REPORT ON SURVEYS OF THE DISTRIBUTION AND MIGRATIONS OF THE NORWEGIAN SPRING SPAWNING HERRING AND THE ENVIRONMENT OF THE NORWEGIAN SEA AND ADJACENT WATERS IN LATE WINTER, SPRING AND SUMMER OF 1996

1. INTRODUCTION

In 1994 representatives of the marine research institutes in the Faroes, Iceland, Norway and Russia initiated a co-ordination of surveys of the distribution and migrations of the Norwegian spring spawning herring and the environmental conditions of the Norwegian Sea and adjacent waters. In the period March-August 1995 research vessels from these institutes surveyed the area in accordance with a common plan which previously had been agreed upon (*Anon.* 1995a). The results were evaluated during a meeting in September 1995 where it was decided to continue the investigations in 1996 (*Anon.* 1995b).

A planning meeting for the 1996 surveys was held in Tórshavn 13-14 February 1996, and surveys by several research vessels from the Faroes, Iceland, Norway and Russia during spring and summer 1996 were co-ordinated and executed according to the procedures and techniques outlined by the Tórshavn planning group (*Anon.* 1996). At the Tórshavn meeting it was further decided to evaluate the results from the joint surveys at a meeting in Reykjavík in September 1996. The meeting was held in Reykjavík 24-26 September 1996.

2. PARTICIPANTS

Name	Address	Telephone	Telefax	e-mail
Hjalti í Jákupsstovu	Fiskirannsóknarstovan P.O.Box 3051 FR-110 Tórshavn Faroe Islands	+298 15092	+298 18264	hjaltij@frs.fo
Ingolf Røttingen	Havforskningsinstituttet P.O.Box 1870 N-5024 Bergen Norway	+47 55238404	+47 55238387	ingolf.roettingen @imr.no
Johan Blindheim	As above	+47 55238404	+47 55238387	johan.blindheim @imr.no
Ole Arve Misund	As above	+47 55238404	+47 55238387	ole.misund @imr.no
Aleksandr Krysov	PINRO 6 Knipovich Street 183763 Murmansk Russia	+47 5129510518	+47 5129510518	
Sergei Belikov	As above	+47 5129510518	+47 5129510518	
Hjálmar Vilhjálmsson	Hafrannsóknastofnunin P.O. Box 1390 IS-121 Reykjavík Iceland	+354 5520240	+354 5623790	hjalmar@hafro.is

Jón Jónsson	As above	+354 5520240	+354 5623790	jonj@hafro.is
Sveinn Sveinbjörnsson	As above	+354 5520240	+354 5623790	sveinn@hafro.is
Svend-Aage Malmberg	As above	+354 5520240	+354 5623790	svam@hafro.is
Ólafur S. Ástthórsson	As above	+354 5520240		oliast@hafro.is

3. SURVEYS

The following surveys were carried out:

Country	Vessel	Period	Survey grid
N1	"Michael Sars"	17.02 - 24.03	Fig. 3.1
N2	"G.O. Sars"	21.03 - 01.04	Fig. 3.2
N3	"G.O.Sars"	03.04 - 18.04	Fig. 3.3
N4	"G.O.Sars"	29.04 - 28.05	Fig. 3.4
I1	"Árni Fri›riksson"	03.05 - 29.05	Fig. 3.5
F1	"Magnus Heinason"	03.05 - 21.05	Fig. 3.6
R1	"Fridtjof Nansen"	19.05 - 05.06	Fig. 3.7
I2	"Bjarni Sæmundsson"	21.05 - 11.06	Fig. 3.8
I3	"Árni Fri›riksson"	03.06 - 14.06	Fig. 3.9
R2	Fridtjof Nansen”	12.06 - 11.07	Fig. 3.10
I4	"Árni Fri›riksson"	08.07 - 15.07	Fig. 3.11
N5	"G.O. Sars"	19.07 - 15.08	Fig. 3.12
N6	"Johan Hjort"	20.07 - 05.08	Fig. 3.13

Reports on these surveys were presented at the meeting and furnished the basis of the present joint report.

4. HERRING DISTRIBUTION AND AGE COMPOSITION

4. 1. *Adult herring*

March

Spawning took place on the coastal banks off the west and northern coast of Norway from about 15 February and towards the end of March in the area between 59°N and 70°N.

Figure 4.1 shows the distribution of adult mature herring in the period 17 February-10 March as surveyed by R/V «Michael Sars». At this time very few herring were recorded

in the area west of Lofoten. The 1991 year class dominated in the spawning stock of 1996.

In the second part of the R/V «Michael Sars» survey, during 13 March-24 March, herring were also recorded west of the Lofoten area with patches of herring schools north to approximately 70°N. (Fig. 4.2). The herring concentrations in the Vestfjord consisted of immature herring of the 1992 year class, while maturing or spawning herring of the 1991 and 1992 year classes were recorded west of Lofoten.

In general, no major differences in spawning time or area were detected in 1996 as compared with 1995.

At the end of March herring were also recorded west of the coastal bank area. Figure 4.3 shows herring recordings west to 5°E. However, the western border of the distribution was not reached in the area north of 66°N. The 1991 and especially the 1992 year classes (some individuals of the latter year class were immature) dominated in the trawl catches, but specimens of the 1983 year class occurred in some samples. However, at 65°30'N the western border was recorded and there was no herring west of 5°E. In the area west and south of 66°30'N, 05°00'E no herring were recorded (Fig. 4.3). This is in contrast to the 1995 situation and indicates that the herring in 1996 may have taken a more northern feeding migration route.

Thus by the end of March the herring, including some immature individuals, had already migrated a considerable distance westward in the area north of 66°N, although the position of the western border is not known. However, south of 66°N, no herring were recorded west of 5°E.

April

In April 1996 the front of the feeding migration was mapped by R/V «G O Sars». Figure 4.4 indicates that the main herring distribution was located in the area between 67° and 69°N, east of 2°W. The herring were schooling at 300-400m depth during daytime. At night the herring ascended to the surface layers and occurred both in dense schools and in scattered shoals.

