to get knowledge of the transporting system.

During this survey 143 hydrographic stations have been taken covering the whole area investigated (Fig. 1). Both temperature and salinity have been observed, giving a basic material for an analysis of the current and transport system. At this stage the salinity samples have not been worked up and hence we can only discuss the temperature condition presented by a series of horizontal and vertical section charts in the Figs. 2, 3 and 4.

However, some information of the general features in the current system can be drawn even from these charts, particularly those showing the temperature at the deeper layers (viz. 100 and 200 meters) (Fig. 3). Since the inflowing water of the Barents Sea and the West-Spitsbergen water are much warmer than the water originating from these areas, the inflow will cause tongue shaped out bends of the isotherms, as seen from the horizontal charts, for example outside the West-Spitsbergen, or along the banks near Novaya Zemlya.

The two vertical sections presented in Fig. 4 (North Cape - Bear Island and Bear Island - W) have been chosen because there already exists a large material from these sections, giving the opportunity to compare the present conditions with those of previous years. The average temperature at the section North Cape - Bear Island is about 1° below the normal and the anomaly along the Kola meridian is -0.4° which might indicate that the inflow to the Barents Sea also has been less than the normal. However, other factors may also contribute to such low anomalies.

3.2. Distribution and abundance of 0-group fish

Fig. 5 shows the total distribution of pelagic echo-recordings. In the central part of the Barents Sea and along the continental edge from the Norwegian coast to West-Spitsbergen most of these recordings are caused by 0-group fishes, and to some extent also medusa and euphausiids. In the south western part of the area investigated the recordings also include large blue whiting and large herring, and in the north-eastern parts most of the recordings were probably of large capelin and/or polar cod.

The distribution charts for the different species dealt with in the following paragraphs are based on the catch composition of the trawling experiments and on detailed analysis of the echo-recordings.

3.2.1. Herring

0-group herring were observed in two limited areas (Fig. 6) i.e. 1) between Bear Island and the Norwegian coast (72-73° N and 18-25° E), and along the edge of the continental shelf from NW of Bear Island to Isfjorden on West-Spitsbergen (75-78° N). Outside these small areas no group herring was identified. Special attention was also paid to investigating some of the traditional "småsild" fjords north of the Lofoten Islands (Eidsfjord, Ullsfjord, Lyngenfjord, Revsbotn and Varanger). In contrast to the conditions observed at the same time in previous years, when 0-group herring were present in these fjords or at their entrances, this survey indicated that there were only insignificant numbers of 0-group herring in the coastal areas.

It is thus evident that the abundance of 0-group herring in the area investigated is exceptionally low as compared with previous years.

3.2.2. Cod

0-group cod was caught in a small number at only one of the 86 trawl stations. Neither did the echo-recordings show any traces, which could be interpreted as caused by 0-group cod. In the same month in previous years cod fry have frequently been found pelagically distributed in the same areas, and in some years in large abundance. It is hardly likely that this year nearly all the young cod had already at the beginning of September descended to the bottom strata, and it is therefore justified to conclude that the 1965-year-class of cod is very small.

3.2.3. Haddock

Haddock were observed in two very limited areas (Fig. 7) i.e. 1) midway between Bear Island and the Norwegian coast, and 2) between Bear Island and West-Spitsbergen. It is safely concluded that also the 1965 year-class of haddock is poor.

3.2.4. Redfish

Redfish were found in abundance in the areas between the Norwegian coast and Bear Island (Fig. 8), between Bear Island and West-Spitsbergen along the continental slope, off West-Spitsbergen, and west of Andenes. The area of distribution extended to Skolpen Bank, but in the eastern part the abundance was low. It should be noticed that the size distribution varies between different regions, and in particular that the redfish in the southwestern most part were very small.

This distribution is very similar to that observed in 1964, and the total abundance in the area this year seems to be of the same order of magnitude. According to the Norwegian investigations conducted in the years before 1964 such a wide distribution of 0-group redfish has never been observed, nor has the abundance been nearly as large. This may indicate that there have been two strong year-classes in succession, but or cannot exclude that the high abundance may mainly be caused by a change in the total distribution pattern for the 0-group redfish.

3.2.5. Capelin

Capelin were found in two main areas (Fig. 9) 1) from North Cape to 41° E south of 74° N, and 2) between Bear Island and West-Spitsbergen. In addition a small patch was found southeast of Bear Island.

Compared with previous observations in the Barents Sea it is evident that the young capelin this year have a westerly distribution, but there is not sufficient data from previous years to make any statement about year class strength.

3.2.6. Long rough dab

Long rough dab was found to have a very wide and continuous distribution extending from Novaya Zemlya in the east (72°-73° N) through central part of the Barents Sea and further northwest along the Spitsbergen continental edge. The areas of greatest density seemed to be in the central part between 72°30' to 74°30' N and 28° to 25° E, between Bear Island and the Norwegian coast, and in the area between Bear Island and Spitsbergen. According to previous Norwegian investigations long rough dab has not been found in comparable abundance since 1960.

4. Concluding remarks

Perhaps the most striking result that has come to light from this survey is the very low abundance and restricted distribution area of the 0-group of the commercially important species, herring, cod and haddock. This may be caused by a very low survival rate for the 1965 broods of these species and/or a low inflow of Atlantic water into the Barents Sea, as indicated by the westerly distribution of capelin fry and the negative temperature anomaly in the North Cape - Bear Island section.

This emphasizes the need for more studies of the interrelationship between the transport of water masses and the distribution of fish larvae and fry.

The experience from this first four-ship survey confirms that a joint multi-ship investigation along similar lines as that of the present one may provide a reliable picture of the distribution and abundance of 0-group fish. However, it is necessary to improve the methods of identifying the echo recordings and for providing biological samples, i.e. by better pelagic trawls and trawling technique, direct under-water observation facilities, acoustic techniques etc.

It was therefore unanimously agreed by the participating Soviet and Norwegian scientists that these joint investigations shall be continued in the future, and possibly be extended both with regard to scope and volume of work.

The program for next year is to be discussed by correspondence and finally agreed at a meeting in Murmansk immediately prior to the start the 1966 survey.

Reference

Dragesund, O. and Olsen S. 1965. On the possibility of estimating year class strength by measuring echo-abundance of 0-group fish Fiskeridir. Skr. Havundersøk., 13 (8) (in press).

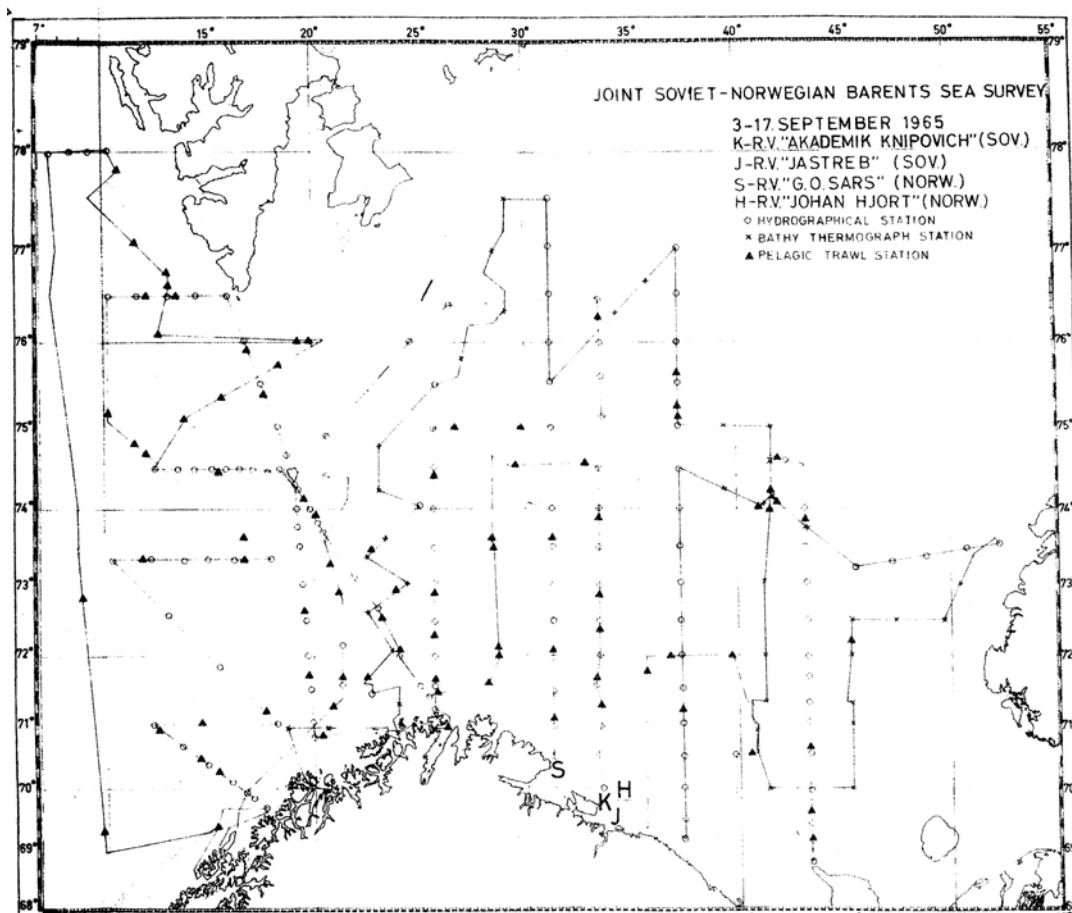


Fig. 1. Routes and stations

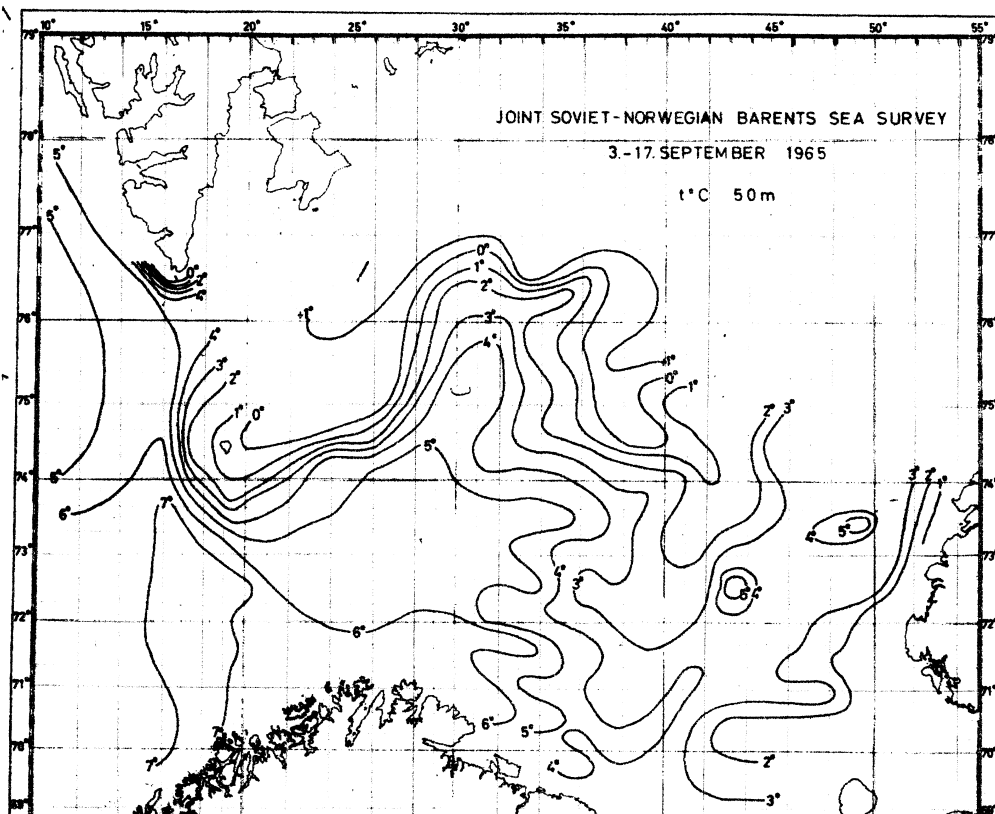
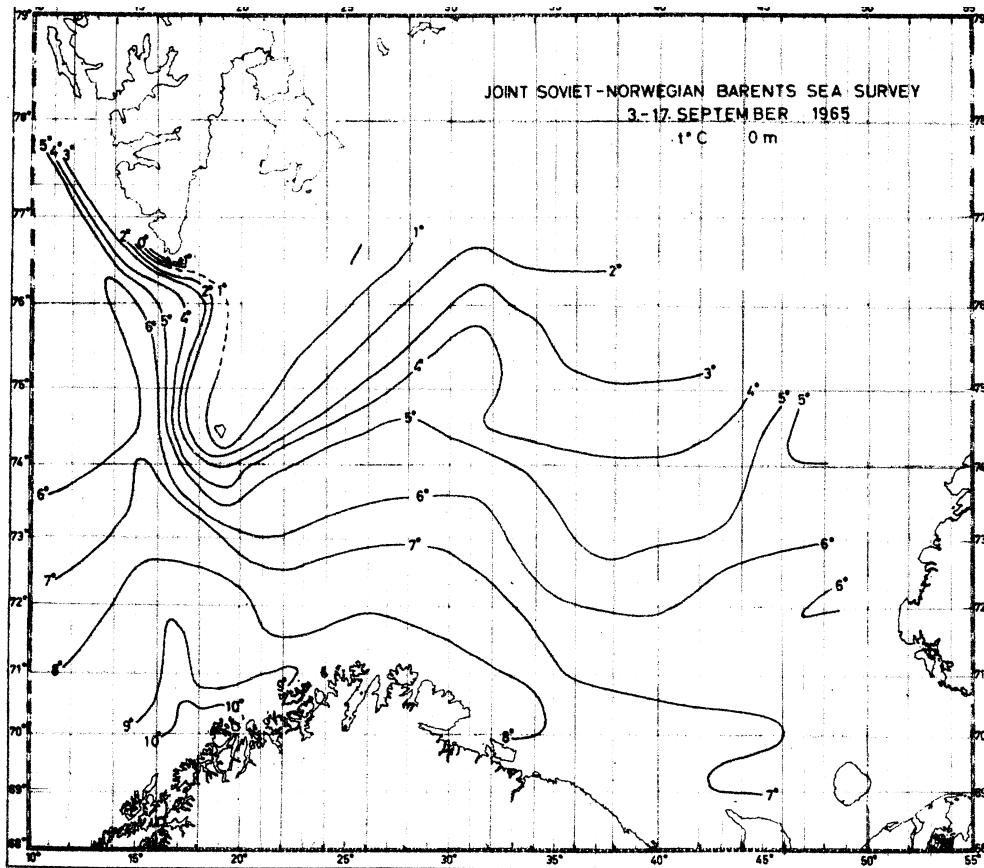


