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A REVIEW OF O-GROUP SURVEYS IN THE ICELAND-EAST GREENLAND AREA IN THE YEARS 1970-1975

by

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Introduction

Since 1965 annual attempts have been made to estimate the abundance of late summer and early autumn fish fry in the Barents Sea and adjacent waters. The project has involved scientists and vessels of a number of nationalities. Following the very promising results from these surveys it was decided at the Statutory Meeting of the International Council for the Exploration of the Sea in the autumn of 1969 to initiate a similar project in the waters around Iceland, in the Irminger Sea and off East Greenland to see how the Barents Sea methods worked in these areas. Investigations of this kind require that the survey area is covered in as short a time as possible and multinational participation was obtained and arranged through the Council.

Five nations have participated in the Iceland/East Greenland/Irminger Sea surveys from time to time. The work mainly took place in August with additional effort in some years in July and September. The scattering of the effort was both for experimental purposes and due to occasional difficulties in finding survey time in the crowded schedules that most research vessels have.

Participation, timing and coverage of the various cruises are summarised in Appendix 1.

At the end of each year's survey, the results were evaluated, a report written and submitted to ICES Statutory Meeting in the autumn of the same year. In 1972 and 1973 Faroe waters were included in the project. It was then decided, however, to discontinue this combination and separate reports from the Faroe area have been submitted to the Council since 1972.

The following is a review of the O-group abundance of some of the most important fish species in Iceland and East Greenland/Irminger Sea waters during the six year period 1970-75. An attempt is made to obtain an estimate of yearly fluctuations in their O-group year class strength and, when possible, to correlate these estimates to actual year class strength later in life. An evaluation of this technique for estimating year class strength is made and some needed future adaptations will be considered.

Methods

Basically the survey methods were the same as those previously and presently used in the Barents Sea O-group research. These have been described by Dragesund, Midttun and Olsen (1970).

The acoustic instrumentation generally consisted of 38 or 50 KHz echo-sounders, giving the normal type of paper record, and in later years in most, but not all, vessels coupled to a Simrad two-channel echo-integrator. At an early stage of these surveys the trawls became fairly standard, having a maximum opening of about 25 x 25 metres and a cod end with a mesh size of $\frac{1}{2}$ x $\frac{1}{2}$ cm. In practise, however, the trawl opening was somewhat less or no more than 18-20 metres square.

The scatterers responsible for the echo records were identified by frequent sampling and comparative estimates of their abundance obtained. Trawl stations were, therefore, not fixed but worked when required by changes in the appearance and/or volume of the echo record. The absence of echo traces was also checked by occasional trawl hauls. In trawling it was general practise to go back on the last mile or so of the previous track in order to ascertain that one was fishing a known echo density. When echo abundance was above a certain minimum level there was usually a strong positive correlation with the catch. At lower densities, this correlation tended to break down. Information on the depth of trawling and the vertical opening was obtained from headline transducers and a tentative estimate thus obtained of the efficiency. The distance towed in the scattering layer was measured and the catch recorded as the number of individuals per tow of 1 nautical mile.

The distribution maps of the various species of fish give a fair indication of the area surveyed. For a number of reasons a fixed survey grid was not adopted, but each year work proceeded along some general plan, previously agreed upon, which was then adjusted according to the particular distribution pattern of that year. Generally speaking, off N-, E- and S-Iceland, the surveys covered the continental shelf and farther out when necessary. Off NW Iceland and in the Northern Irminger Sea the area was limited by pack ice as occasionally was the case off East Greenland, where the boundary was otherwise determined by the cold waters of the East Greenland Current. In the Southern Irminger Sea the southernmost limit was somewhat variable but never farther south than Cape Farewell.

In most cases it has thus been possible to cover the total area inhabited by 0-group cod, haddock and capelin that are the subject of this paper together with the redfish. The redfish, on the other hand, had a much wider distribution than it was possible to cover.

When re-evaluating the data from the six year period 1970-75, it was concluded that the most reliable information on 0-group year class strength would be calculated from catch per unit effort after having used the acoustic data to determine the extent of the different concentration categories of each species. Thus, in the case of the cod, haddock and capelin the following method was adopted:

1. Density charts were drawn using catch per unit effort data from the trawl sampling as well as acoustic data to determine the boundary lines of the different concentration categories of each species.

2. Using a planimeter the area of each of these categories was then calculated from the density charts.

3. Since the horizontal opening of the trawl is about 10 fathoms or 0.01 of a nautical mile each tow of 1 n.m. covers about 0.01 square mile. Therefore the number caught per square mile was obtained by multiplying the catch figures by a factor of 100.

4. For the same category the average number of fish per square mile were multiplied by the total number of square miles in that category.

The basic equation therefore is $\frac{\bar{c}_n \times a_n}{d} \times k = n_n$

where $\bar{c}_n$ denotes average catch in numbers,

a_n denotes area with fish density n,

d denotes distance towed. Preadjusted and = 1

k denotes corrective factor (100) to obtain number/1 nm^2

and n_n denotes total number in area with fish density n.

Adding then gives:

$$n_1 + n_2 + \ldots\ldots n_5 = N$$

where N denotes the total year class size for the species under analysis.

In the case of the redfish, however, it was impossible to estimate the total size of the year class since coverage was incomplete. The method of calculation, nevertheless, is the same but the final figure chosen is average number of fish per one nautical mile square and the final equation therefore becomes

$$\frac{n_1 + n_2 + \ldots\ldots n_5}{A} = \bar{N}$$

where A denotes total survey area in square nautical miles

and $\bar{N}$ denotes average number of fish per one nautical square mile.

Obviously a number of factors are inherently causing error in calculations of this nature. It is for instance by no means certain whether the measured opening of the trawl is the same as its effective opening. This is particularly doubtful in the case of capelin, which to a considerable extent is caught entangled in the larger meshes of the trawl rather than in the cod end itself. Such deviations could introduce sizeable errors both in c and k.

Errors in d should be minimal since the towing distance in the scattering layer can be recorded accurately. In most cases it is also fairly certain that the trawl was fishing all the scattering layer.

Uncertainty in drawing the actual concentration contours probably is the greatest single source of error. Areas of exceptionally high concentrations usually are relatively few and limited in extension compared to others. Sometimes such areas are,nevertheless, responsible for the bulk of a particular year class and any deviations in determining their extension are, therefore, most important.

Results

Hydrography

Isotherms for the 50 m depth level were drawn for the years 1970-75 (Figs. 1-6). These charts were then compared to mean charts based on all observations up to and including 1960 (Stefánsson, 1962). The results were briefly as follows:

1 9 7 0

West of Iceland: the temperature was very close to the long-term mean, except inside Faxaflói and Breidafjördur where it was slightly below normal.

North of Iceland: very close to the long-term mean, except in the deep waters off the northwest coast where an intrusion of cold water with a negative anomaly of 2° was apparent. Similarly, the deep waters off the Continental Shelf NE of Langanes had a negative anomaly of 1°.

East of Iceland: the temperature was 1-2° below normal in the northern part of the region.

1 9 7 1

West of Iceland: close to the long-term mean in and west of Faxaflói, but over the shelf off the Northwest Peninsula there was a positive anomaly of 1-2°.

North of Iceland: in the western part of the area the temperature was about normal in nearshore waters. Farther north there was considerable negative anomaly, particularly off Húnaflói where it was 2-3°. Off the eastern north coast there was a negative anomaly of up to 2° over the continental shelf but approximately 1° farther offshore.

East of Iceland: the temperature was about 2° below the long-term mean almost everywhere north of the frontal zone between Arctic and Atlantic water.

1 9 7 2

West of Iceland: warmer than normal (about 1° in most of the area). The warm water extended far to the west resulting in a positive anomaly of several degrees in the deep waters off the Northwest Peninsula.

North of Iceland: in the western part somewhat above the mean (0.5-1°) on Strandagrunn Bank and off Húnaflói, but an intrusion of cold water reached shorewards over the shelf area off Skagi. The temperature was close to normal in the eastern part, but a cold tongue extended southeastward in the deep waters to the NE of Langanes.

East of Iceland: slightly below the long-term mean.

1 9 7 3

West of Iceland: a little above the long-term mean especially off the Northwest Peninsula (+ 1°).

North of Iceland: the temperature in the region was on the whole close to normal; slightly above normal in the coastal area, but slightly below in the deep waters. These negative anomalies of the deep area increased somewhat towards the east.

East of Iceland: on the whole about 1° above normal.

1 9 7 4

West of Iceland: here the temperature was slightly below normal especially over the inner continental shelf and also farther offshore off NW Iceland.

North of Iceland: close to the long-term mean off the western north coast except for a cold intrusion off Cape Horn. In the eastern part of the region positive anomalies were recorded in shelf waters but in the deep waters between Iceland and Jan Mayen temperatures were about average.

East of Iceland: positive anomalies of 1-2°.

1 9 7 5

West of Iceland: the temperature at the 0-50 m depth level was about 1°C below the long-term mean.

North of Iceland: for this time of the year the Atlantic influence in the north Icelandic region was unusually weak, particularly in the western half of the area. The negative anomaly was about 1-2°C in most parts of the coastal waters and over the continental shelf. Farther offshore, in the oceanic area northeast of Iceland, the temperature was relatively higher.

East of Iceland: in the northern part of this region the temperature was about 2°C below the long-term mean, but somewhat higher in the southern part. A comparison of surface temperatures to those of 1974 indicated negative anomalies of 1-2°C.

The observations are summarised in Table 1.

Table 1. Comparison of temperature anomalies at 50 metres during the years 1970-75.

Year	West of Iceland	North of Iceland W-area	North of Iceland E-area	Oceanic area between Langanes and Jan Mayen	East of Iceland
1970	0	0-	0	-	--
1971	0+	-	--	-	--
1972	+	0+	0	-	0-
1973	+	0	0	--	+
1974	-	0	+	0	++
1975	-	-	-	0	-

0: about normal, 0-: slightly below, 0+: slightly above,
+: above normal, -: below normal, ++: anomalies positive
--: anomalies highly negative

A characteristic of the distribution is the relatively low temperature during the years 1970-73 in the deep oceanic area northwest of Iceland due to greater admixture of Polar water than during the years before 1960. East of Iceland low temperatures also prevailed during the first three and the last year but in 1973 and 1974 the temperature was considerably above average in that region.

The years 1971 and 1975 were by far the coldest, while the year 1974 may be classified as the warmest north and east of Iceland. The deviations in temperatures west of Iceland are seldom in phase with those found north and east of Iceland. Frequently an intrusion of cold water from north extends into the area off Húnaflói.

The Atlantic influence in the eastern part of the North Icelandic shelf area and in particular east of Iceland increased progressively during the 3 year period 1972-74 but this trend was reversed in 1975.

It has not been possible to detect any correlation, positive or negative, between the year class size of the various fish species and sea temperature in mid-summer. In order to relate year class size to oceanographic conditions one presumably has to look at data from earlier in the year.

Cod

The distribution and density (numbers/nm towed) of 0-group cod is shown in Figures 7-12. It is reasonably certain that in most if not all years the total range of distribution has been covered. To time such cruises in August seem quite suitable for this species although late July and the first half of September can obviously also produce good results. The young cod generally do not descend to the bottom until later in the autumn.

It has long been known that the bulk of the cod usually spawn off SW Iceland. Subsidiary spawnings also take place elsewhere, i.e. at the NW-, N- and SE-coasts. In view of the relatively limited range of distribution in all the years except 1973 and 1975, it is suggested that the SW-coast spawning was almost entirely responsible for the brood in these years. It should be noted that in 1970 Icelandic waters were not surveyed until September and in 1971 comparatively late, or in August/early September. Apart from suggesting a strong year class, the wide range of the 1973 distribution clearly indicates a considerable spawning both off N- and SE-Iceland. The length distribution by area in 1975 (Fig.13) also suggests a comparatively successful spawning off N Iceland while the main spawning off SW Iceland has failed. This is further supported by the length distribution from these years which together with those of 1970-72 and 1974 is shown in Figure 14.

Abundance estimates of 0-group cod for the six year period 1970-75 are given in Table 2.

Table 2. Abundance estimates of 0-group cod in 10^6 fish.

Year class	SW Iceland	W Iceland	Dohrn Bank	N Iceland	E Iceland	SE Iceland	Total
1970	0	23	+	848	0	+	873
1971	9	60	+	214	0	0	283
1972	22	21	+	36	0	0	79
1973	107	96	135	757	86	10	1 191
1974	0	22	2	30	+	0	54
1975	2	50	+	73	5	0	130

By far the most important area is that off N Iceland between Cape Horn and the Langanes peninsula. SW- and W-Iceland are relatively unimportant except in years of low abundance such as 1972, 1974, and 1975. Very little was found on the Dohrn Bank except in 1973 when 11% of the total were taken there. This phenomenon is probably associated with strong year classes and possibly with fluctuations in the current system. Similarly, young cod were almost never found off E- and SE-Iceland except in 1973 and 1975. As mentioned above this is most likely associated with a successful spawning off SE Iceland and the eastern north coast.

The last column of Table 2 gives an estimate of the total abundance during the six year period. As yet independent estimates from virtual population analyses are only available for the first of these six year classes. VPA assessment of the 1970 year class clearly indicates a strong year class in the order of 342 x 10^6 individuals as 3 year old cod (Schopka, personal communication). The 0-group estimate at 4 months of age of 873 x 10^6 is at least of the same order of magnitude as that obtained from the VPA. Thus, the ratio between the 0-group and VPA estimate corresponds to a Z of approximately 0.9 during the 2 1/3 year period in question or to an 0-group mortality of say, 0.33 during the last months of the year and an annual mortality of 0.33 and 0.24 in the one and two groups respectively. Although these mortalities are highly speculative they are, however, well within the probable range that could be expected.

Haddock

This species has always presented a problem in 0-group surveys of the Icelandic area. It seeks the bottom much earlier than the cod and is, in August, evidently not entirely available to a pelagic survey except at night.

The quantitative distribution of the haddock is illustrated in Figures 15-20. The apparent distribution pattern is irregular but does not necessarily reflect the true one, since the young fish have to some extent left the pelagic state. Moreover, its abundance is generally much lower than that of the cod and its distribution more patchy. Therefore the survey grid has probably not been detailed enough. This applies particularly to the coastal waters off the south- and southwest coast.

The length distribution and mean lengths in various areas are shown in Figure 21. Several spawning localities are indicated as well as the rapid growth rate of the haddock, resulting in relatively flat and horizontally extended length diagrams.

Abundance estimates of the six year classes are given in Table 3.

Table 3. Abundance estimates of 0-group haddock in 10^6 fish.

Year class	SW Iceland	W Iceland	Dohrn Bank	N Iceland	E Iceland	SE Iceland	Total
1970	0	28	0	14	+	0	43
1971	30	2	0	5	0	3	40
1972	28	2	0	2	0	0	32
1973	22	11	0	5	+	+	39
1974	+	2	+	13	+	0	15
1975	5	4	0	2	0	0	11

Unfortunately independent estimates of these year classes are not yet available but it is noteworthy that the maximum fluctuation between year classes is only about 1/4. This is about 5 times less than observed among the 0-group cod.

In the absence of any comparative estimates the haddock 0-group indices must be treated with caution. The small fluctuation in year class size of this species may simply reflect an inefficiency, particularly as regards the timing and coverage of the cruises.

Capelin

At Iceland the bulk of capelin spawning usually takes place in shallow waters off the SE-, S- and SW-coasts. As a rule the spawning is heaviest in the Vestmannaeyjar-Snæfellsnes area but latecomers are usually responsible for heavy spawning further to the east. Subsidiary spawning also takes place in most years off the north coast and the Northwest Peninsula. The year 1970 was irregular inasmuch as no spawning occurred farther west than Vestmannaeyjar. During the remaining 5 years under consideration no such irregularities were observed and spawning was geographically distributed as described above.

The distribution and density of the 0-group capelin are illustrated in Figures 22-27. The absence of spawning capelin on the grounds off SW Iceland in the spring of 1970 is quite clearly reflected in the distribution pattern of the 0-group. Even in September they had only reached the western north coast and apart from one station were practically absent off NE Iceland. In the years 1971-75 the capelin had a much wider distribution with a similar pattern. Its distribution was particularly widesprpad during the last 3 years when a number of young capelin were registered off the Icelandic east coast. In the same three years a drift of considerable magnitude was observed westwards across the Dohrn Bank towards East Greenland as also was the case in 1972, although on a much smaller scale. In all probability the westward drift is mainly associated with year classes of superior size, while the occurrence of capelin larvae off NE- and E-Iceland can be associated with increased influx of Atlantic water from the west in the shallower region of that area during the years 1972-1974. In 1975 the east coast capelin was comparatively small and therefore probably originated from a north coast spawning.

The length distribution of 0-group capelin is shown in Figures 28-30. Examination of the length curves further supports the observation of a westward drift to East Greenland in the years 1972-75. Figure 29 illustrates the sharp boundary that one sometimes encounters between size groups and which most likely results from different spawning maxima with somewhat varying drift pattern of the larvae.

Abundance estimates of 0-group capelin are given in Table 4.

Table 4. Abundance estimates of 0-group capelin in 10^9 fish.

Year class	SW Iceland	W Iceland	Dohrn Bank	N Iceland	E Iceland	SE Iceland	Total
1970	3	5	1	2	0	0	11
1971	2	5	+	12	0	+	19
1972	4	33	+	52	+	+	89
1973	26	13	14	46	16	1	116
1974	+	44	26	57	7	0	134
1975	5	32	3	46	3	0	89

Looking at the last column one inevitably gets the impression of a great and continuous increase in year class size during the first half of the period. This, however, is false and mostly caused by the fact that the method of retrieving the capelin from the fishing gear had not become standardised until 1972. On account of its small size, slender shape and inferior musculature the capelin do not react to the trawl to the same degree as species such as cod, haddock and redfish. Comparatively few individuals are therefore herded into the cod end to be collected in the ordinary way. The bulk of the catch, on the other hand, becomes entangled in the rear corners of the large meshes of the wings and front half and must be shaken from the net onto the deck and collected from there. As this technique took some time to develop, the abundance in 1970 and 1971 is grossly underrated compared to the last 4 years.

The absence of herding by the fishing gear must cause a further underestimate of the actual number of 0-group capelin, since a large proportion will escape completely through the large meshes of the trawl. This is supported both by the high catch in numbers of adult capelin of the 1970-72 year classes and by estimates of fishing mortality in the mature stock. Catch records and samples during the last four fishing seasons (1972-75) give actual catch in numbers of the 1970-72 year classes as 18,22 and 22 x 10^9 fish respectively. The 1972 year class has not yet been caught as 4 year olds. This exceeds the 0-group estimates of the 1970 and 1971 year classes which of course is absurd. As mentioned above, estimates of the size of these year classes are out of phase with the rest and should not be compared to them. The 1972 figure of 89 x 10^9 individuals is no more than 5 times the expected final catch. This must be a considerable underestimate since there is reason to believe that fishing mortality in the spawning stock may be as low as 0.1 and that natural mortality in the $2\frac{1}{2}$ - $3\frac{1}{2}$ year period before maturing is almost certainly much higher than in many other species, such as the cod.

In view of the inefficiency of the fishing gear as regards the capelin it is clear that the present method of estimating its 0-group abundance can only give relative and not actual year class size. However, data collected in later surveys suggest that the figures for the years 1972-75 are in fact comparable and represent actual differences in magnitude of 4 large year classes.

Redfish

Certainly this species has by far the widest distribution in the Iceland/East Greenland/Irminger Sea area (Figs. 31-36). Its southern and southeastern boundary was never reached and consequently one is unable to estimate its total numbers. Although the central Irminger Sea was in all years very rich in 0-group redfish the distribution was somewhat irregular. Thus, in 1971 the highest numbers were recorded off SW Iceland, in 1972 and 1974 off the East Greenland continental shelf and south of the Dohrn Bank, and in 1973 and 1975 in the central Irminger Sea.

The length distribution is shown in Figure 40. The length curves are quite regular and show little variation, but the 0-group redfish was on average somewhat larger in 1971 and 1974 than during the rest of the period. In later years an attempt has been made to obtain a more detailed picture of the length distribution. The results are shown in Figures 37-39. In 1972, small fish dominate in the central and southern Irminger Sea, the size increasing outwards from there with the largest fish being caught at the continental shelf around the basin. Although the same general trend was detected in the following year (1973) the picture was much more irregular. An important difference was that in 1973 a number of very small redfish were caught in the relatively shallow water over the East Greenland continental shelf as well as the Dohrn Bank and 90 nm SW of Reykjanes. Finally, as regards 1975, the picture is practically the reverse of that from 1972, at least in the western half of the area.

Although none of the surveys have come near to covering the total range of distribution of the redfish, it is clear that its numbers surpass the producing capacity of any known and exploited stocks. Due to the inadequate coverage an index figure of individuals/nautical square mile was chosen in order to measure year to year fluctuations in abundance.

The results are shown in Table 5.

Table 5. Number of redfish x 10^{-6} per nm^2.

Year class	No. of fish
1970	8.6
1971	12.6
1972	38.1
1973	74.0
1974	23.6
1975	12.6

Due to beginners problems there is some doubt if the figures for 1970 and 1971 are exactly comparable to those of the last four years. The approximate order of magnitude of the fluctuations should, however, be reflected in the above series. The total abundance of 0-group redfish in the Irminger Sea part of the survey area is sometimes fantastically high and was, for instance, in the years 1972-74 estimated as 534, 962 and 308 x 10^9 individuals respectively.

In the practical absence of reference data it is difficult to visualize the actual meaning of the redfish abundance indices. However, recent information on the occurrence of juvenile redfish (Magnússon, personal communication) indicates that the series probably includes a period of relatively high numbers.

Other species

Although not the subject of this paper, various other species appeared both on echo records and in the catch while, others, notably the coalfish, were absent.

This method of estimating 0-group year class strength, understandably, is less well suited for some species than others due to differences in spawning time, behaviour and shape of the young. Thus, if the 0-group surveys were somewhat more detailed in certain areas sufficient information should, in all probability, be obtained to supply a reasonable estimate for such species as summer spawning herring, Greenland halibut, catfish and Norway pout.

In order to catch the coalfish, as well as to get a more reliable estimate of the haddock, the timing would have to be advanced. By August the coalfish are no longer available at all, having reached the adjacent coastal waters and therefore being inaccessible.

Concluding Remarks

There seems to be enough evidence to suggest that, over the last 6 years, the present technique of estimating 0-group year class strength of some of the more important fish species has proven its merit in Icelandic and East Greenland waters. However, it is clear that in order to include most of the commercially important species and to improve the present estimates it is necessary to survey some of the area twice, notably the shallowest waters at Iceland. The added effort should take place already in June.

