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International Council for  
the Exploration of the Sea

Pelagic Fish (Northern) Committee  
Demersal Fish (Northern) Committee  
Ref:  
Gear and Behaviour Committee  
Hydrographic Committee

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 (U.S.S.R., Norway and England), agreed that the results achieved in 1965 and in 1966 showed considerable promise for determining 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 Knipovich"	Yu.K. Benko
	R.V. "Fritjof Nansen"	A.S. Seliverstov
Norway	R.V. "Johan Hjørt"	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 24th of August and continued through 9th 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 (100kHz) 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 Vest-Spitsbergen, as far as 80°00' NE, 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 which 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).

<u>Year/Layer</u>	<u>0-50 m</u>	<u>50-200 m</u>	<u>0-200 m</u>
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  $0.5^{\circ}\text{C}$  higher than average, and in the shallow waters of the south-eastern area it was considerably above average and  $3.5^{\circ}\text{C}$  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 midwater 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 scatterers 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  $20^{\circ}00'$  E and  $45^{\circ}00'$  E, with a subsidiary concentration further east along the coastal waters of Novaya Zemlya. In 1966 this principal scattering layer extended eastward from meridian  $15^{\circ}00'$  E. On the Svalbard shelf and off Vest 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 Vest 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 <sup>considerably</sup> more 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 Vest 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 north-wards 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-yearclass 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 Vest 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 mm 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 Nowaya 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 Vest 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 Vest 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 were also found further east on the Central Bank and near Novaya Zemlya.

I-group capelin were observed over a wide area east of  $42^{\circ}00' E$  stretching from Cape Kanin to  $74^{\circ}00' N$ . 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  $74^{\circ}30' N$  and  $76^{\circ}00' N$  and  $07^{\circ}00' E$  to  $12^{\circ}00' E$ .

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 Vest 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 Vest 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 24th 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 programme of the full survey to be discussed at a meeting in Murman. This programme 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 scatterers.
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 <sup>te</sup>ingrated signal voltage and the abundance of the scatterers.

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.



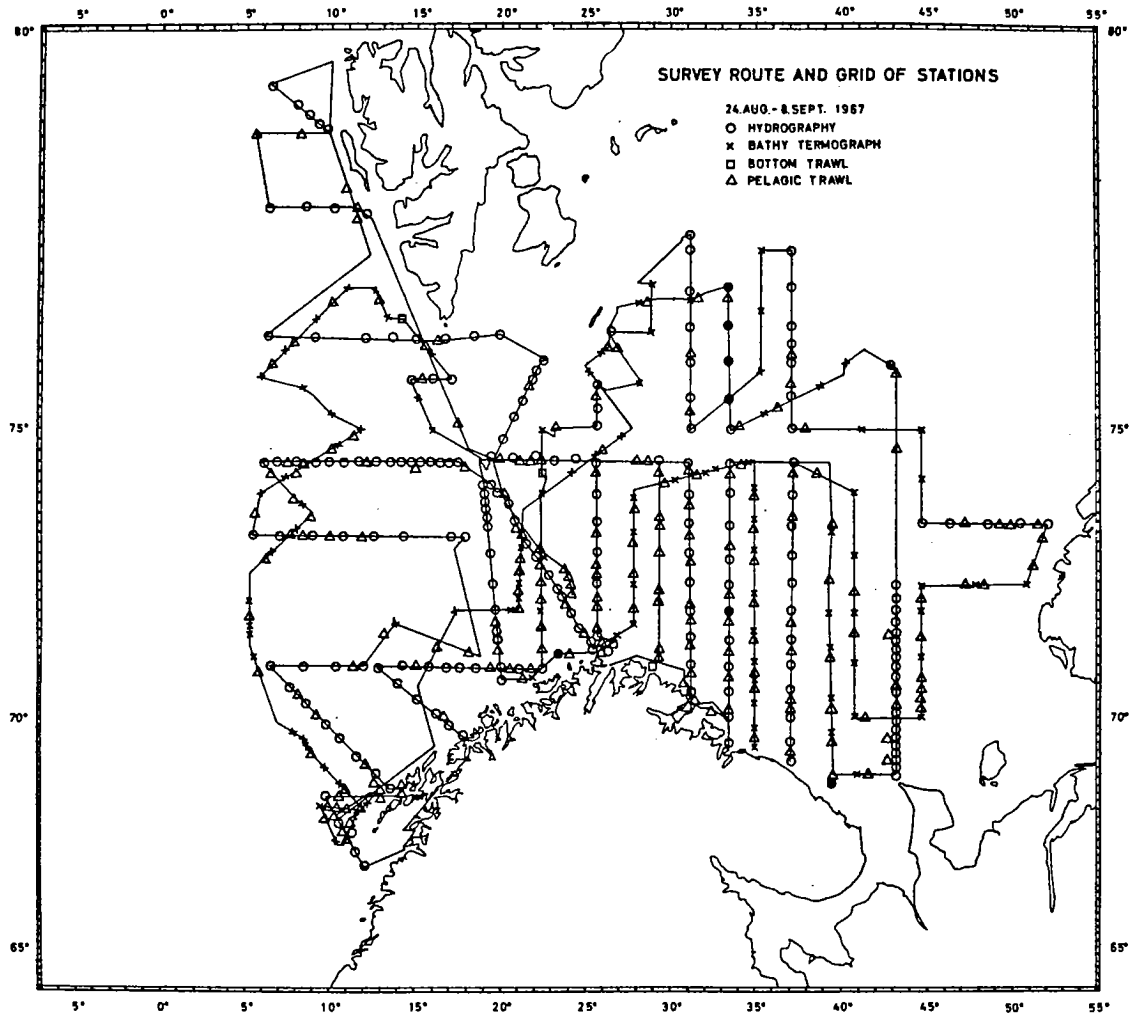


Fig. 1. Survey routes and grid of stations.