Fig. 2. Isotherms at 0 and 50 m

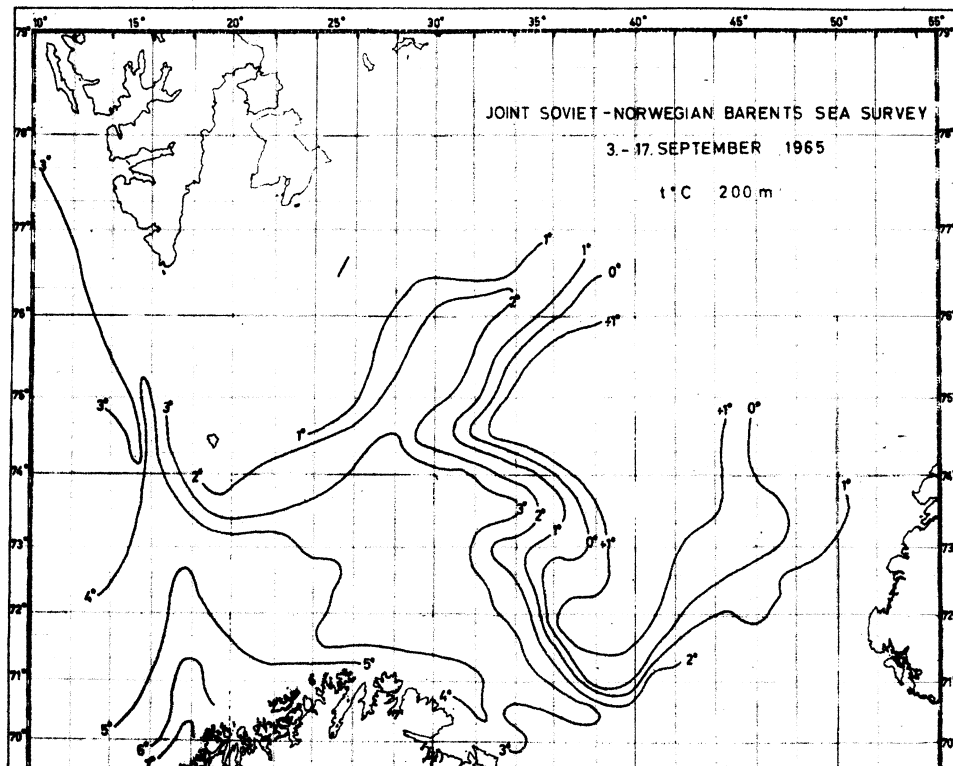
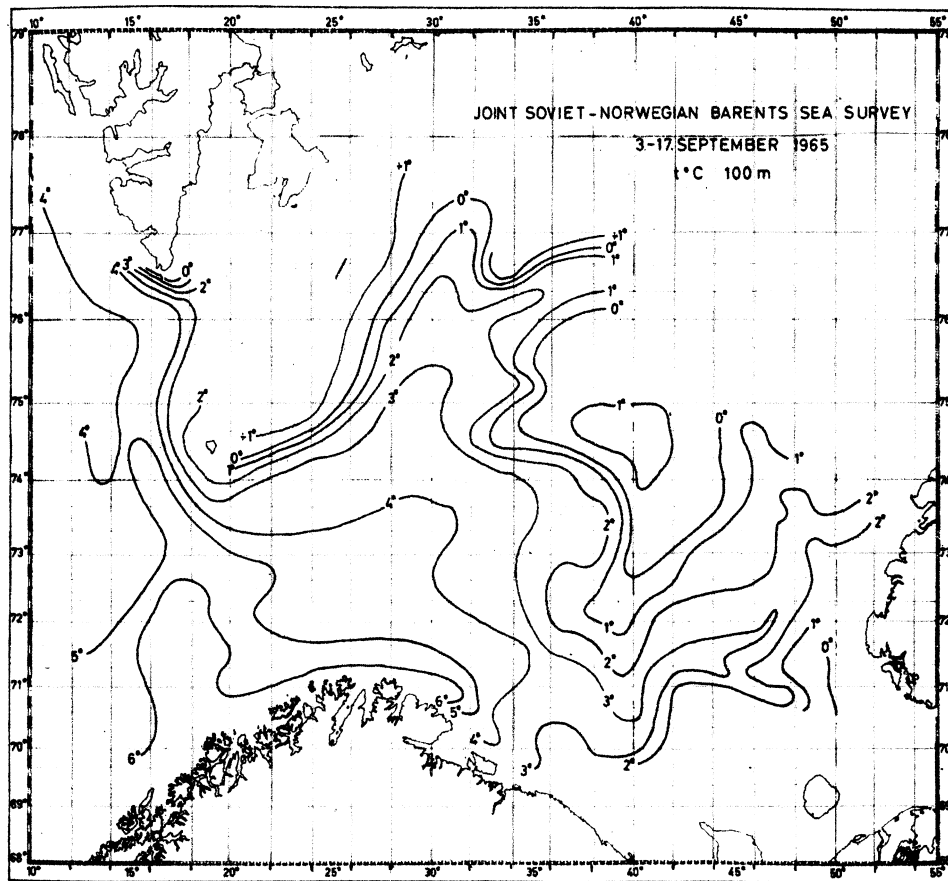