Four and five year old herring (1992 and 1991 year classes) in the size range of 24-31 cm dominated in the trawl catches in the investigated area. The 1992 year class represented 54% of the total catch by number, whereas the 1991 year class represented 32%. The 1983 year class accounted for only 3% of the total catch, occurring at 8 trawl stations. However, in one single sample some 17% of the individuals consisted of the 1983 year class. In April most of the herring had some food in their stomachs.

No herring was recorded south of 66°N in April. North of 67°40'N the main swimming direction was towards east, while the main swimming direction south of this latitude was southward.

May

Herring were recorded over wide areas in the Norwegian Sea in May (Fig. 4.5). The southern border was at about 62°30'N in the EU-zone and at about 63°N in the Faroe zone. The western border followed the cold front between about 8•W at 64°N to 3°W at 70°N, the most northern and eastern concentrations were found at about 71°N, 16°E.

The herring occurred in two distinct categories of distribution according to size:

1) Young herring, dominated by the 1991 and 1992 year classes were distributed in a wide area off the Norwegian coast, into the eastern regions of the international area of the central Norwegian Sea and south into the Faroe and EU-zones. Within this part of the distribution area the herring occurred mostly in small schools or scattered in layers at about 25-100 m depth. Off the coast of northern Norway the herring occurred in distinct schools at a depth of about 100-250 m.

2) In the easternmost part of the Icelandic zone, the western regions of the international waters and up in the Jan Mayen zone, the herring occurred in large schools, mostly at depths between 250 and 400 m. However, there were also recordings of large schools from the surface to about 200 m depth in the Jan Mayen zone. The herring in this western part of the distribution area were somewhat larger with contributions of up to 45% by the 1983 year class in numbers in one catch in the Jan Mayan zone. Nevertheless, the 1991 and 1992 year classes also dominated in this part of the distribution area while the 1983 year class contributed to about 20 % of the total biomass.

The size distribution of herring during May is shown in Figure 4.6.

Twenty one schools were tracked for up to 30 min. during the May cruise by R/V «G.O. Sars». These schools were located in all parts of the survey area, and occurred at depths from about 20 m to about 300 m. The swimming behaviour of the schools varied considerably. The migration direction varied from 47• to 285• and the migration speed from 0.07 m s^{-1} up to 1.28 m s^{-1} as shown in Figure 4.7a. South of 66•N there did not seem to be any apparent clear tendencies in the migration behaviour of the schools. Even schools recorded close to each other were swimming in opposite directions, one east and the other west. North of 66•N most schools were heading in an easterly direction. This may indicate that the easterly heading schools north of 66^{o} had begun migrating back to the Norwegian coast, while the schools south of 66• north were swimming around in various directions searching for prey. Three of the four schools recorded off northern Norway (position 71•N, 15•40'E) were heading in a southerly direction, while one was heading directly west at a speed of 1.28 m s^{-1}. The schools occurred at about 250 m depth and seemed to be heading out of the western Barents Sea and into the eastern Norwegian Sea.

Five schools were tracked for one hour by «R/V Magnus Heinason» during the May cruise in the Faroe zone. Four of the schools were heading North, one went southwest (Fig. 4.7b).

<u>June</u>
In June herring were recorded in two main areas in the Norwegian Sea as shown on a distribution map in Figure 4.8, based on surveys by R/V «Árni Fri›riksson» and R/V «Fridtjof Nansen».

Between 69•N and the polar front near 69•30'N there were large concentrations of herring from just east of 07•W to 04•W. In this area there was a predomination of large

herring of the 1983 year class (43%), as well as the 1990 and 1991 year classes (34%). East of 4•W, large amounts of herring were probably distributed farther to the east and north in the Jan Mayen zone and therefore not recorded by the surveys.

No herring were found in the area between 66•N and 68•N and only very scattered recordings were observed between 66•N and 65•N east of 05•W.

In the area between 64•N and 65•N small but often quite dense schools were recorded. The largest numbers were located near 64•15'N, between 03•45'W and 05•W. The average size of the herring in this area was about 28 cm, consisting mainly of the 1990 (56%) and 1989 (34%) year classes.

The southern limit of herring distribution in the western Norwegian Sea was not recorded by the June surveys. The Russian survey did not locate any herring in the southeastern part of the Norwegian Sea in June.

July

A survey by R/V «Árni Fri›riksson» of the western part of the Norwegian Sea, between 65•N and 67•30'N from 5-6•W to 10•W, during 8-15 July failed to locate any herring.

On the other hand, in early July a Russian survey by R/V «Fridtjof Nansen» recorded small schools of varying density, consisting of young immature herring with a mean length of 24-25 cm and belonging mainly to the 1992 year class (64%), in the area between 67•30'N and 69•20' from just off Lofoten west to 5-6•W. In addition, some trawl catches of individual young herring were taken during the latter survey in the central Norwegian Sea. The herring distribution, recorded by R/V «Fridtjof Nansen» in July, is shown in Figure 4.9.

Mid-July/August

Figure 4.10 shows the herring distribution recorded in the latter half of July and in August 1996. The main concentrations were located west of Lofoten. Younger herring of age groups 3-5 dominated in trawl samples taken in this area.

North of 70•N, older herring (1990, 1989,1983 year classes) dominated in the samples. However, there were also concentrations of herring farther to the west of Bear Island, where the catches constituted mostly of the oldest herring of the 1983 year class. In the area between 0• and 5•E the northern boundary of the herring distribution was not recorded.

During this period, the herring occurred either in the immediate surface layer, where they were detected by the sonar only, or at a depth of about 20 m where they were recorded by the echo sounder as a thin a "knotted" layer. The sonar recordings were also of small schools of herring only.

4.2. Juvenile herring

After hatching in spring the herring larvae drift northwards along the coast of Norway. Fig 4.11 gives the distribution of herring larvae in April 1996. Figure 4.12 shows the distribution of 0-group herring in 1996.