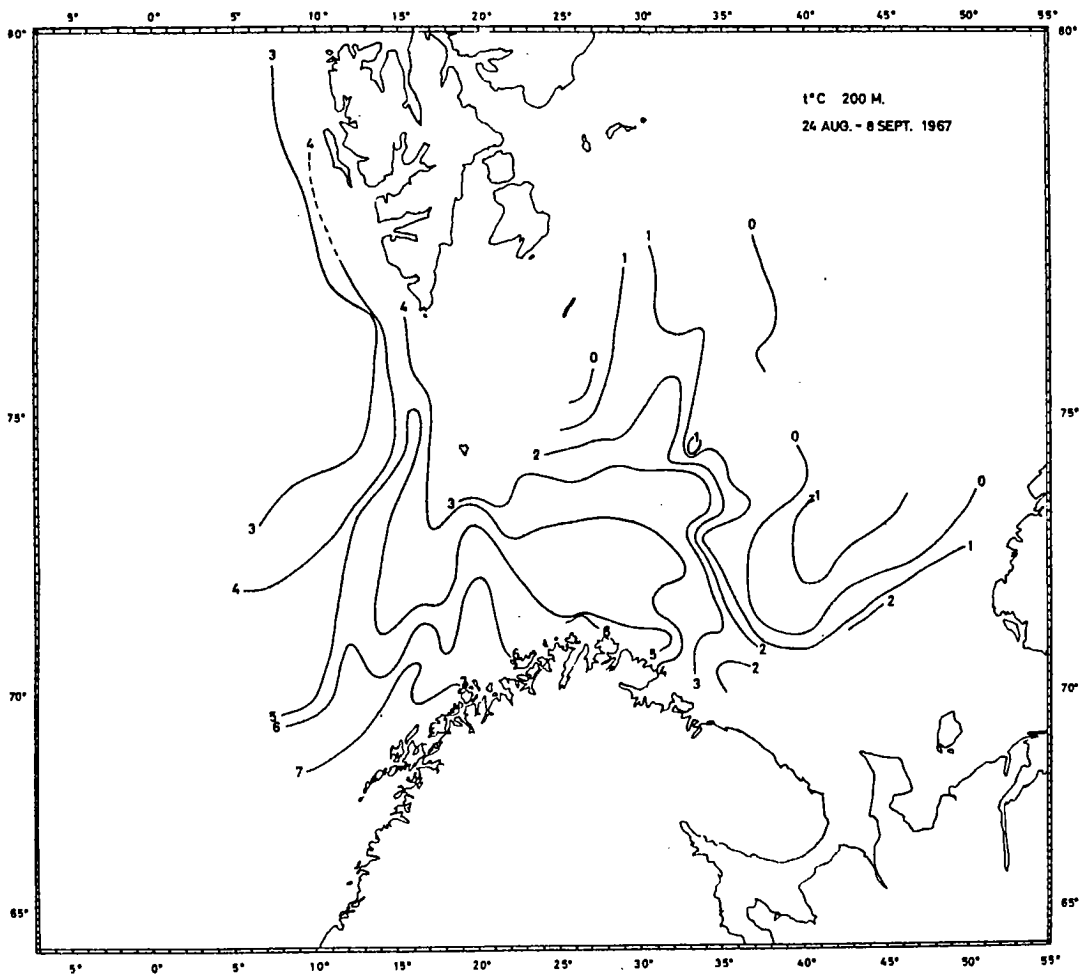
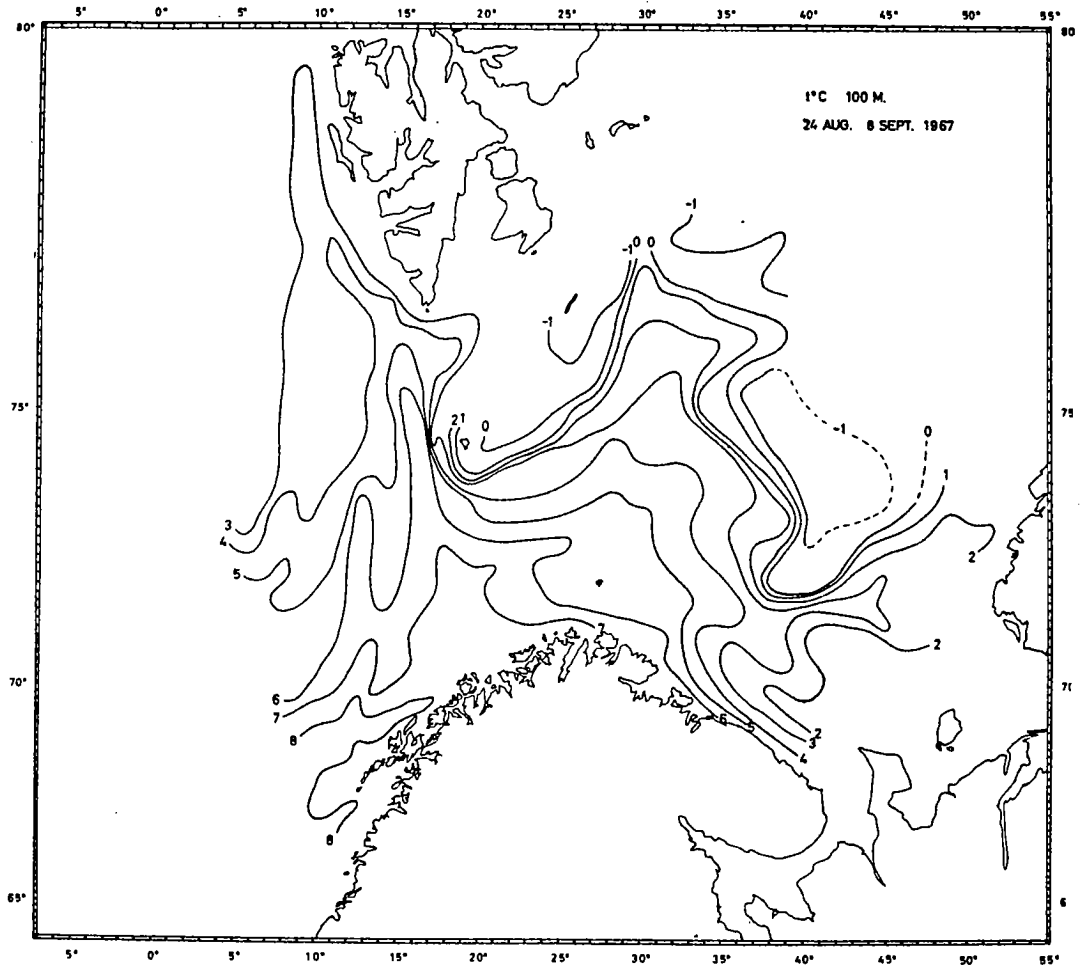


Fig. 3. Isotherms at 100 and 200 m.