Fig. 3. Isotherms at 100 and 200 m

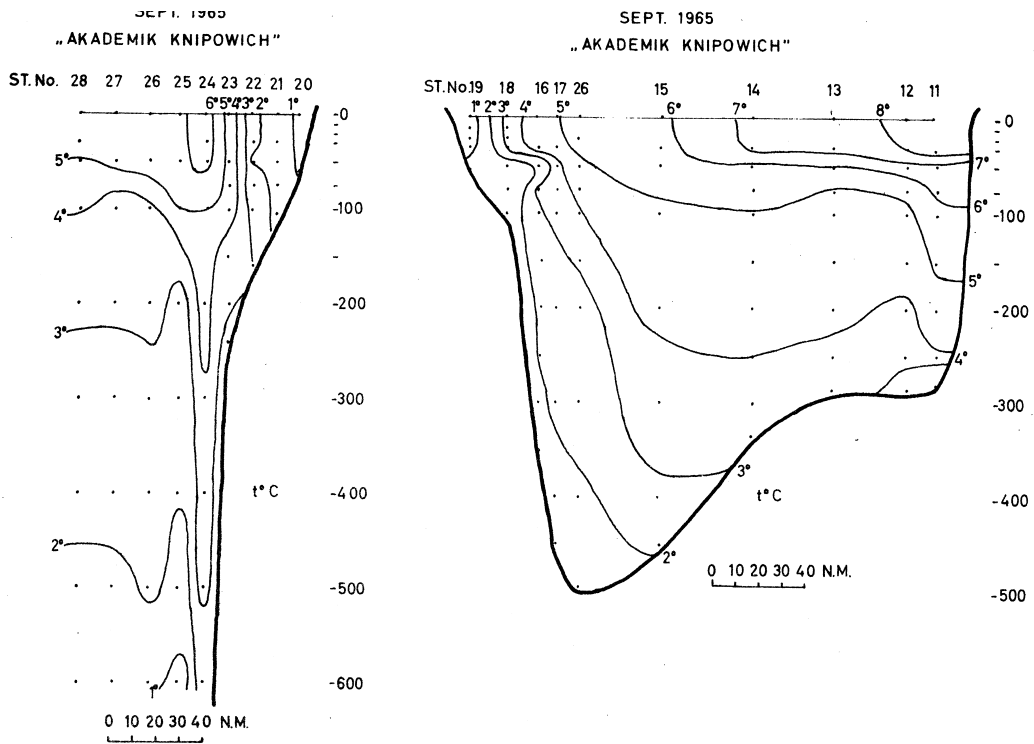


Fig. 4. Vertical temperature section North Cape-Bear Island and Bear Island-West

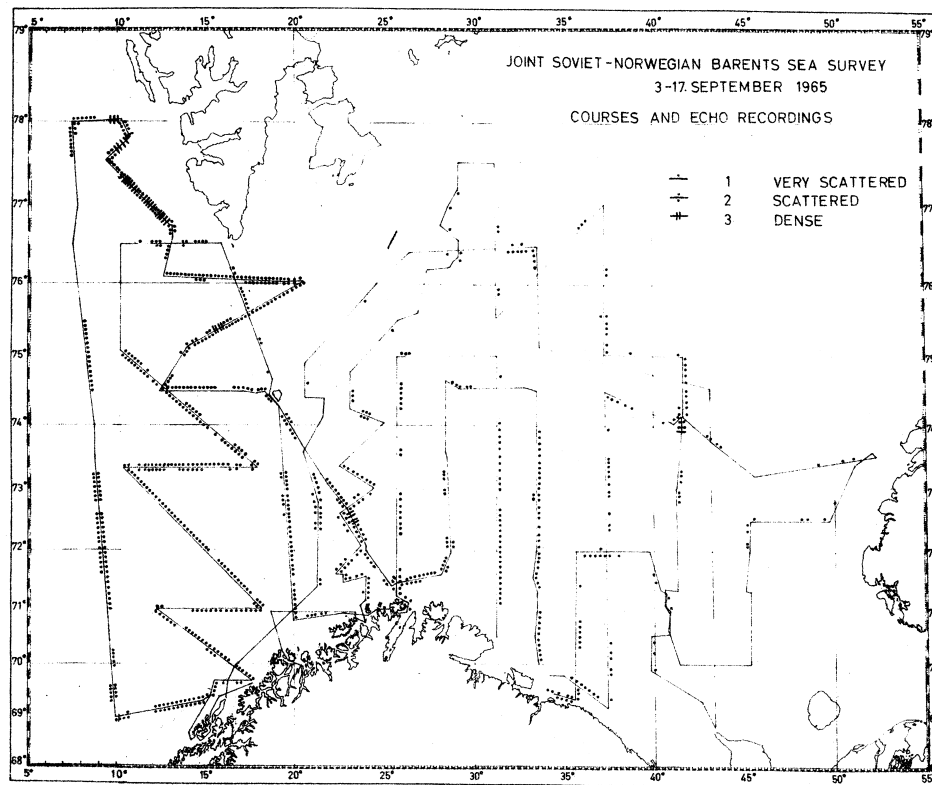


Fig. 5. Courses and echo recordings

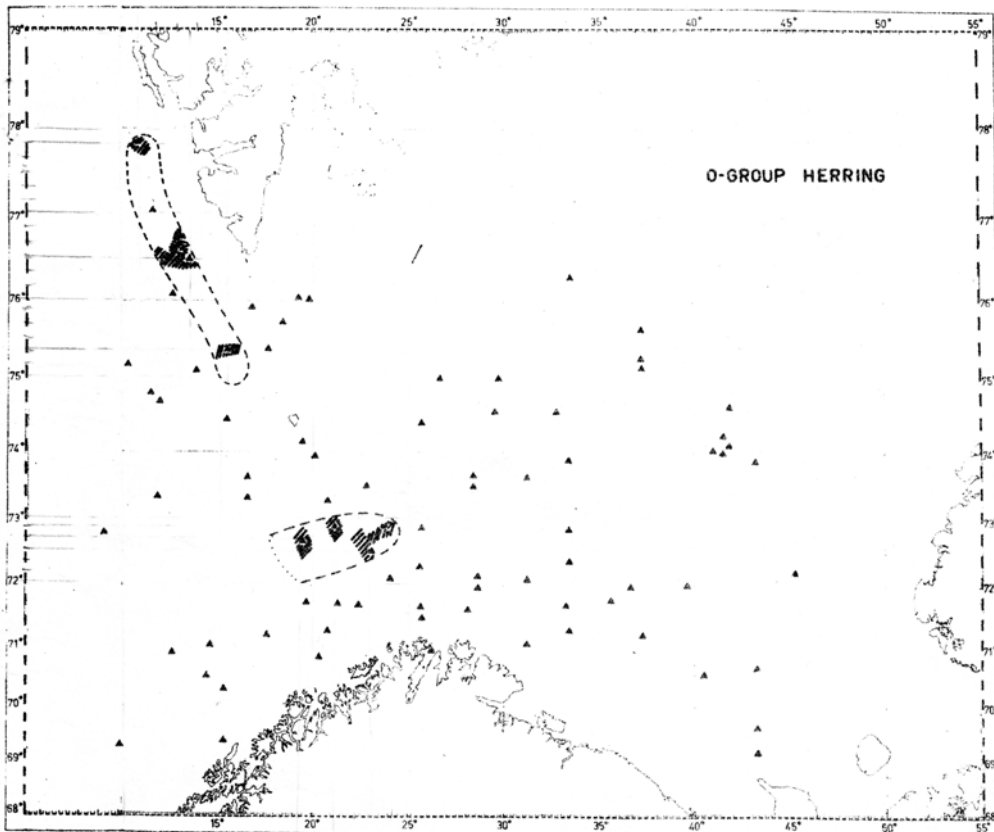


Fig. 6. Distribution of 0-group herring

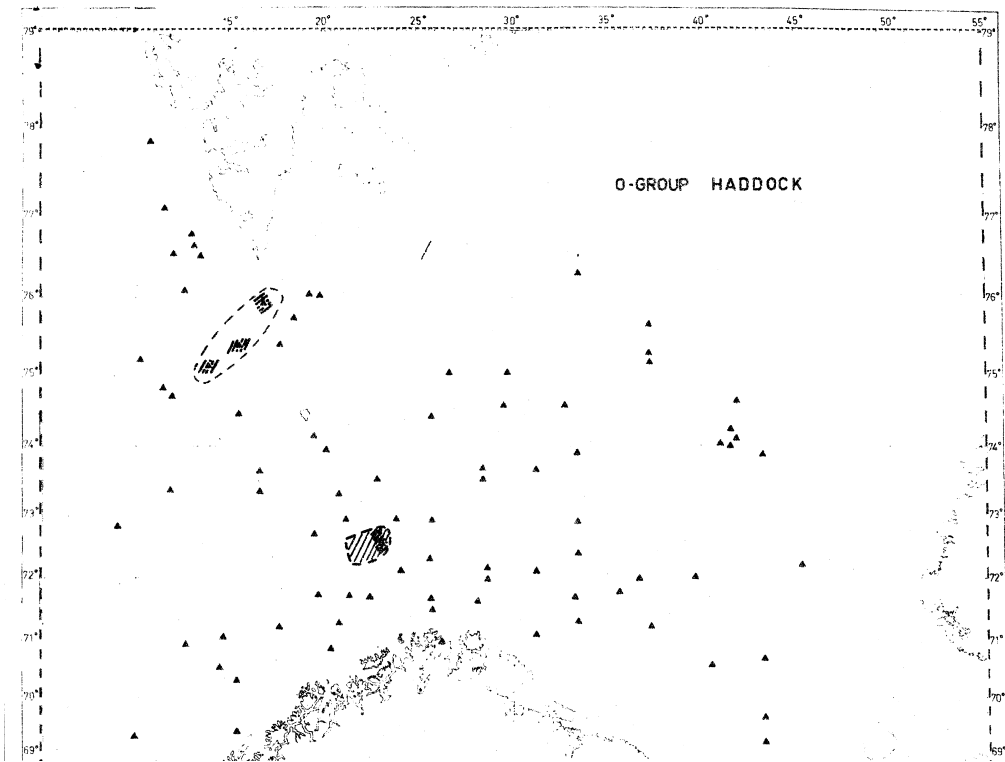


Fig. 7. Distribution of 0-group haddock

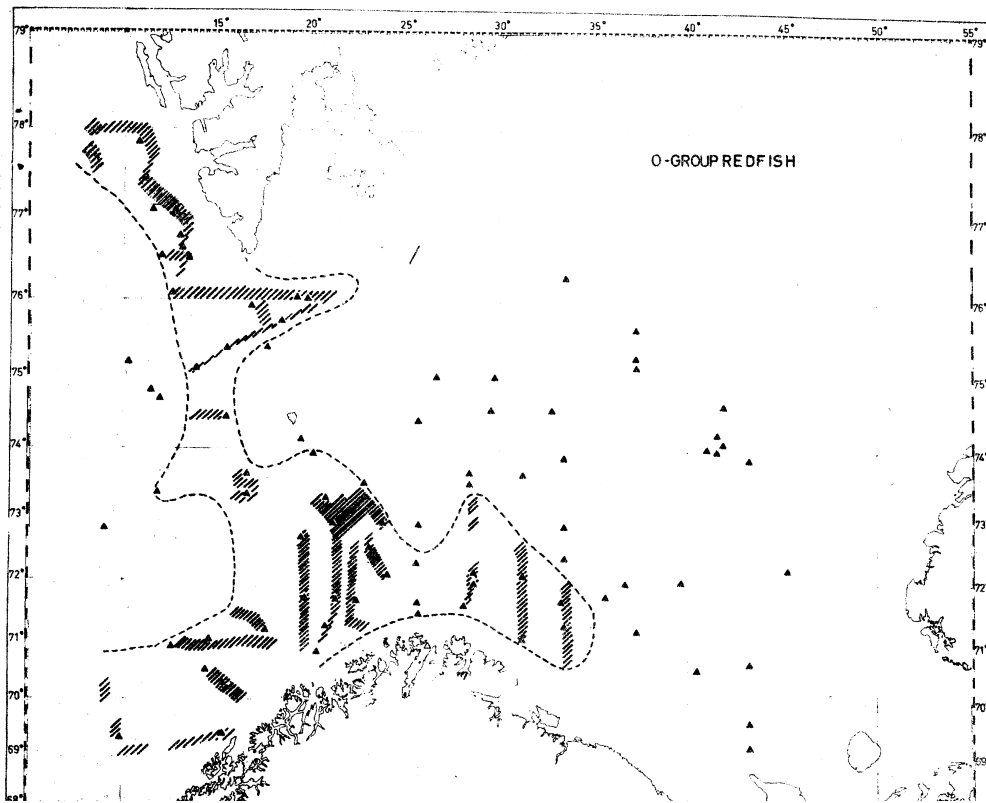


Fig. 8. Distribution of 0-group redfish

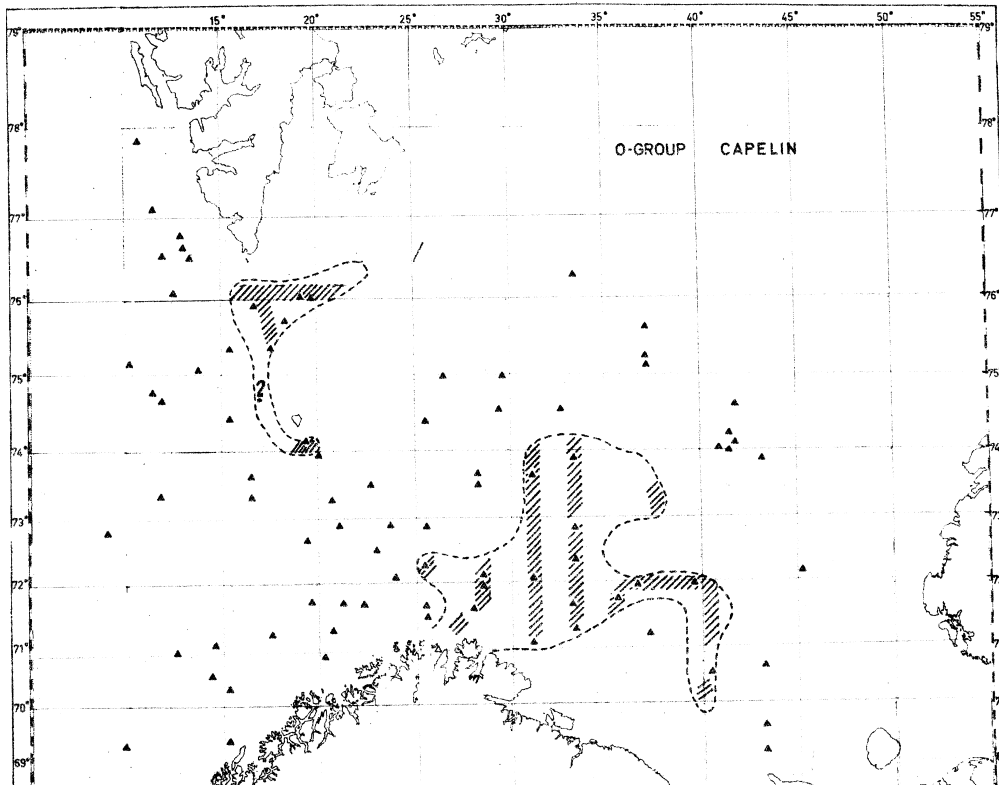


Fig. 9. Distribution of 0-group capelin

Preliminary Report
of the joint international 0-group fish survey in the
Barents Sea and adjacent waters August-September 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:

USSR	R/V "Academik Knipovich"	Yu.K. Benko
	R/V "Fridtjof Nansen"	A.S. Selivorstov
Norway	R/V "Johan Hjort"	L. Midttun, P.T. Hognestad
	R/V "G.O. Sars"	O. Dragesund
England	R/V "Ernest Holt"	D.J. Garrod

The success of a survey of this kind depends upon close cooperation between scientist of different disciplines and a full list of those taking part is given in an appendix. The preliminary for program 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. Program 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 standardized between vessels, but to ensure comparability of the results a preliminary internship 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 0-group fish that had already migrated out of the pelagic scattering layer.

Figure 1 also indicates the grid lines 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 0-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 0-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 has carried the 0-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 Figures 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 - 1.3 °C (0-50 m layer -0,7 °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 0-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 0-group fish have contributed to these traces. In general terms the 0-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°00' N-75°00' N and 05°00' E -15°00' E) and herring of the 1963 and 1964 year-classes were present off the East Finnmark coast southeastward to 40°00' 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 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 0-group fish were heavily mixed with larger invertebrate organisms, particularly Euphausiidae, Amphipodae and various medusa. Some allowance has been made for this in assessing the distribution and abundance of 0-group fish of different species 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 0-group fish of the species discussed below, 0-group fish of other less important species were also recorded. For example 0-group catfish were very widely, but sparsely distributed and 0-group Lumpenus, Cottidae and Myctophidae were occasionally reported and a very few 0-group Greenland halibut were recorded west of Spitsbergen.

3.2.1. Herring (Figure 6)

The 0-group herring were restricted to the Norwegian coastal belt with a slight extension northeastwards from North Cape. None were recorded north of 72°00' N or east of 34°00' E. It appears that the 0-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 0-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 record "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 0-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 0-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 0-group fish on the sea-

bed. This confirms Baranenkova's opinion that 0-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 till this year.

3.2.3. Haddock (Figure 7)

0-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 0-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 0-group saithe were found somewhat more westerly and northerly distributed than the cod and haddock (Figure 7).

3.2.5. Redfish (Figure 8)

0-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°00' E. 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 0-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 "path" along the path of the most important water currents.

The main concentration of 0-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 0-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)

0-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 0-group redfish, with a western boundary at about 23°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 0-group capelin tended to be discontinuous within this whole area, but it is possible to say that the main concentration lay between 71°00' N and 74°00' N. 0-group

capelin was 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 0-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 0-group capelin over a wide area, but it extended further to the northwest beyond Bear Island to Spitsbergen and it had a particularly marked northeast ward 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°00' N to 74°00' N, and 17°00' E to 35°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 0-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°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 0-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 0-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 0-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 0-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 0-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 0-group fish to any distinctive features of the distribution of the water masses. However, an attempt has been made to compare the

distribution of 0-group redfish and the isotherms in 50 m. Judging from Figure 13 it seems to be a fairly good correlation between the 4 °C isotherms 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 0-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 0-group capelin lay further to the east than the distribution of 0-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 "Fridtjof 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. Drageaund, I. Hoff, O. Martinsen, B. Myrseth, O. Chruickshank, G. Sangolt, C.A. Lewis.
	R/V "Johan Hjort"	L. Midttun, P. Hognestad, B. Brynildsen, O. Nakken, W. Løtvedt, H.E. Olsen, S. Agdestein, Sujatno Birowo.
England	R/V "Ernest Holt"	D.J. Garrod, R.R. Dickson, R.B. Mitson, J.E. Nicholls, B.K. Clarke.