The instrumentation, both the acoustic outfit and the fishing gear, appears to work sufficiently well when dealing with pelagic organisms of the size range in question. This is especially true of areas with moderate or high fish densities and has been demonstrated most clearly in the case of the redfish, where there has always been a high degree of correlation between catch and echo abundance. It is nevertheless likely, that due to the relative scarcity of other scatterers, high frequency echo sounders could be advantageously used in large parts of the survey area. This would give a much more detailed information in areas of low densities as well as for individuals of low target strength.

Effort should be made to produce more effective fishing gear and to assess further the efficiency of the present one in order to improve the estimates of filtration per unit volume of water. This is of special interest in the case of the capelin and, probably, the summer spawning herring and Greenland halibut as well.

As already mentioned, areas of high fish density have sometimes been responsible for the bulk of the acoustic recording and catch, and thereby for the size estimate of a year class, even though these areas of high concentrations have only been a minor proportion of the total area of distribution. Such circumstances, therefore, necessitate a more detailed study so that the borders of such areas can be accurately determined. Otherwise errors of unacceptable magnitude may enter the abundance estimates.

Whether the O-group abundance estimates given in Tables 3-6 are absolute or not is perhaps not an all important issue as long as they represent a reliable index of O-group strength. The absolute abundance will be assessed through subsequent VPA analyses or other population studies and in time the true values of the O-group indices should then become established.

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A P P E N D I X 1

Year	Country	Vessel	Time	Scientist in charge	Area
1970	Iceland	"Á. Fridriksson"	1/8 - 11/8	H. Vilhjálmsson	W Iceland
	Norway	"G. O. Sars"	1/8 - 11/8	O. Dragesund	Irminger Sea, Dohrn Bank
	Germany (Fed.Rep.)	"A. Dohrn"	21/8 - 2/9	H. H. Reinsch	Dohrn Bank, E Greenland
	Iceland	"Á. Fridriksson"	28/8 - 12/9	H. Vilhjálmsson	NW- NE-Iceland
1971	Germany (Fed.Rep.)	"A. Dohrn"	28/6 - 10/7	H. H. Reinsch	E Greenland, Dohrn Bank
	U.K.	"Cirolana"	18/7 - 29/7	D. Garrod	E-, N- and NW-Iceland
	Iceland	"Á. Fridriksson"	5/8 - 18/8	H. Vilhjálmsson	W-, NW- and N-Iceland
	Iceland	"B. Sæmundsson"	5/8 - 18/8	S. A. Schopka	SW-, S- and SE-Iceland
	Norway	"G. O. Sars"	5/8 - 18/8	O. Dragesund	Irminger Sea, Dohrn Bank
1972	U.K.	"Cirolana"	11/7 - 20/7	B. W. Jones	E-, N- and NW-Iceland
	Iceland	"B. Sæmundsson"	15/7 - 25/7	S. A. Schopka	W- and S-Iceland
	U.S.S.R.	"F. Nansen"	28/7 - 13/8	V. Kuznetsov	Offshore NE- to NW-Iceland
	Iceland	"Á. Fridriksson"	2/8 - 25/8	H. Vilhjálmsson	Irminger Sea, Dohrn Bank, and nearshore NW- to NE-Iceland
1973	U.S.S.R.	"F. Nansen"	31/7 - 14/8	V. Rossov	Offshore NE- to NW-Iceland
	Iceland	"Á. Fridriksson"	9/8 - 29/8	H. Vilhjálmsson	Irminger Sea, Dohrn Bank
	Iceland	"B. Sæmundsson"	28/8 - 7/9	S. Sveinbjörnsson	SW- to E-Iceland
	Iceland	"Á. Fridriksson"	14/9 - 27/9	H. Vilhjálmsson	Nearshore NW- to NE-Iceland

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Appendix 1 (ctd)

Year	Country	Vessel	Time	Scientist in charge	Area
1974	U.S.S.R.	"A. Knipovich"	22/7 - 18/8	N Ushakov	Offshore E- and SE-Iceland, Southern Irminger Sea
	Iceland	"B. Sæmundsson"	30/7 - 17/8	H. Vilhjálmsson	SW Iceland. Offshore NW- N- and NE-Iceland.
	Iceland	"Á. Fridriksson"	6/8 - 26/8	E. Fridgeirsson	N Irminger Sea and Dohrn Bank; nearshore waters off NW-, N- and E-coasts of Iceland
1975	U.S.S.R.	"F. Nansen"	17/7 - 15/8	V. Kuznetsov	Offshore E- and SE-Iceland, Southern Irminger Sea
	Iceland	"Á. Fridriksson"	7/8 - 26/8	H. Vilhjálmsson	Nearshore W-, NW-, N- and NE-Iceland, N Irminger Sea and Dohrn Bank
	Iceland	"B. Sæmundsson"	22/7 - 14/8	E. Fridgeirsson	SW-, S- and E-Iceland. Offshore NE- and N Iceland