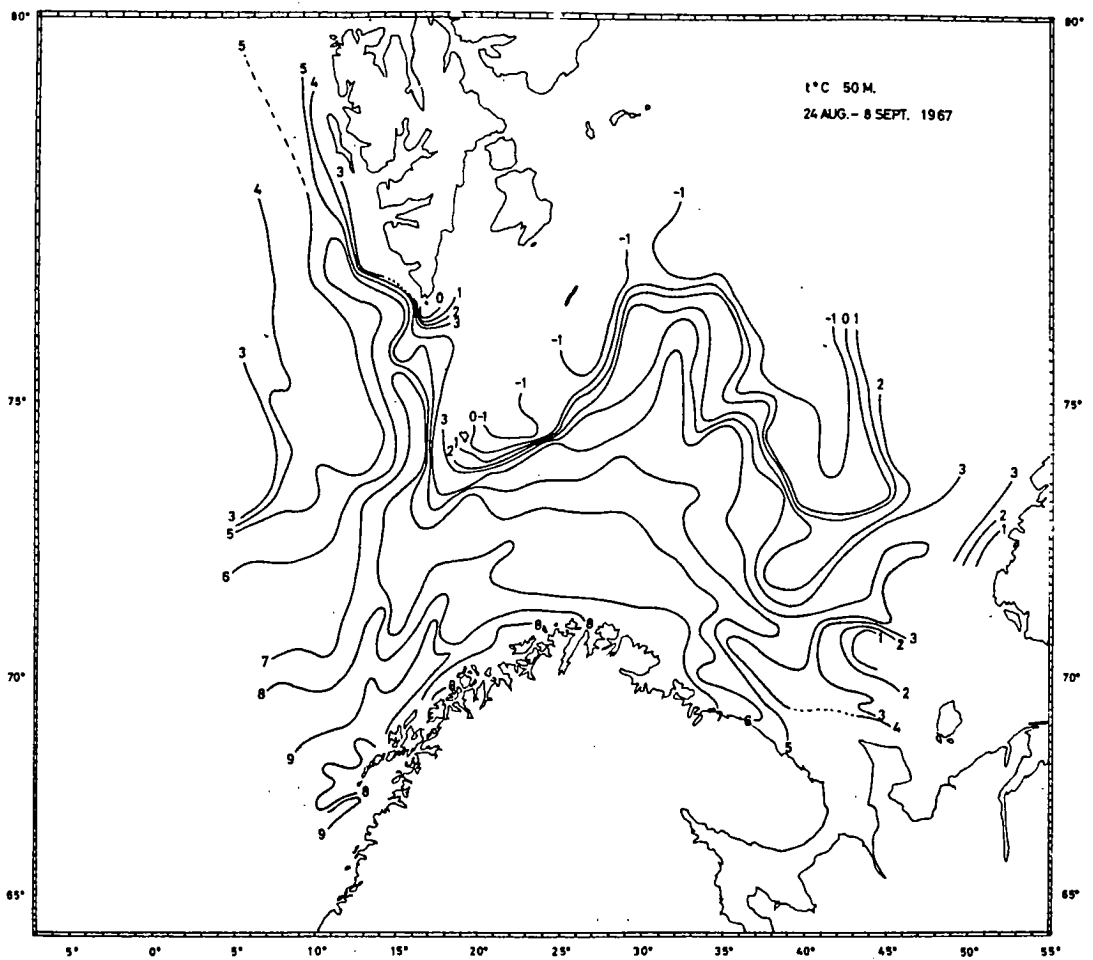
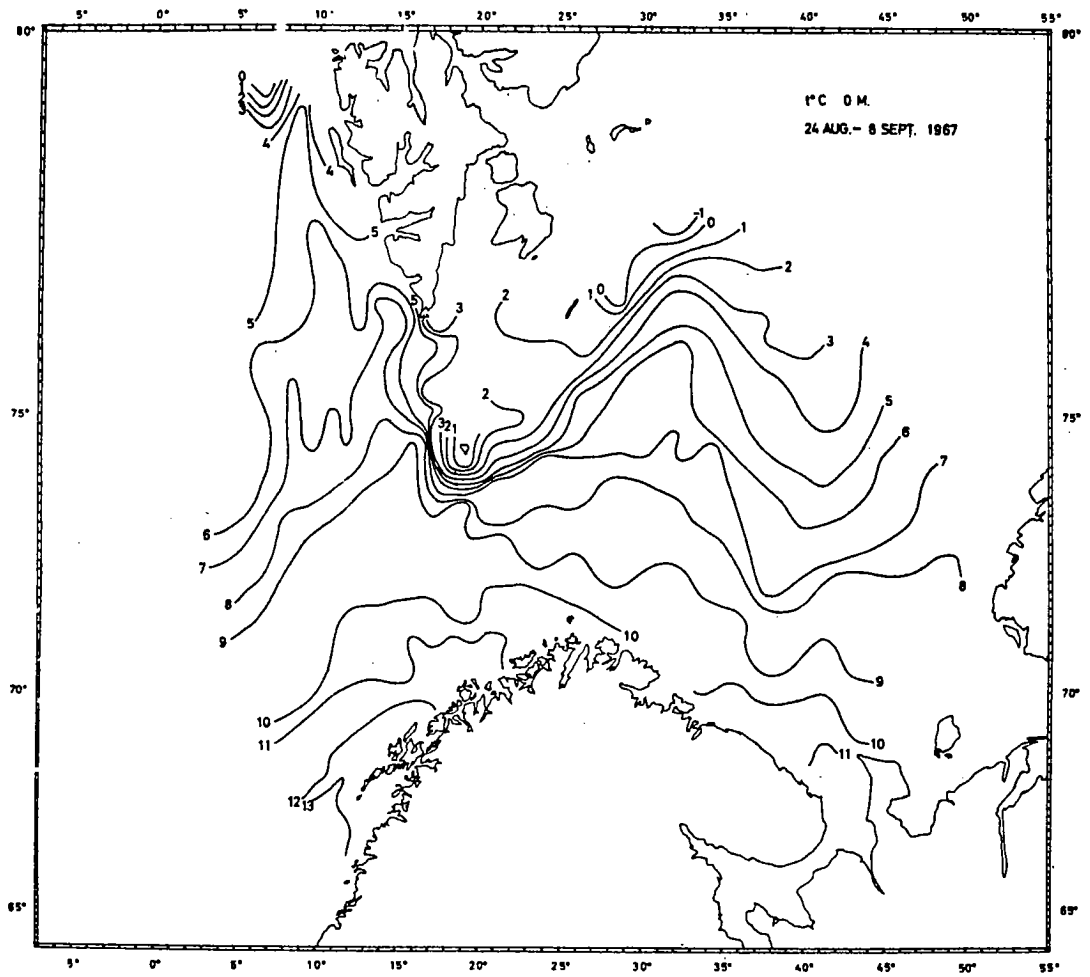


Fig. 2. Isotherms at 0 and 50 m.