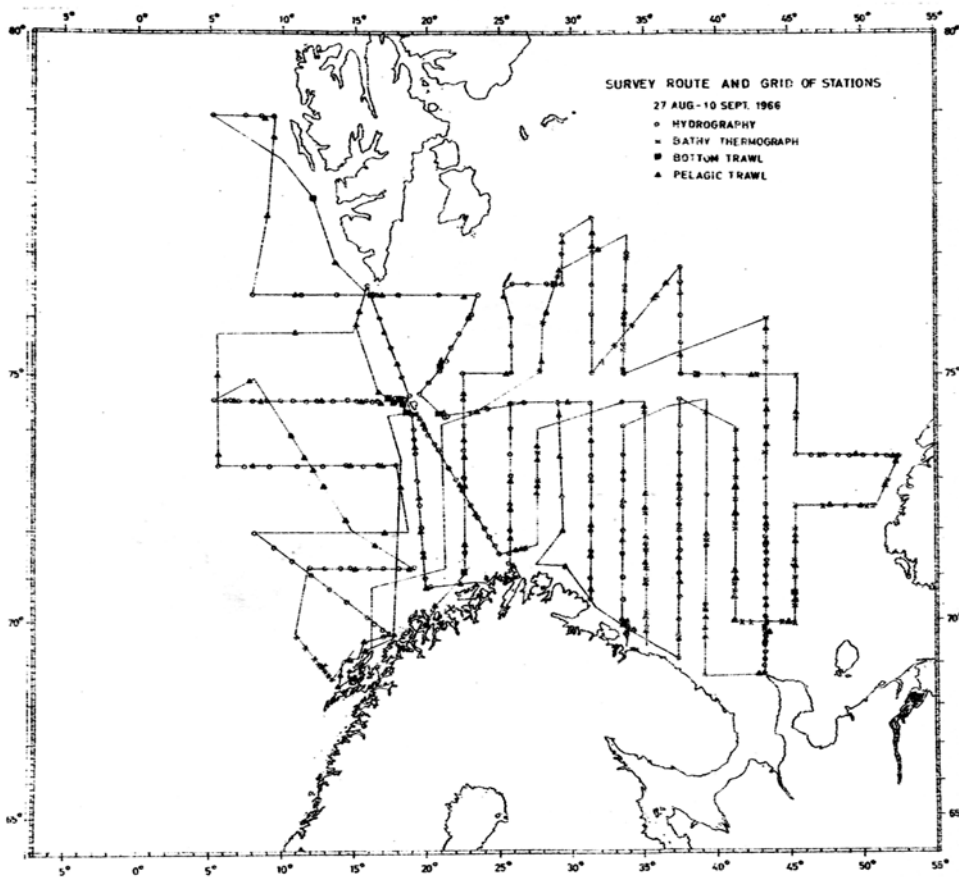


Fig. 1. Survey routes and grid of stations

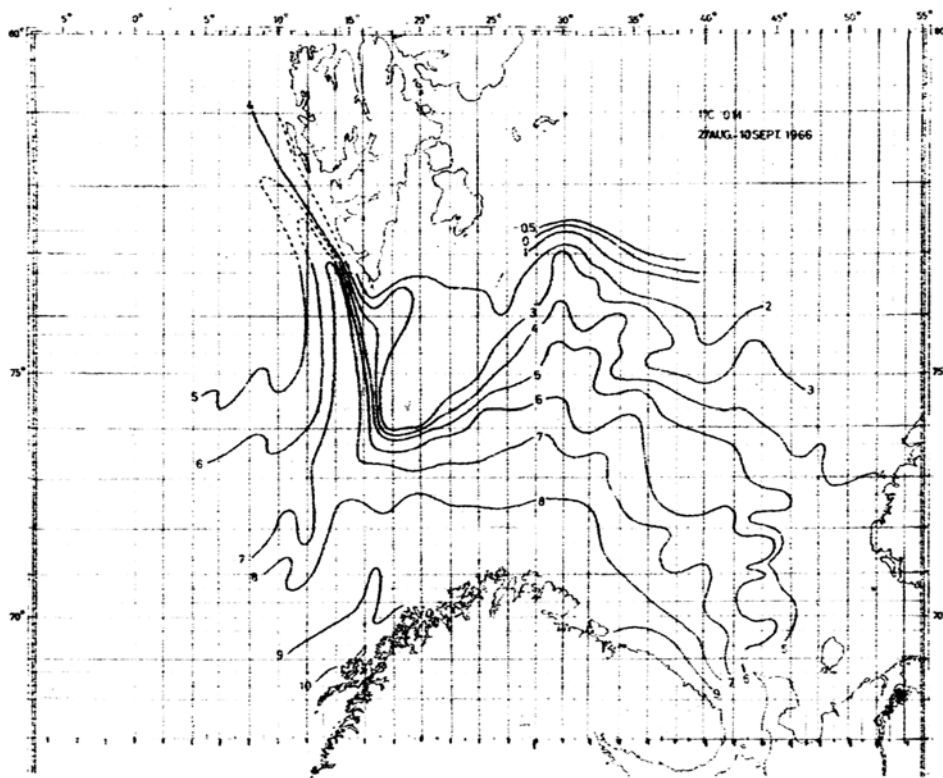


Fig. 2. Isotherms at 0 m

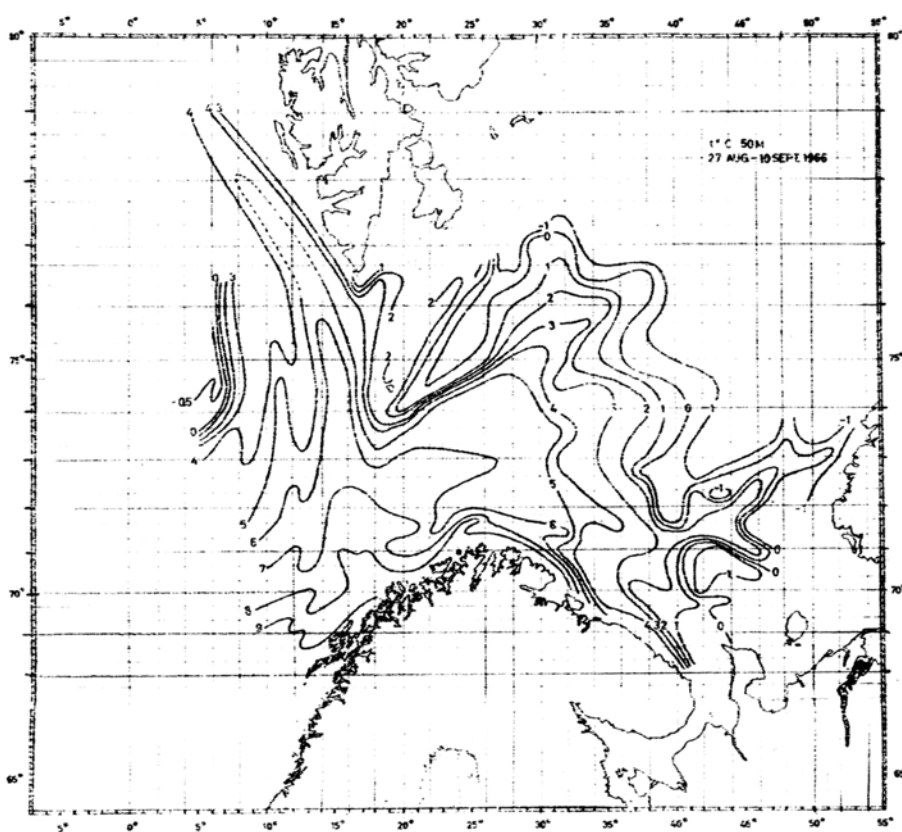


Fig. 2a. Isotherms at 50 m

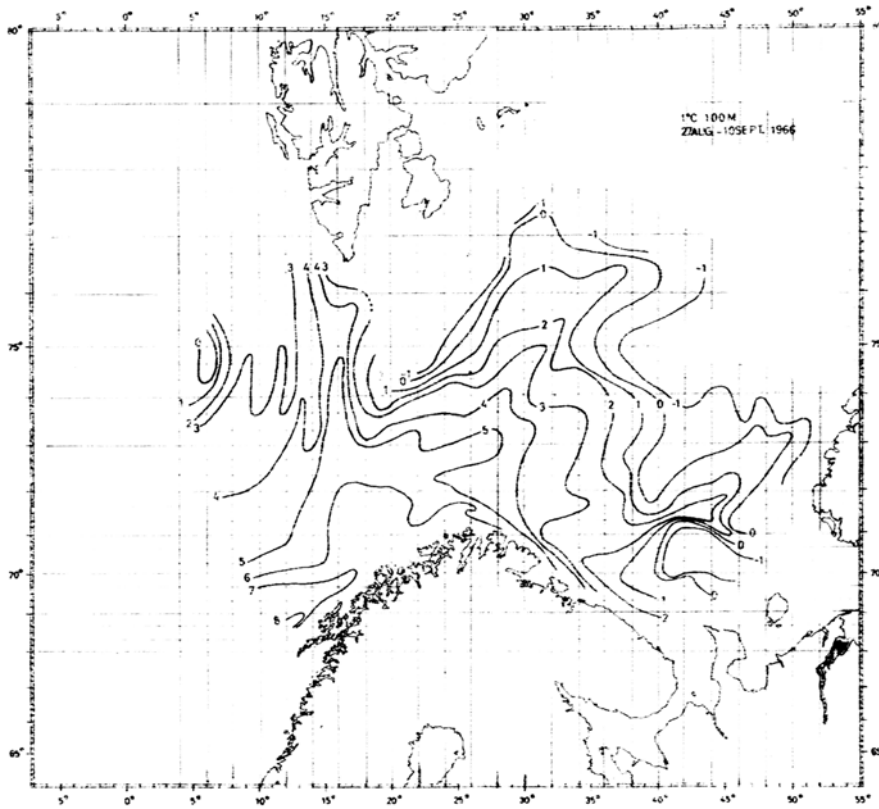


Fig. 3. Isotherms at 100 m

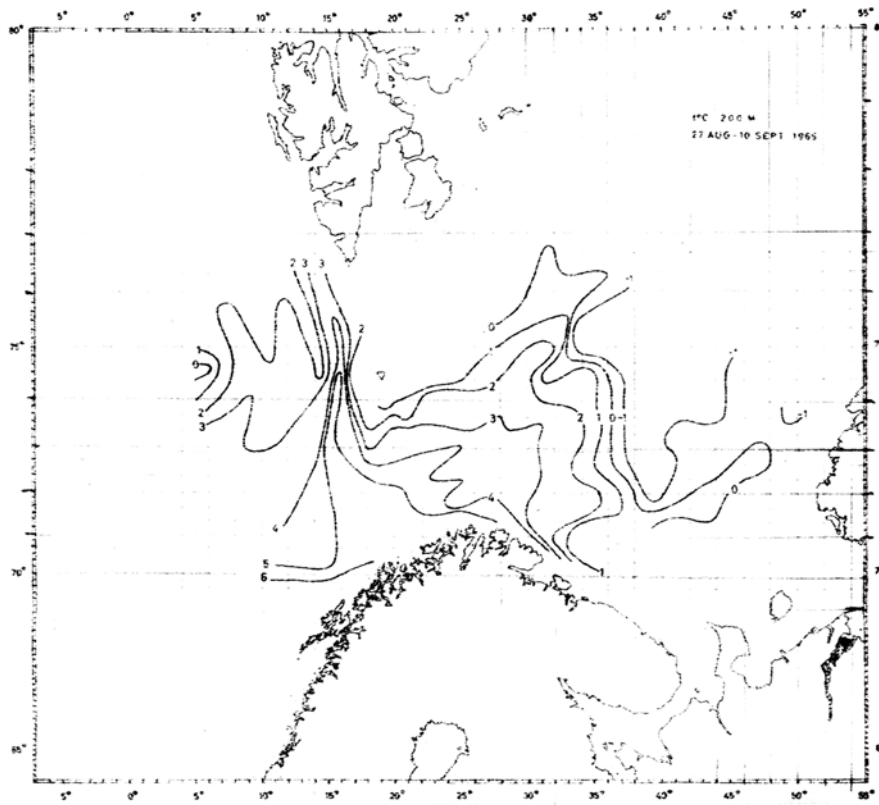


Fig. 3a. Isotherms at 200 m

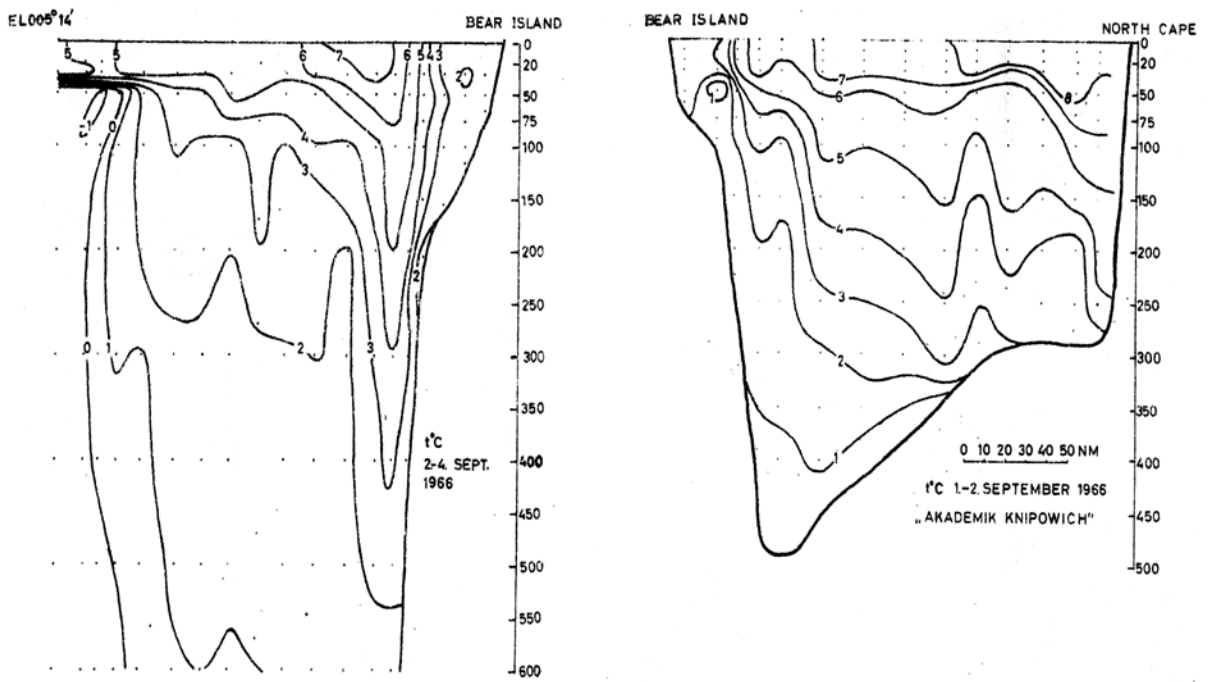


Fig. 4. Vertical temperature section North Cape-Bear Island and Bear Island-West

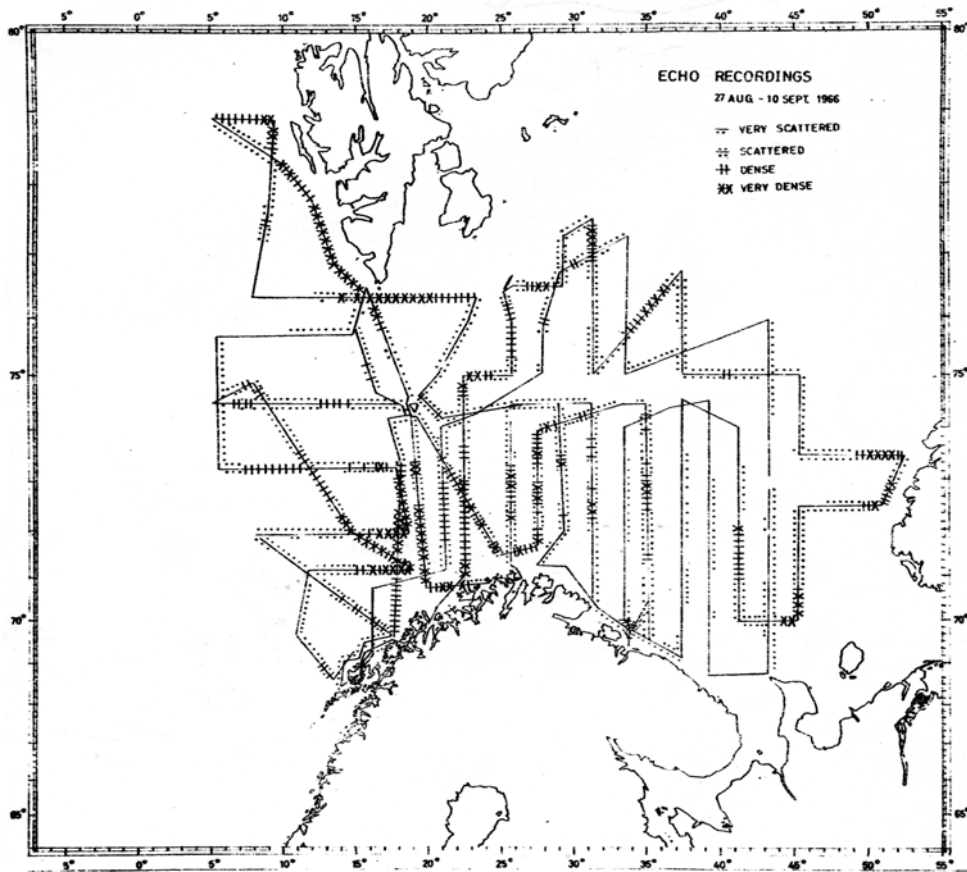


Fig. 5. Courses and echo recordings

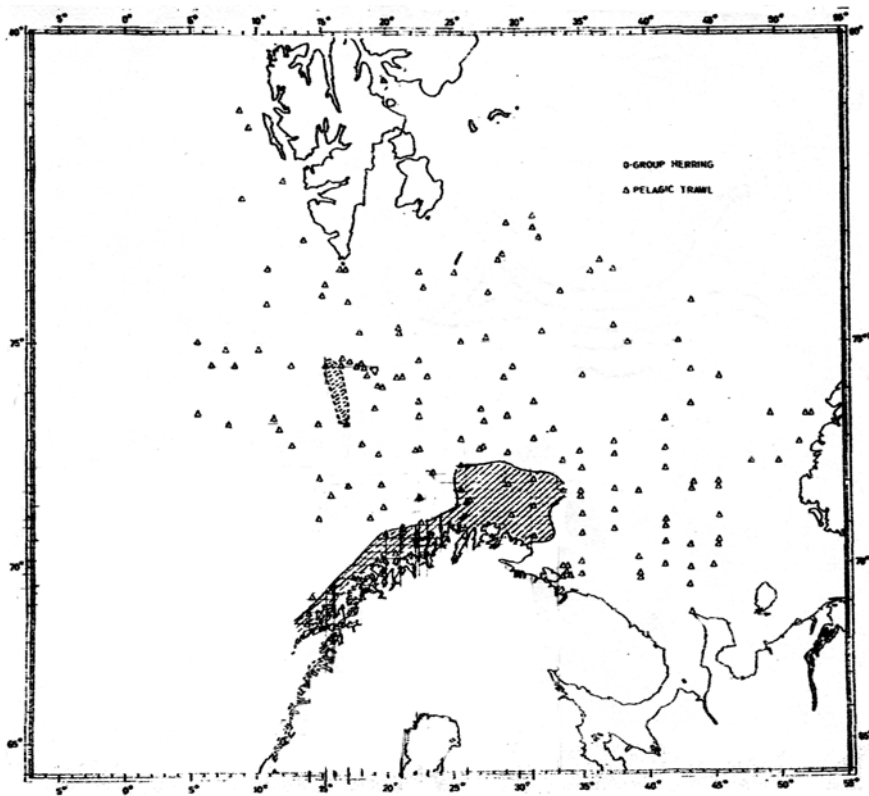


Fig. 6. Distribution of 0-group herring

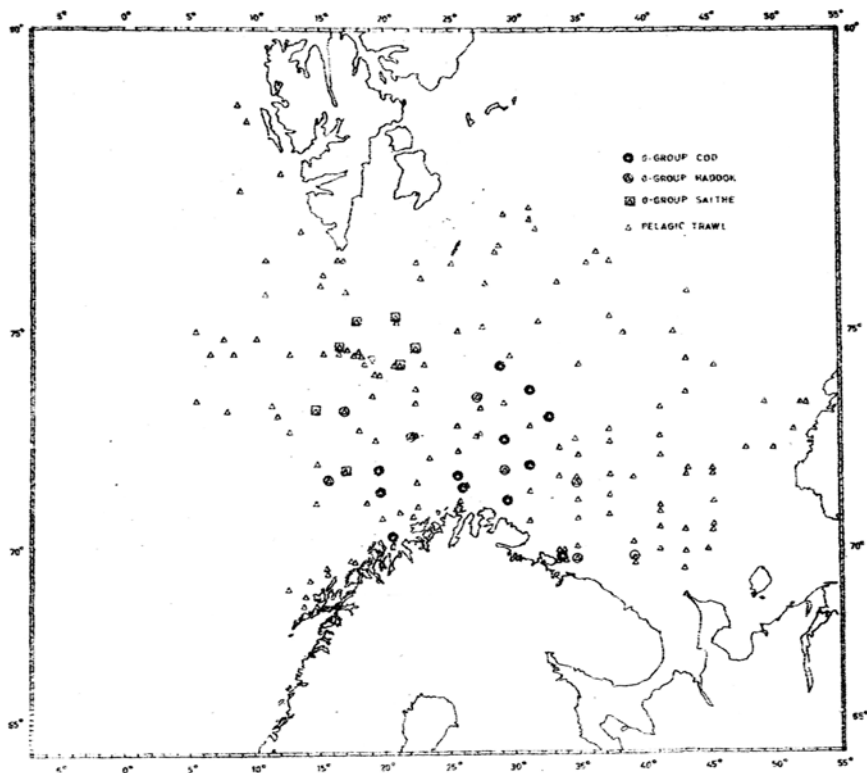


Fig. 7. Distribution of 0-group cod, haddock and saithe

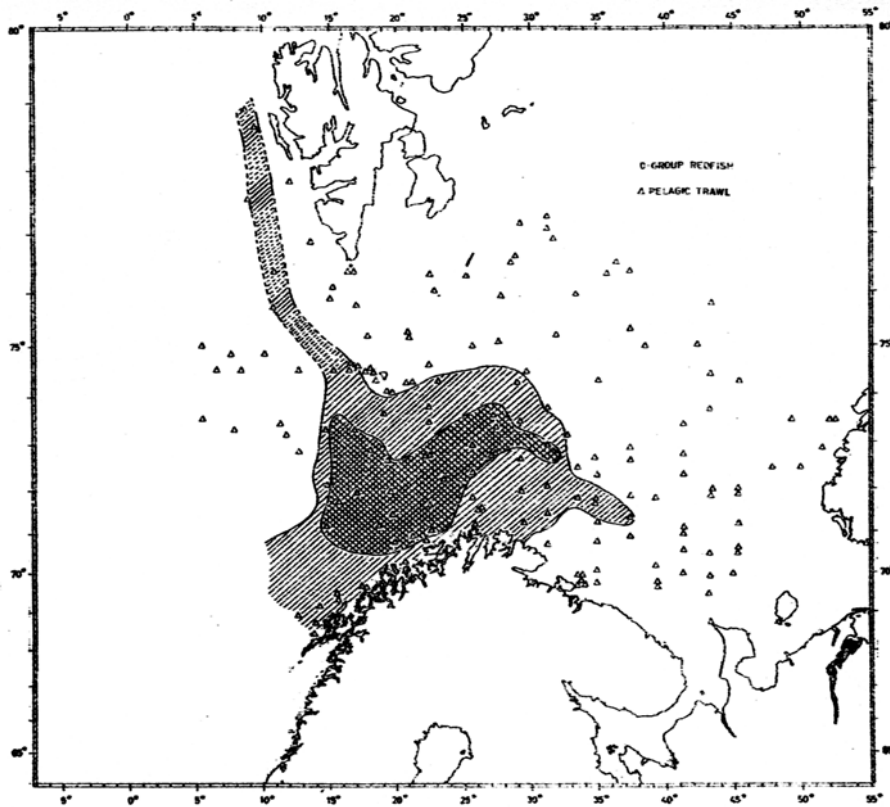


Fig. 8. Distribution of 0-group redfish. The double hatching indicates the highest abundance

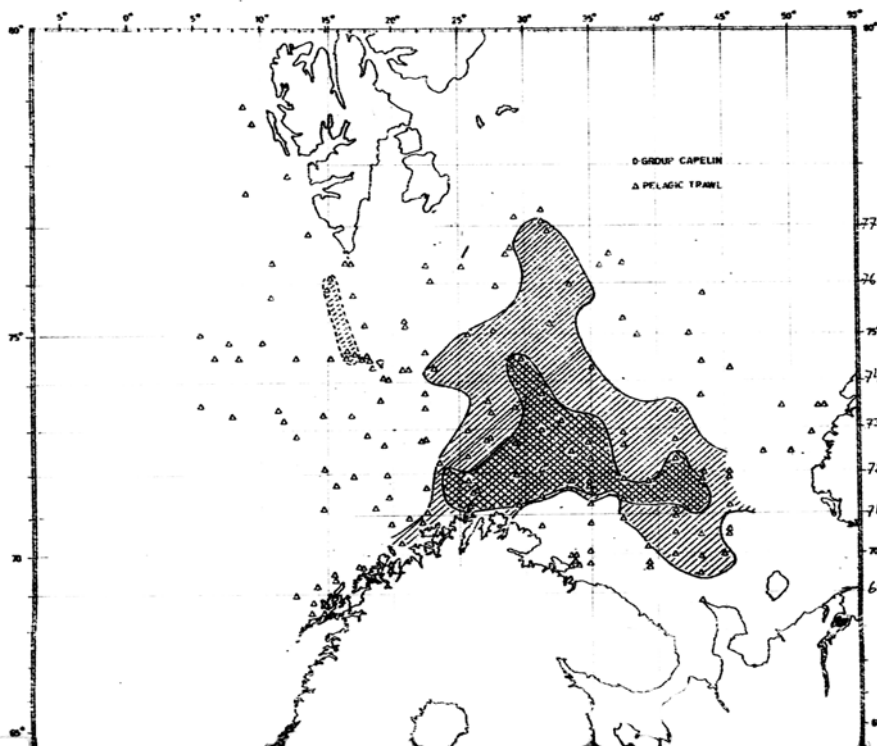


Fig. 9. Distribution of 0-group capelin. The double hatching indicates the highest abundance