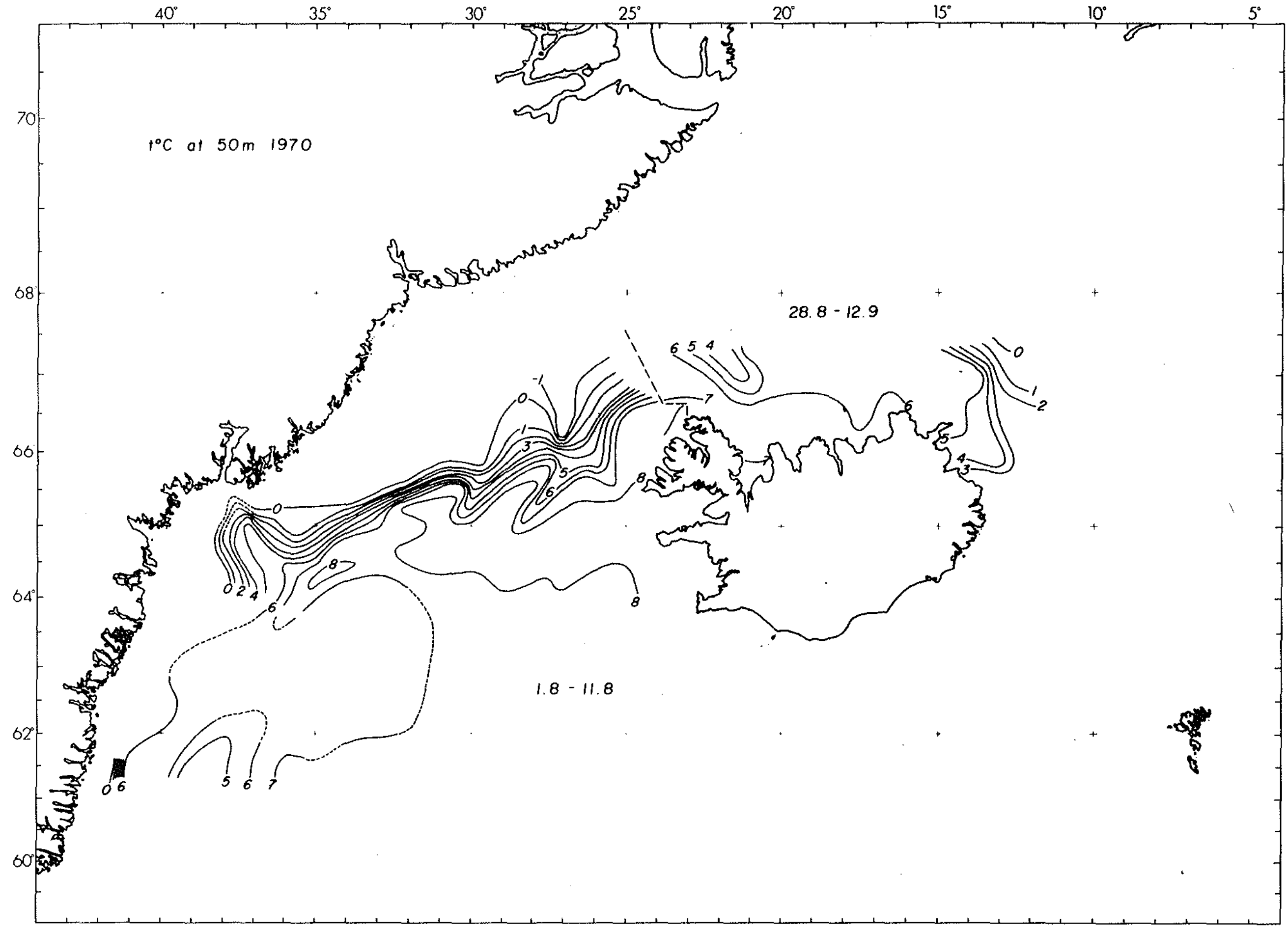

Figure 1. Isotherms at 50 m depth 1970

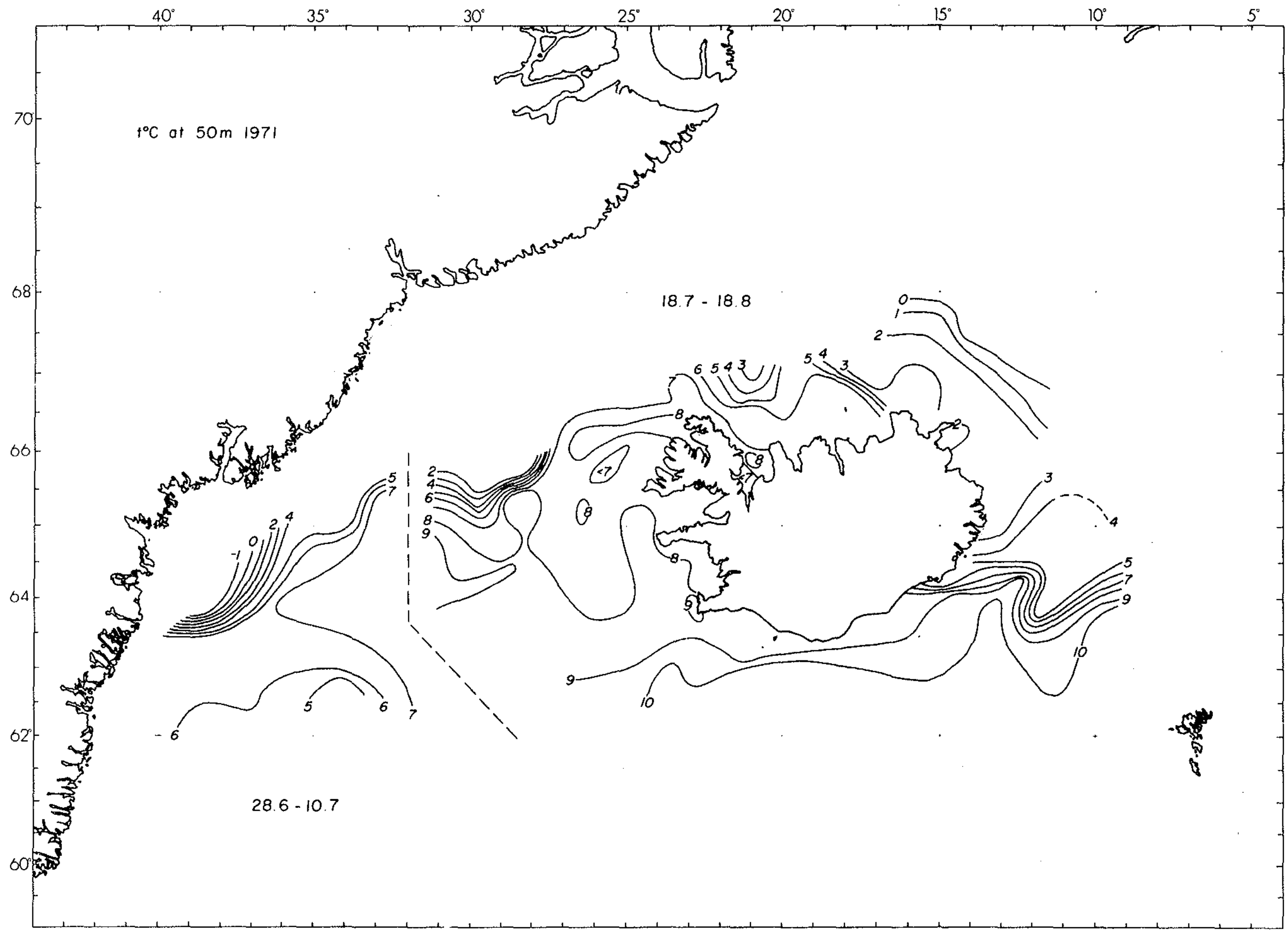

Figure 2. Isotherms at 50 m depth 1971

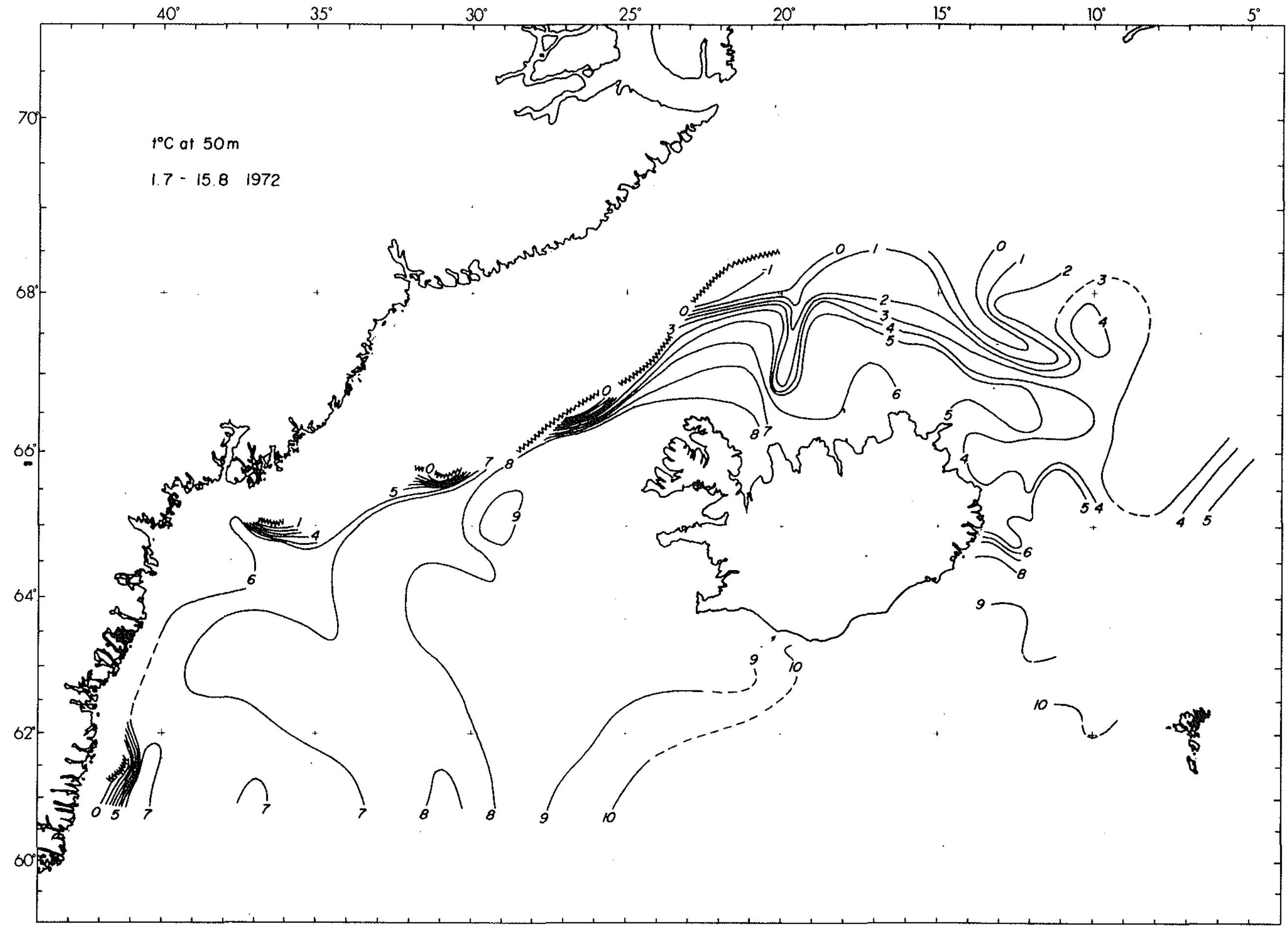

Figure 3. Isotherms at 50 m depth 1972

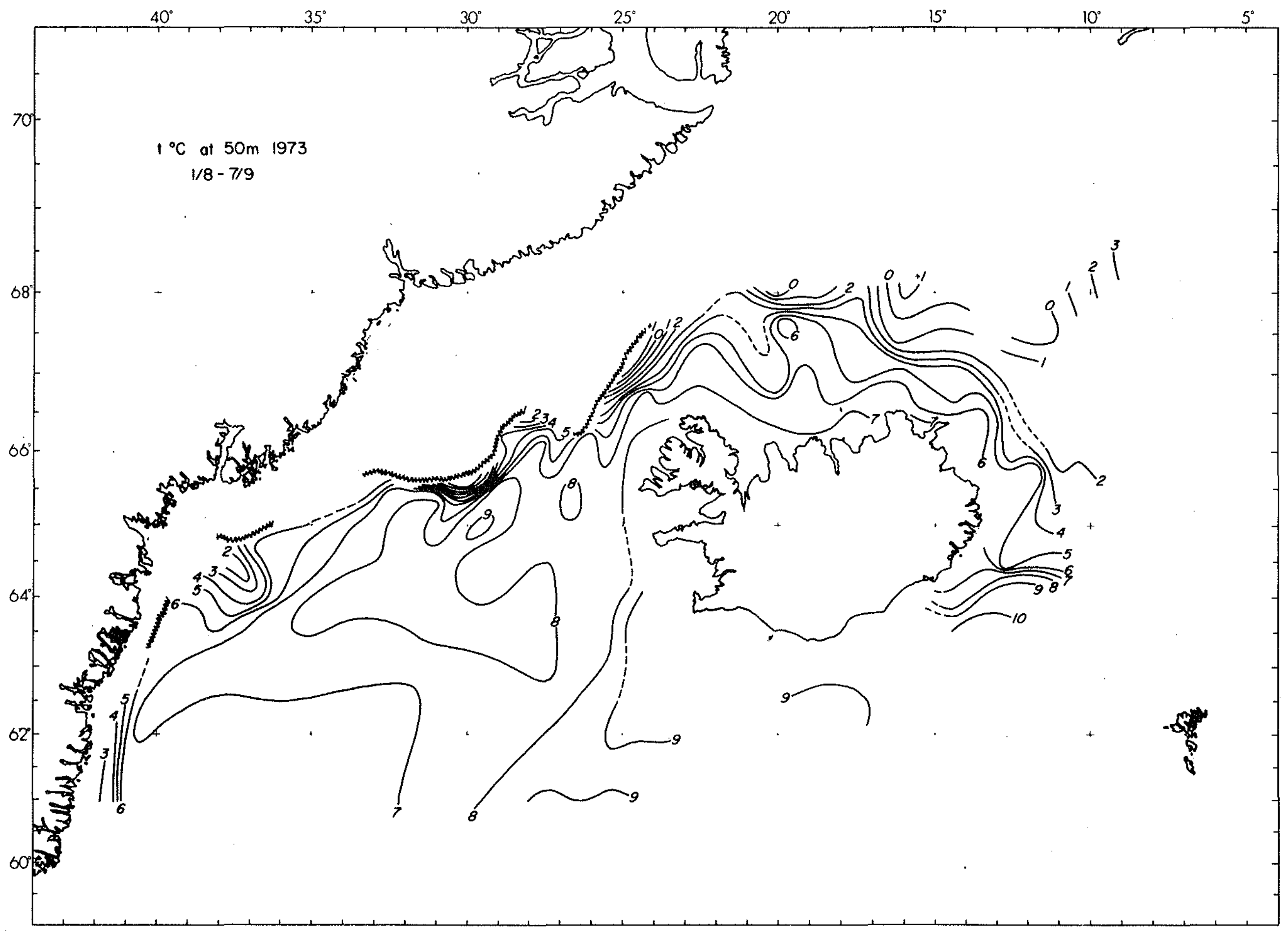

Figure 4. Isotherms at 50 m depth 1973

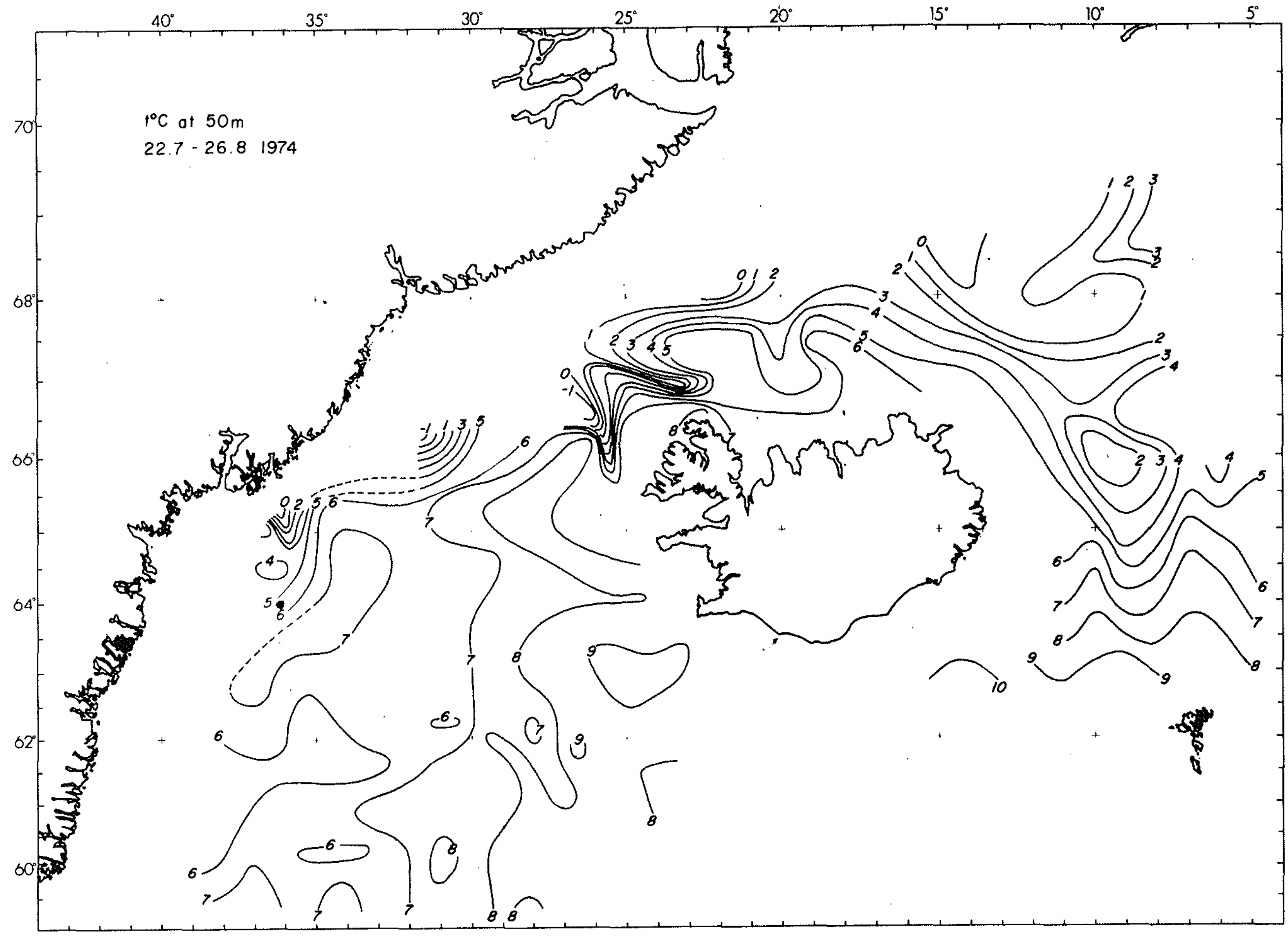

Figure 5. Isotherms at 50 m depth 1974

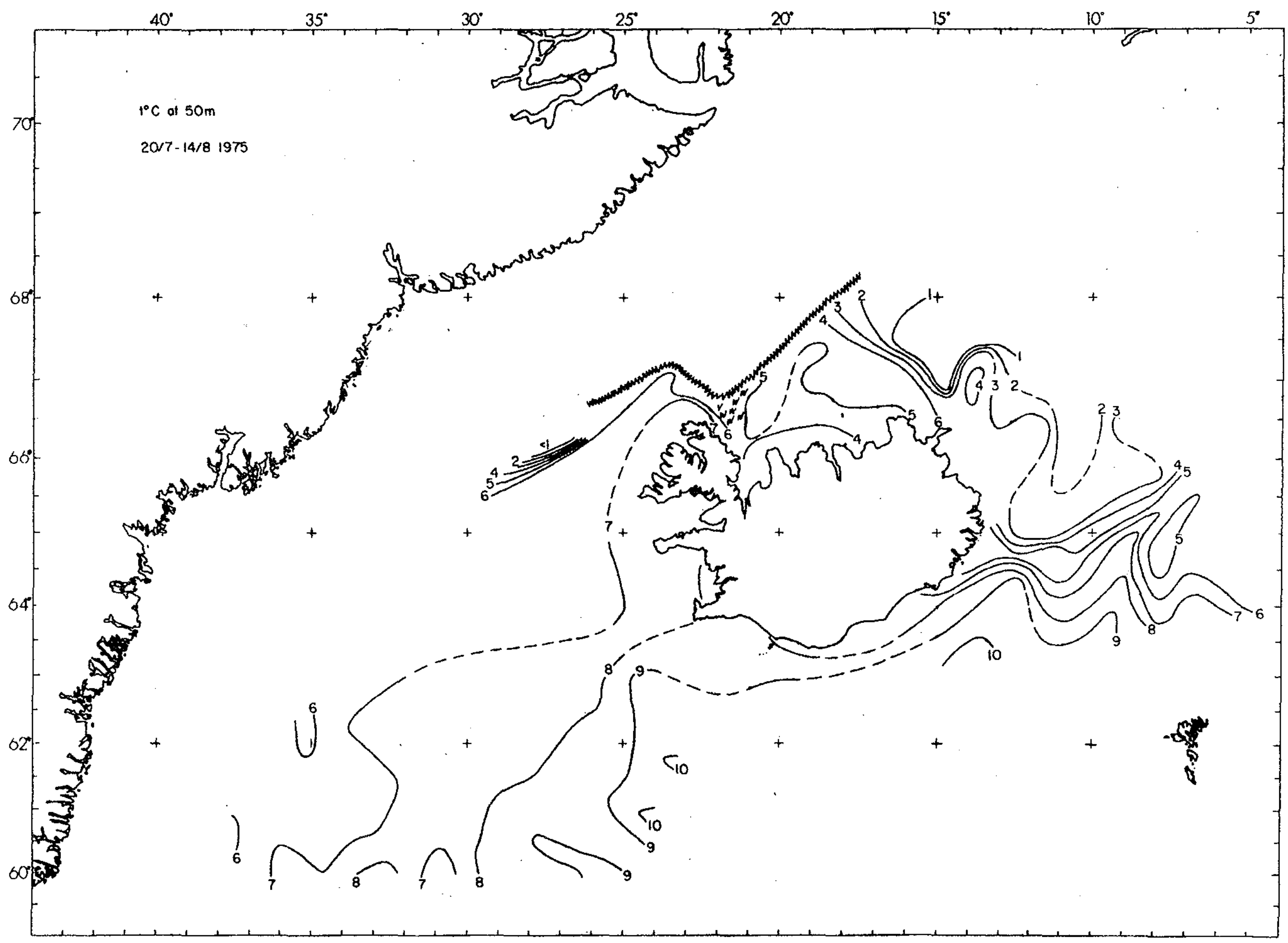

Figure 6. Isotherms at 50 m depth 1975.

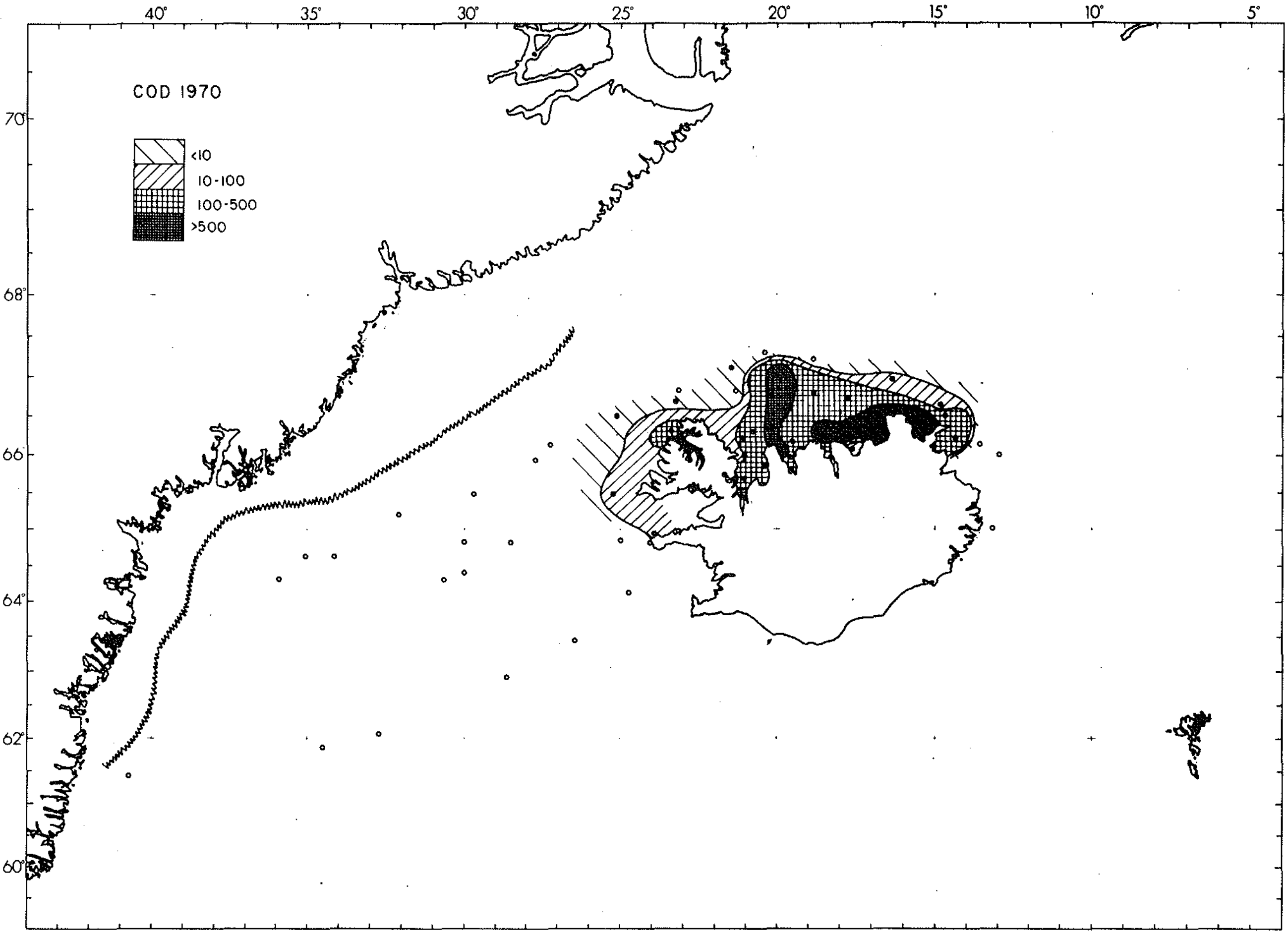

Figure 7. Quantitative distribution of 0-group cod 1970 (Number of fish per 1 nautical mile trawled).

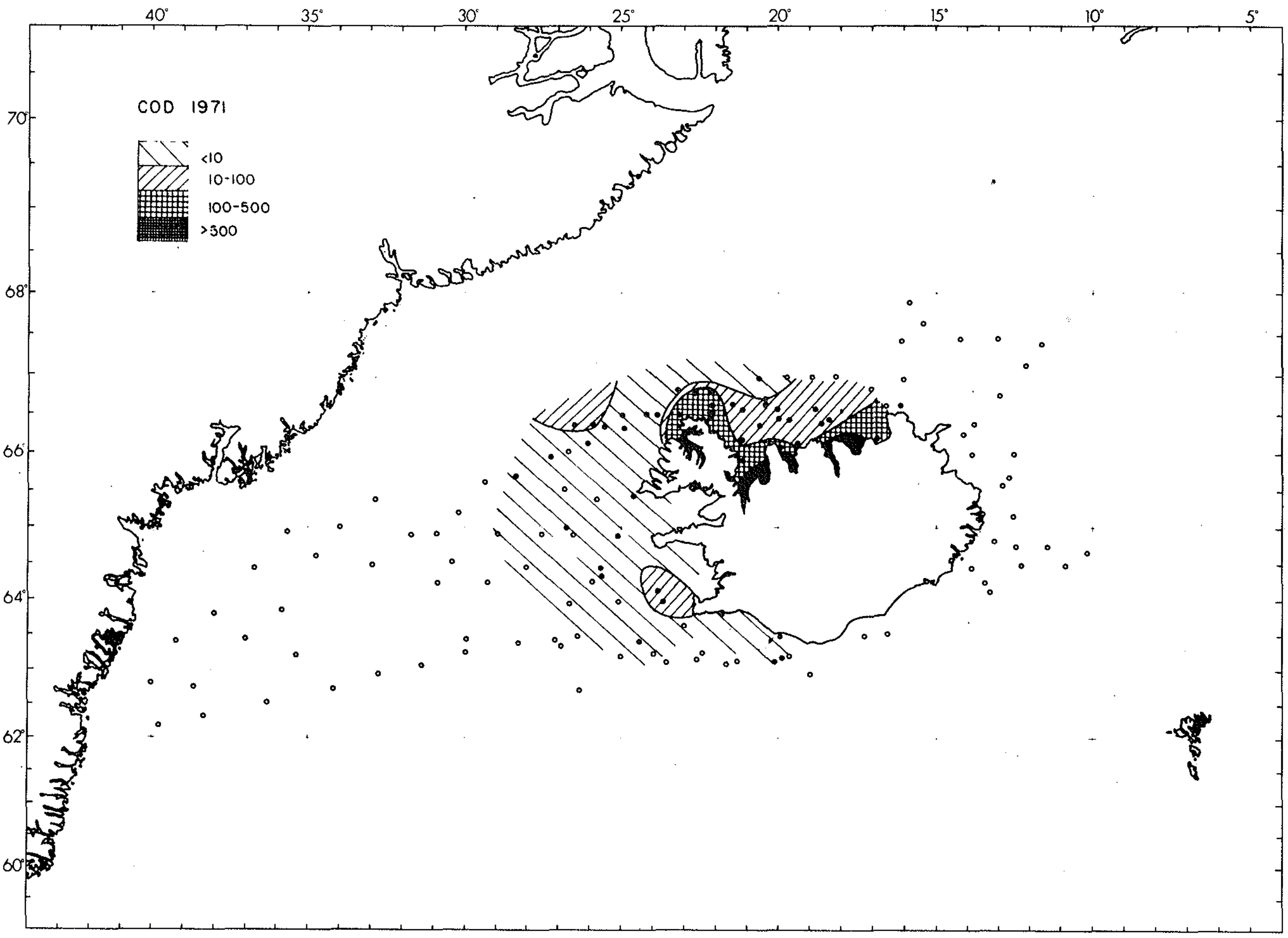

Figure 8. Quantitative distribution of 0-group cod 1971 (Number of fish per 1 nautical mile trawled).

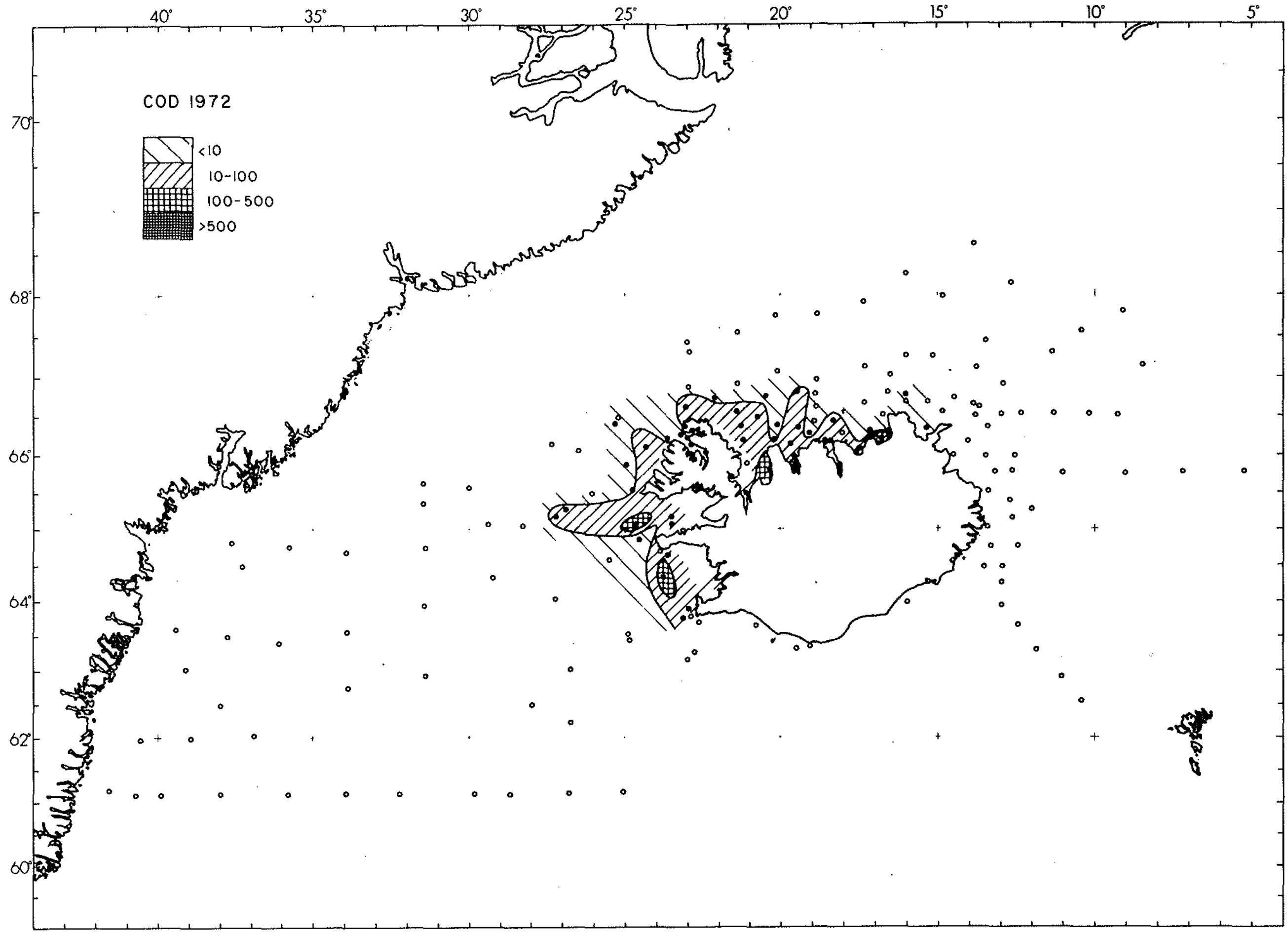

Figure 9. Quantitative distribution of 0-group cod 1972 (Number of fish per 1 nautical mile trawled).

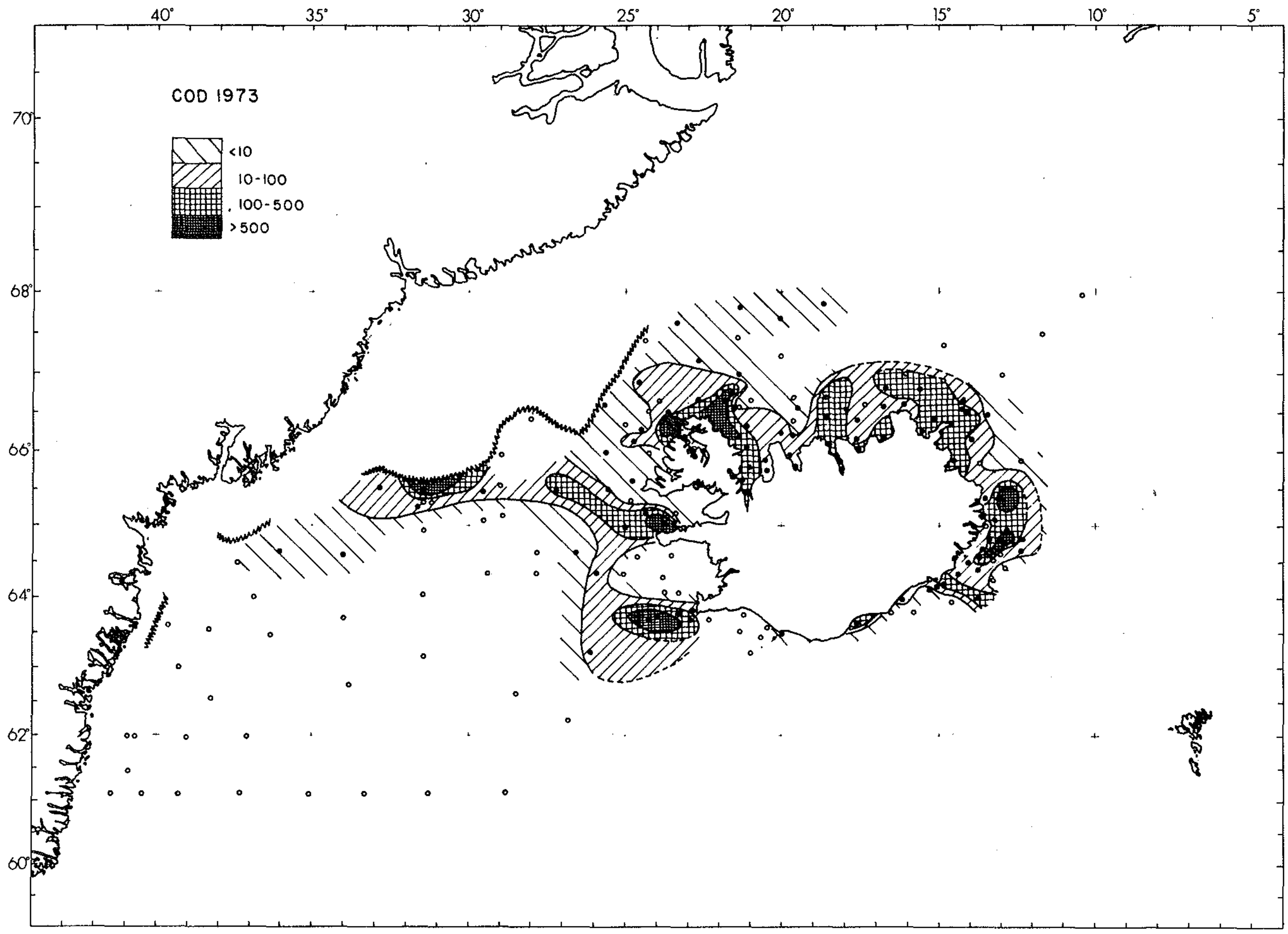

Figure 10. Quantitative distribution of 0-group cod 1973 (Number of fish per 1 nautical mile trawled).

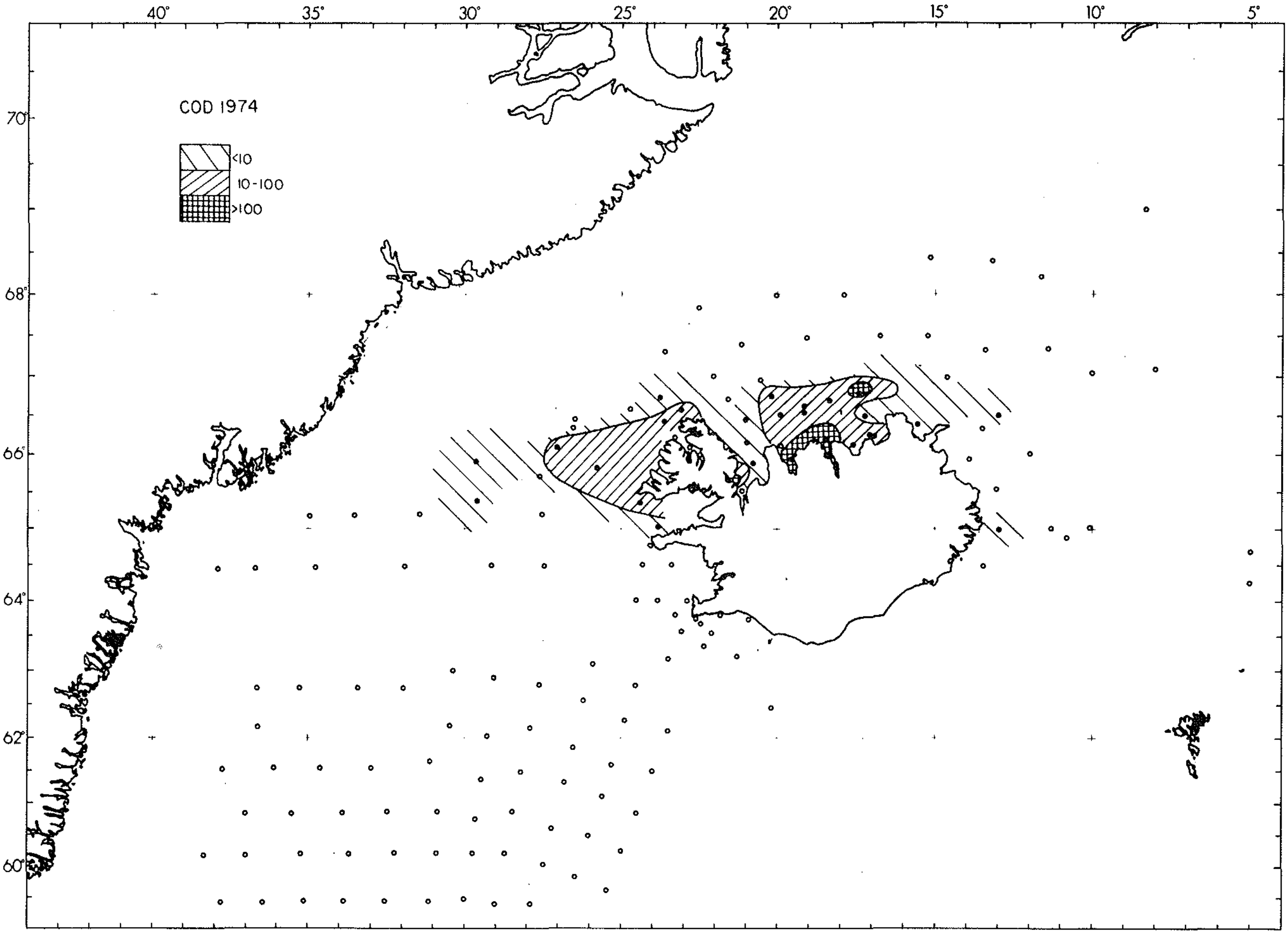

Figure 11. Quantitative distribution of 0-group cod 1974 (Number of fish per 1 nautical mile trawled).