Herring younger than 3 years are generally distributed in the Barents Sea and in the fjords of North Norway. In years with strong year classes the larger part of these herring will be located in the Barents Sea. At about the age of 3 years (2-4 years), the herring will migrate out into the Norwegian Sea, and remain there for 1-2 years while reaching maturity.

The distribution area of immature herring (1-4 years old) in the Barents Sea was surveyed by the Russian R/V «Fritjof Nansen» in May and the Norwegian R/V «G O Sars» in June. The recorded distribution of herring from these surveys are given in Figures 4.13 and 4.14. The recorded abundance of immature herring (year classes 1993-1995) in 1996 (100 -300 thousand tonnes) is very low compared to 1992-1994 when the year classes 1991 and 1992 were present in the area. The present low estimate indicates a minor migration into the Norwegian Sea and lower recruitment to the spawning stock in the coming years.

Considerable amounts of immature herring wintered in the inner part of Vestfjorden in 1995/96. By the end of March these herring had migrated to the outer part of the Vestfjorden (Fig. 4.2). In the summer of 1996, individuals of immature herring were found over large areas in the Norwegian Sea in April-June.

5. ABUNDANCE ESTIMATES

During May three vessels (surveys N4, I1 and F1) co-operated to obtain an acoustic assessment of the total abundance of adult herring in the Norwegian Sea and adjacent waters. The cruise tracks during these surveys are shown in Figure 6.1. At the same time, a Russian survey (R1) assessed the abundance of juvenile herring in the southern Barents Sea (Fig. 3.7)

Herring were distributed over most of the Norwegian Sea in May. As shown in Figure 4.5, the highest densities were recorded in the western and eastern parts of the survey area with lesser concentrations in the central Norwegian Sea and in the vicinity of the shelf off western Norway. The largest herring occupied the western- and northernmost parts of the distribution area, while the smaller and younger fish occurred in the central and eastern Norwegian Sea as well as north of the Faroes (Fig. 4.6).

During the joint survey, the younger herring east of the 0• meridian were mostly recorded in scattering layers or loose, small schools at a depth of about 50-150 m and did not seem to be migrating in any particular direction. In the area north of the Faroes, south of about 65•N, there were numerous small schools registered by sonar in the near-surface layer. Almost all of these herring were outside of echo sounder transducer range. Based on school counts by the use of sonar, some 240 000 schools were estimated to be present in the immediate surface layer in this area (Fig. 5.2). No attempt was made to account for these herring and the survey must, therefore, have underestimated the abundance in the area south of 65•N, west of 2•W.

Otherwise, the herring in the western Norwegian Sea generally occurred as schools of varying density at a depth of about 50-300 m, migrating north and northeast. Although the survey progressed in the same direction, the northward migration of the stock at the time was too slow to have biased the estimate in practical terms.

In general, it is felt that there were good conditions for acoustic assessment of herring by the echo sounder/integration technique in May 1996. For the reasons stated above it is likely that the younger part of the stock was underestimated but otherwise the present stock estimate should represent a fairly reliable measure of adult stock abundance.

The following table gives the results of the joint stock estimate by number at age in the various areas. A comparison between the first and last lines of the table shows that the recorded stock abundance does not deviate significantly from the latest assessment made by the NP&BW Working Group (*Anon.* 1996).

The area west of longitude 0^0, north of 64• 30'N, and south of the Jan Mayen zone was surveyed partly by the Faroese vessel, and completely by the Icelandic and Norwegian vessels. A combined abundance estimate, based on recordings along the Faroese, Icelandic and Norwegian cruise tracks together, indicates 20.2 billion herring in this area. On their own, the Norwegian recordings alone indicate 22.6 billion herring in the same area. These findings show consistency of recordings by the participating vessels and lend support the above contention of suitable conditions for acoustic assessment of herring in most of the western part of the survey area as well as east of the zero meridian.

The total abundance of herring in the Norwegian Sea in May is estimated to be about 47 billion individuals. The inclusion of Russian recordings from the Barents Sea, therefore indicates a total biomass of Norwegian spring spawning herring, 3 years and older, of 50.5 billion individuals in May 1996.

ESTIMATE	AGE 3	4	5	6	7	8	9	10	11	12	13	SUM
ICES NP&BW WG	5600	20986	16291	4988	2992	1020	54	55	243	288	3173	55690
Norway, May, total Norwegian Sea	1421	19584	11939	4793	2032	424	14	7	145		3134	43493
Faroes, May, south of 64.5 N	34	1974	1260	123	10				10			3404
Russia, May, Barents Sea	2659	903	45									3607
Total, Norwegian Sea (Faroes, Iceland, Norway)	1455	21558	13199	4916	2042	424	14	7	155		3134	46897
Total, Norwegian and Barents Seas (Faroes, Iceland, Norway, Russia)	4114	22461	13244	4916	2045	424	14	7	155		3134	50504

6. HYDROGRAPHIC CONDITIONS

The hydrographic situation in May/June is depicted in Figures 6.1, 6.2 and 6.3 which show the temperature distribution at 50, 100 and 400 m depth, respectively. These Figures are based on Faroese, Icelandic and Norwegian cruises (see Table, section 3).

Similarly, the situation in June/July, based on a Russian survey, is shown in Figures 6.4, 6.5, 6.6 and 6.7, representing the temperature distribution at 50, 100, 200 and 500 m depth respectively.

In general, both periods are characterized by a warming trend since the extremely cold year 1995. As in 1995, the eastern boundary of the East Icelandic Current was located at about 7•W, whereas the temperature in the uppermost 200 m was about 1•C higher this year than in 1995. Furthermore, the cold water tongue did not extend as far south this year and sub-zero temperatures were not found in the upper 100 m.The salinities in the surface layer were, however, still relatively low (below 34.7) in the core of the East Icelandic Current. To the northeast of the Faroes the northern boundary of the warm Atlantic water of the North Faroese Current reached some 60 naut. miles farther north than in 1995. Further east, in the central Norwegian Sea, the differences between 1995 and 1996 were smaller.