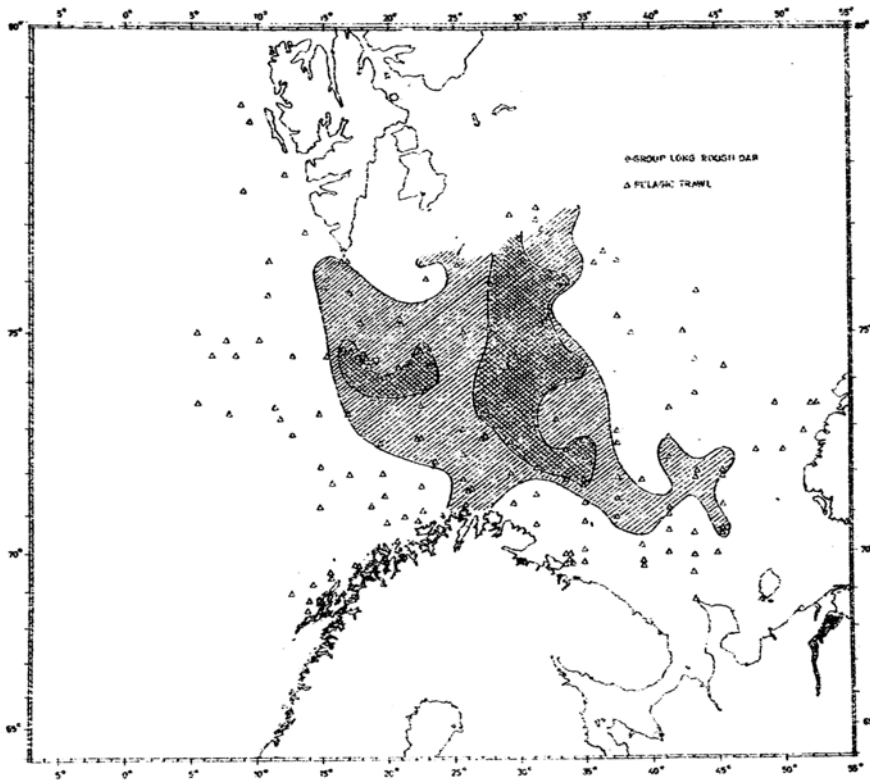


Fig 10. Distribution of 0-group long rough dab. The double hatching indicates the highest abundance

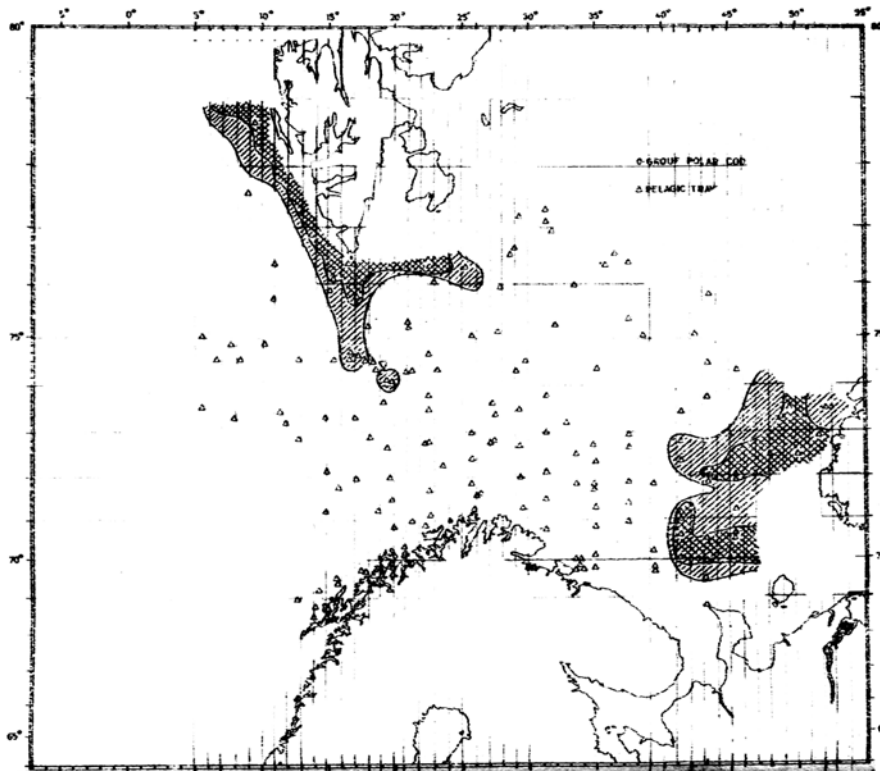


Fig. 11. Distribution of 0-group polar cod. The double hatching indicates the highest abundance

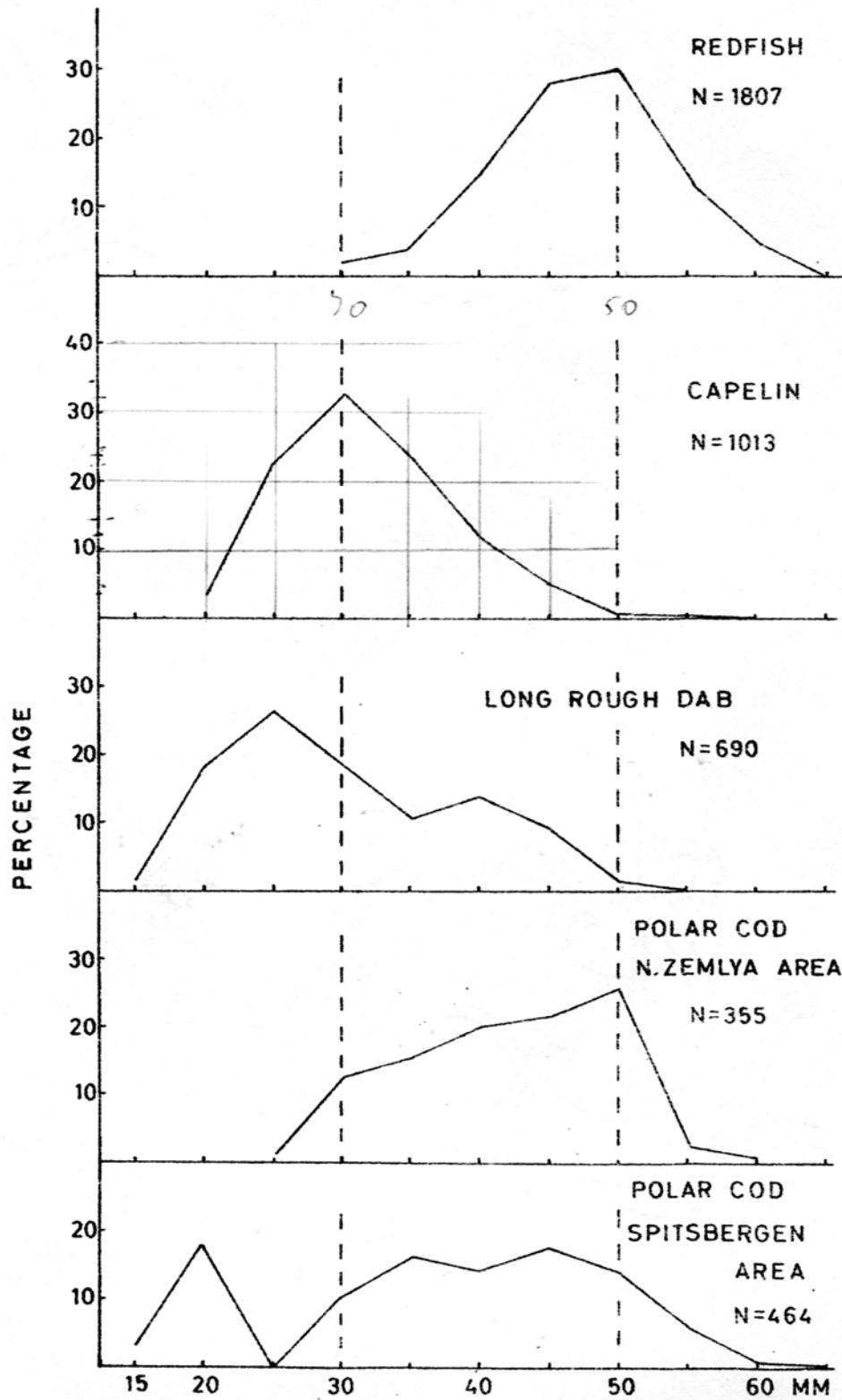


Fig. 12. Length composition

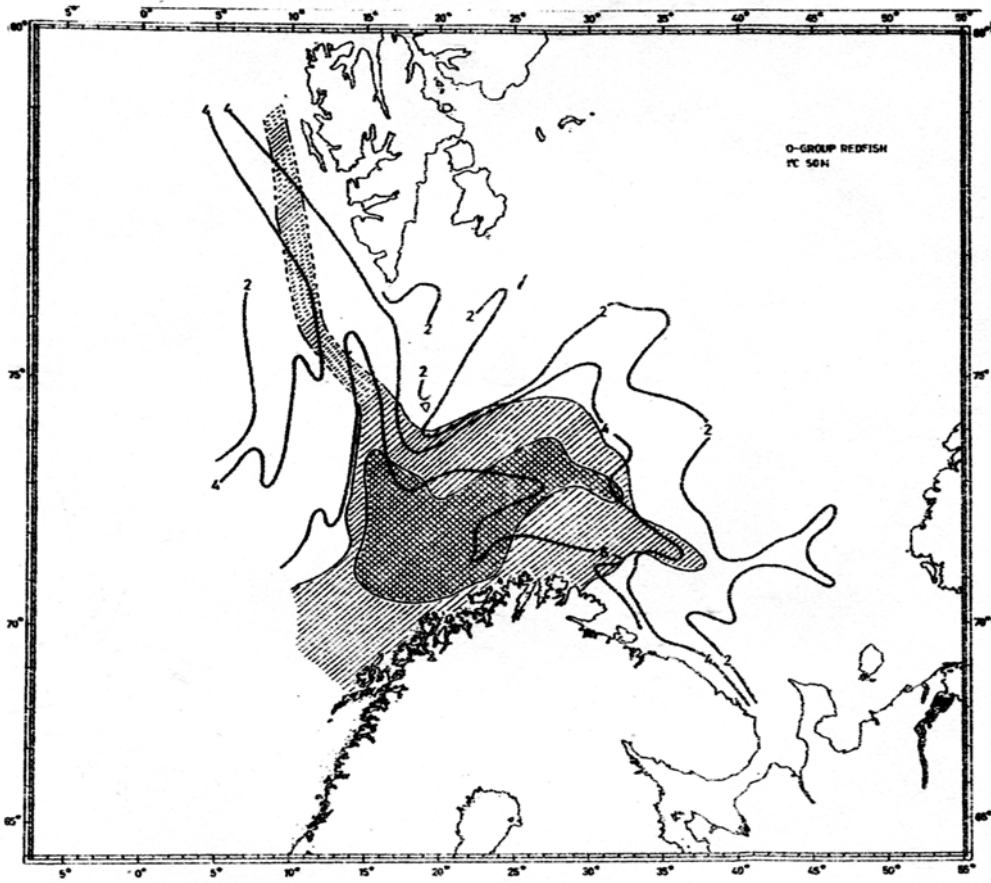


Fig. 13. Distribution of 0-group redfish compared with isotherms at 50 m

Preliminary Report
of the international 0-group fish survey in the
Barents Sea and adjacent waters August-September 1967

1. Introduction

Representatives of the countries participating in the previous 0-group surveys (USSR, Norway and England), agreed that the results achieved in 1965 and in 1966 showed considerable promise for determine the abundance and distribution of 0-group fish of the different species of commercial importance. It was therefore concluded that a similar survey should be carried out in autumn 1967 with especial reference to the distribution of 0-group herring, capelin, cod, haddock and redfish, but including other species important to the ecological system of the area e. g. long rough dab and saithe.

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

U.S.S.R.	R.V. "Akademik Khipovich"	Yu.K. Benko
	R.V. "Fridtjof Nansen"	A.S. Seliverstov
Norway	R.V. "Johan Hjort"	O. Dragesund, P.T. Hognestad
	R.V. "G.O. Sars"	L. Midttun, S. Olsen
England	R.V. "Ernest Holt"	D.J. Garrod

Following preliminary planning in Bergen in June 1967, and at Murmansk on 22—23 August, the survey was commenced on 24-th of August and continued through 9-th September, and was followed by a meeting in Tromsø 9 - 12 September in order to exchange data and analyse the results.

2. Methods

The techniques used were exactly the same as those used in the previous survey of 1966, namely the estimation of the density, distribution and identity of the pelagic scattering layer by echo-sounding, supported by direct sampling with a pelagic trawl. In order to improve the quantitative aspects of the survey experiments were also carried out with echo integration techniques and with high frequency echo-sounding (100 kHz) in order to give more precise details of the infrastructure of the scattering layer.

The survey grid, which can be seen in Fig. 1, follows closely the grid of 1966 with extended coverage to the north-west of West-Spitsbergen, as far as 80°00' N, and to the south-west off the Norwegian coast to 10°00' E and 67° N the latitude of Vestfjord.

3. Results

A comprehensive analysis of the data could not be carried out during the time available at Tromsø. In particular it was not possible to prepare a complete synopsis of the hydrographic situation, but nevertheless it is possible to identify the main features of the distribution of 0-group fish and to contrast it with the distribution observed in previous years.

3.1. Hydrography

The salinity samples have not yet been analysed and only the temperature condition in a series of horizontal and vertical sections are presented (Figs. 2, 3 and 4).

In the section Bear Island towards west the temperature of the surface layer was approximately 1.0 °C higher than in 1966 (Fig. 4). The temperature also appeared to be higher in the deeper layers and this may have been caused by increased transfer of heat within the branches of the Norwegian Current.

It is evident from observations made by U.S.S.R. that the large anomalies have been observed within the North Cape Current during the last years decreased in the spring and summer of 1967. Thus, the temperature of the 0-200 metre layer within the section North Cape - Bear Island increased during the period March to August with 0.7 °C compared to a normal increase of 0.4 °C. In the 0-200 m layer the absolute value of the temperature was 5.7 °C i.e. slightly below average, and in deeper layers (from 200 m to the bottom) the temperature was above the long-term average and about 1 °C higher than in 1966.

In the section crossing the Murman Current in the Kola meridian, and further east, the temperature in 1967 is almost at average level and considerably higher than last year (Table 1).

Table 1. The temperature in various layers measured in the Kola section (70°30' N - 72°30' N).

Year/Layer	0-50 m	50-200 m	0-200 m
1967	7.5	4.05	4.9
1966	6.6	2.7	3.6
average	7.5	4.05	4.9

In the Goose Bank Current the 3 °C isotherm extended to the meridian. 45°00' E in 1967, whereas in 1966 it extended only to 35°00' E.

During the period of this survey the surface temperature in the western areas reached the long-term average, at the Kola meridian it was 0.5 °C higher than average, and in the shallow waters of the south - eastern area it was considerably above average and 3.5 °C higher than in 1966.

Thus, in general the distribution of temperature observed in the Barents Sea in 1967 was near the long term average, in contrast to the low temperatures observed in 1966. This change which began in spring 1967 has been brought about by increased transfer of heat by the current system.

3.2. The distribution and abundance of 0-group fish

The variation in total density of the scattering layer is shown in Fig. 5. As in previous years this figure includes also traces from organisms other than the 0-group fish, especially from certain invertebrate species of Medusae, Euphausidae, Amphipodae, which contribute to

the uppermost scattering layers. The illustration also includes the contribution from fish of older age groups laying in mid water down to 250 m.

Intership calibration of results obtained from the same area has shown that the methods used give consistent agreement between vessels as to the location and density of the traces. Variations in echo abundance have been expressed on a subjective scale of 0 to 4. The experiments with electronic integrators show that these subjective estimates are too coarse and rather inaccurate at high densities. Further experimental work on the influence of diurnal variation in the distribution of the scatters is also necessary before more precise quantitative measurements can be made.