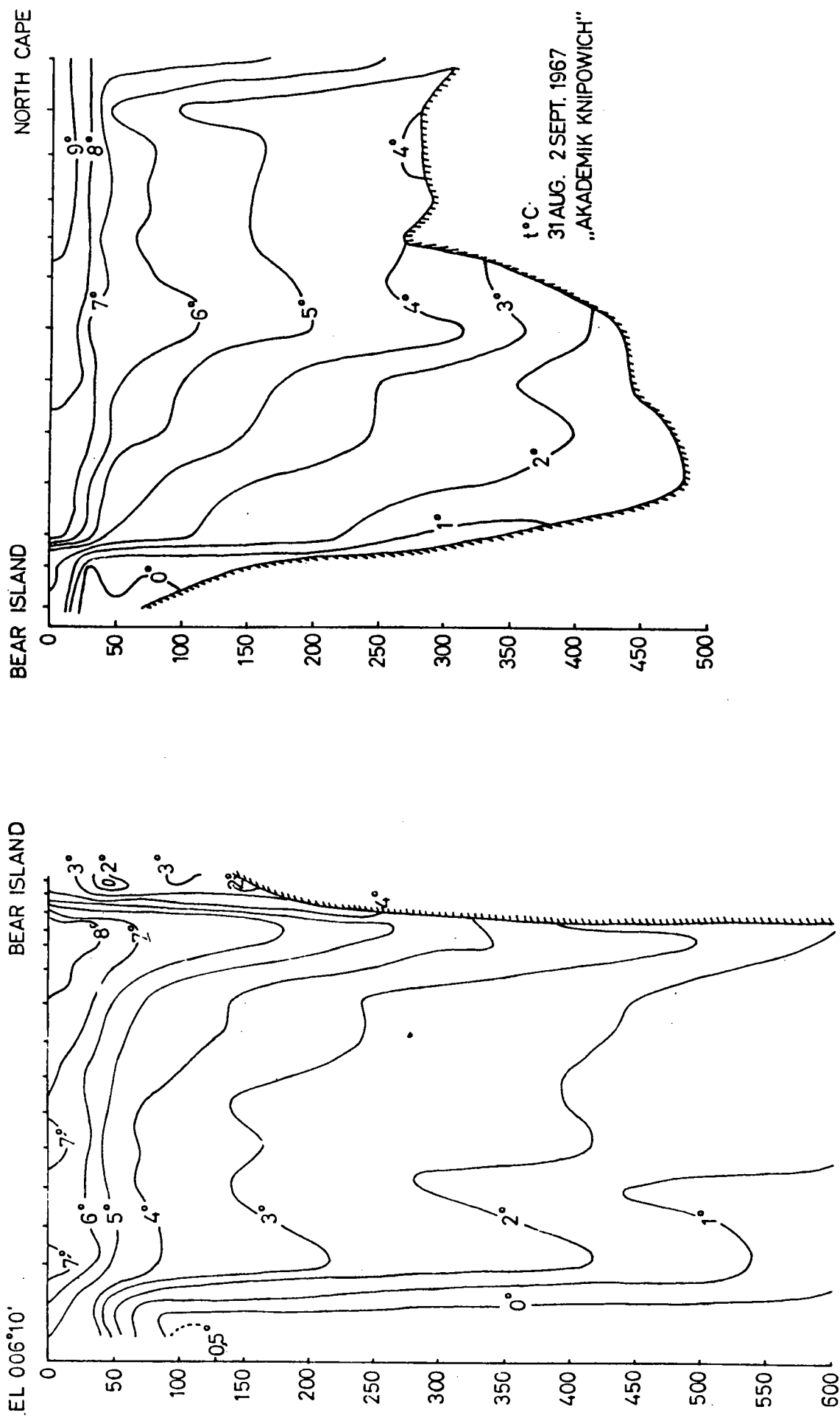


Fig. 4. Vertical temperature sections North Cape - Bear Island and Bear Island-W

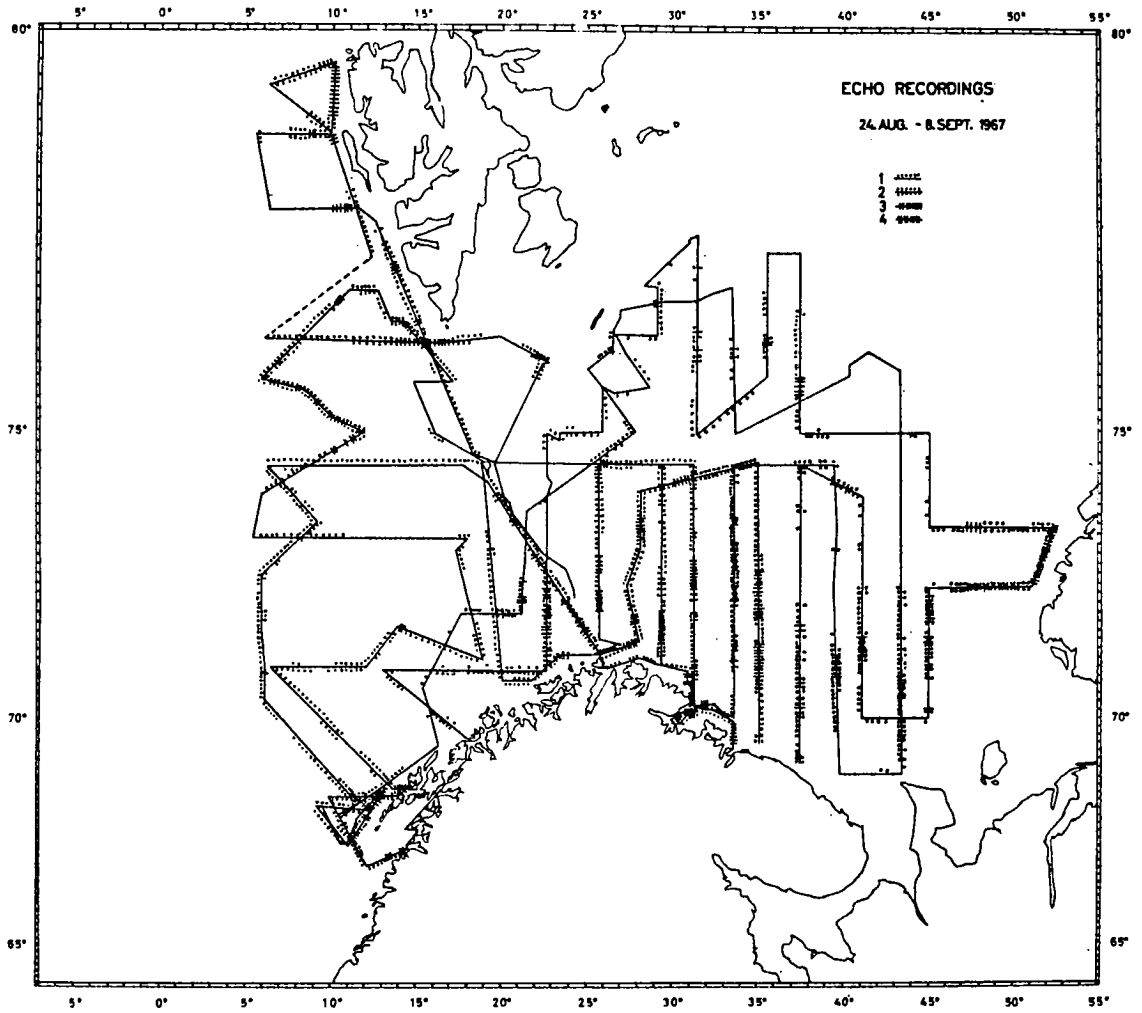


Fig. 5. Courses and total echo recordings.