The hydrographic changes observed in May/June 1996, relative to 1995, were confirmed by observations during the Russian survey in June/July. The mean temperature in the upper 200 m of the East Icelandic Current was about 2•C higher than in 1995. This is 0.8•C above the long-term mean (1958-1995). In the central Norwegian Sea the Atlantic water was in general 0.4•C warmer than the long-term mean while the difference from the cold previous year of 1995 was 1.4•C.

Except for the seasonal warming of the surface layer, the hydrographic conditions later in the summer were not much different from those observed in May, June and July.

7. ZOOPLANKTON BIOMASS AND DISTRIBUTION

Figure 7.1. shows the distribution of zooplankton at 50-0 m (mg dry wt/m^3) in May as based on data from G.O. Sars and Arni Fri›riksson. The highest zooplankton biomass (> 1000 mg dry wt/m^3) was generally observed in the western, northern and northeastern part of the survey area. The lowest biomass, however, was observed in the southern and middle part of the area i.e. the Atlantic water where the herring had apparently migrated across or was encountered in greatest densities during the survey.

It should be noted regarding the combined distribution map in Figure 7.1. that the zooplankton sampling gears and the methods of sampling used on board G.O. Sars and Árni Fri›riksson were not the same and therefore the data collected may not be entirely comparable. On the basis of different sampling procedures one might expect the MOCNESS sampler hauled obliquely from G.O. Sars to catch more of the larger and faster swimming animals than the WP-2 net operated only vertically on board Árni Fri›riksson. This might partly explain why the very highest densities (> 1000 mg dry wt/m^3) were to a large extent confined to the north and northeastern part of the survey area covered by the G.O.Sars. On the other hand large fast swimming zooplankton species (e.g. euphausiids) are usually confined to depths >50 m showed in Figure 7.1 and therefore the different nets may have been catching the zooplankton in the near surface layer to the same extent. If that is the case, Figure 7.1 is showing actual differences in the zooplankton distribution in the area.

The Russian investigations shown in Figure 7.2 were undertaken in June-July. The Figure shows wet weight and the shading has not been quantified/graded. Nevertheless it can be seen that somewhat similar to the observations in May, the greatest zooplankton biomass observed in the northernmost part of the survey area 66-68°N, 2-4°E. High densities of zooplankton were also observed to the east of the Faroes, an area which was not covered in May.

8. DISCUSSION

The main elements of the winter distribution, spawning migration and spawning areas were comparable to 1995.

The older parts of the adult population (year classes 1983 and 1988-1990) have, together with minor concentrations of the 1991 year class, by and large retained the elements of the feeding migration described in last year's report (*Anon.* 1995). However, the clockwise feeding migration of these herring seems to have followed a more northerly route in 1996 as compared to 1995. Thus, in 1996 the southern limit of this migration seems to be about 65•N with a northern limit at about 75•N. This is in accordance with observed changes in the hydrography of the southern Norwegian Sea during the intervening period. The western border seems to be the same in 1996 and 1995 and was in both years demarked by the cold, low salinity waters of the eastern edge of the East Icelandic Current. A generalized map of the migrations of the older components of the adult stock is shown in Figure 8.1.

The younger part of the adult population (mainly the 1991 and 1992 year classes) seem to have extended their migrations as compared with 1995. In that year, these herring fed outside the coastal bank area off Norway throughout the summer. In 1996, after

spawning for the first time, these year classes seem to have executed a rapid migration north and west into the Norwegian Sea.

However, in late April 1996 this part of the population appears to have split into two components, one of which seems to have begun a return migration towards the coastal banks of Lofoten already in late April - early May where the herring seem to have arrived in June.

The other component migrated south and west into Faroese waters. The latest recording of part of the stock was obtained in the period 3-14 June, when it was located between 64° and 66°N, around 5°W. After that, the movements of the west migrating component are more uncertain. However, it seems most likely that in late June and July these herring migrated to the northeast towards the coastal banks of Norway. The general migration patterns of the younger part of the herring population is shown in Figure 8.2.

The distribution of the 1996 summer fishery was, in addition to the migrations and behaviour of the herring, constrained by a number of factors of national character. Examples of these are accessibility to exclusive economic zones, distances to markets and prices. Any interpretation of relations between movements of fishing fleets and herring migrations should take account of these factors.

Because the Icelandic fleet could fish freely in most of the distribution area of the adult stock in May and June, its development may be said to reflect stock migrations and fish behaviour during that period. The fishery started on the 9th of May in the border area between the Faroe zone, the Icelandic zone and the international zone, clearly reflects the subsequent migrations and behaviour of the two components of the adult stock in that period. Thus, the fishery shifted to the north and northeast right up to the Jan Mayen zone as the fleet followed the large herring of the older component of the feeding. At the same time, however, a fishery was being conducted farther south in the southern part of the international zone and in the Faroe zone on younger and smaller herring.

Due to unsuitable behaviour of the large herring in the north making it difficult to catch, practically all the Icelandic fishing effort soon shifted south to the area between 65• 30‘ N and 68•N from 3• to 5•W.

In the period 1-10 June, the Icelandic fishing fleet had moved almost entirely to an area south of 65• 30’N into the Faroe zone and only few small catches were taken in the Jan Mayen area north of 68•30´N. By about mid-June the catch rate had diminished drastically, both in the Faroe zone and in the Jan Mayen area. This was due to the fact that by that time the herring had dispersed and were feeding in the surface layer in scattered concentrations. The last Icelandic catch was reported on 24 June.

The total Icelandic catch in May and June 1996 amounted to 164.805 tonnes.

The Faroese fishery started in late April in the northern part of the Faroe zone. During May and up to mid-June, the fishery gradually moved north into international waters and the Jan Mayen zone following the northward migration of the large herring. No Faroese

fishery took place on Norwegian spring spawning herring in the period mid-June to mid-August.

From the latter part of August onwards, Faroese vessels have fished herring migrating towards the wintering areas. This fishery has been conducted to the west of Vesterålen.