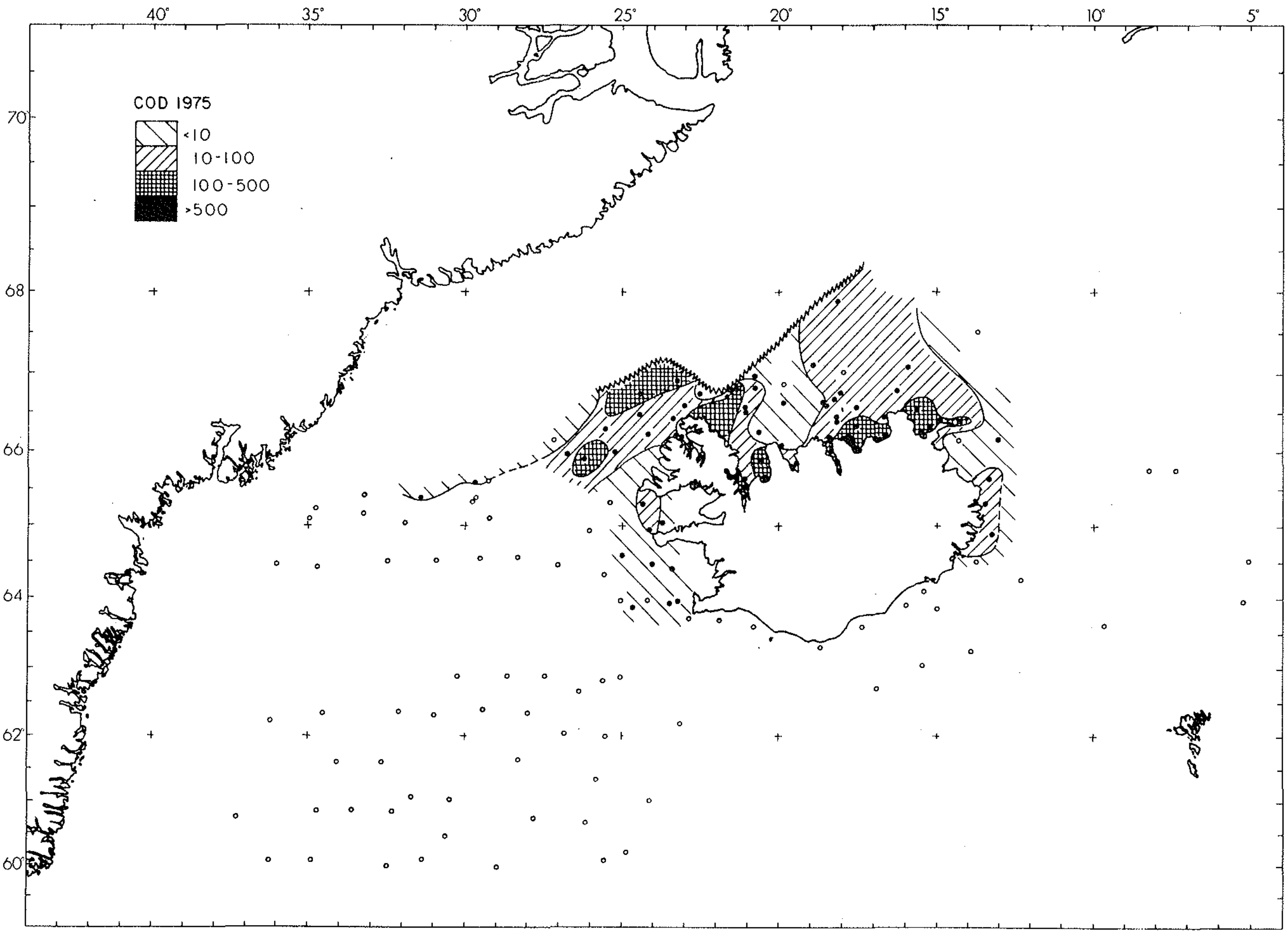

Figure 12. Quantitative distribution of 0-group cod 1975 (Number of fish per 1 nautical mile trawled).

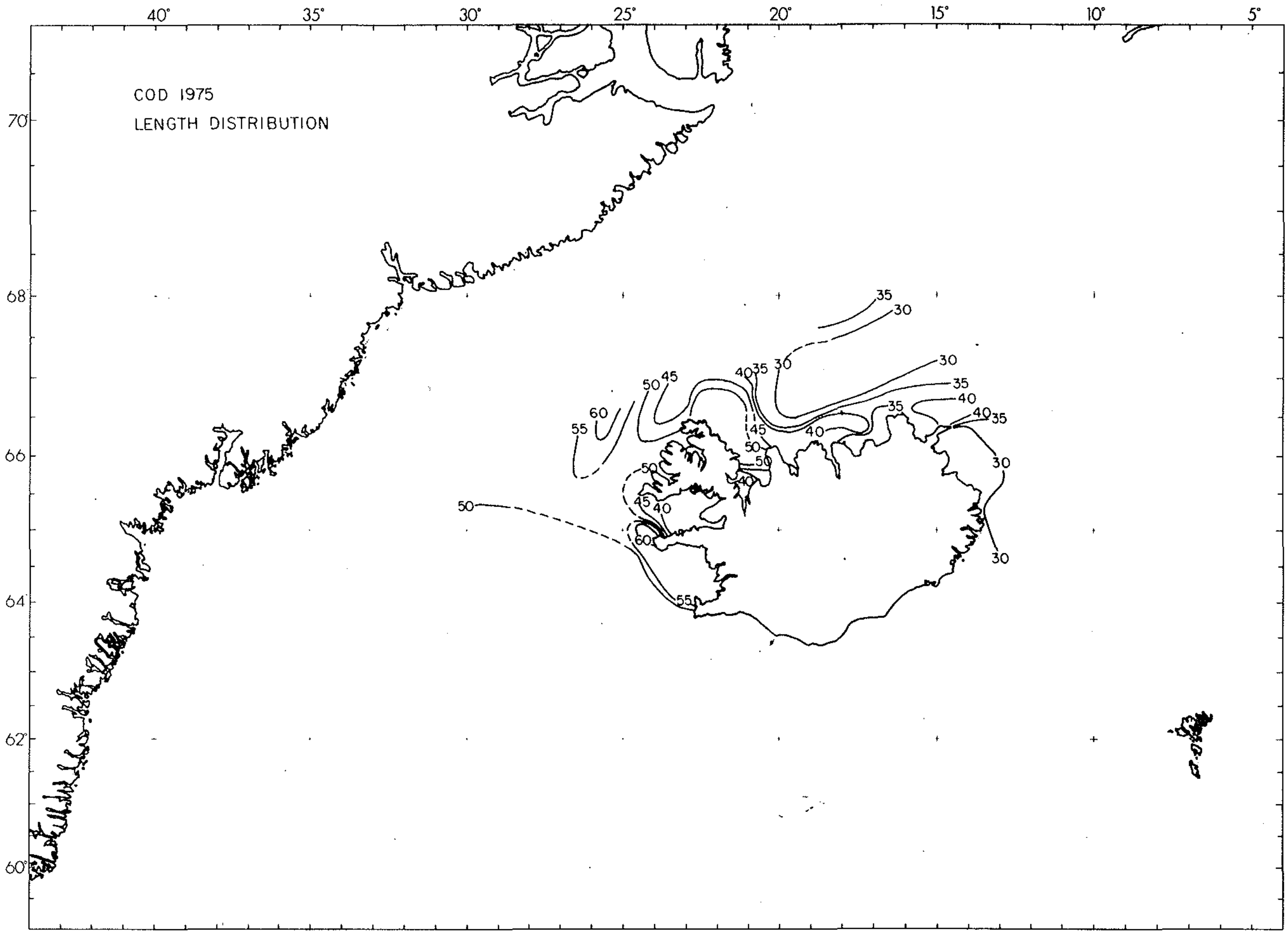

Figure 13. Length distribution of 0-group cod 1975.

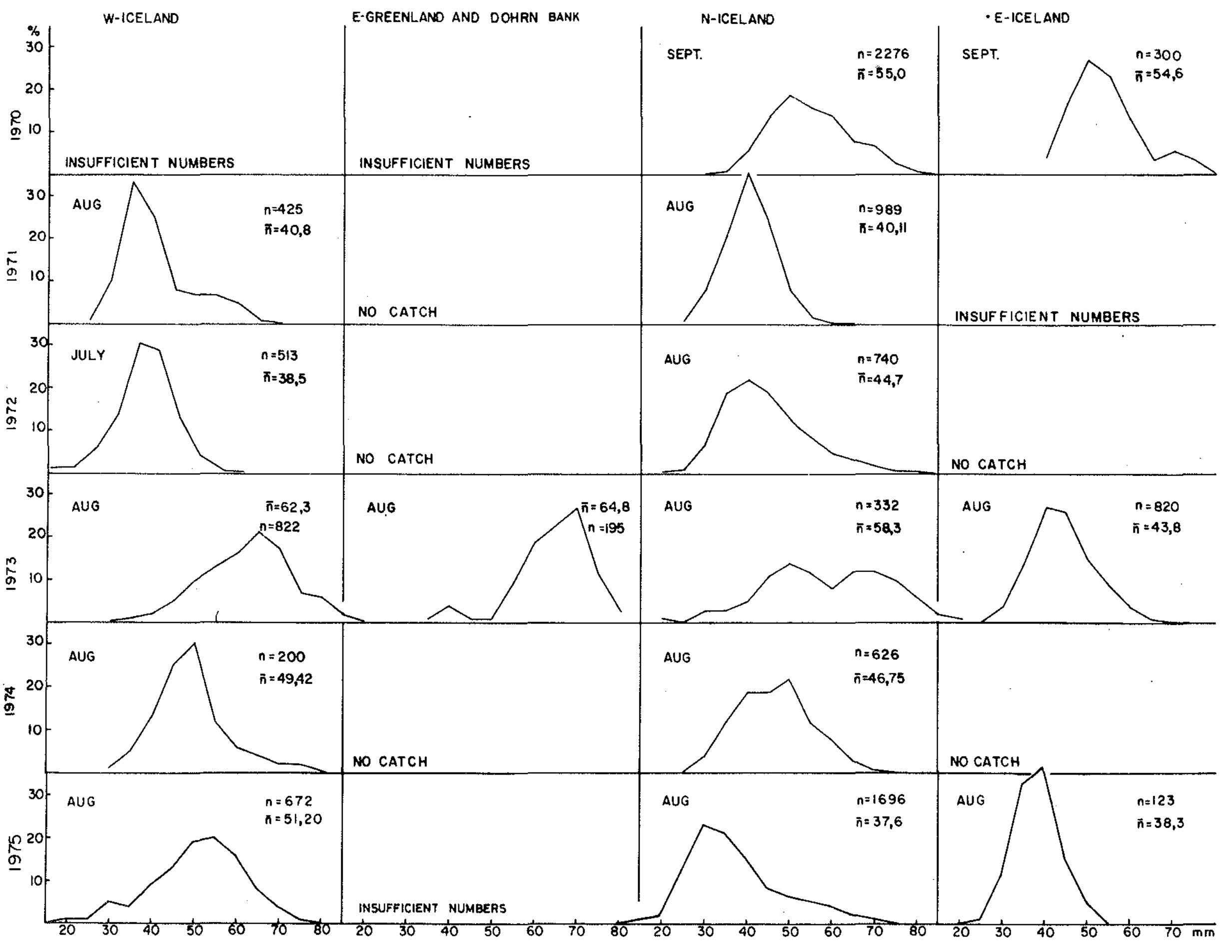

Figure 14. Length distribution by area of 0-group cod 1970-75.

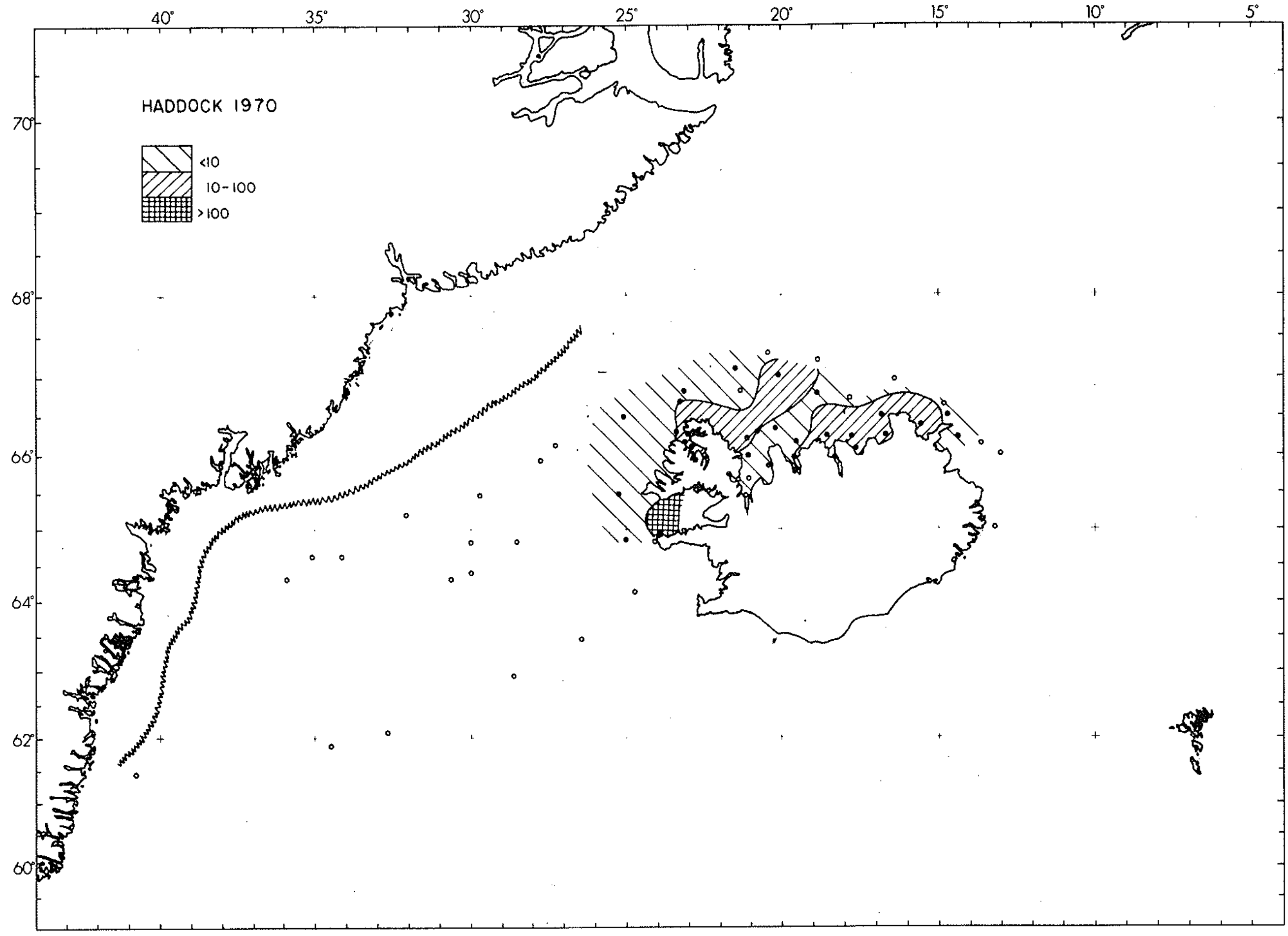

Figure 15. Quantitative distribution of 0-group haddock 1970 (Number of fish per 1 nautical mile trawled).

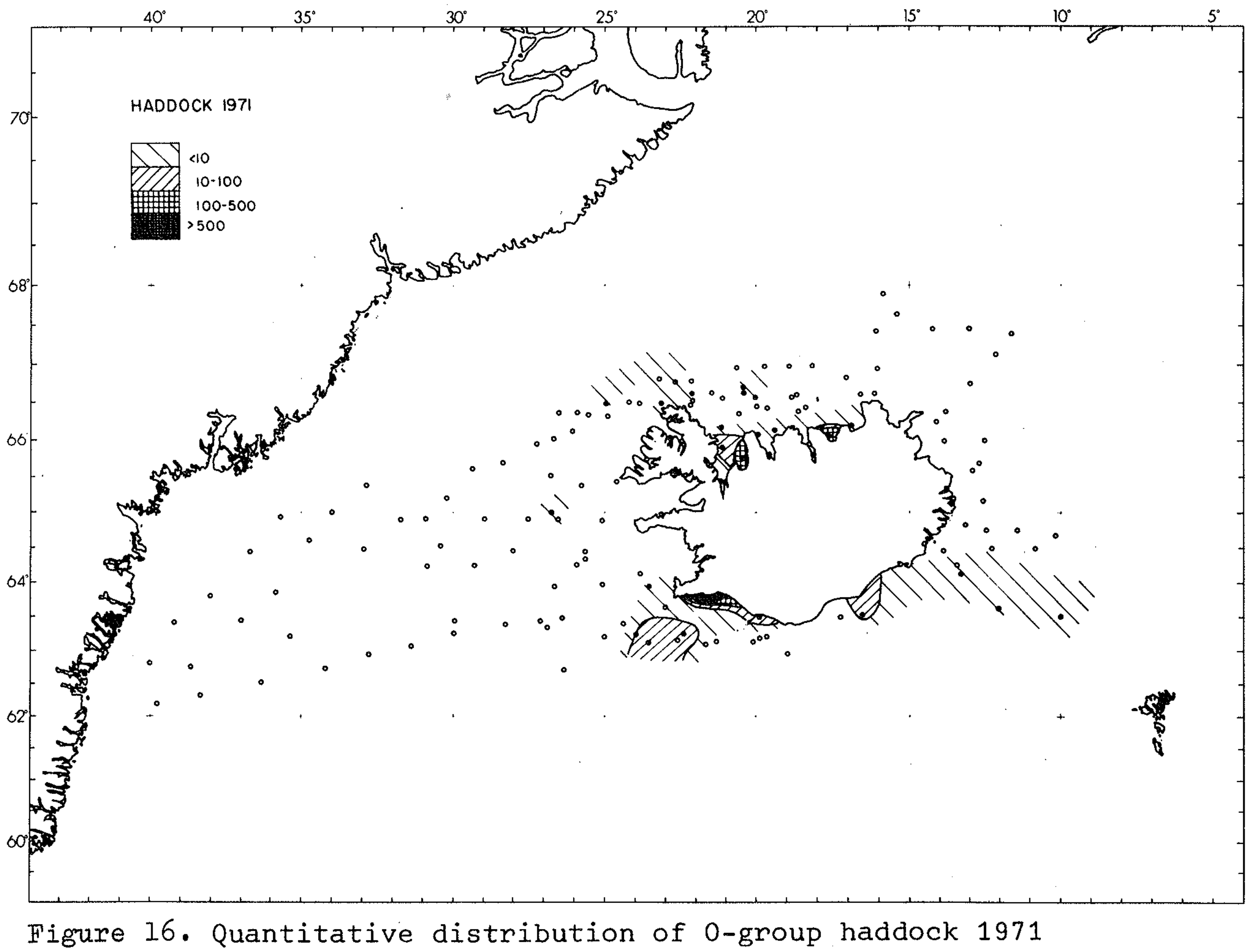

Figure 16. Quantitative distribution of 0-group haddock 1971 (Number of fish per 1 nautical mile trawled.