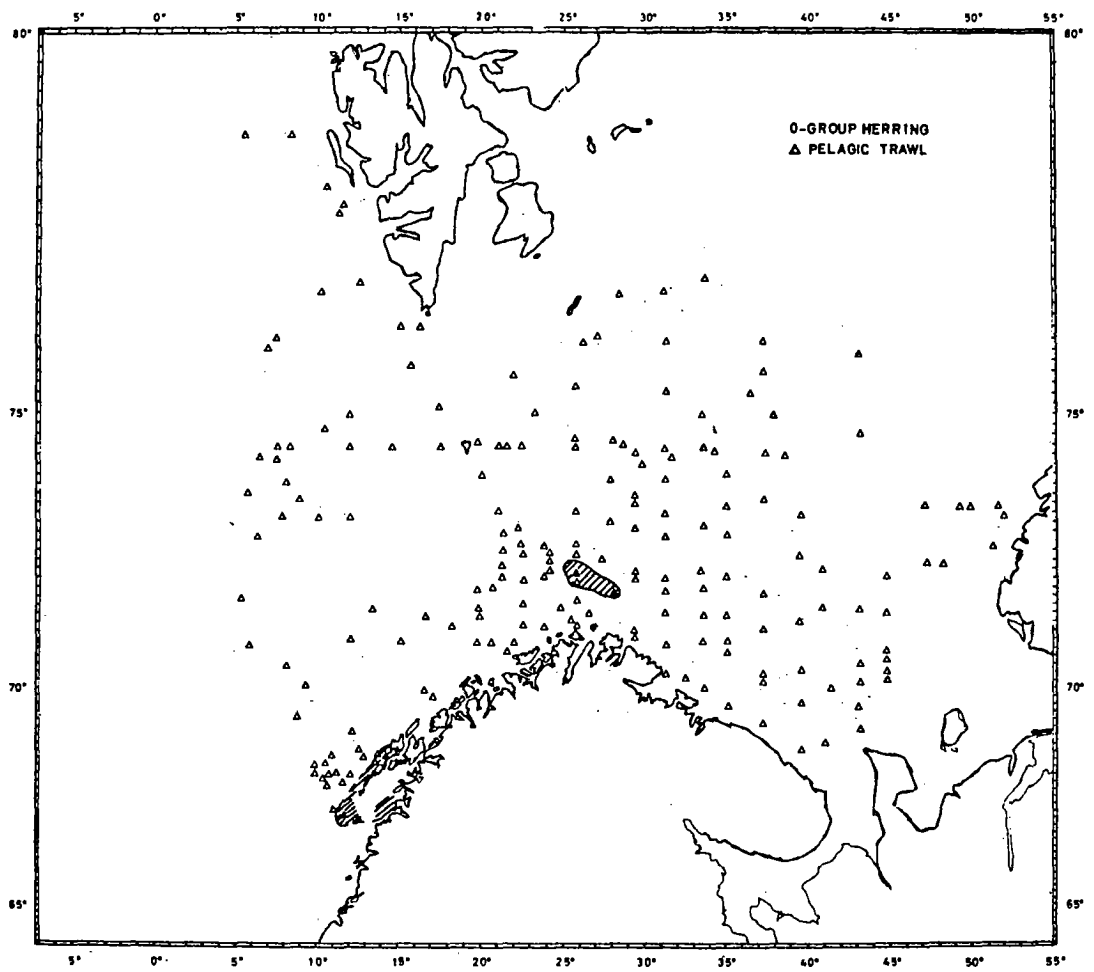


Fig. 6. Distribution of 0-group herring

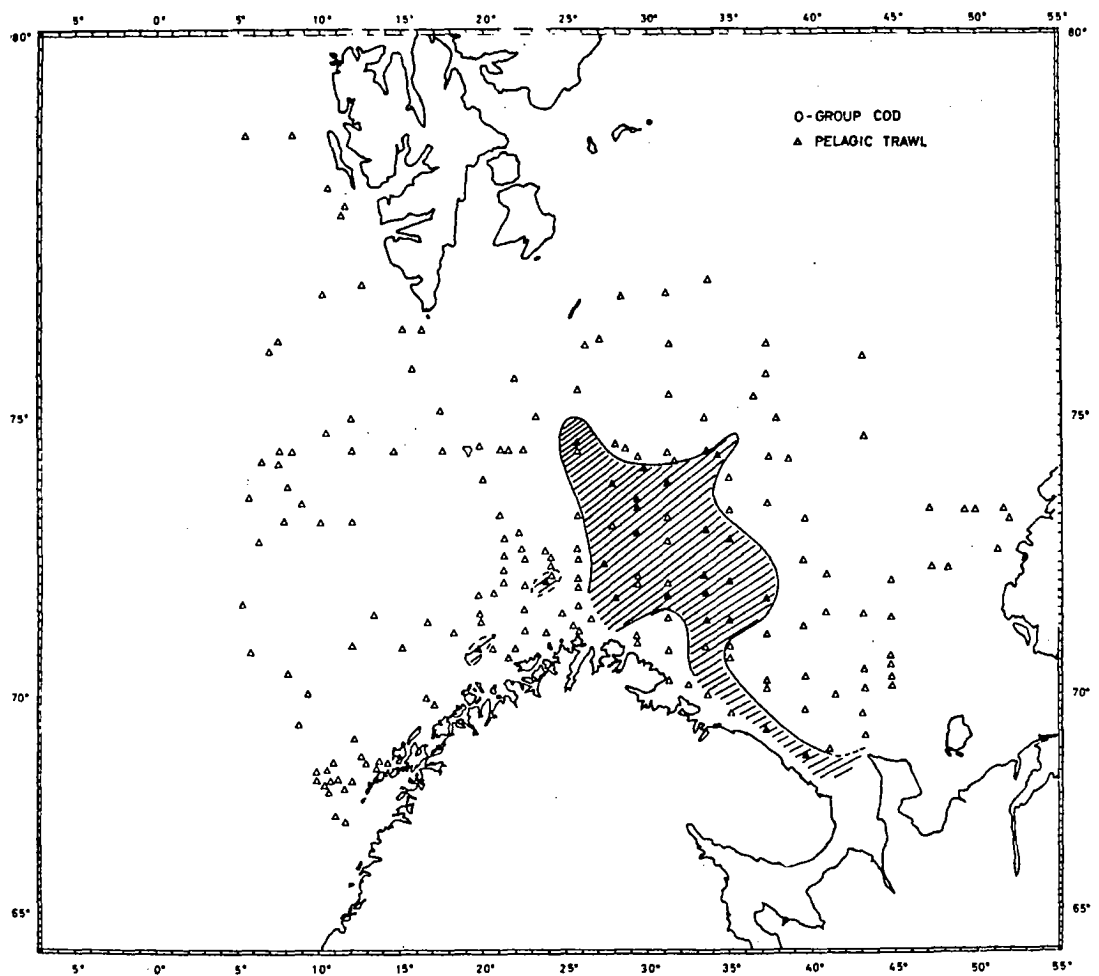


Fig. 7. Distribution of 0-group cod.

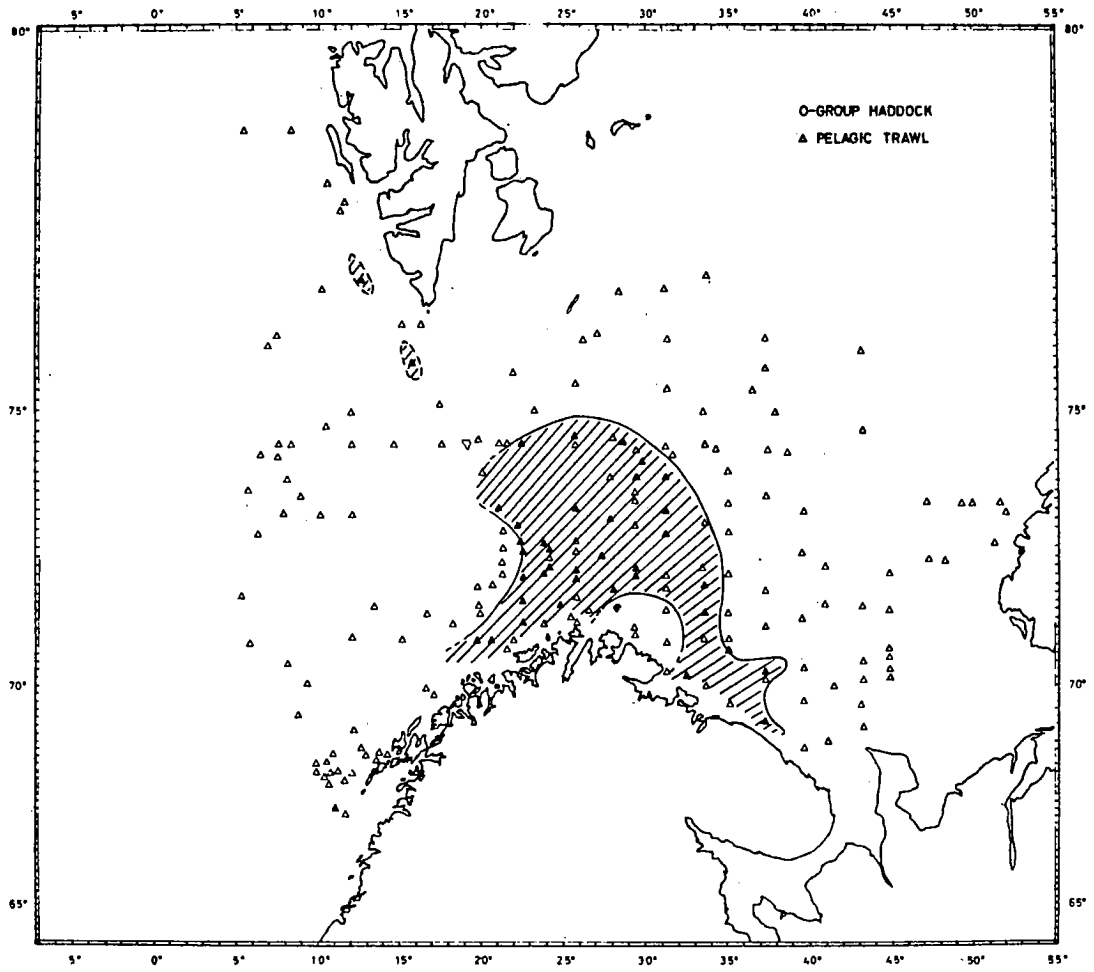


Fig. 8. Distribution of 0-group haddock.