The results show clearly that the main distribution of the scattering layer was almost entirely confined to the central part of the Barents Sea between the meridians 20°00' E and 45°00' E, with a subsidiary concentration further east along the coastal waters of Novaya Zemlya. In 1966 this principal scattering layer extended eastward from meridian 15°00' E. On the Svalbard shelf and off West Spitsbergen there was a marked contrast in the total abundance of scattering layer as compared with last year. The density was relatively low on the banks, but on the other hand there were significantly greater concentrations of the mid-water shoals off the edge of the continental shelf.

Apart from the principal 0-group species discussed below isolated specimens of *Anarhichas*, *Agonus*, *Triglops* and *Leptagonus*, were also recorded, and 0-group mackerel, *Argentina* and *Myctophum* occurred in the south-western area of the survey off Vestfjord. It was noticed that the *Myctophum* in particular were more numerous and more widely distributed than in previous years.

3.2.1. Herring (Fig. 6)

Throughout the entire survey 0-group herring were only located in small numbers in isolated patches in the south-western area and off North Cape. The abundance was probably lower than that of the 1966 year-class, which itself is regarded as being a very poor one. Thus, in all three years during which the joint surveys have been carried out, the recruitment to the Norwegian spring spawning stock of herring appears to have been extremely low. It is, therefore, to be expected that the impact of these three very poor year-classes on the abundance of the exploited stock will in due time be seriously felt.

3.2.2. Cod (Fig. 7)

0-group cod with a length range 40-90 mm (Fig. 14) were distributed throughout the area north of Norway between the approximate limits of 25°00' E to 38°00' E with a narrow extension along the Murman coast. However, they were absent from a small area of coastal water off the eastern Finnmark coast. Even more important and unexpected, no 0-group cod were found on the Svalbard shelf, either to the south-east of Bear Island, or anywhere in the main part of the West Spitsbergen Current. In comparison with previous years it is clear that the 1967 year-class is rather weak though more numerous than those of 1965 and 1966. During the early years of the life history there is very little movement of cod between the Barents Sea and the Svalbard shelf, so the present distribution suggests that recruitment to the cod stock on the Svalbard shelf will be very poor indeed, and it is noticeable that this year the 0-group cod are almost entirely distributed within the Barents Sea itself.

3.2.3. Haddock (Fig. 8)

Haddock were observed within the general limits 20°00' E and 35°00' E with an extension towards south-east off the Murman coast. This distribution follows basically the same pattern as in previous years, though they did not extend quite so far to the east as the 0-group cod. There were some variations in abundance within the main distribution of the haddock stock, with a higher concentration in the central part of the region. Overall these haddock were more considerably numerous than in 1965 and 1966, but it is not yet possible to assess how much better this year-class might be.

3.2.4. Saithe (Fig. 9)

Saithe were distributed over the Barents Sea more widely than cod and haddock, and in contrast to these two species a considerable number of saithe shoals was found and identified along the West Spitsbergen Current. Recently ingested 0-group saithe were found in stomach contents of cod at Bear Island, and positive identification of shoals extended to 78°00' N. However, similar traces were recorded northwards to the limit of the survey.

The experience of this year has also shown that already at this stage the saithe tend to form shoals with high target strength, indicating high numbers of individuals in spite of the relatively small size or volume of the shoals. This is confirmed by some incidental catches up to 200 tons in one shot by Norwegian purse seiners fishing for herring in the area at the brim of the survey.

Evidently the present sampling technique is quite inadequate for the fast-swimming, shoal-forming 0-group saithe. Nevertheless, it can be concluded that this year the abundance of saithe fry is exceptionally high with the main concentration in the area to the west and northwards from Bear Island. There is no previous observation of a comparable oceanic mass distribution of 0-group saithe, and no hypothesis can at this stage be advanced as to the chances of survival of these young fish. However, it is noticed that at the time of the survey the condition of the saithe fry was good and their size (Fig. 14) rather large for their age. Consequently, unless a mass mortality occurs the indications are that the 1967 year-class of saithe will be very rich.

3.2.5. Redfish (Fig. 10)

The 0-group redfish were found to extend less far to the north than in 1966 with fewer identifiable traces in the West Spitsbergen Current. This more limited distribution is perhaps consistent with their reduced abundance compared with the two last years, and it may also be significant that the redfish caught in the trawl catches had a lower length range than in 1966, 20 - 50 mm in length (Fig. 14) compared to 30 - 60 on last year.

3.2.6. Capelin (Fig. 11)

The distribution of the young capelin was much the same as in previous years, being principally more to the eastward than the distribution of cod and haddock, with well defined extension and area of increased abundance along the main currents, reaching almost to Novaya Zemlya. One of the main features of the distribution of the 0-group capelin this year compared to that of 1966 is the close approach to the Murman coast. Last year the capelin distribution had a well-defined southern boundary. It will also be seen that in contrast to cod, isolated patches of capelin were located in the West Spitsbergen Current, off the Storfjordrenna. The extent and overall density of the distribution suggest that though they

may not be quite so numerous as in 1966, nevertheless this is an indication of a good 1967 year-class of capelin.

3.2.7. Long rough dab (Fig. 12)

As in previous years the 0-group long rough dab were distributed further to the north-east than any of the other warm-water species. This concurs with the presumed area of the spawning relative to the spawning grounds of cod, haddock and redfish. Even so, comparison of the distribution of long rough dab with the isotherms at 50 metre indicates that the main area of distribution is confined by the cold water front of the north and eastern Barents Sea. Very few long rough dab were observed in the West Spitsbergen Current.

3.2.8. Polar Cod (Fig. 13)

This species were found distributed in exactly the same area of the eastern Barents Sea as in previous years, with a roughly comparable abundance. However, no concentration was to be found on the Svalbard shelf. This is a marked change from last year and must indicate that their total abundance is lower.

3.2.9. Adult and juvenile pelagic fish

It has already been noted that the survey detected mid-water shoals of age groups other than 0-group fish.

Maturing capelin were observed along the slope east of Bear Island to north-east of Hope Island with the densest concentrations on the Hope Island Bank. Some few adult capelin was also found further east on the Central Bank and near Novaya Zemlya.

I-group capelin were observed over a wide area east of 42°00' E stretching from Cape Kanin to 74°00' N. Scattered observations of I-group capelin were also made on the Central Bank east of Bear Island.

Adult polar cod were observed over a wide area stretching from the shelf east of Bear Island to Hope Island, the Central Bank and the Novaya Zemlya, where the greatest concentrations were observed.

Shoals of fat herring (1963 and 1964 year-classes) were distributed at the entrances of Varangerfjord and Kola Bay, and at the time of the survey mature herring were concentrated in an area north-west of Bear Island between 74°30' N and 76°00' N and 07°00' E to 12°00' E.

Similar to the survey of last year, blue whiting were found over wide areas along the eastern boundary of the Norwegian Sea. In view of the size of the area where blue whiting were observed it can be concluded that the stock size of this species, which is presently unexploited, must be quite considerable.

4. Discussion

Although the broad distribution of the scattering layer was rather similar to that of 1966, we have found considerable changes in its structure. Firstly, redfish were less abundant this year, cod and haddock were present in larger numbers, but herring were again very scarce indeed. Throughout the Barents Sea the distribution of total echo traces of 0-group fish corresponded very well with the distribution of the isotherms recorded at the hydrographic sections. The extension of the capelin, cod, haddock and redfish along the main part of the Goose Bank is very clear. It is also clear that this year the 0-group fish have penetrated along

the east coast of Finnmark and the Murman coast in the Murman Current, leaving a relatively barren area on the East - Finnmark coast. The presence of concentration of 0-group fish in these coastal waters contrasts with the result of 1966 when the scattering layer was confined more to the Goose Bank Current with no significant traces along the coast.

To the north the weakness of the scattering layers on the Svalbard shelf and off West Spitsbergen is a very significant change from 1966 and particularly from 1965. These changes are probably associated with the changes in hydrographic structure throughout the area and the return this year to near average temperature conditions. This might also be associated with the large quantities of saithe found in the West Spitsbergen Current. The contrast between this and the distribution of cod and haddock has already been referred to, and it seems possible that as in the other species the difference may in part be attributed to differences in the location of the time and area of the spawning with respect to the principal current system.

Recommendations

1. The results obtained during the three years surveys appear to be of sufficient interest to warrant a continuation of the work. The participating scientists, therefore, recommend that the joint survey should be repeated annually, at least until such time as separate assessments of the strength of some of the year-classes studied as 0-group fish by these surveys can be made from the catches of the commercial fisheries.

2. The survey should be maintained in its present scope and be carried out at the same time of the year. For 1968 a tentative starting date of August 24-th is suggested for the work at sea of all the vessels, but immediately prior to this date Soviet scientists will carry out a pre-survey as a guide for finalizing the program of the full survey to be discussed at a meeting in Murmansk. This program will be established at a meeting in Bergen in June 1968, during which the surveying technique is to be thoroughly reviewed.

3. Since the main short-coming of the present technique appears to be the difficulties encountered in identifying the echo-recordings, it is strongly recommended that high priority should be given to work on improving the identification and sampling methods. This work could follow two lines of approach, namely:

a) making the catch of fish fry more efficient and reliable by improving the design or type of the trawl used and simplifying the handling and control of the trawl. Serious consideration should also be given to the application of a suitable small purse seine;

b) refining and developing further methods of acoustic identification, for instance by applying echo-sounders with higher resolution, and by carrying out more detailed studies of target strength and trace pattern of the scatters.

4. The experience gained so far suggests that the subjective method of grading the intensity of echo-traces received is not adequate for proper quantitative assessments. Further efforts should therefore be made to develop and utilize precise methods for obtaining unbiased quantitative estimates of the echo-traces received. If possible, all vessels should during the 1968 - survey use integrators, and intership calibrations of the equipment should be carried out. It is also essential that theoretical and experimental work are conducted to establish the relationship between integrated signal voltage and the abundance of the scatters.

5. The participating scientists will endeavour to prepare each year at the end of the survey a progress report of their work for submission to the appropriate committees of ICES. It is recommended that a more comprehensive analysis and record of the data should be published at intervals of 3 to 5 years.

A suggestion for the scope and list of contents of the publication, comprising the data of the first four years (1965 - 1968), is to be prepared by the Norwegian participants within the end of 1967, to be circulated for comments by their colleagues within June 1968.

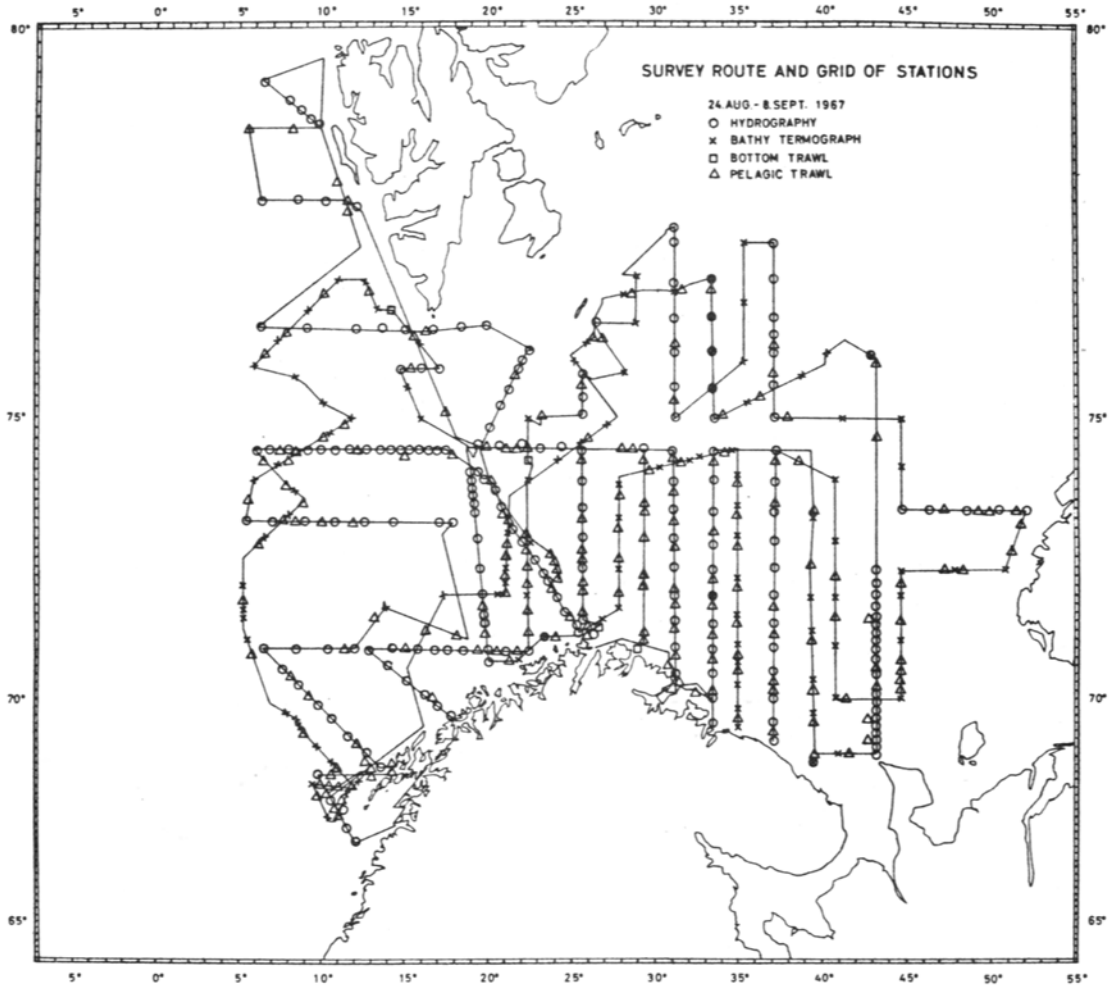


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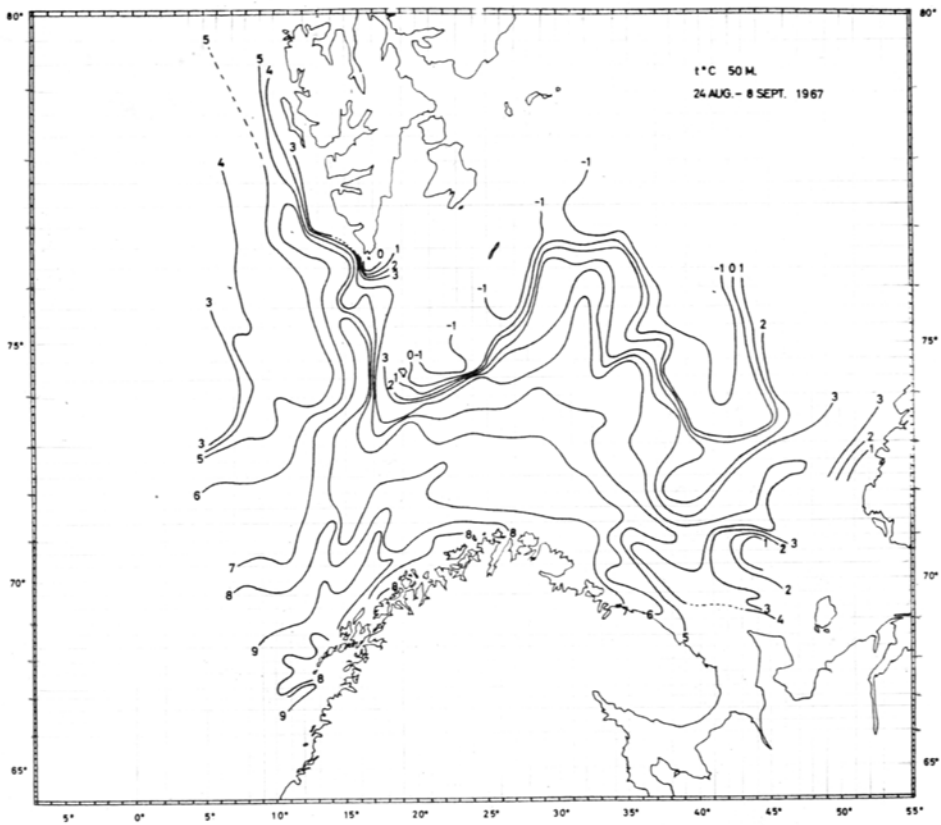
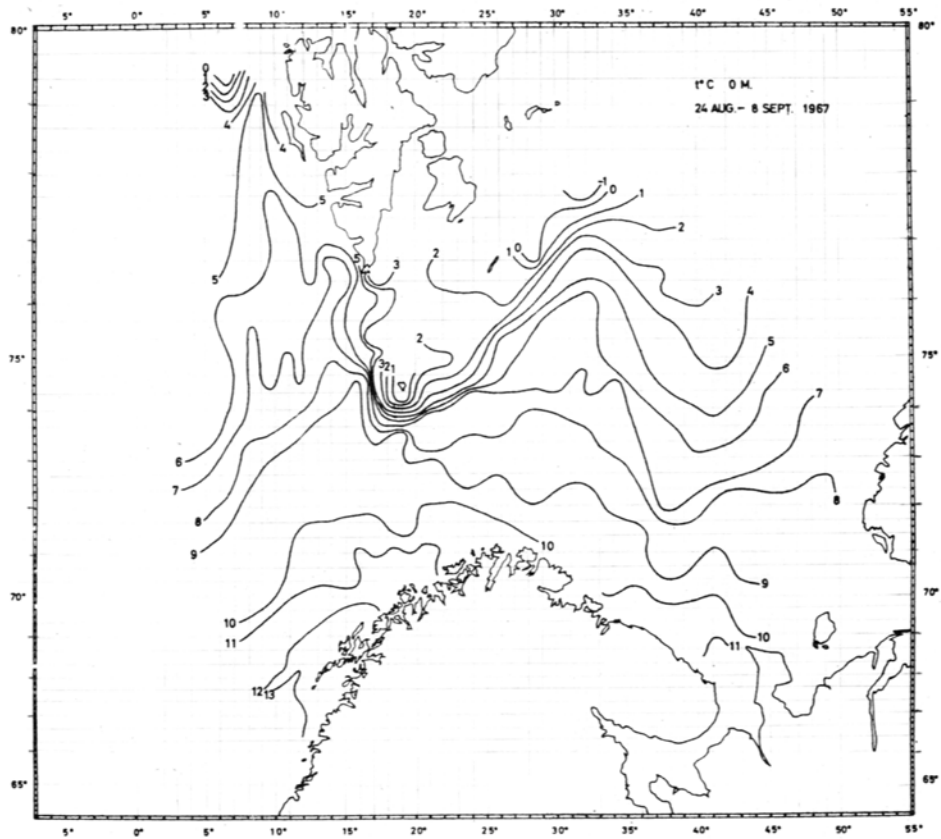