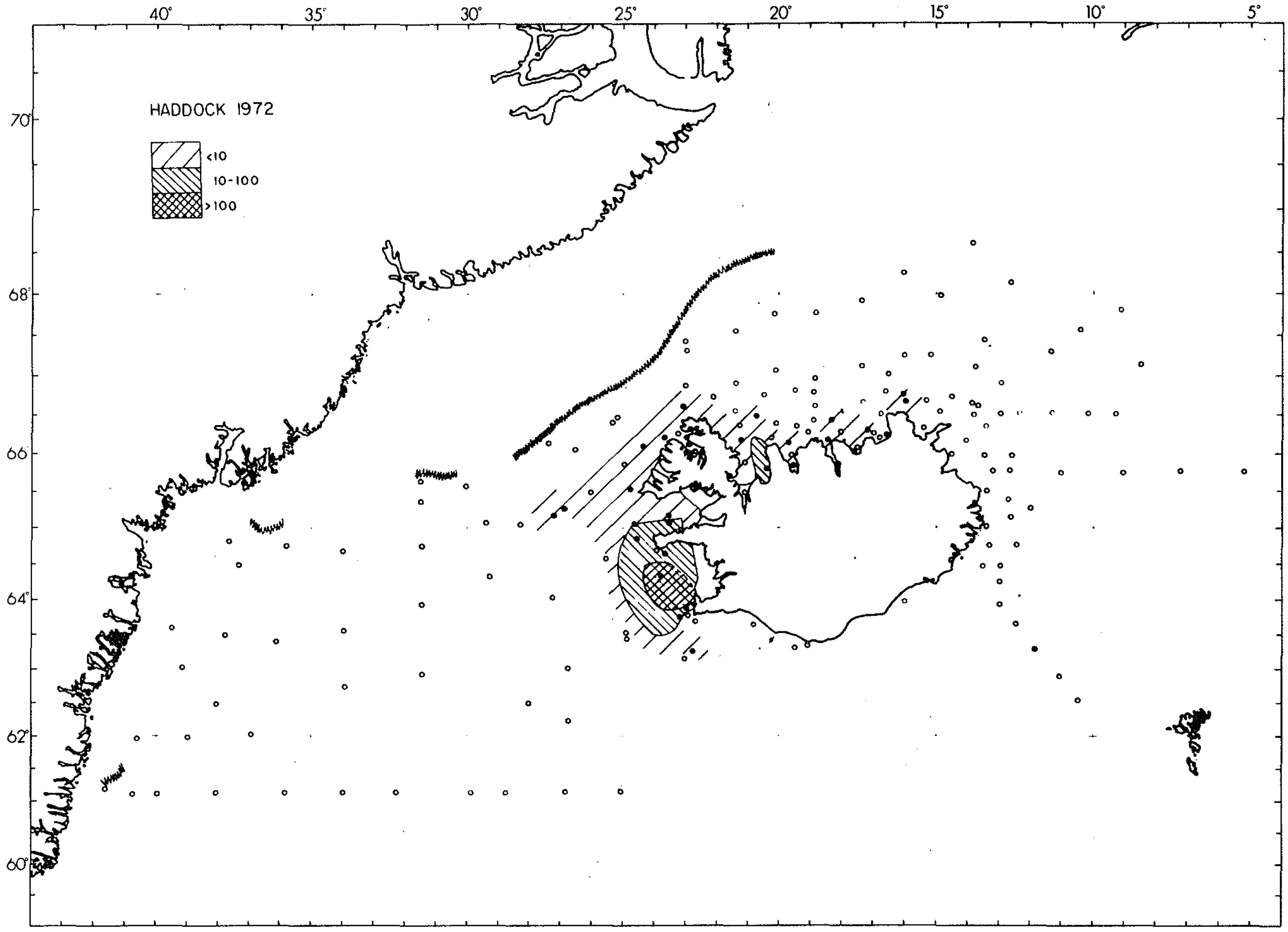

Figure 17. Quantitative distribution of 0-group haddock 1972 (Number of fish per 1 nautical mile trawled).

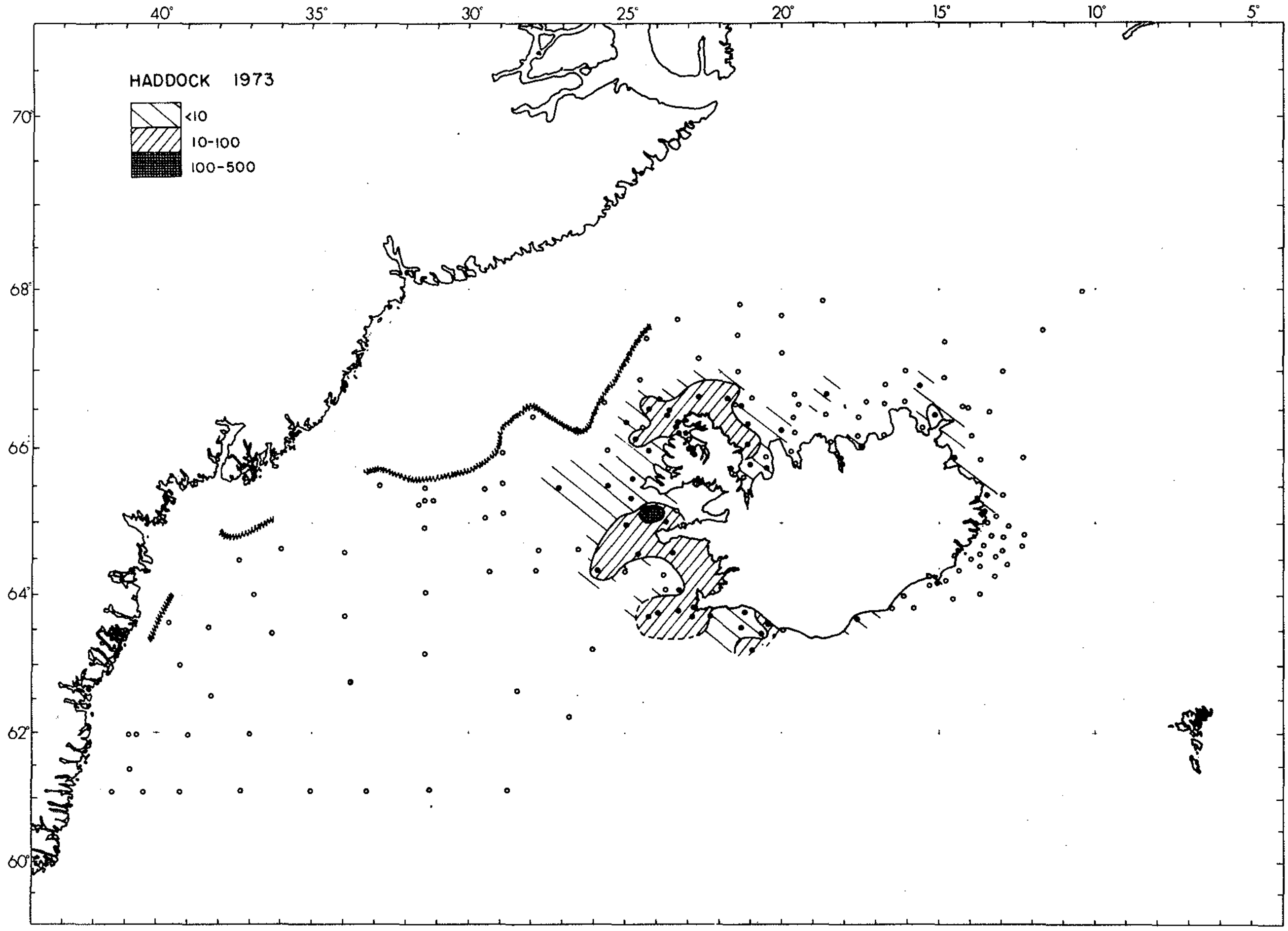

Figure 18. Quantitative distribution of 0-group haddock 1973 (Number of fish per 1 nautical mile trawled).

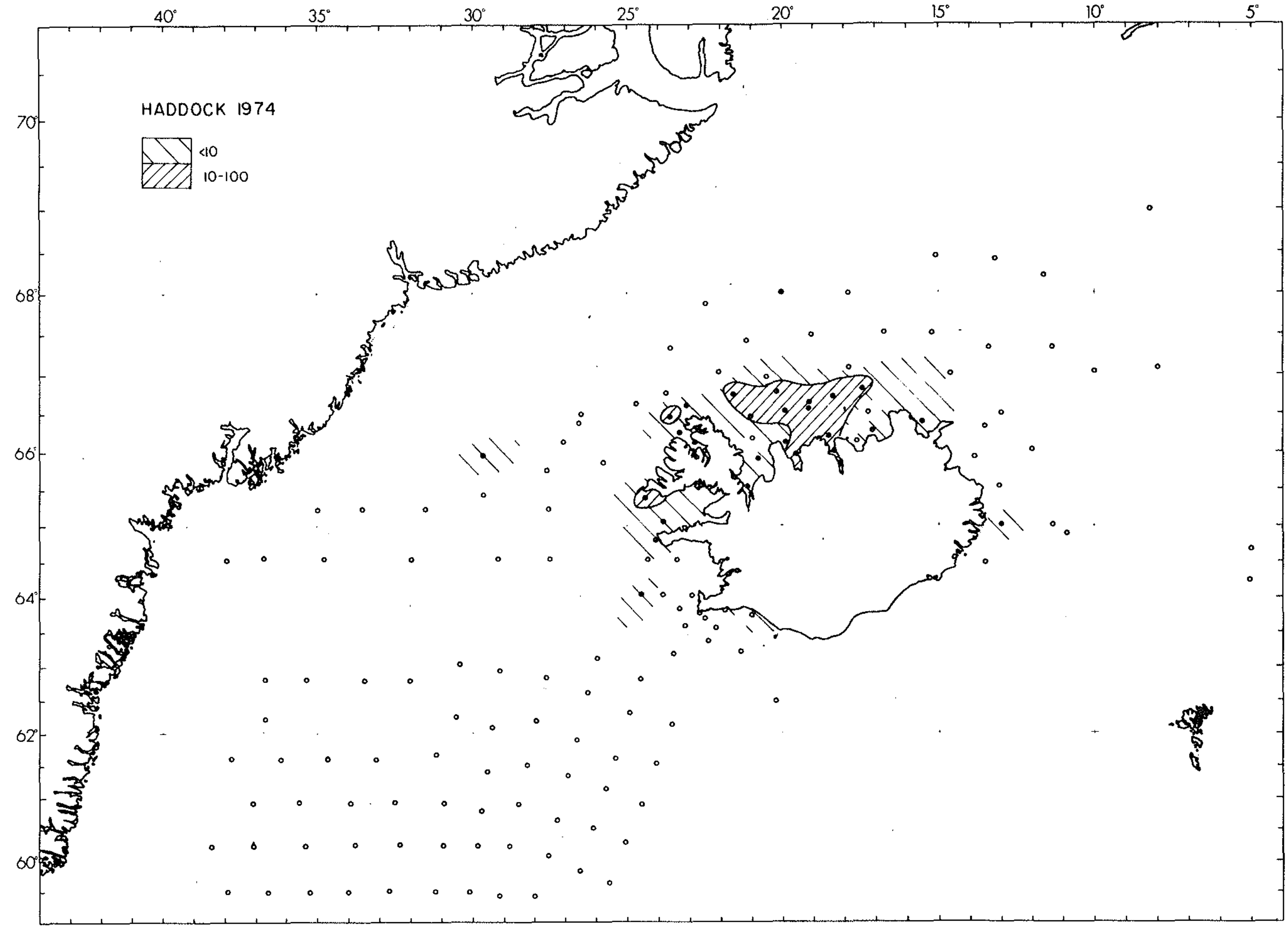

Figure 19. Quantitative distribution of O-group haddock 1974 (Number of fish per 1 nautical mile trawled).

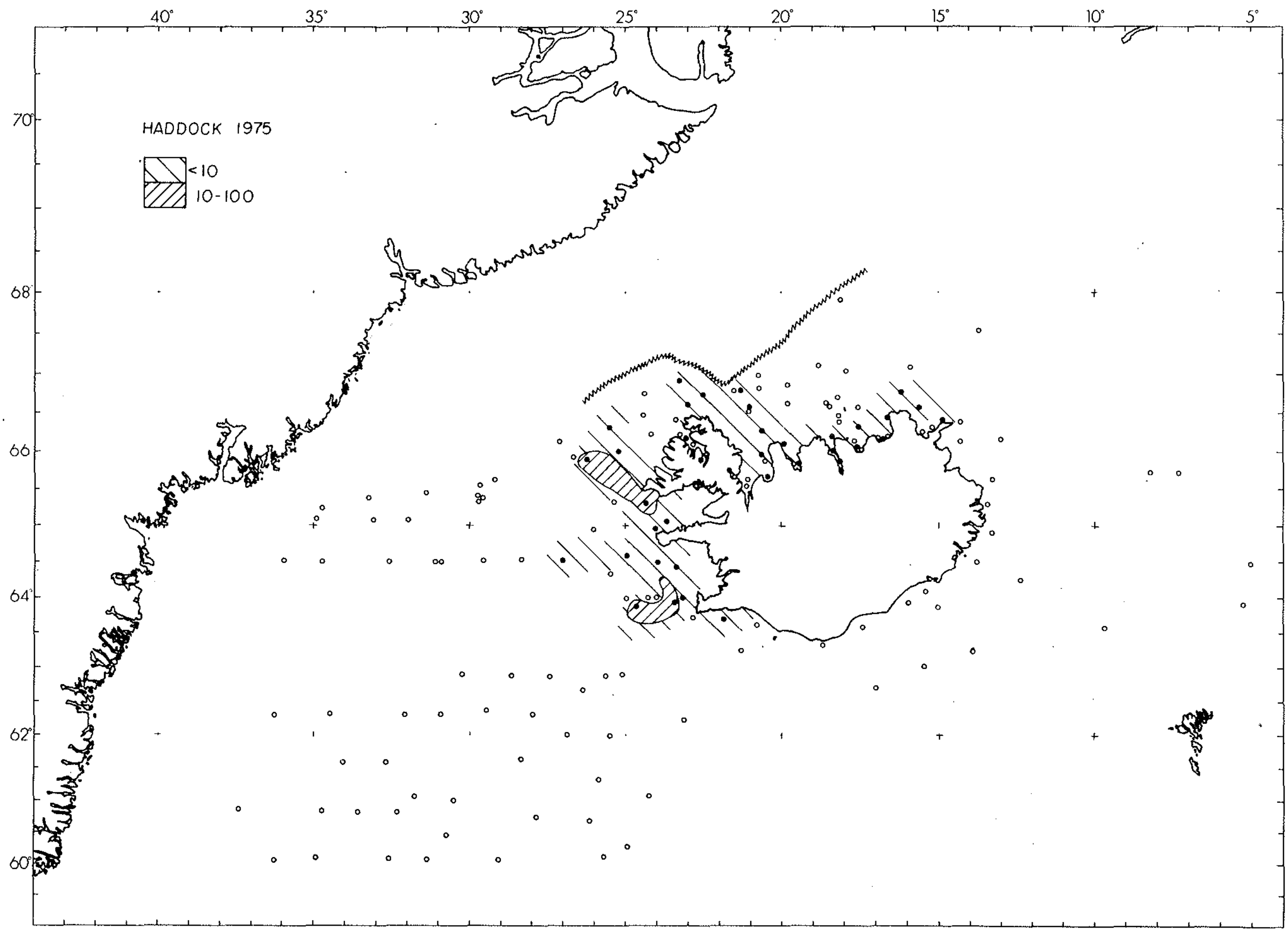

Figure 20. Quantitative distribution of O-group haddock 1975 (Number of fish per 1 nautical mile trawled).

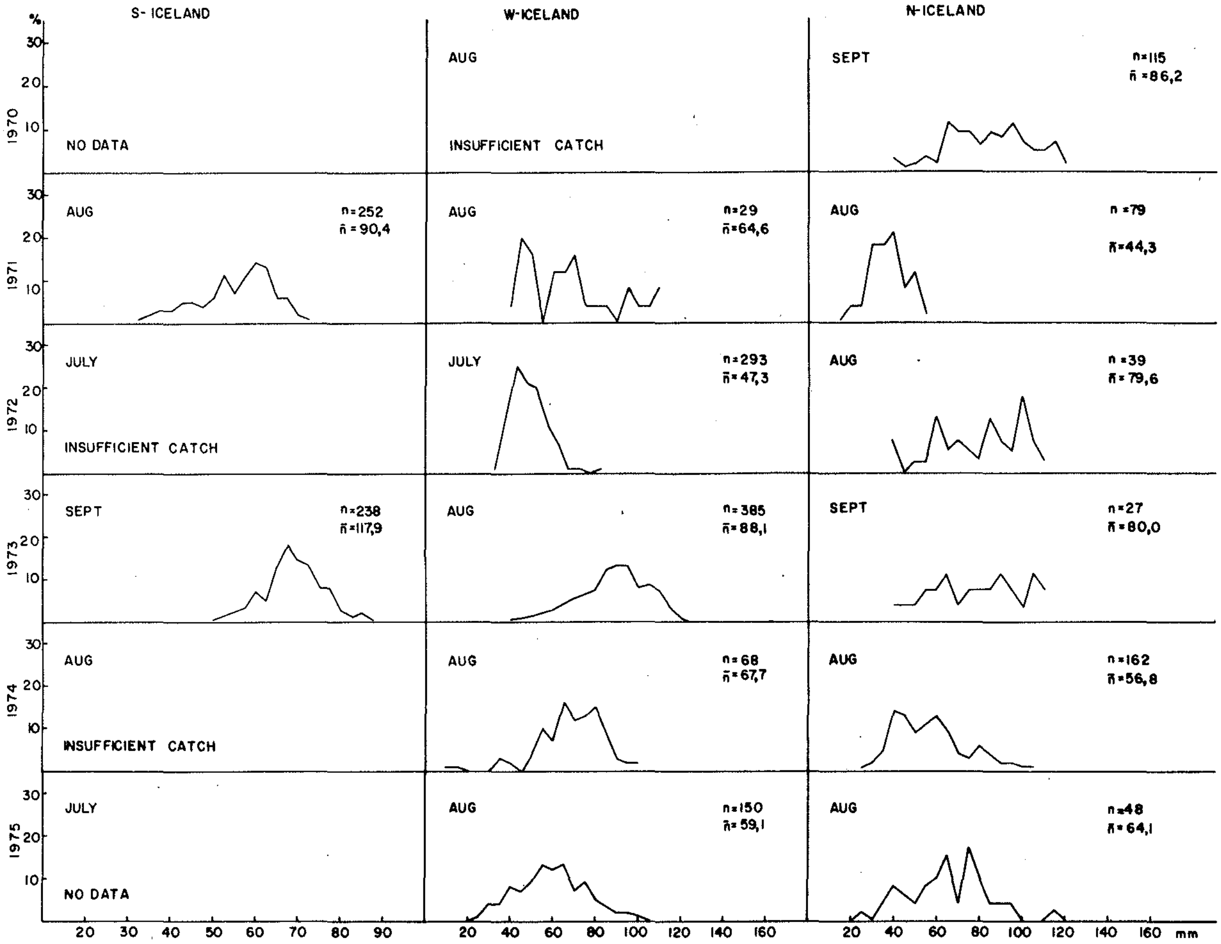

Figure 21. Length distribution by area of 0-group haddock 1970-75.

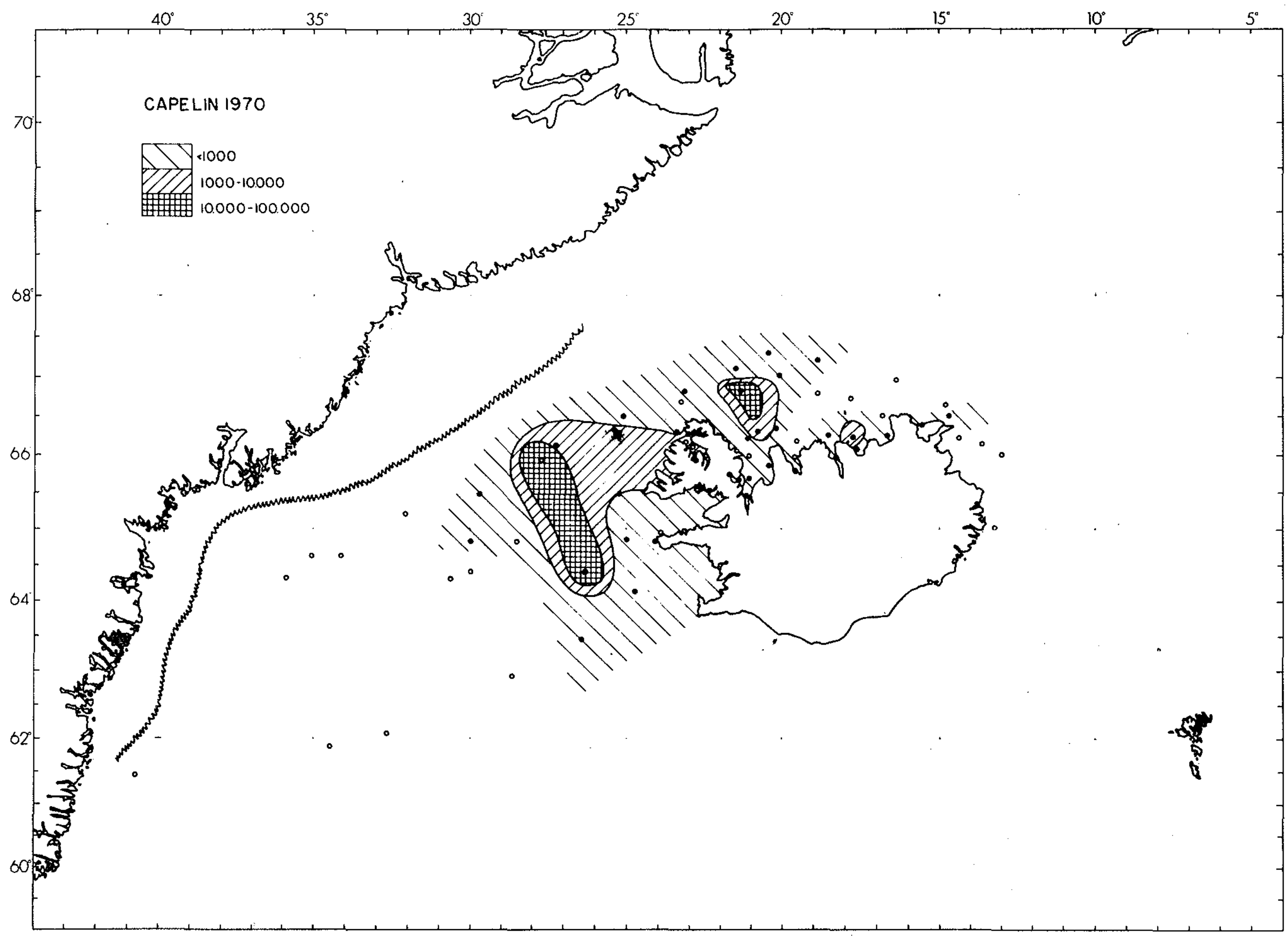

Figure 22. Quantitative distribution of 0-group capelin 1970
(Number of fish per 1 nautical mile trawled).