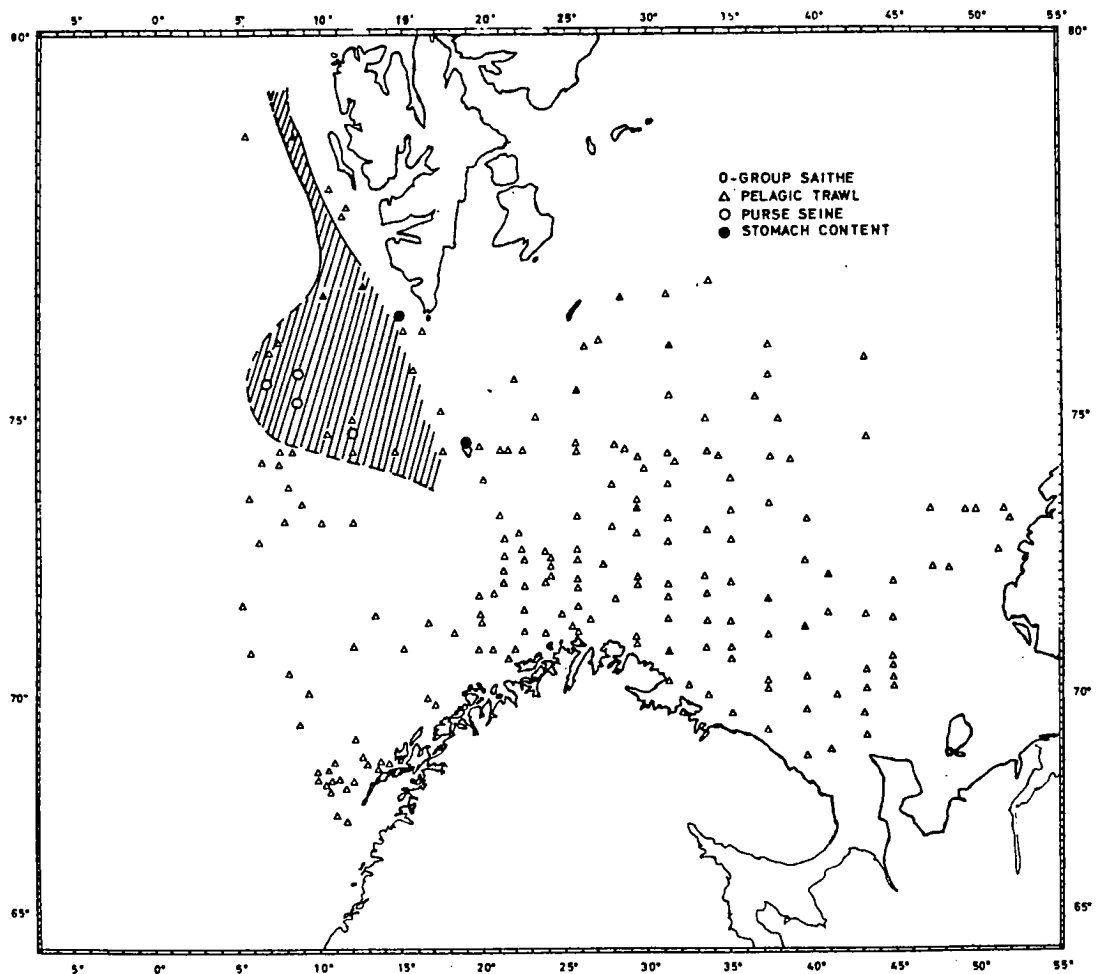


Fig. 9. Distribution of 0-group saithe.

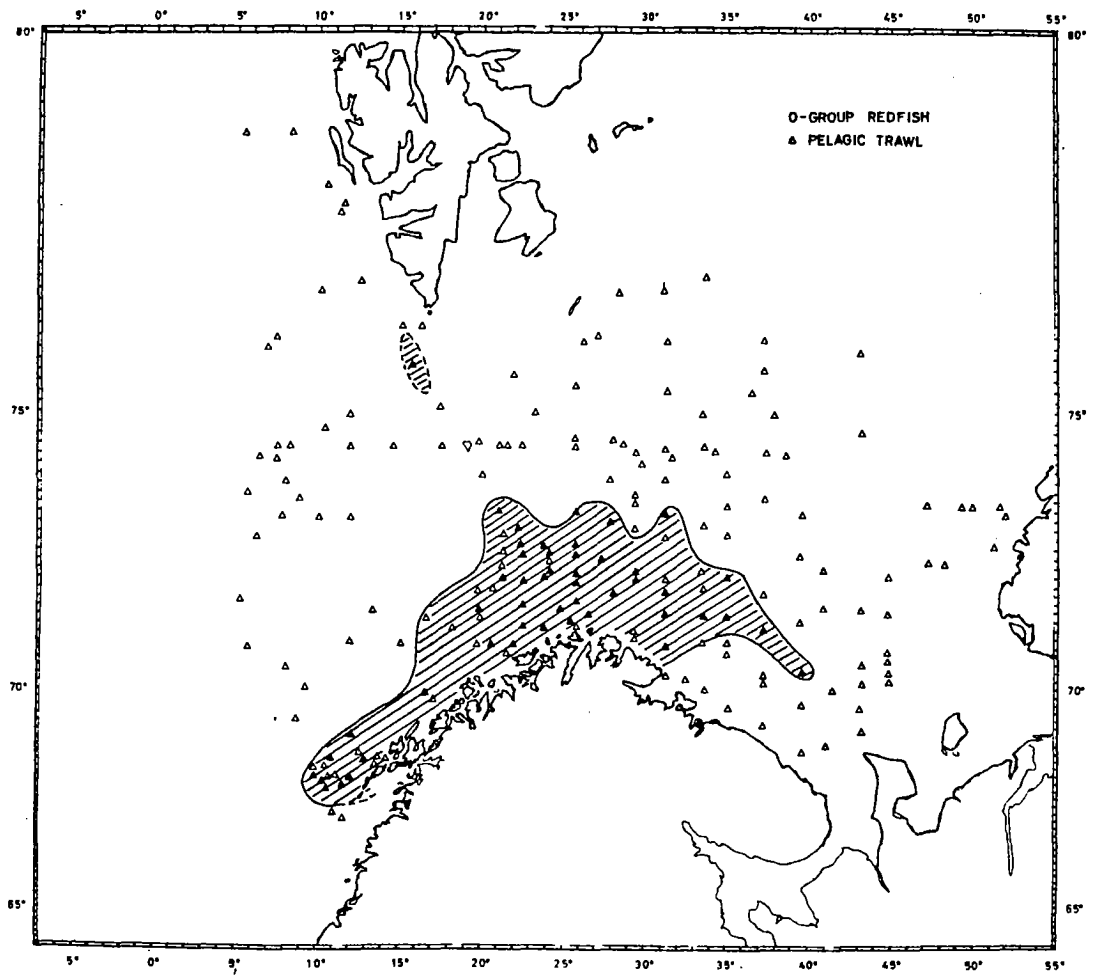


Fig. 10. Distribution of 0-group redfish.