Fig. 2. Isotherms at 0 and 50 m

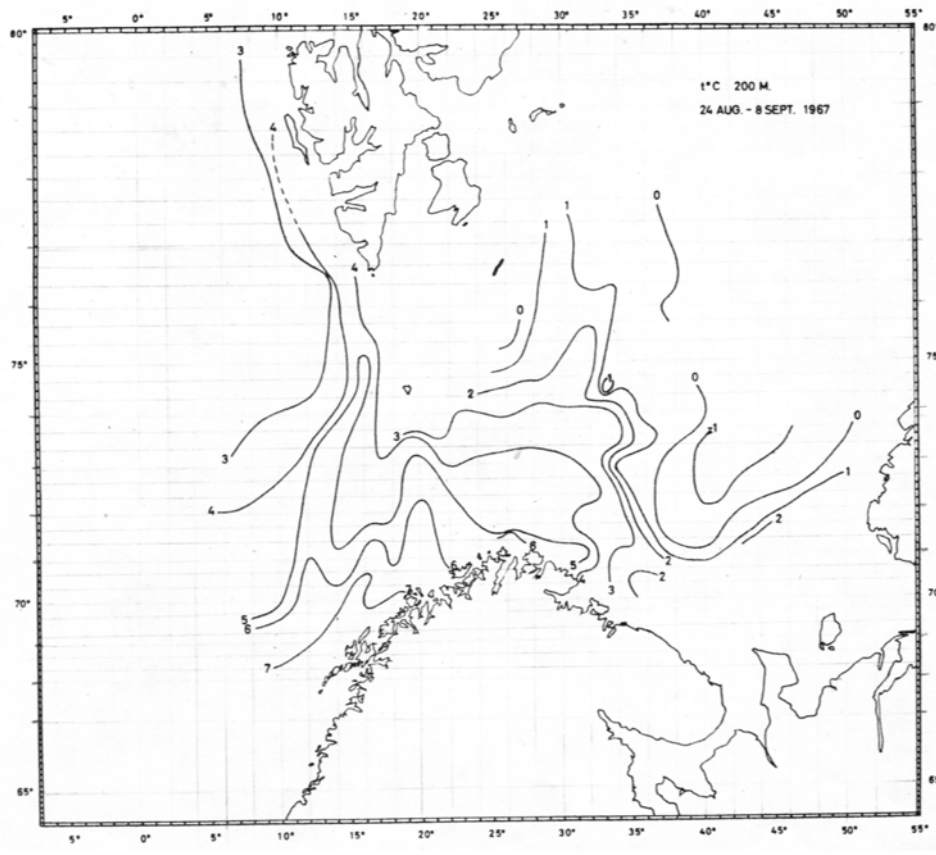
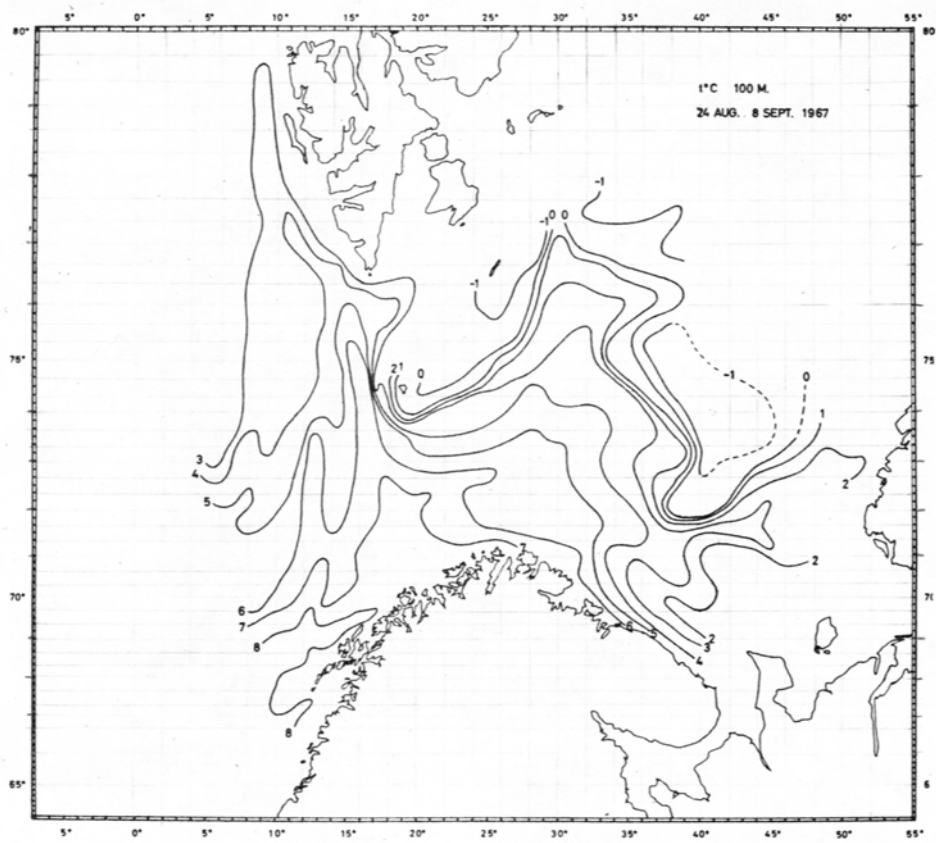


Fig. 3. Isotherms at 100 and 200 m

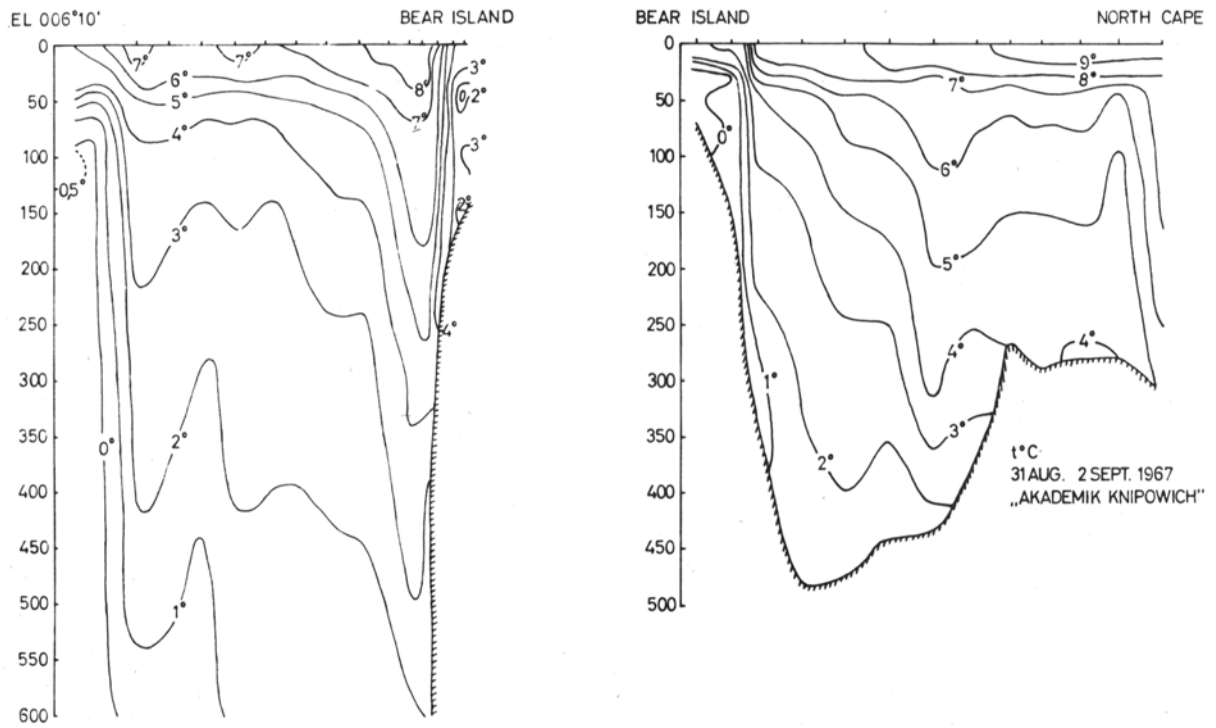


Fig. 4. Vertical temperature section North Cape – Bear Island and Bear Island-West