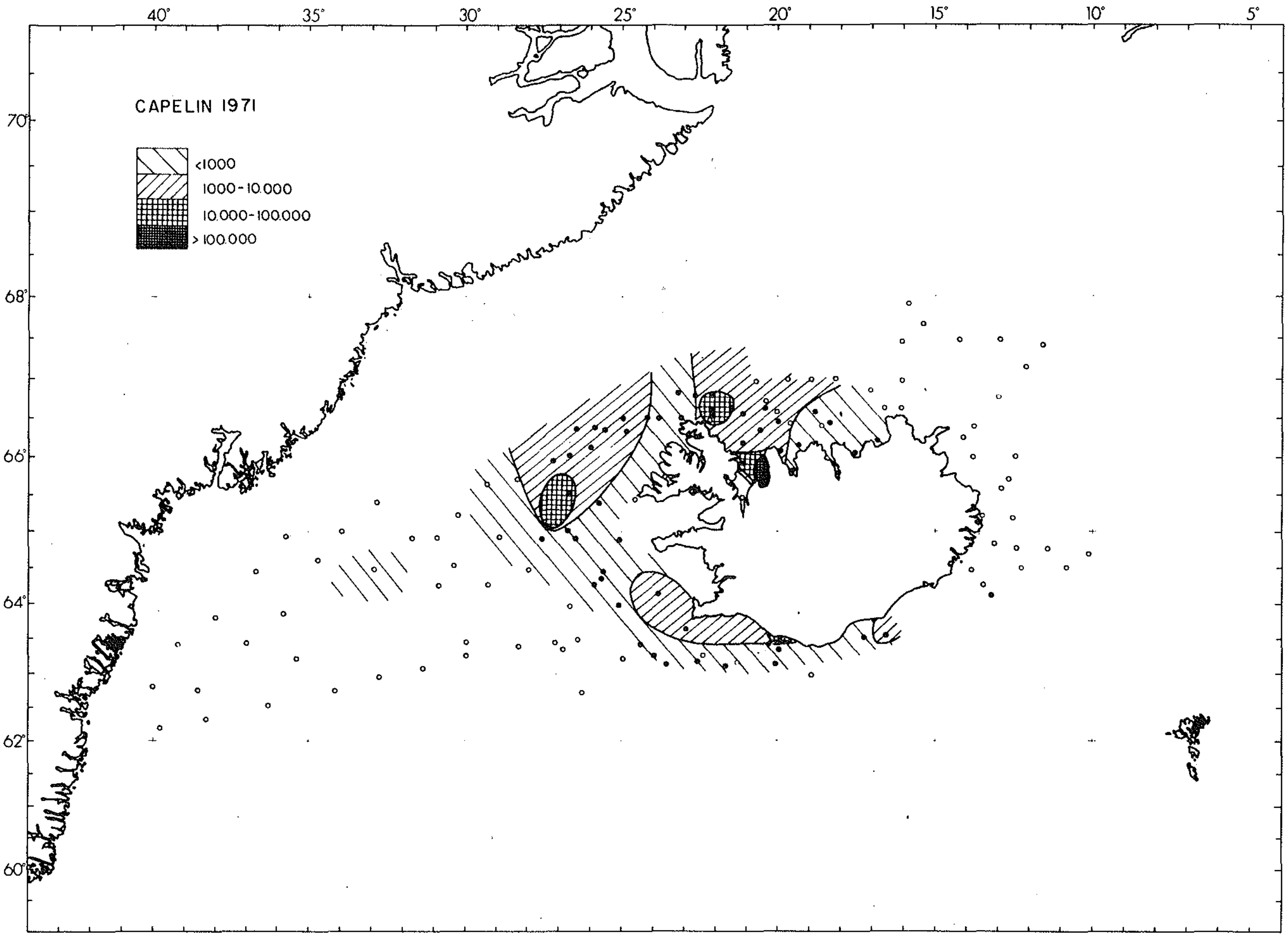

Figure 23. Quantitative distribution of 0-group capelin 1971
(Number of fish per 1 nautical mile trawled).

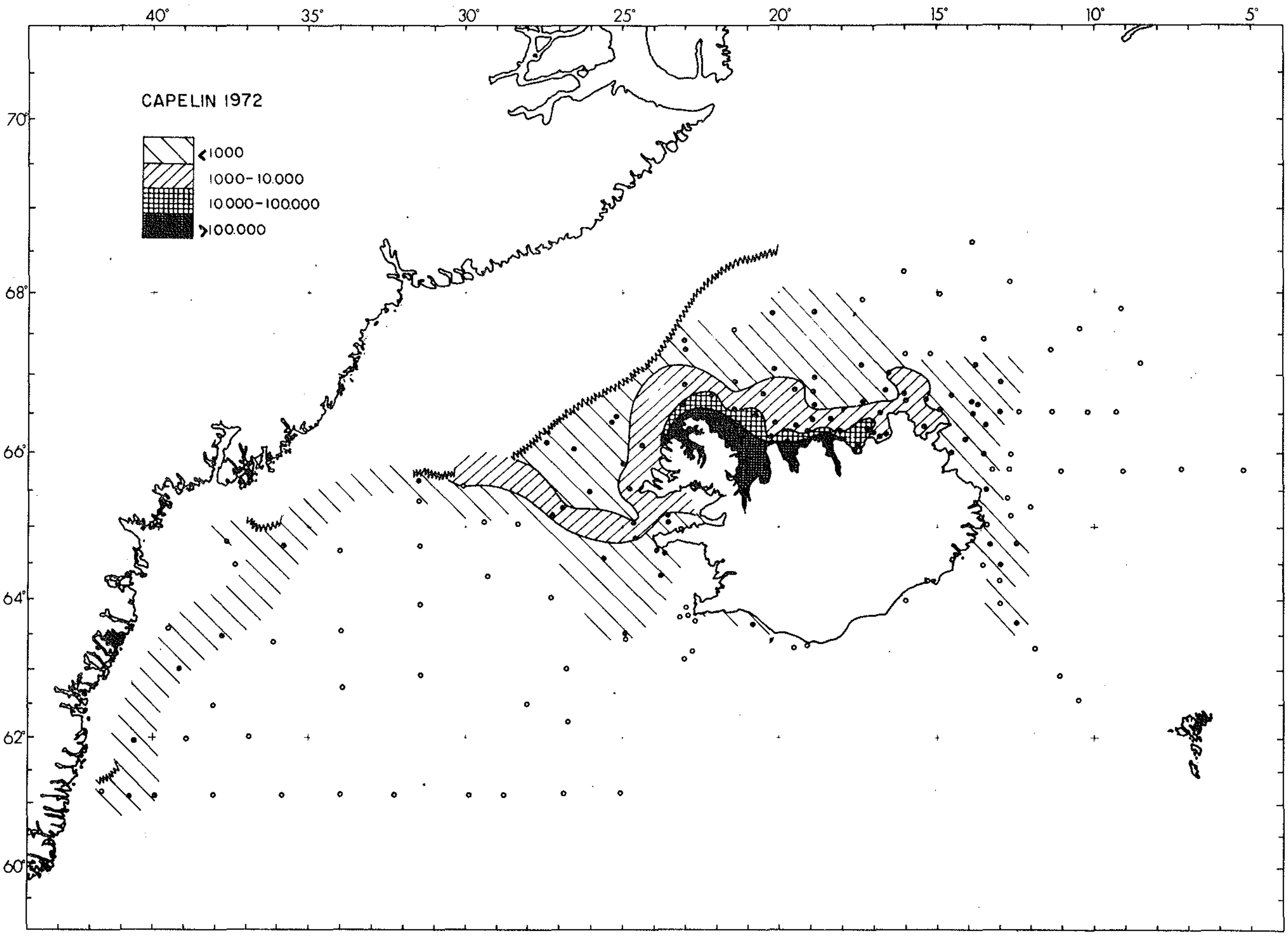

Figure 24. Quantitative distribution of 0-group capelin 1972
(Number of fish per 1 nautical mile trawled).

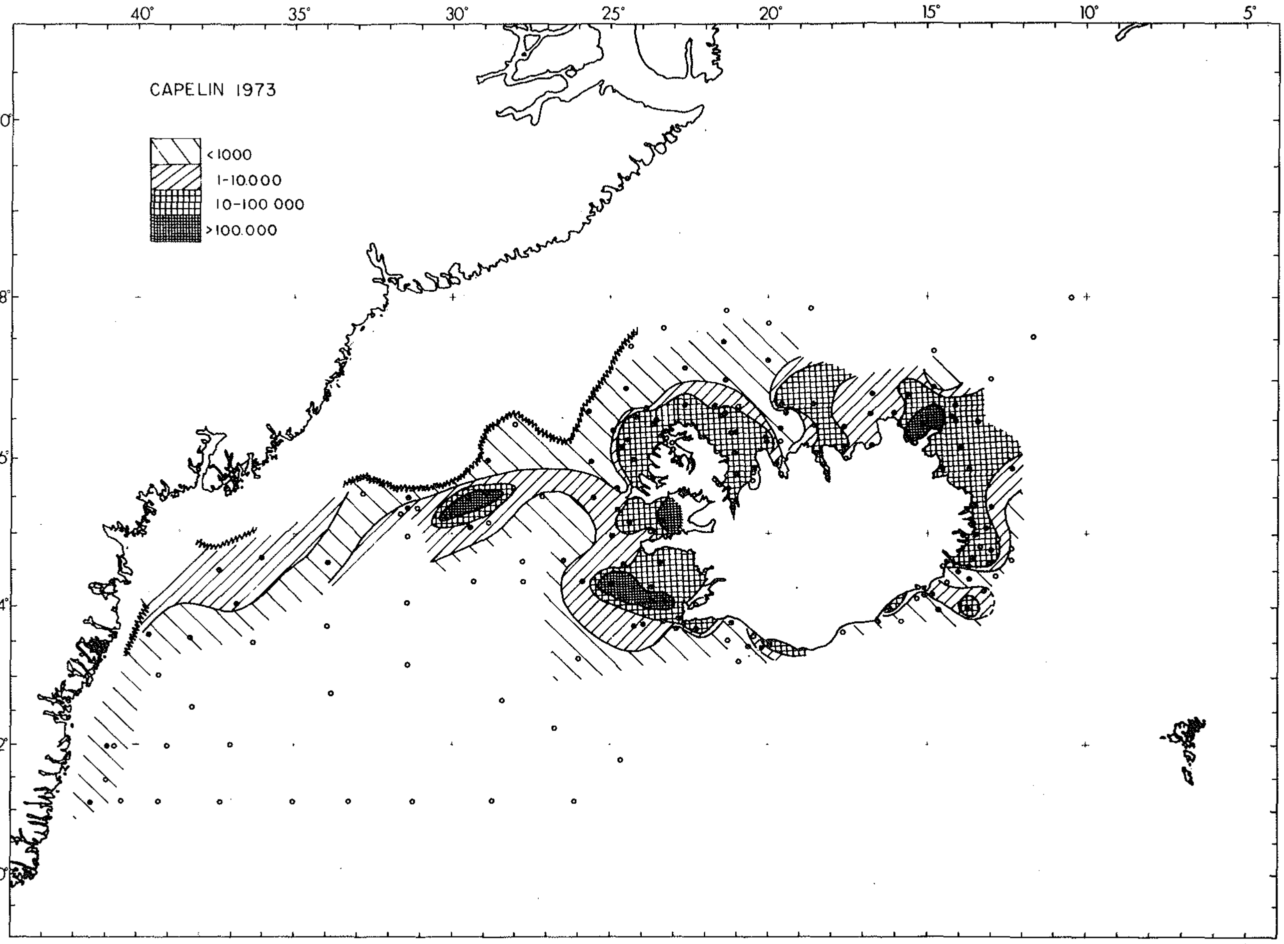

Figure 25. Quantitative distribution of 0-group capelin 1973 (Number of fish per 1 nautical mile trawled).

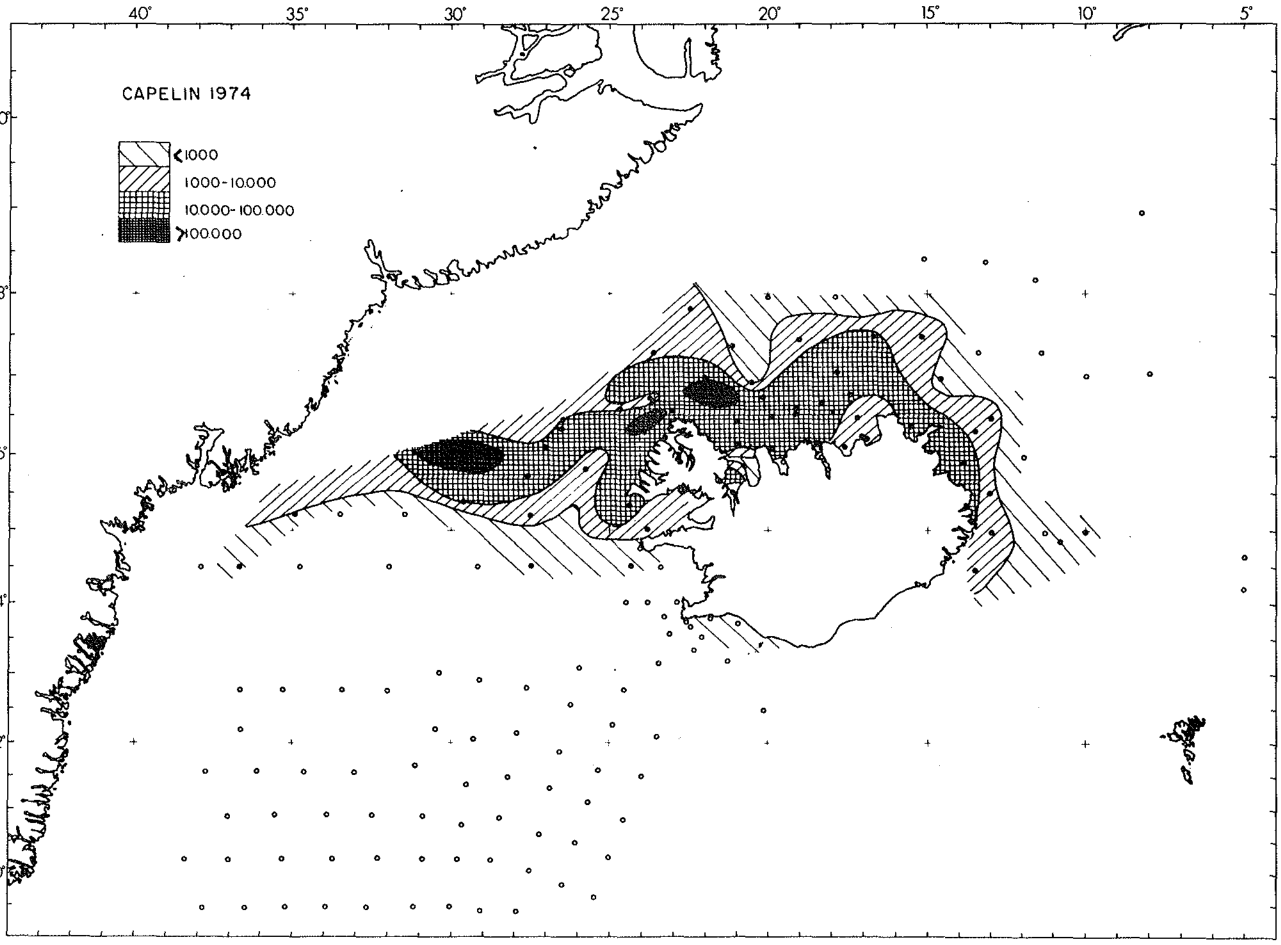

Figure 26. Quantitative distribution of 0-group capelin 1974 (Number of fish per 1 nautical mile trawled).

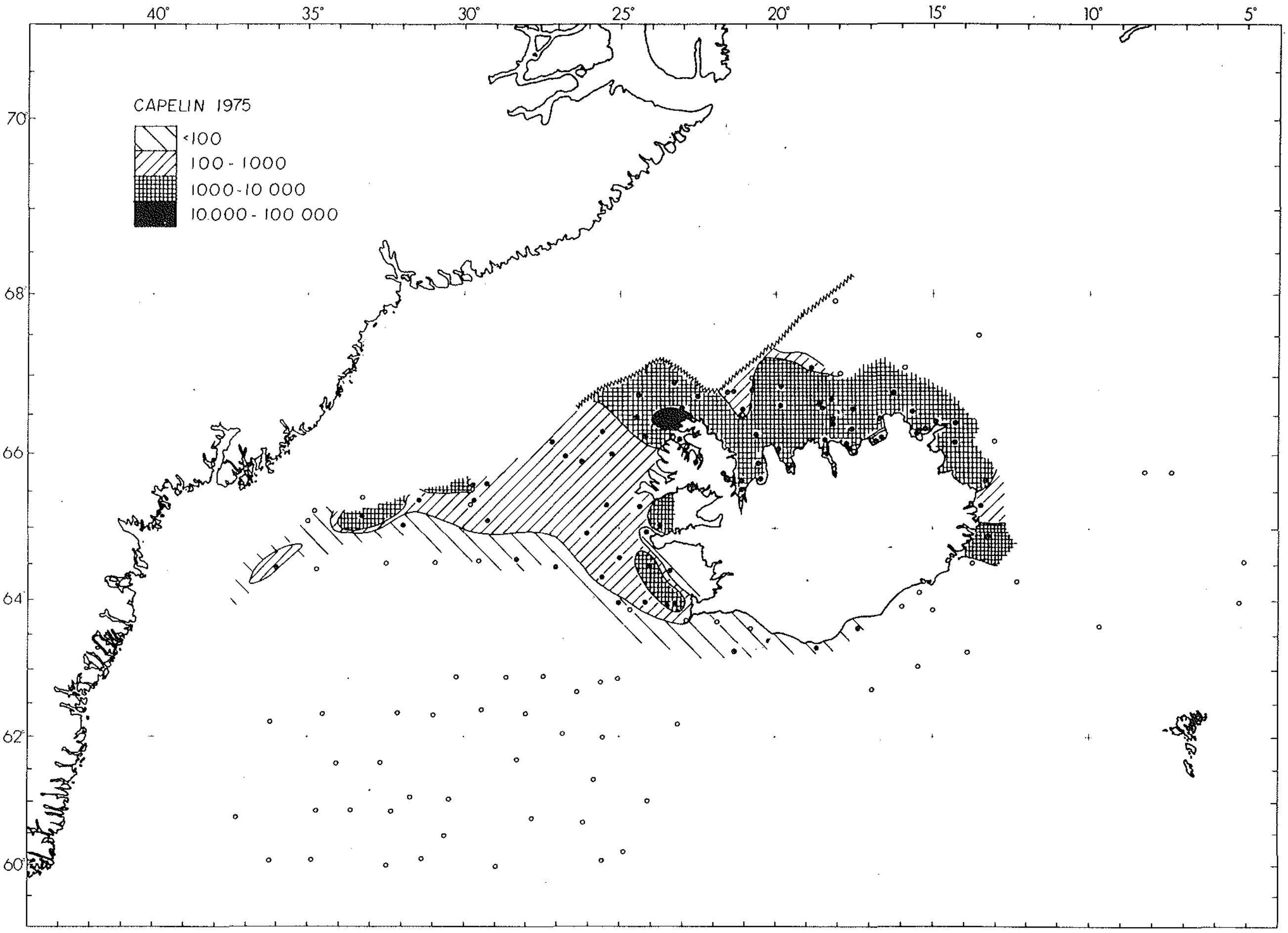

Figure 27. Quantitative distribution of 0-group capelin 1975 (Number of fish per 1 nautical mile trawled).

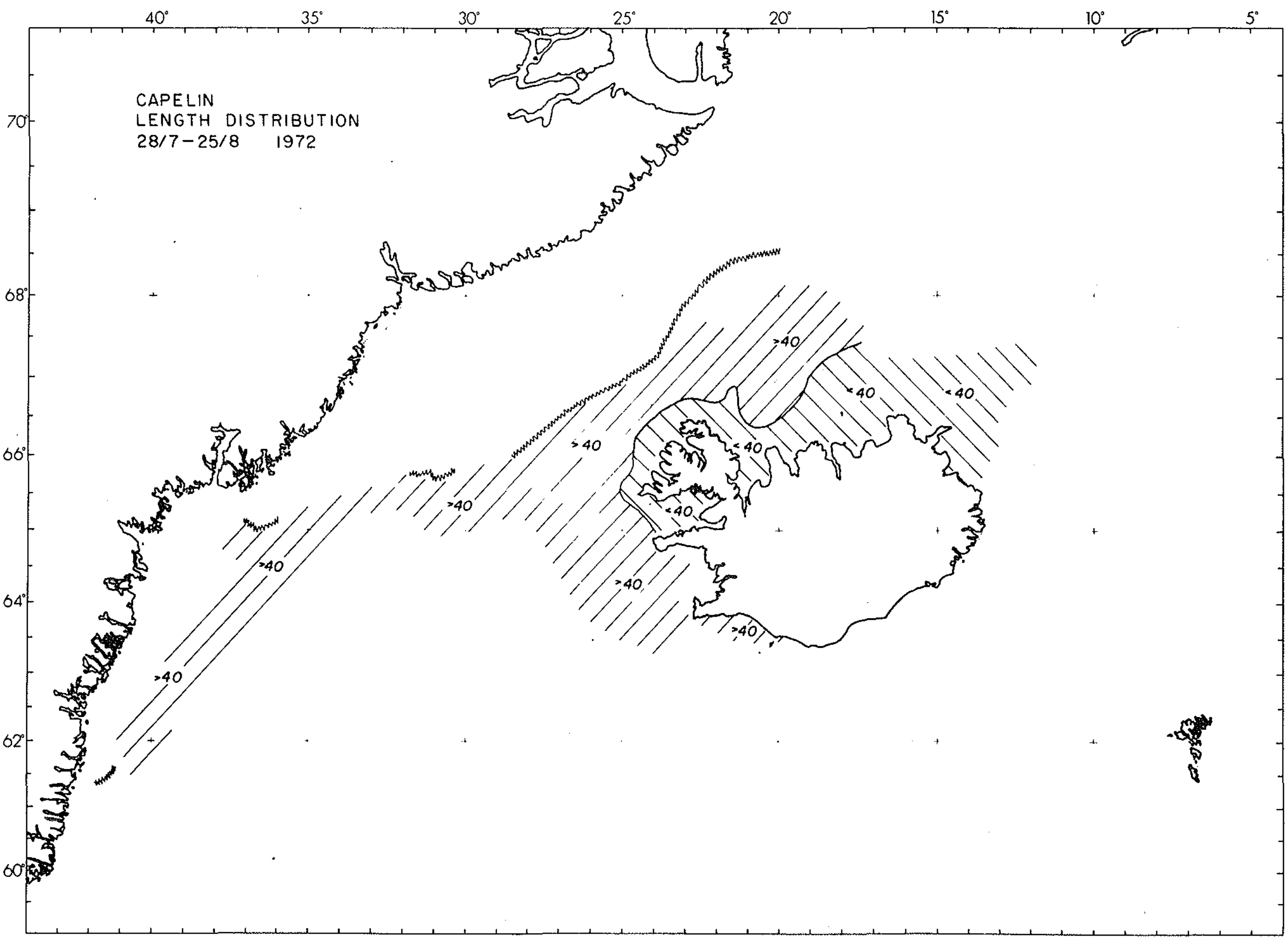

Figure 28. Length distribution of 0-group capelin 1972.