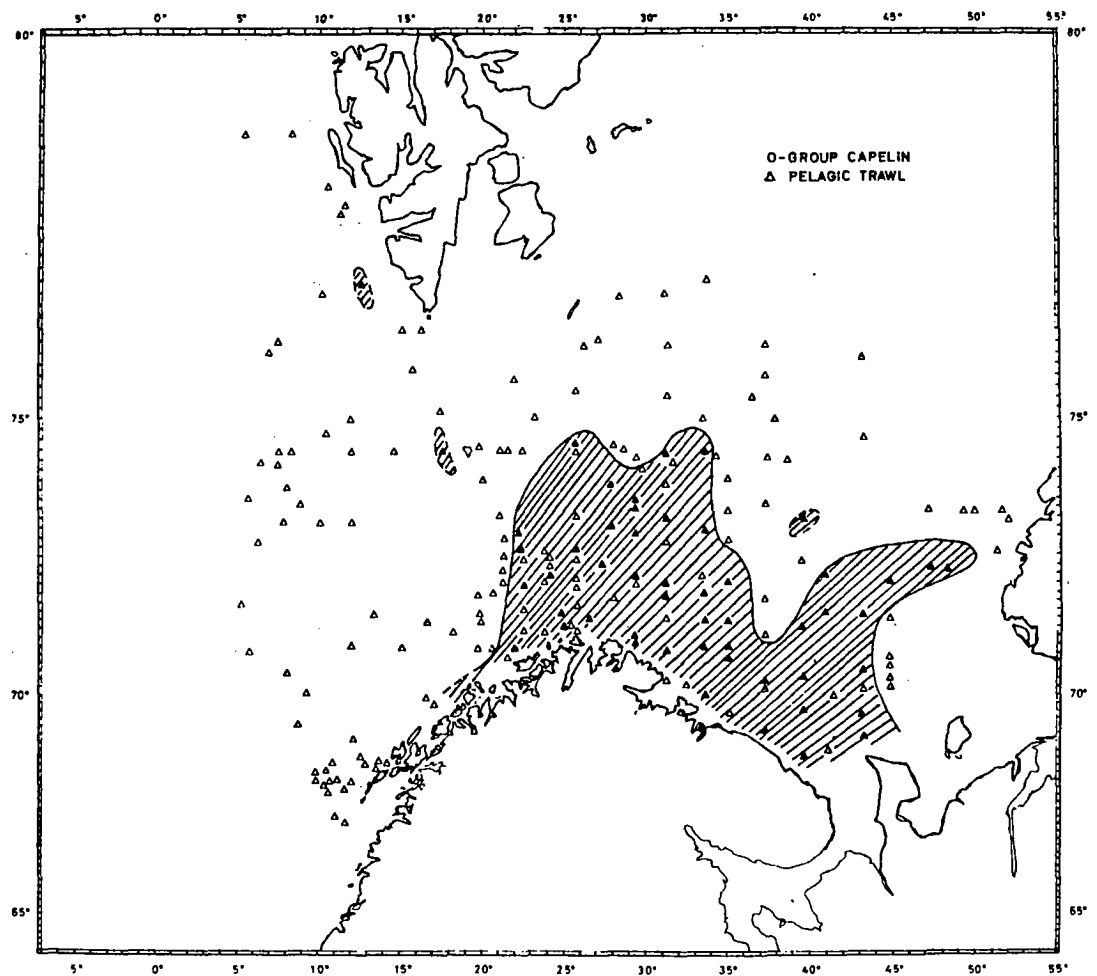


Fig. 11. Distribution of 0-group capelin.



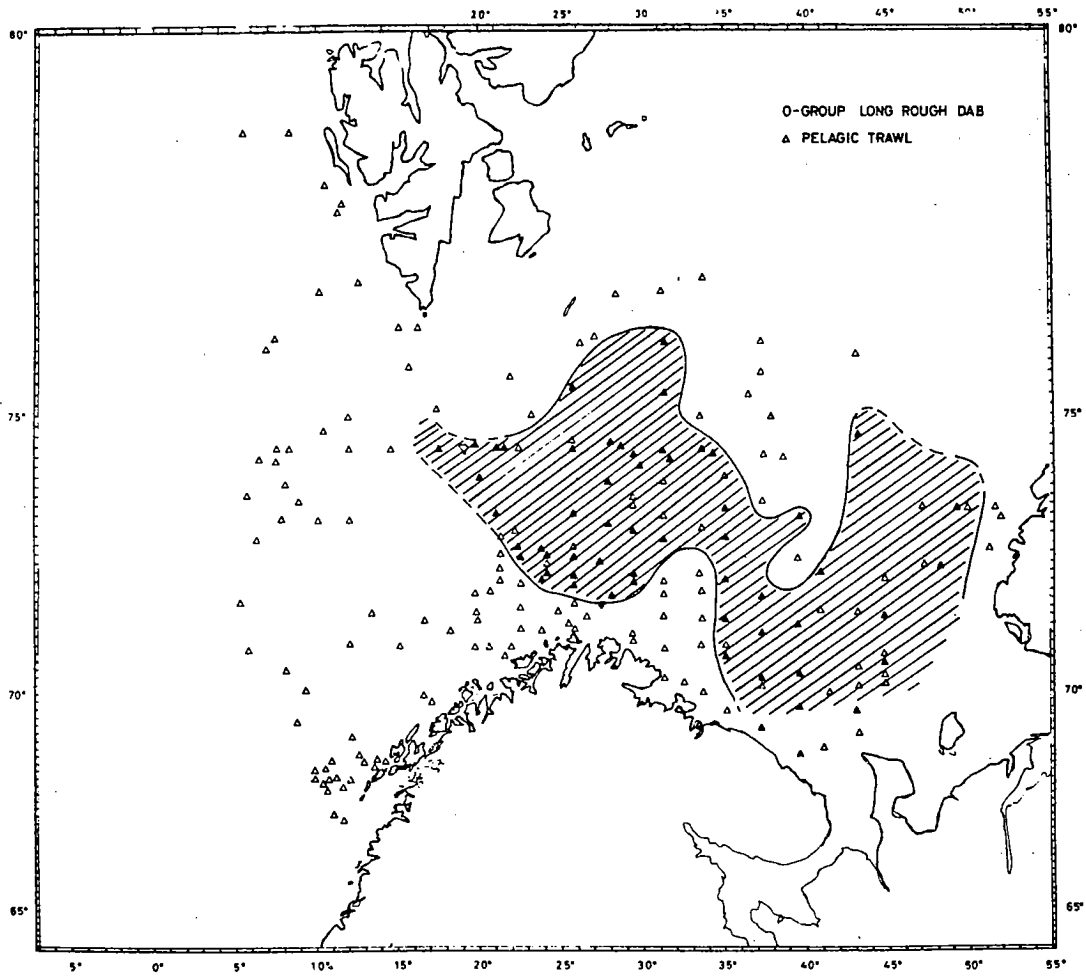


Fig. 12. Distribution of O-group long rough dab.