By the end of September Faroese vessels had fished a total of 45-50 000 tonnes, whereof 30 000 tonnes were taken in the Faroe zone and the remainder in the Norwegian zone.

The Norwegian fishery in the area was in the order of 20 thousand tonnes. The fishery moved northwards from approximately 66•N, 05•01W in May to 70•-71•N, 0• in July thus confirming the migration pattern described in Figure 8.1.

The Russian fishery started in the Norwegian zone in February and continued through the spawning season. The fishery was resumed in the second half of August and continued in September in the area between 67•00'N and 69•00'N off Lofoten in the Norwegian zone. Preliminary statistics indicate a total catch of over 20 000 tonnes in the latter area.

9. FUTURE WORK

In the opinion of the participants of the Reykjavík evaluation meeting, the 1996 joint surveys of herring distribution and environmental conditions in the Norwegian Sea have attained their objective according to the plans by the Tórshavn meeting. Such international co-operation can obviously be highly effective and is necessary for monitoring the highly dynamic biological processes in this large area. The meeting stresses the need for continuing and improving the co-operative research effort, already established in the Norwegian Sea and adjacent waters, in the years to come.

During the ICES Annual Meeting in Reykjavík in September 1996, the Pelagic Committee recommended that a planning group should meet (under the auspices of ICES) in Bergen, Norway (chairman: O. A. Misund, Norway) for two days in February 1997 to plan and co-ordinate surveys of pelagic fish and the environment in the Norwegian Sea in 1997.

10. CONCLUSION - TRENDS AND DEVELOPMENT

Hydrography

In 1996 the waters of the Norwegian Sea were characterized by a warming trend as compared to the extremely cold year of 1995.

Zooplankton

The distribution of zooplankton biomass in the Norwegian Sea in 1996 seems to be similar to that of 1995 with the possible exception that the biomass appeared to be lower in the southernmost part of the survey area. However, it must be pointed out that the coverage of this part of the area was less complete in 1996.

Herring

Immature herring
The abundance of immature herring in the Barents Sea has decreased since 1995 due to the emigration of the large 1991 and 1992 year classes. However, during the 0-group survey in August 1996, herring of the 1996 year class (0-group) were recorded in the Barents Sea and adjacent waters. The abundance of this year class is classified as average at the 0-group stage.

Adult herring
The older part of the adult herring (1983 and 1988-1990 year classes) seem to have followed a slightly more northern route in 1996 as compared to 1995. The youngest part of the adult herring (year classes 1991 and 1992) have migrated farther west and southwest than in 1995. However, these year classes have not yet established their final migration route.

In general, the stock of the Norwegian spring spawning herring has, therefore, until mid-August 1996 retained the main features of the 1995 migration pattern.

12. REFERENCES

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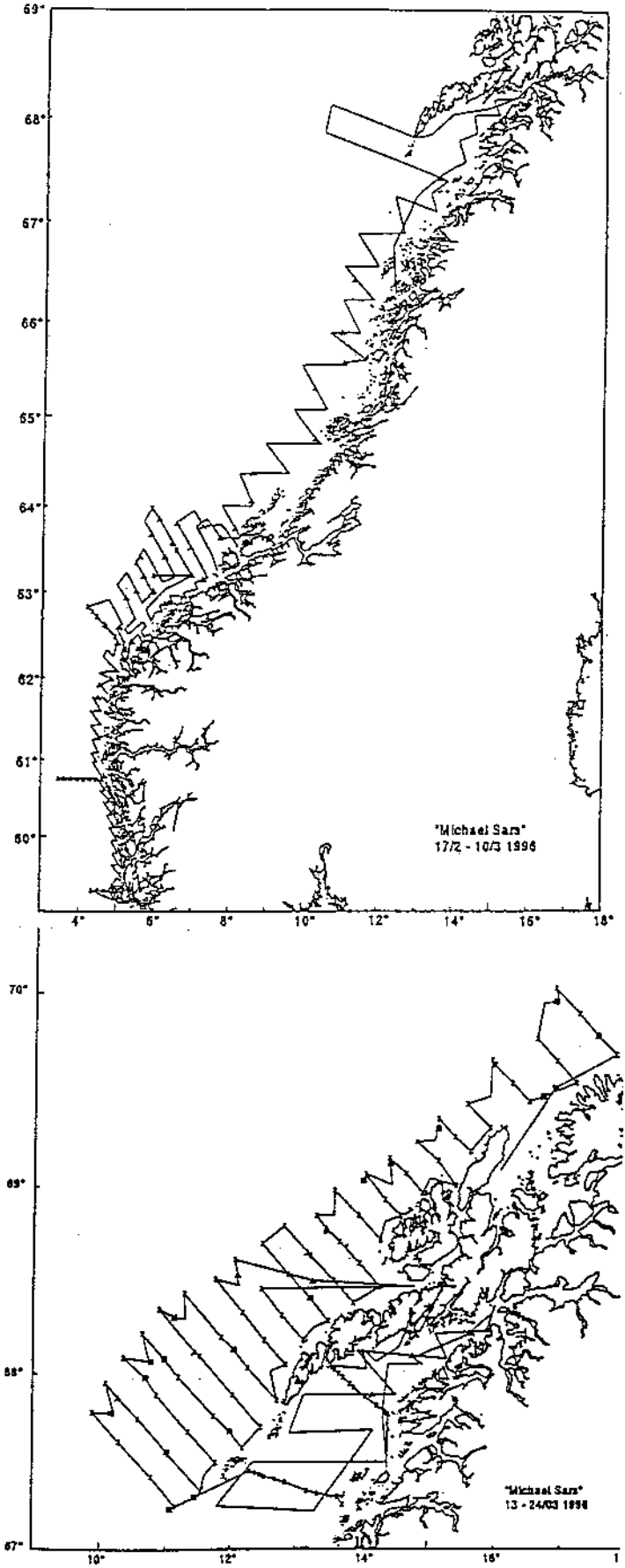

Fig. 2. Cruise tracks and stations.
Legend: Z - CTD sonde
▲ - Pelagic trawl station
■ - Bottom trawl station