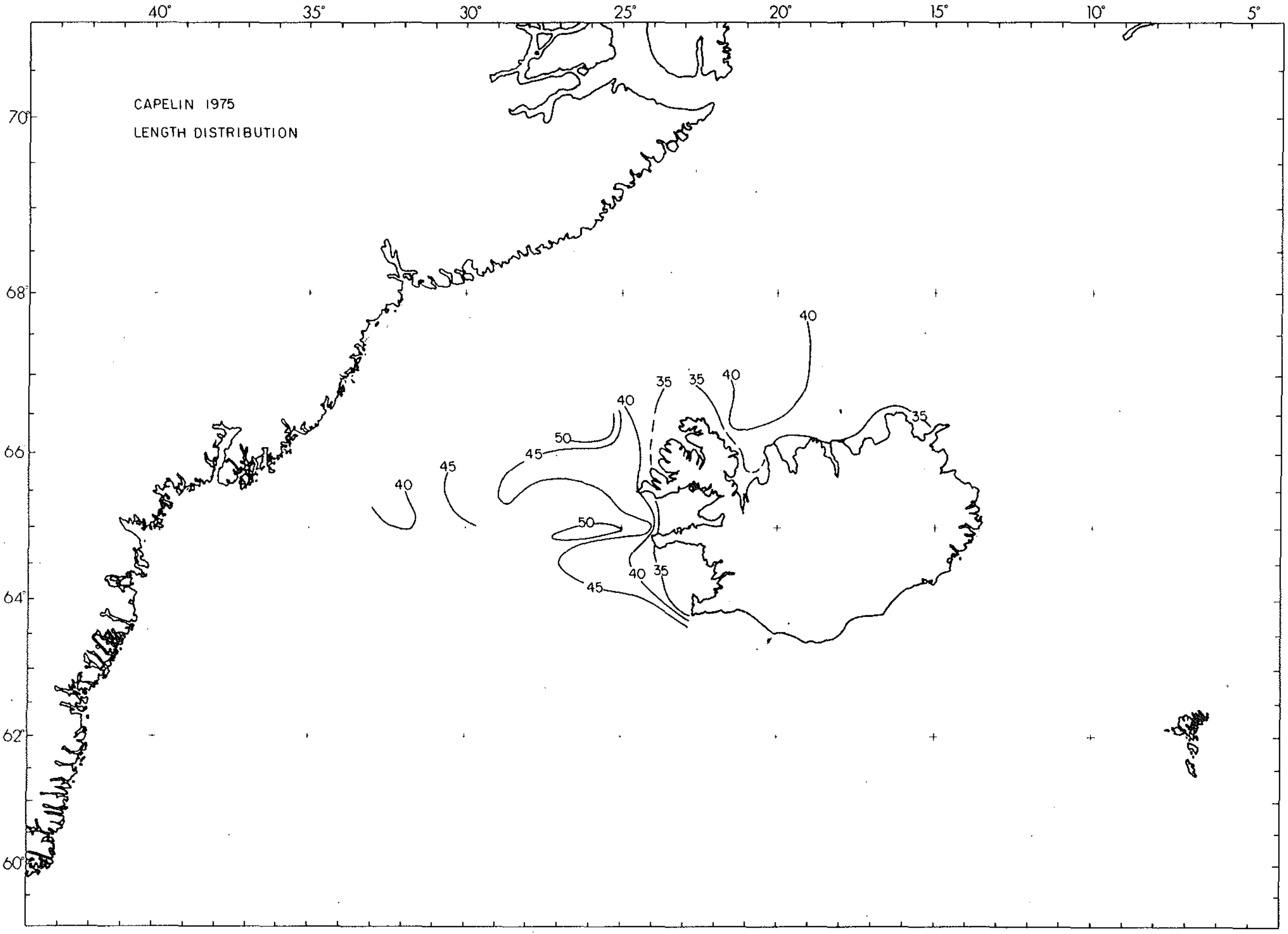

Figure 29. Length distribution of 0-group capelin 1975.

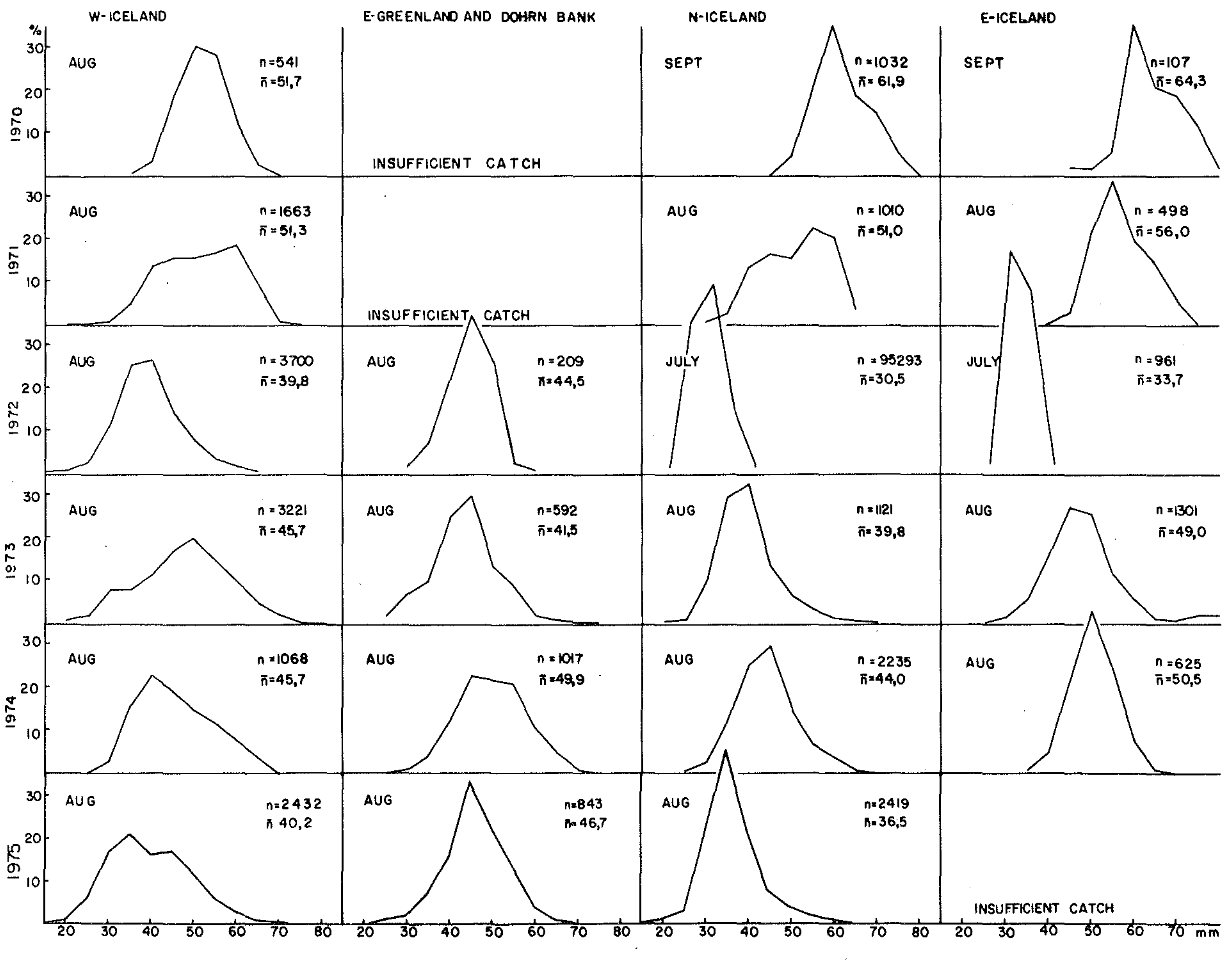

Figure 30. Length distribution by area of 0-group capelin 1970-75.

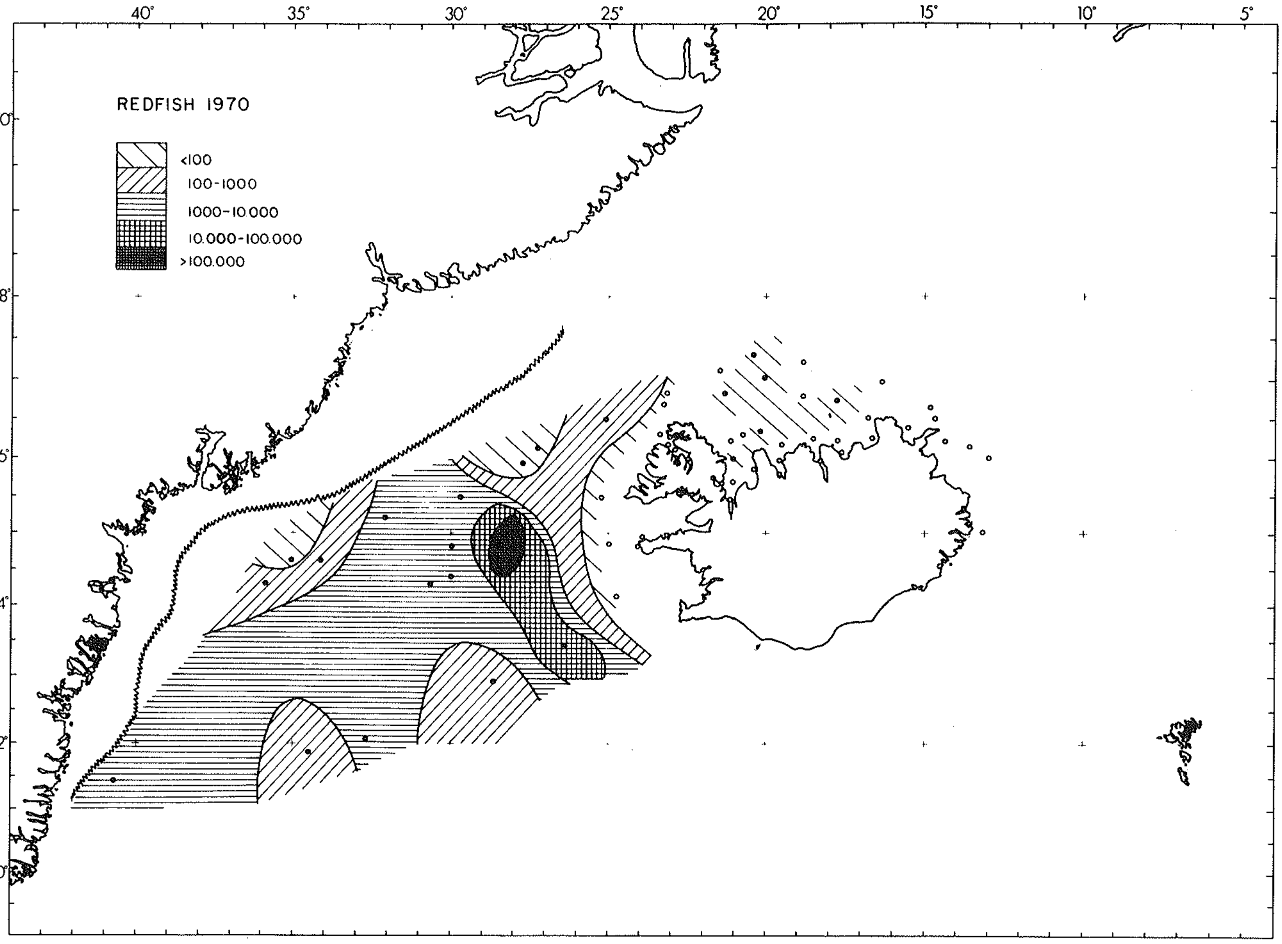

Figure 31. Quantitative distribution of 0-group redfish 1970 (Number of fish per 1 nautical mile trawled).

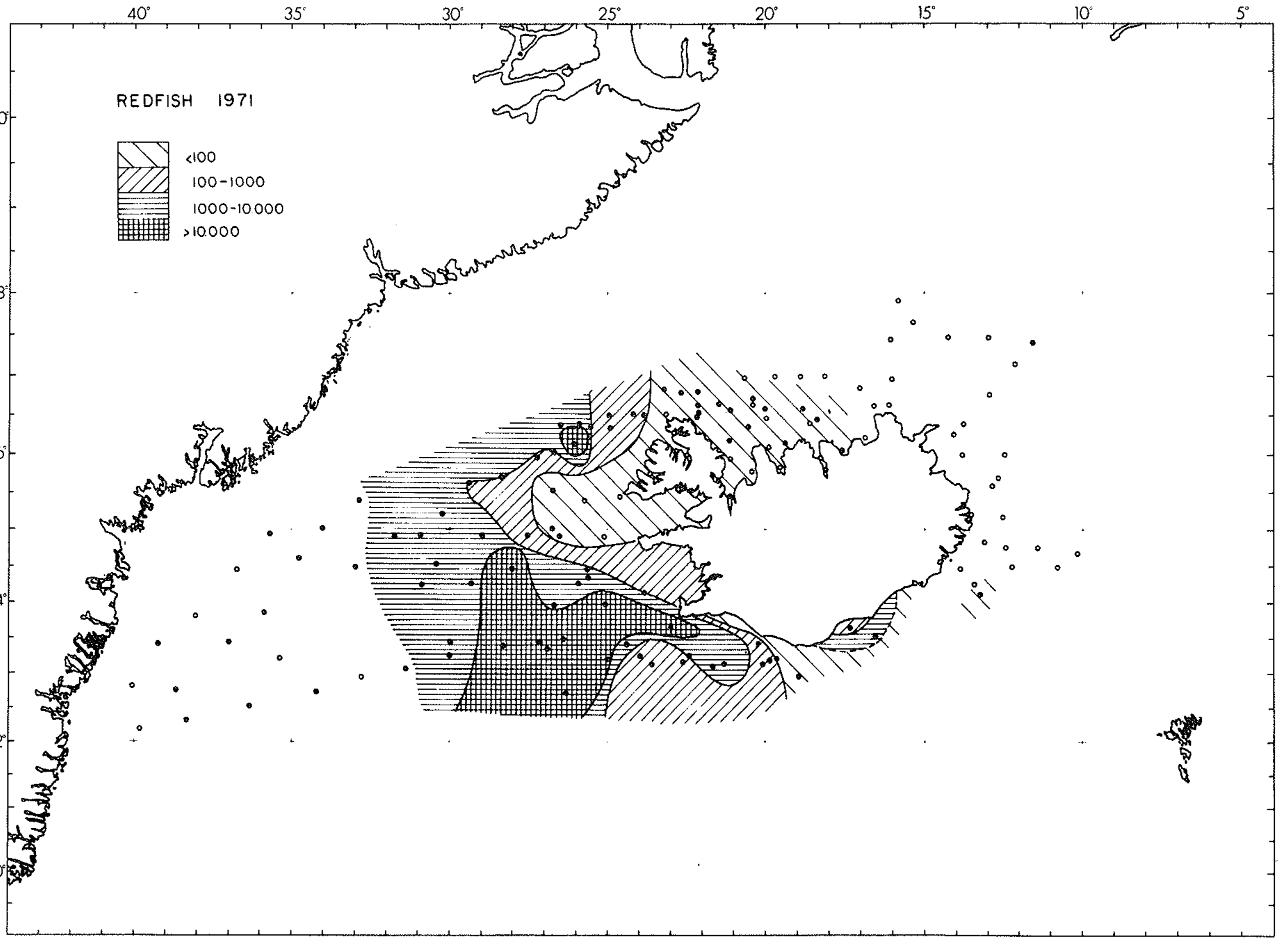

Figure 32. Quantitative distribution of 0-group redfish 1971 (Number of fish per 1 nautical mile trawled).

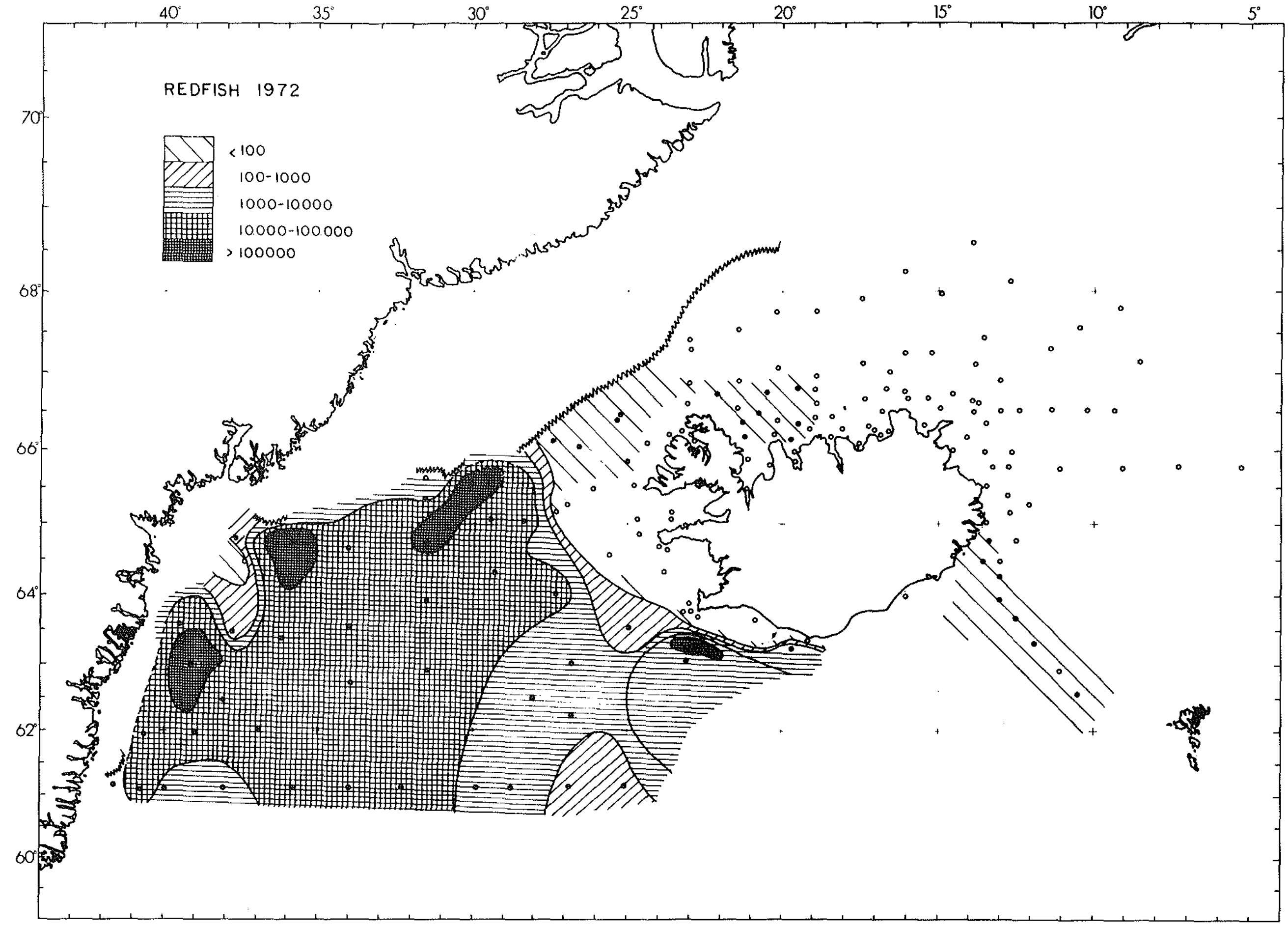

Figure 33. Quantitative distribution of O-group redfish 1972 (Number of fish per 1 nautical mile trawled).

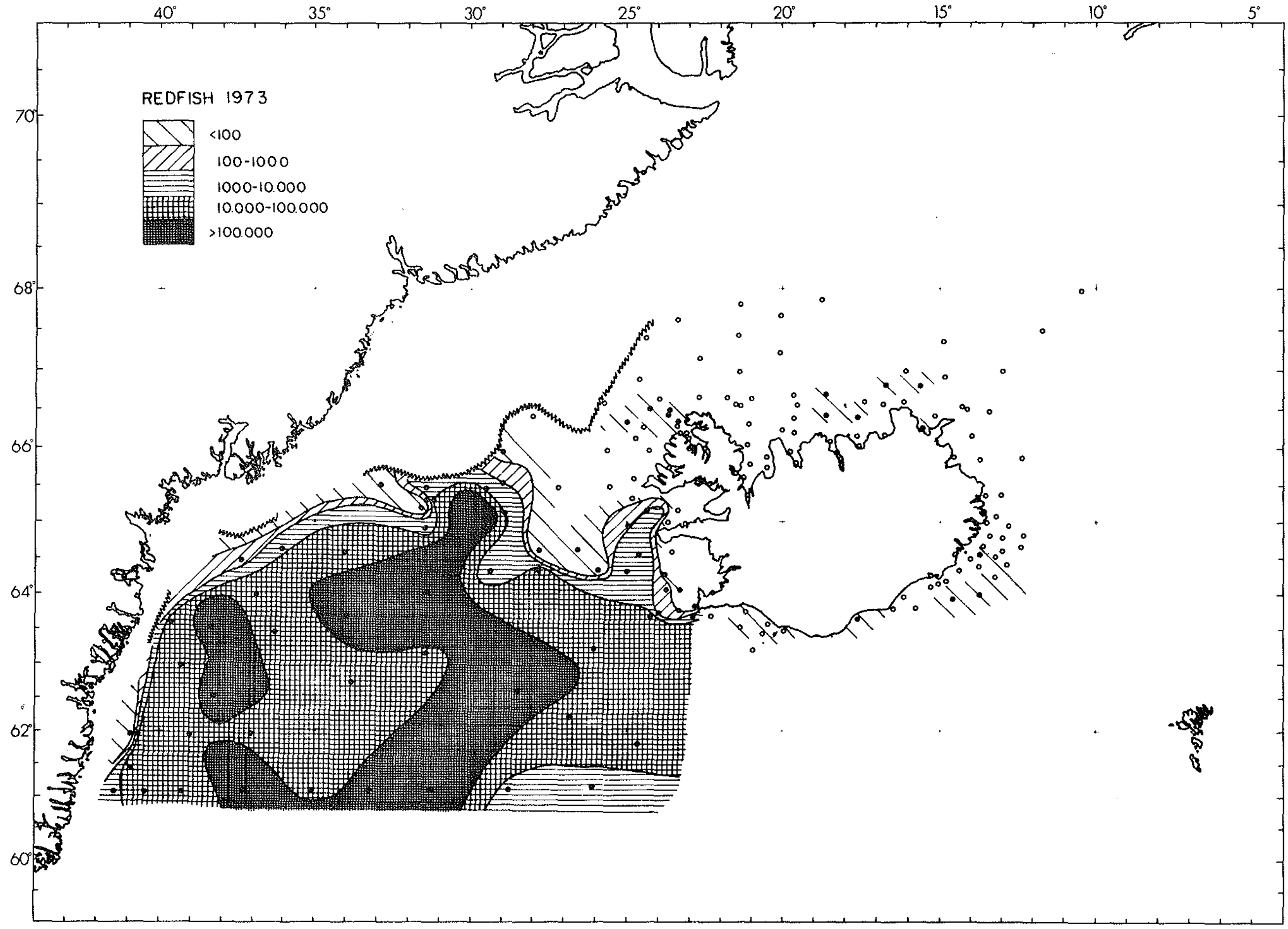

Figure 34. Quantitative distribution of O-group redfish 1973 (Number of fish per 1 nautical mile trawled).