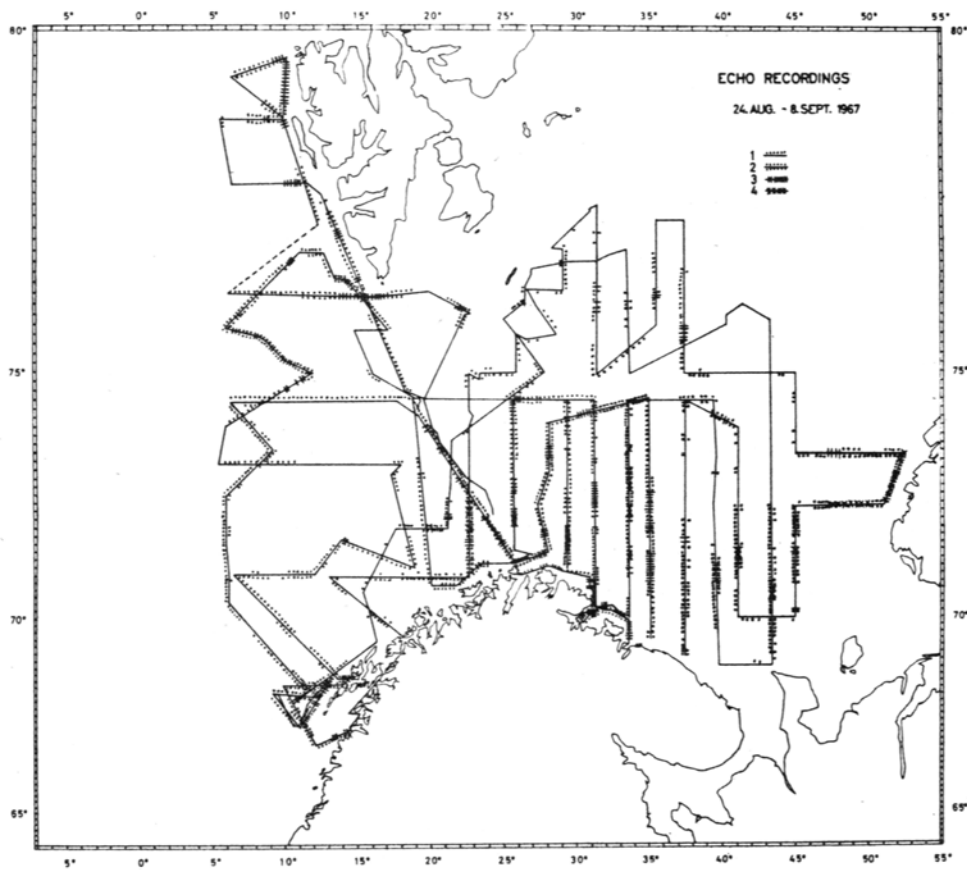


Fig. 5. Courses and total echo recordings

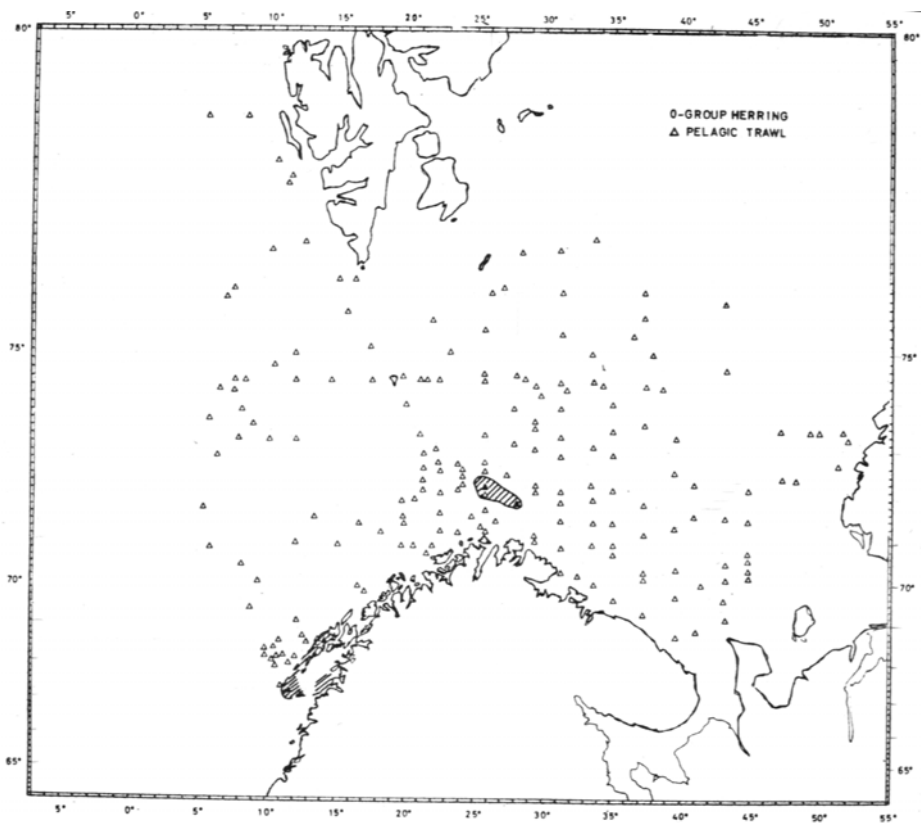


Fig. 6. Distribution of 0-group herring

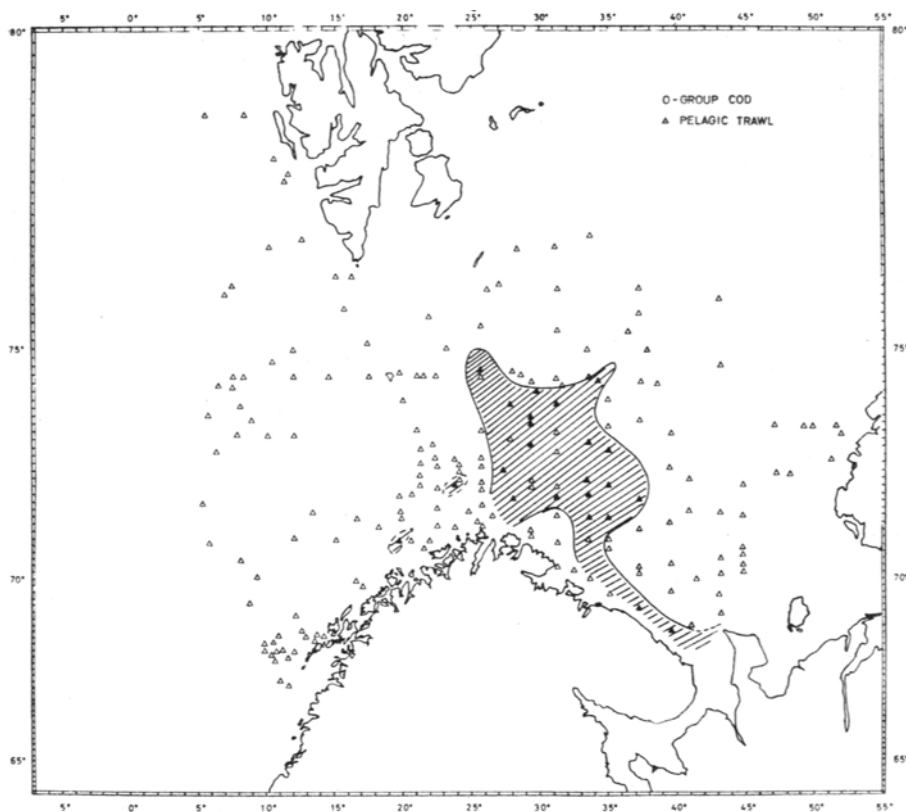


Fig. 7. Distribution of 0-group cod

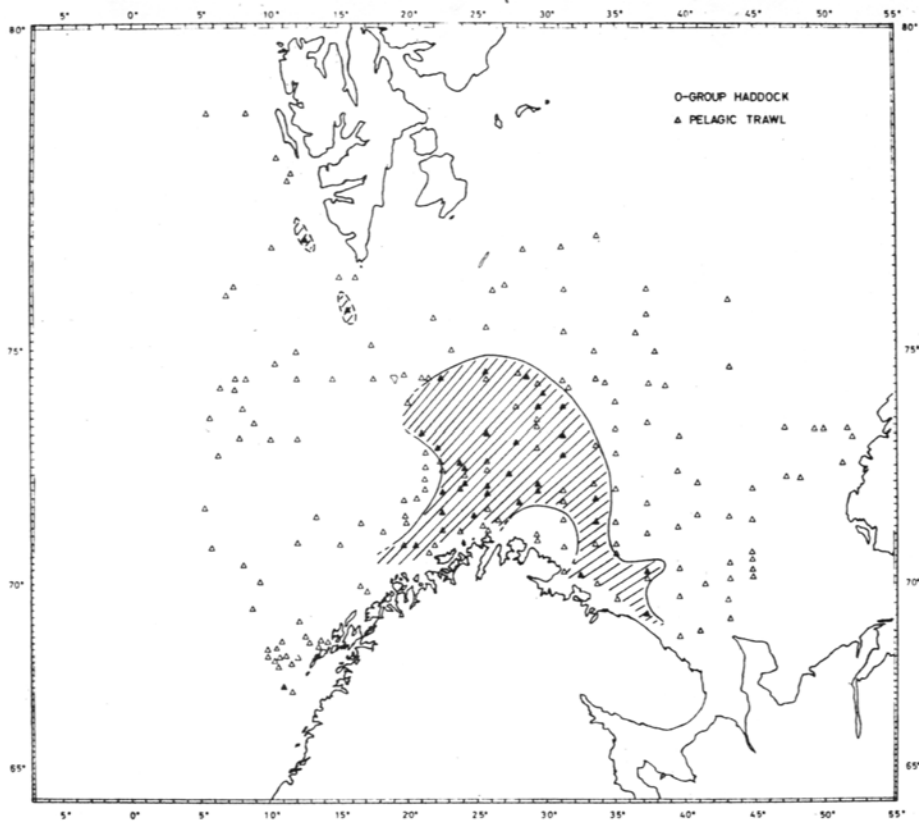


Fig. 8. Distribution of 0-group haddock

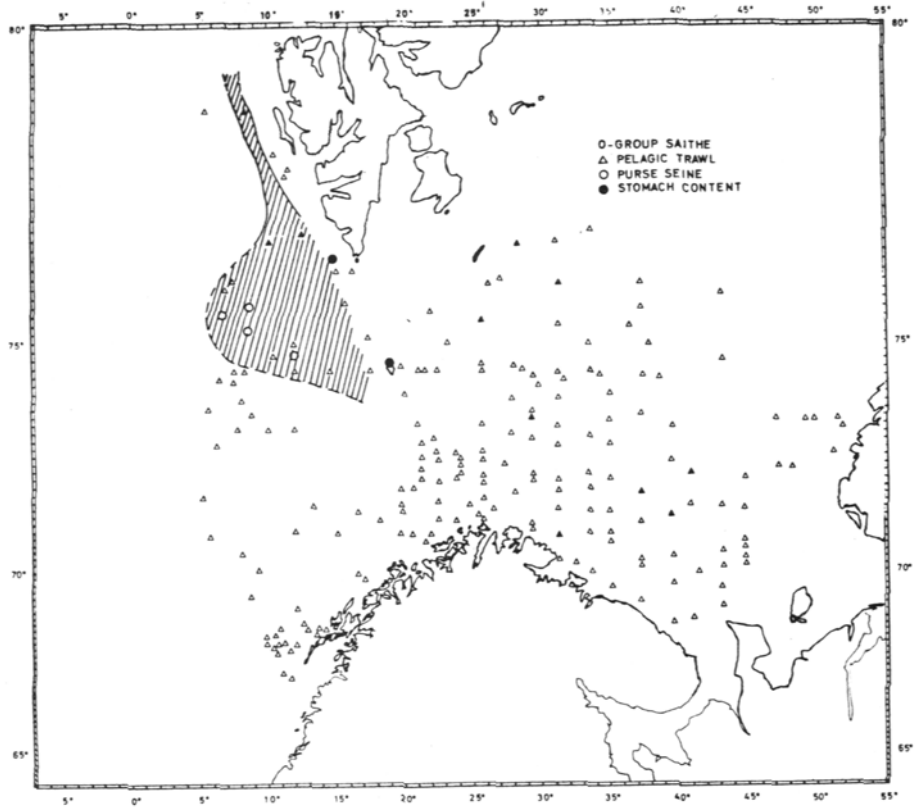


Fig. 9. Distribution of 0-group saithe

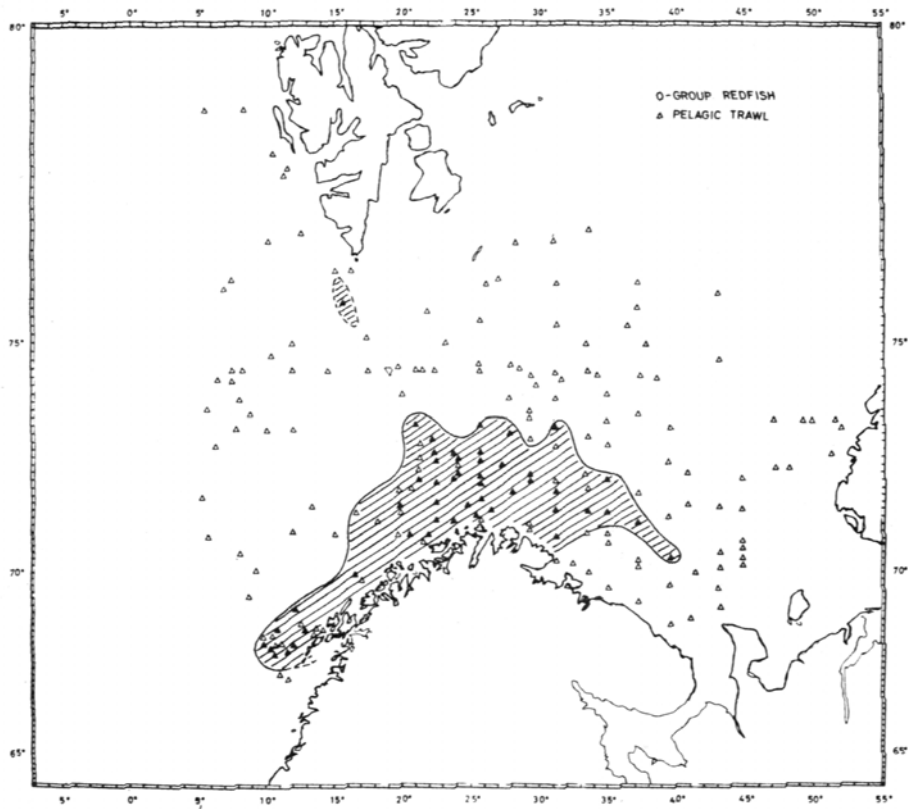


Fig. 10. Distribution of 0-group redfish

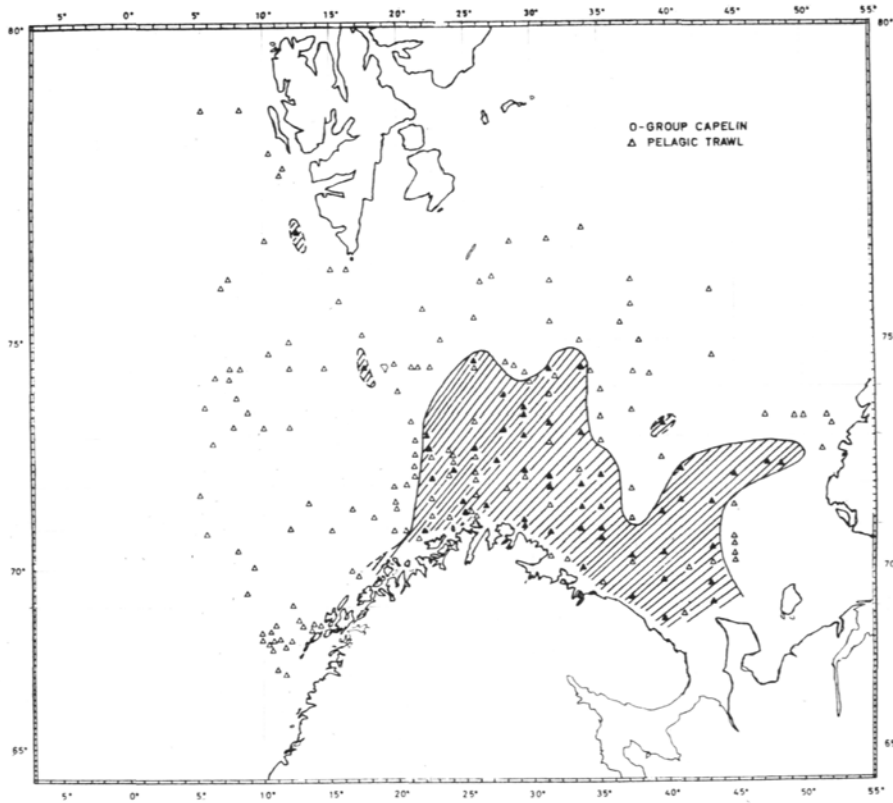


Fig. 11. Distribution of 0-group capelin

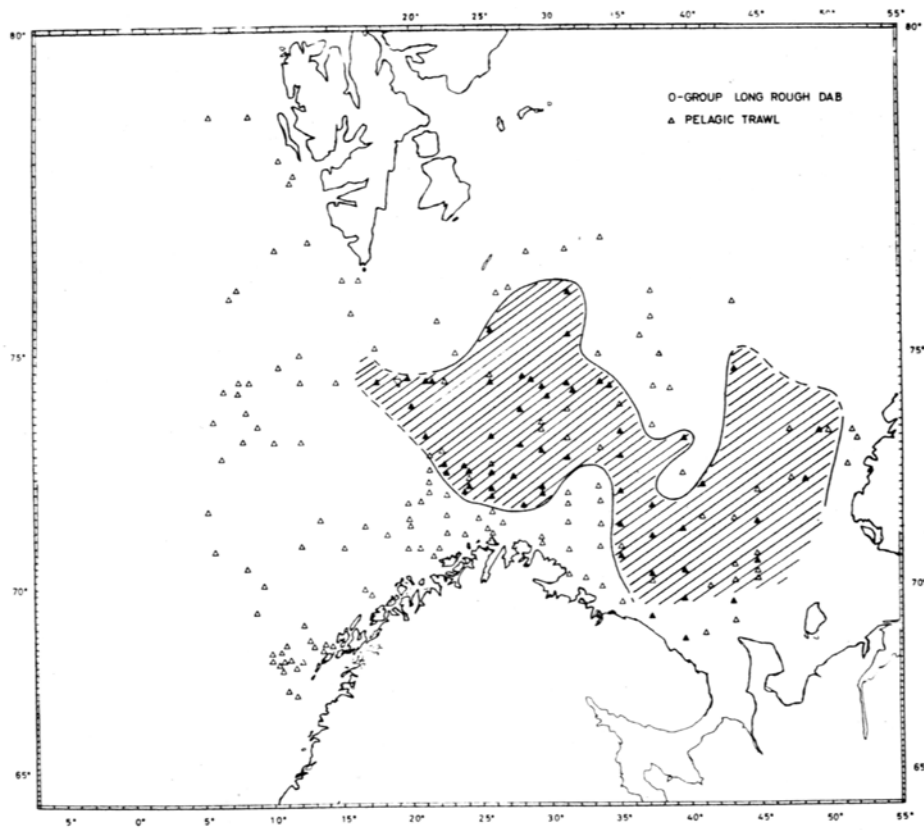


Fig. 12. Distribution of 0-group long rough dab

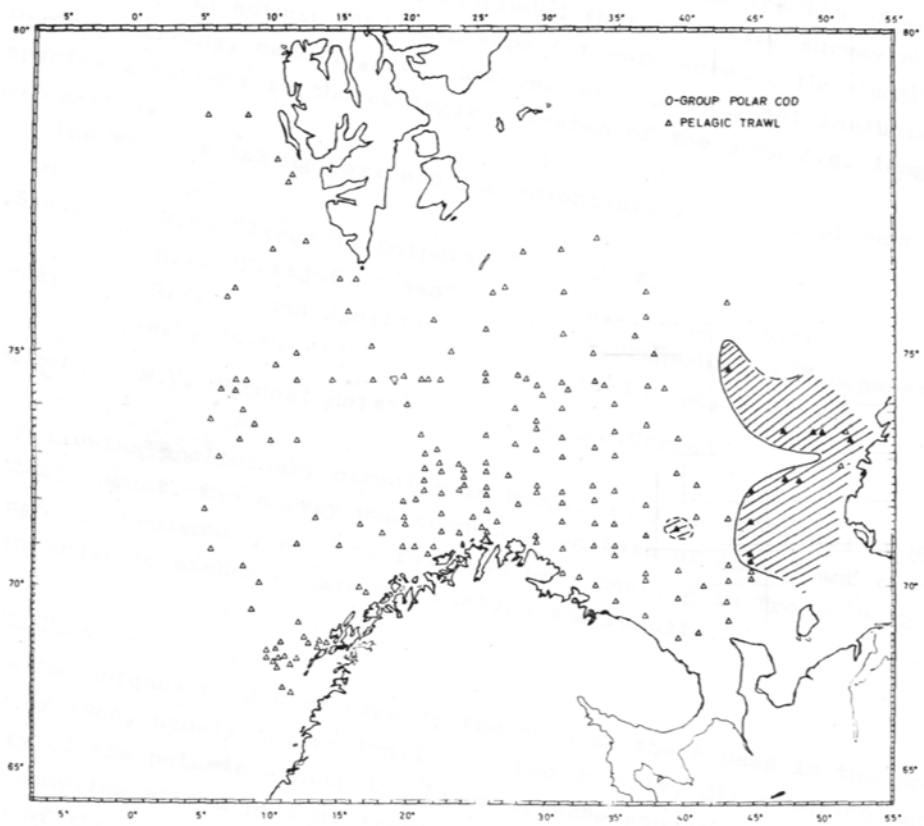


Fig. 13. Distribution of 0-group polar cod

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REPORT