Fig. 3.1. Cruise tracks and trawl stations, R/V Nichael Sars, 17/2-24/3 1996

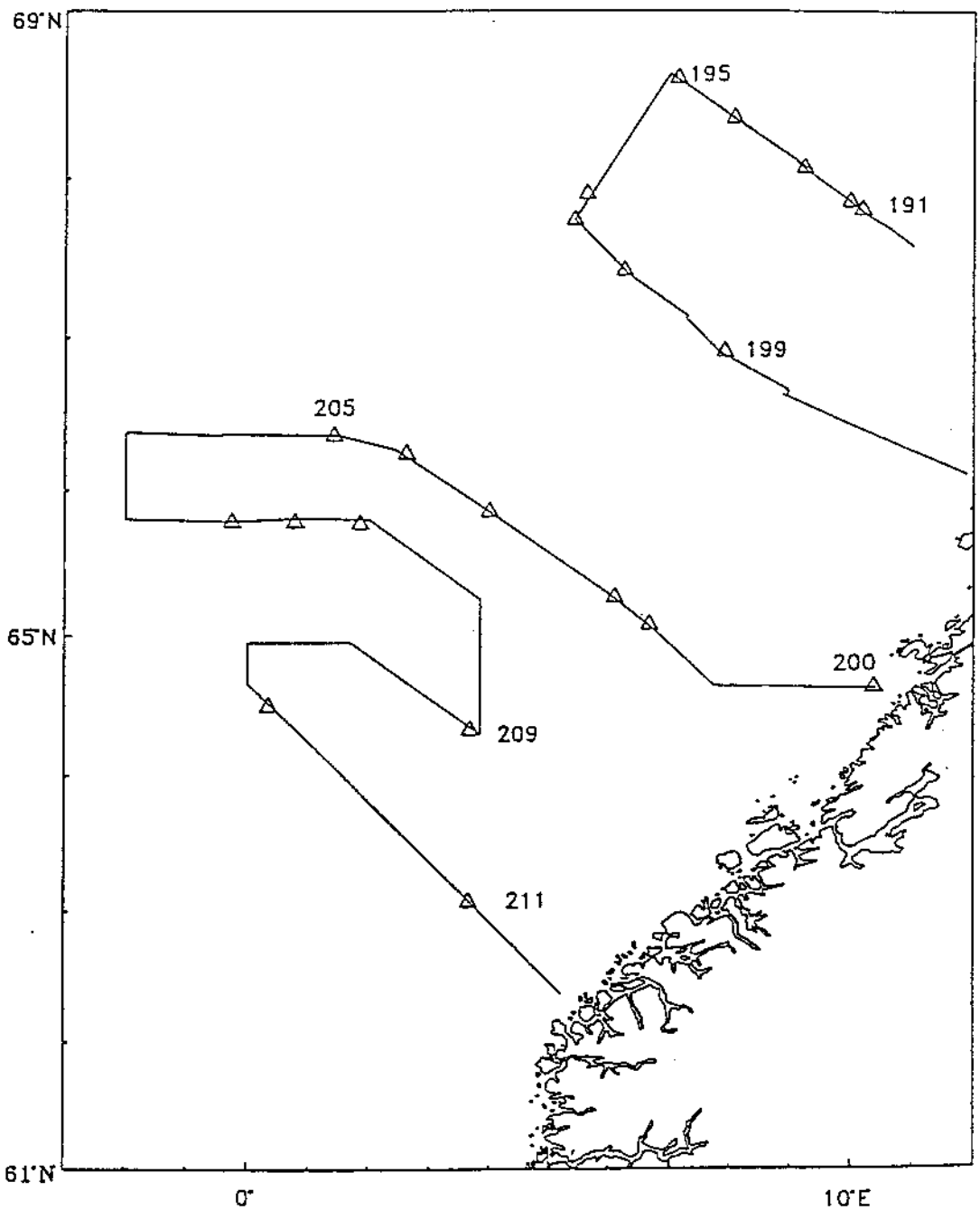

Fig. 3.2. Cruise tracks and trawl stations, R/V G.O.Sars, 21/3-1/4 1996.