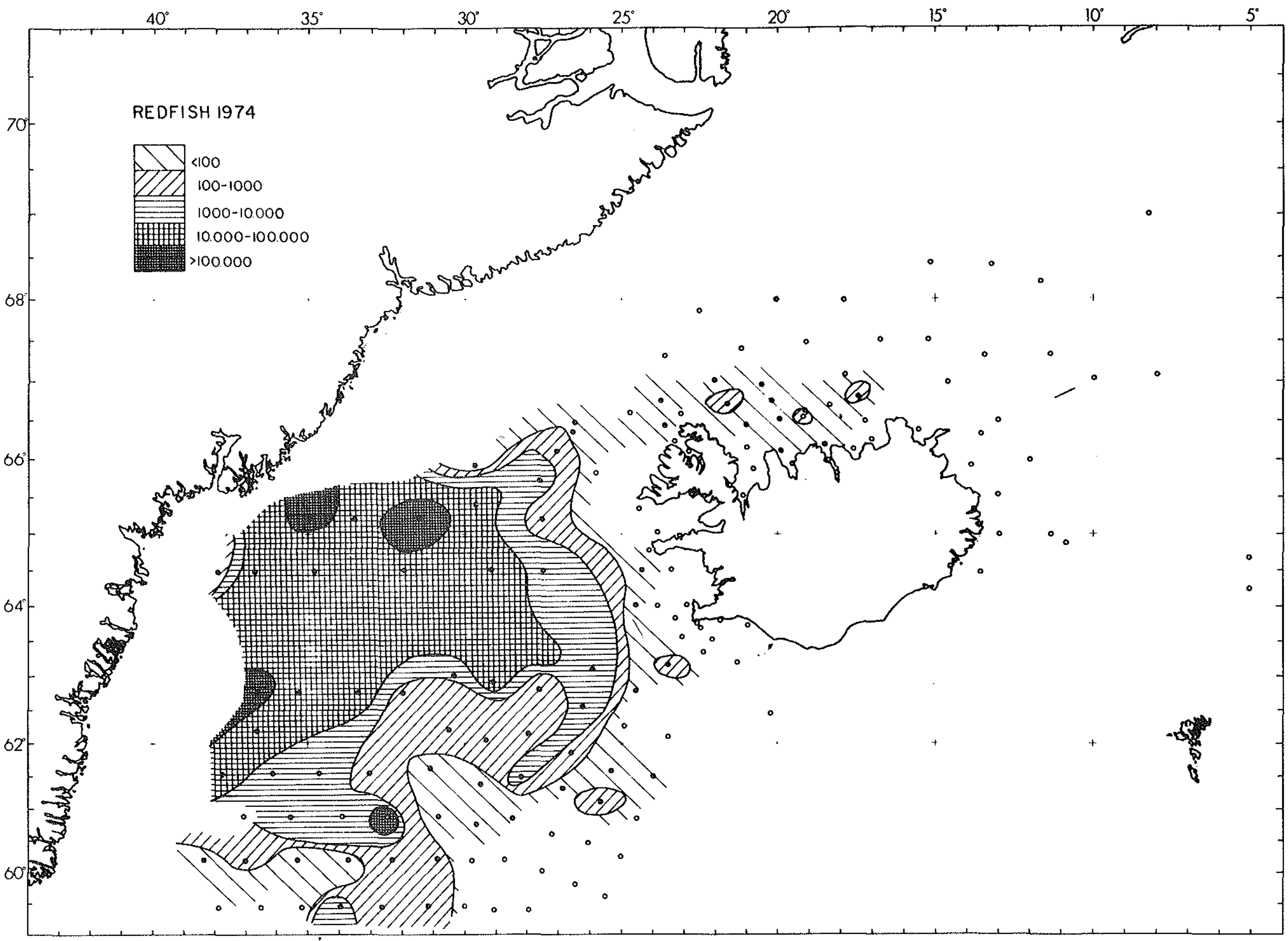

Figure 35. Quantitative distribution of 0-group redfish 1974 (Number of fish per 1 nautical mile trawled).

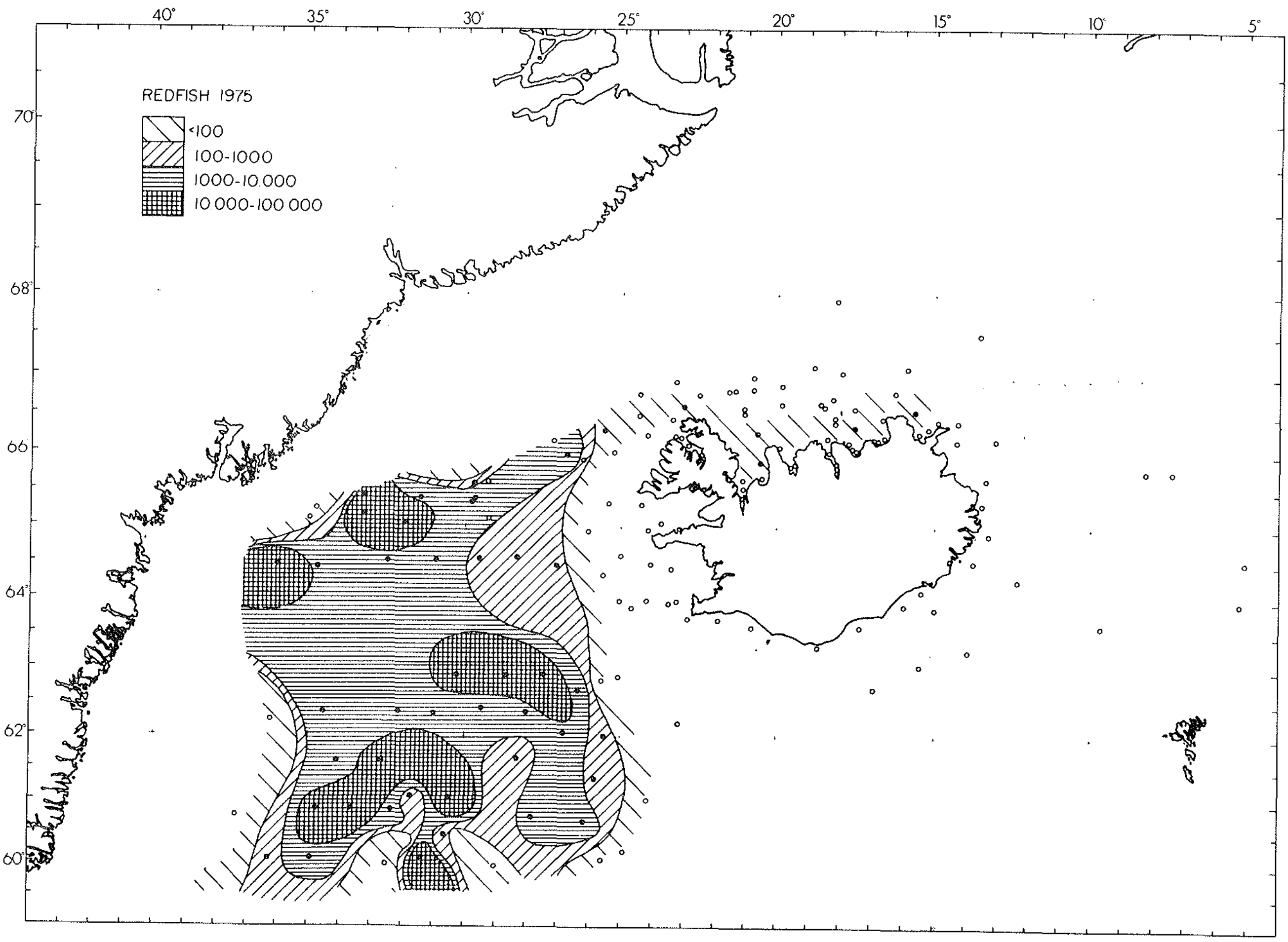

Figure 36. Quantitative distribution of 0-group redfish 1975 (Number of fish per 1 nautical mile trawled).

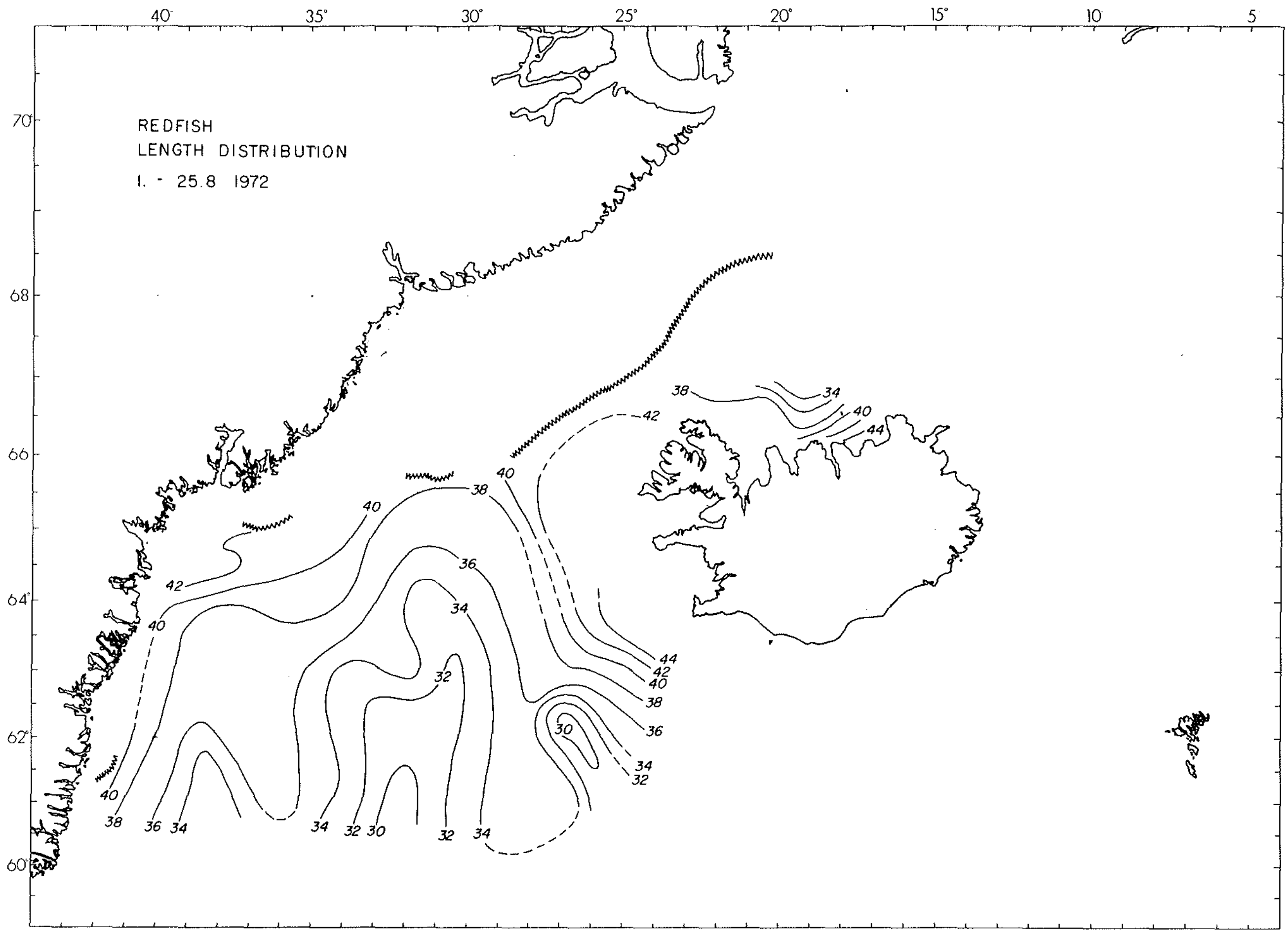

Figure 37. Length distribution of 0-group redfish 1972.

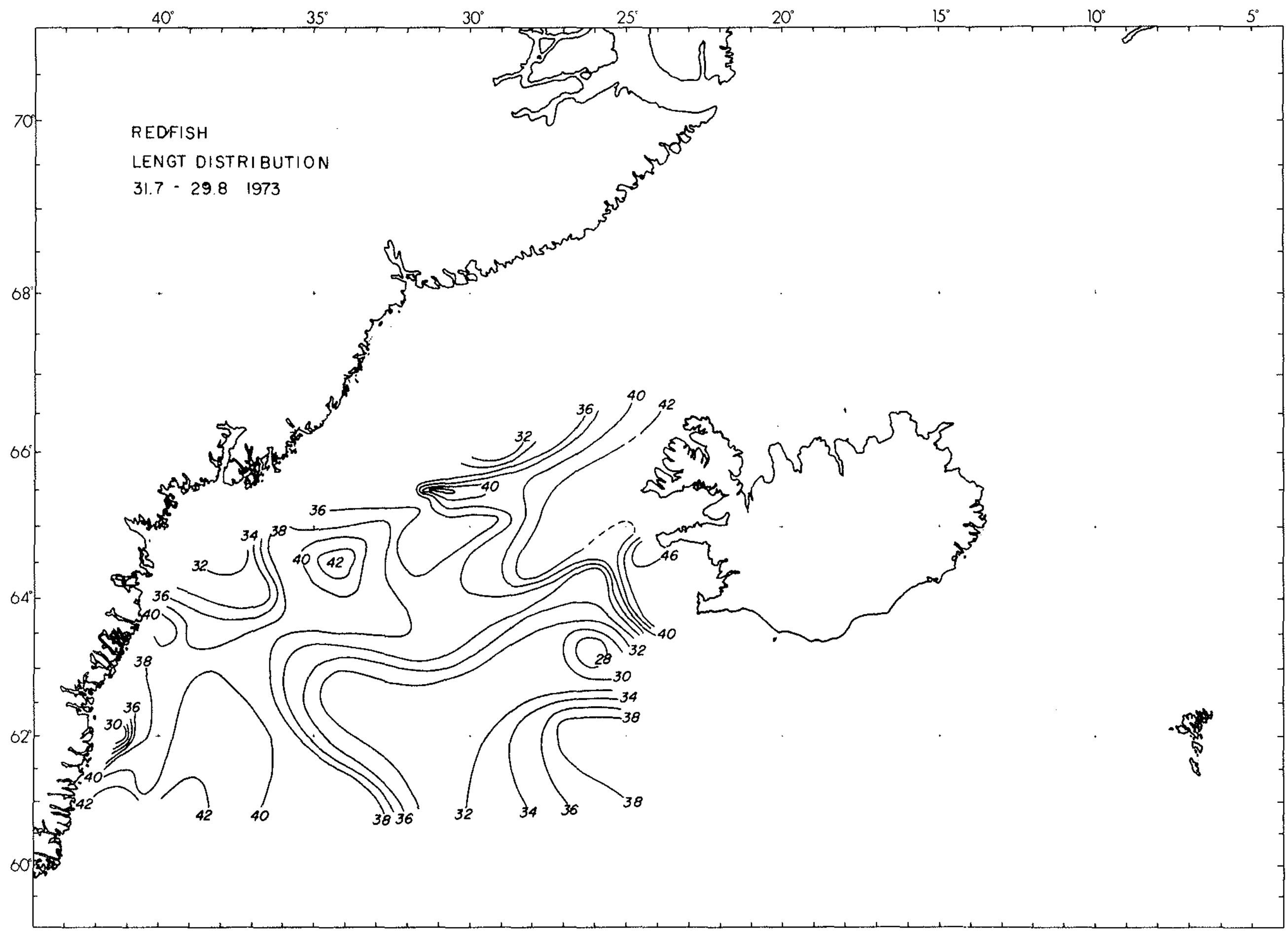

Figure 38. Length distribution of 0-group redfish 1973.

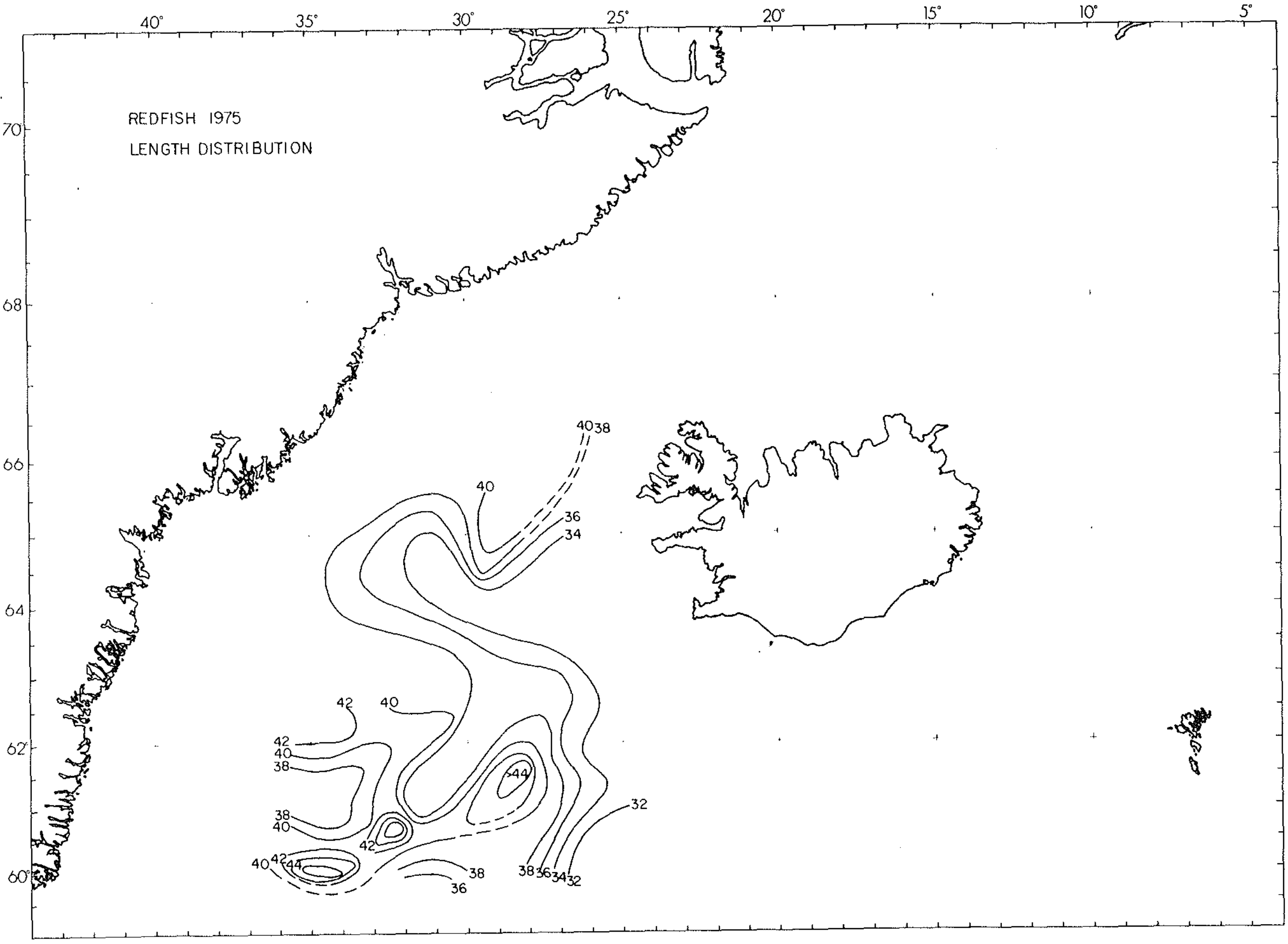

Figure 39. Length distribution of 0-group redfish 1975.

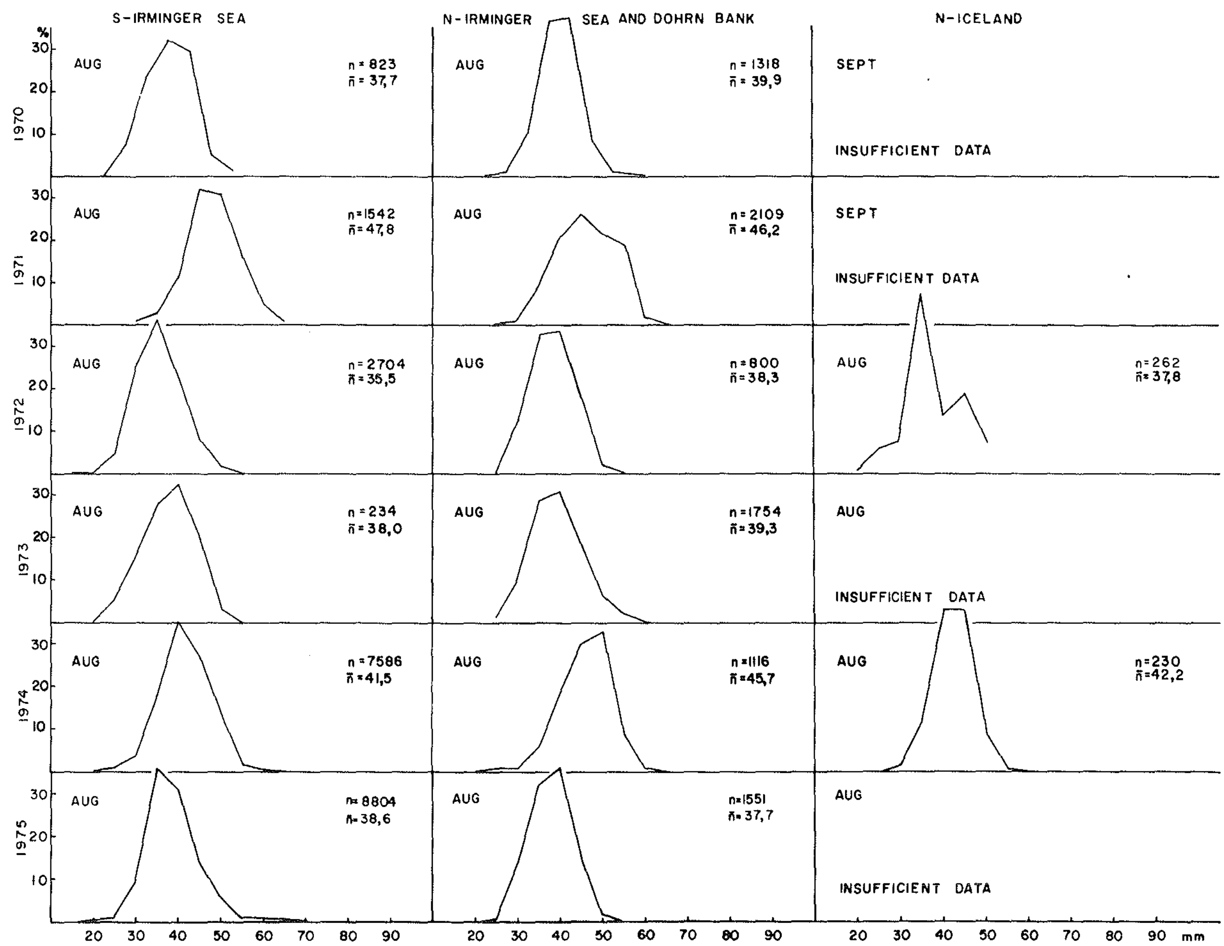

Figure 40. Length distribution by area of 0-group redfish 1970-75.