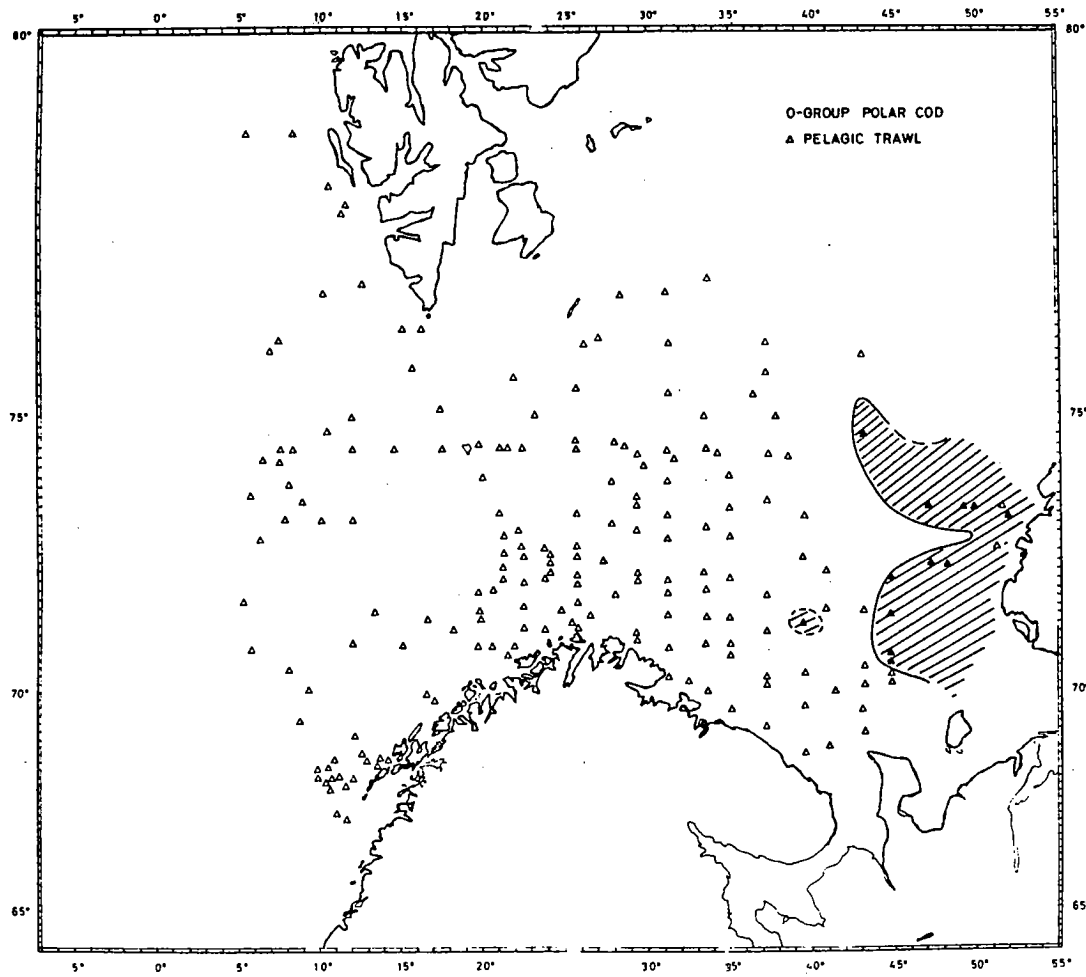


Fig. 13. Distribution of O-group polar cod.

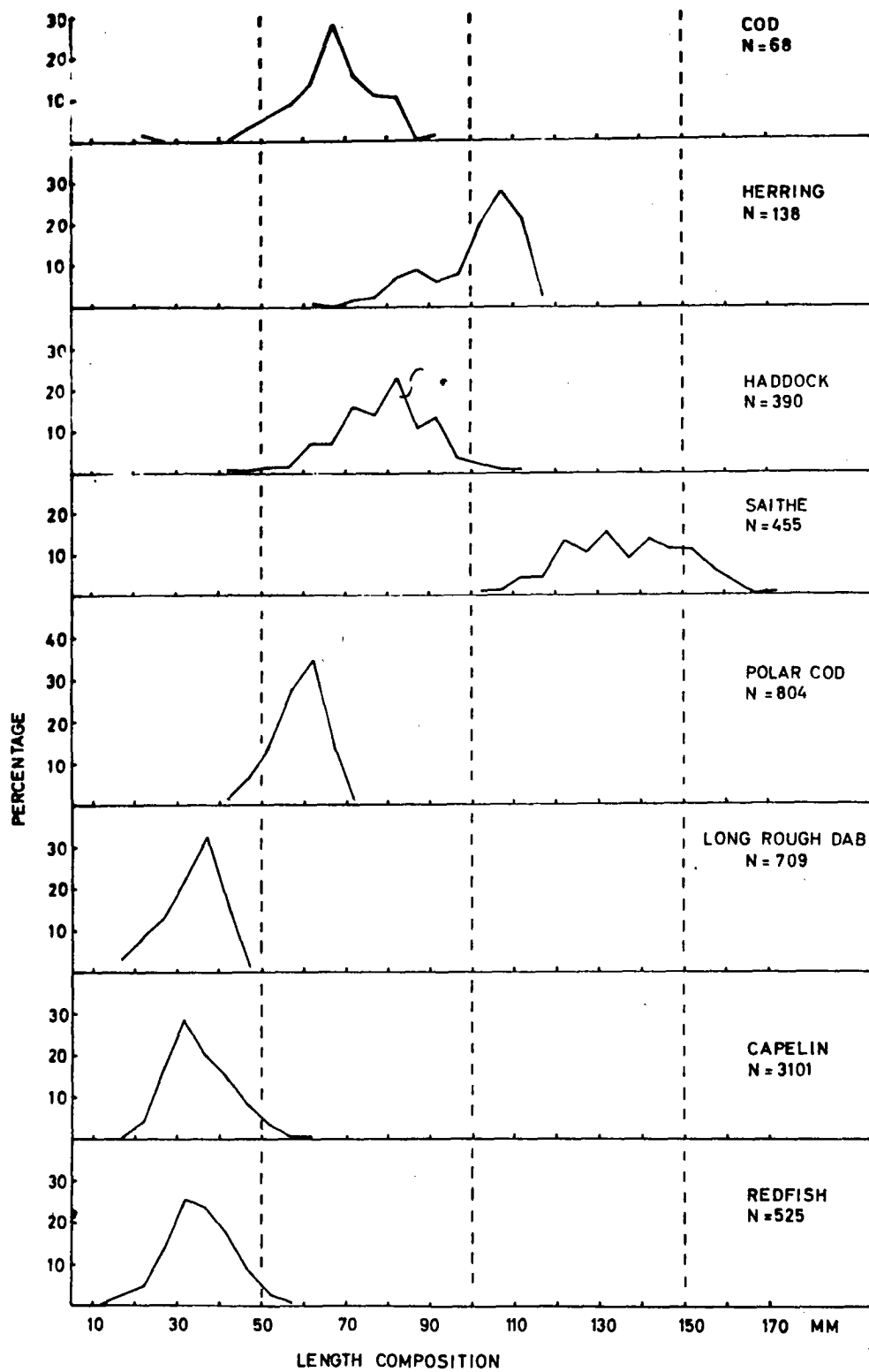


Fig. 14. Length composition