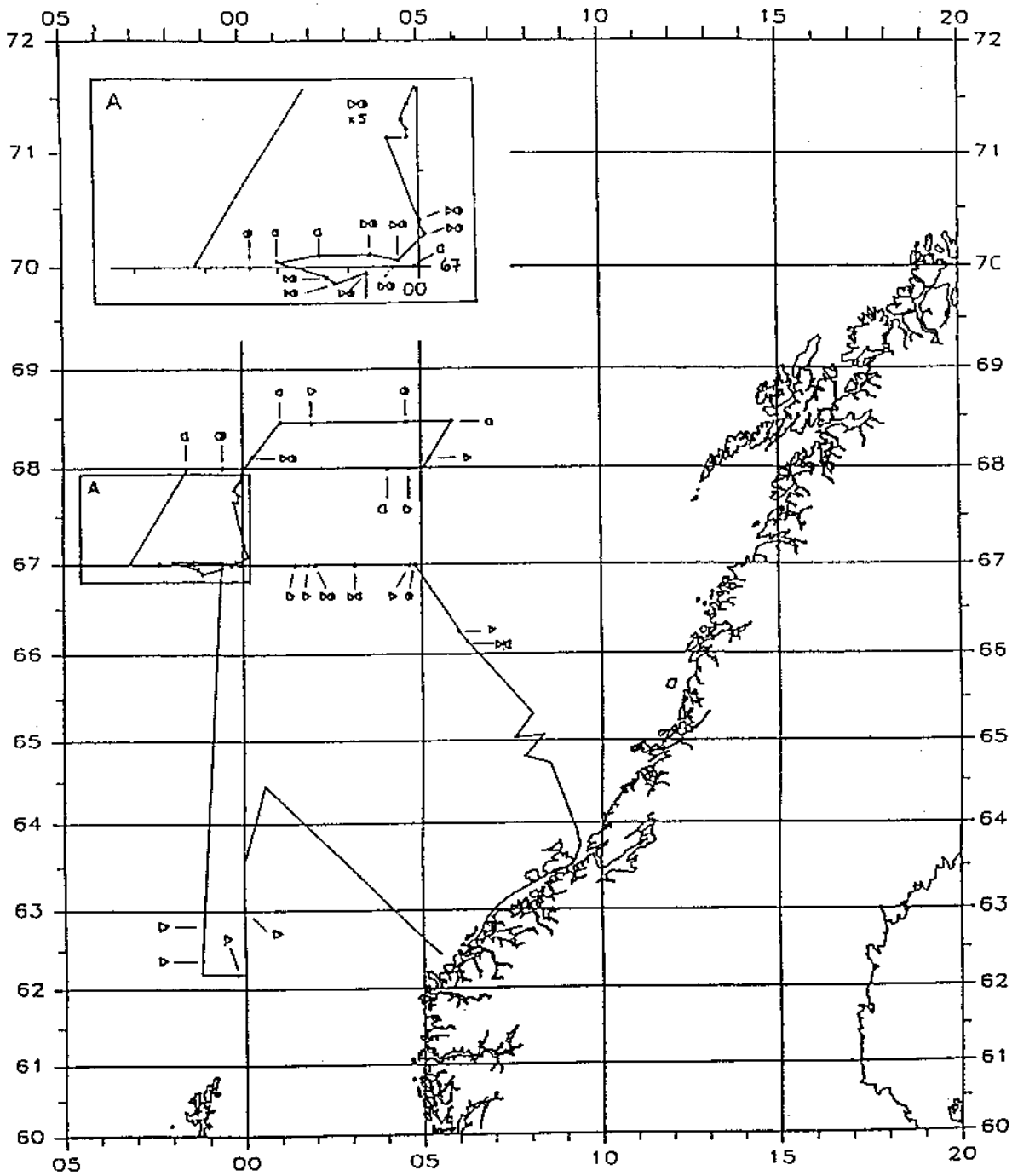

Fig. 3.3. Cruise tracks and stations, R/V G.O.Sars, 3/4-18/4 1996.

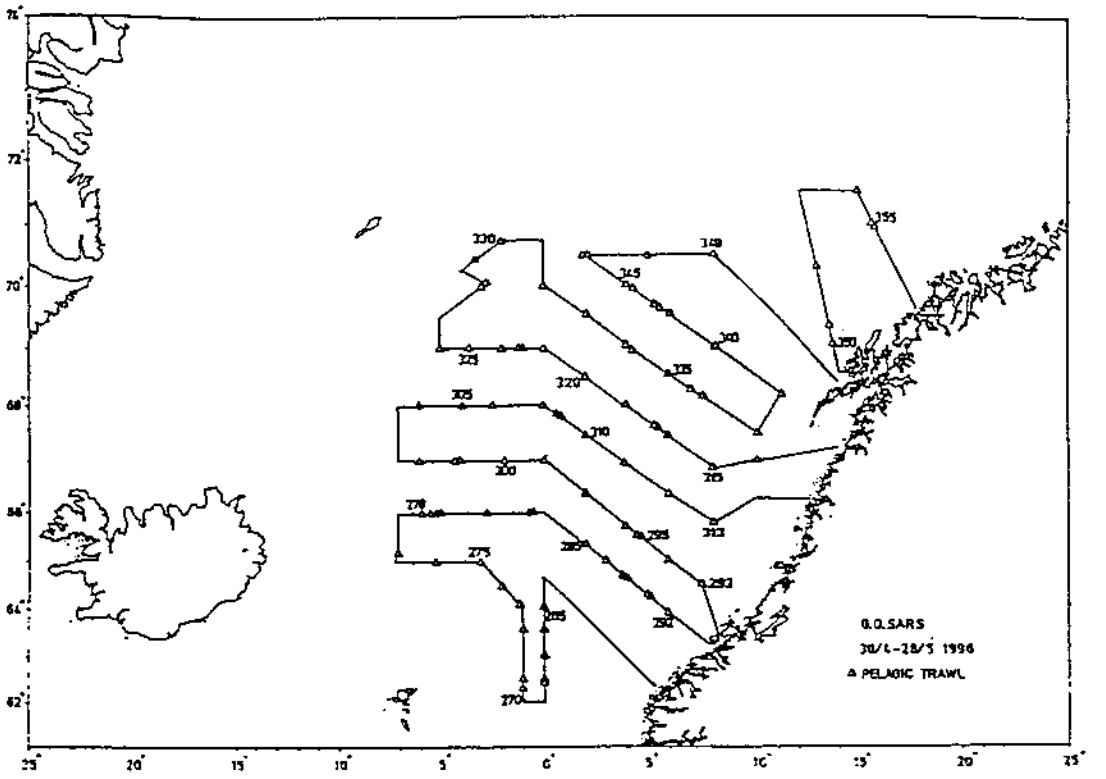

Fig. 3.4 a. *Course tracks and pelagic trawl stations taken in the period 30 April - 28 May 1996.*

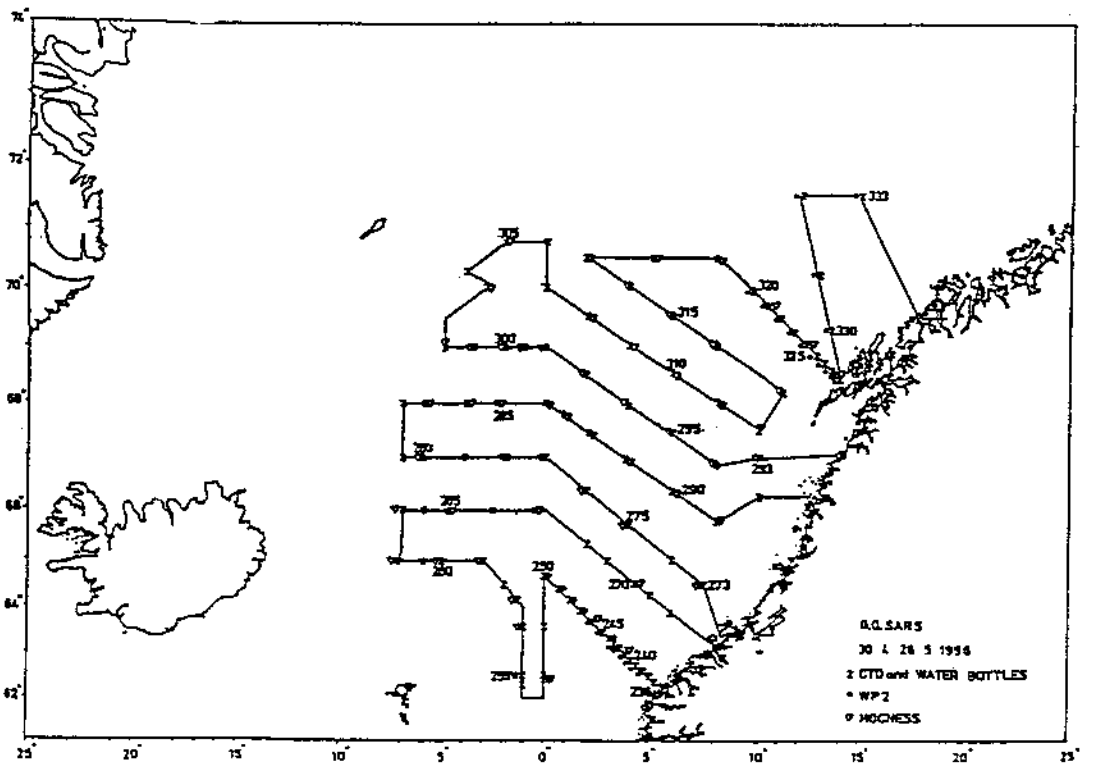

Fig. 3.4 b. *Course tracks and CTD, water bottles and MOCNESS stations taken in the period 30 April - 28 May 1996.*

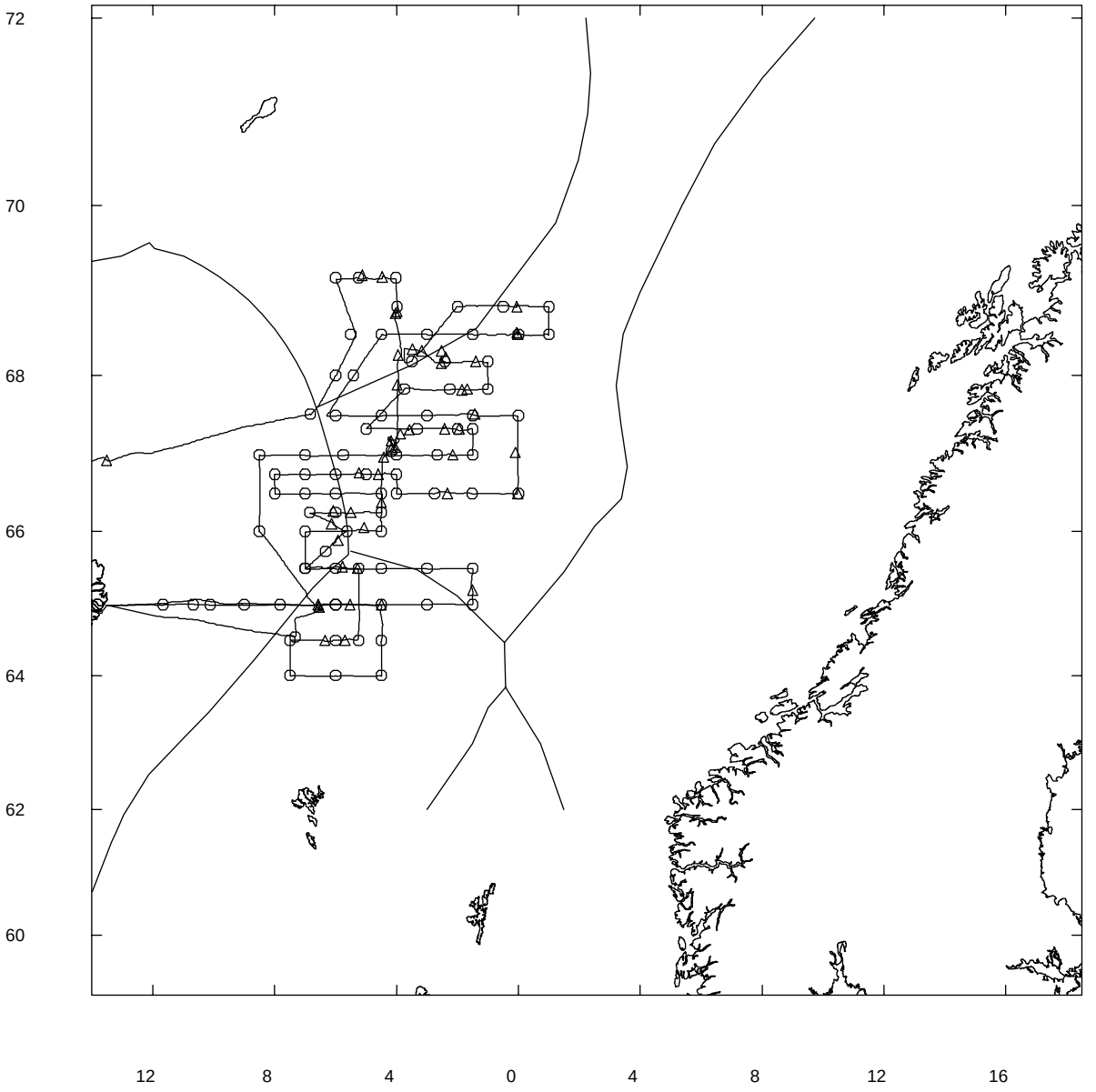

Figure 3.5. Cruise tracks and stations, R/V `rni Fri riksson, 3.5 - 29.5 1996

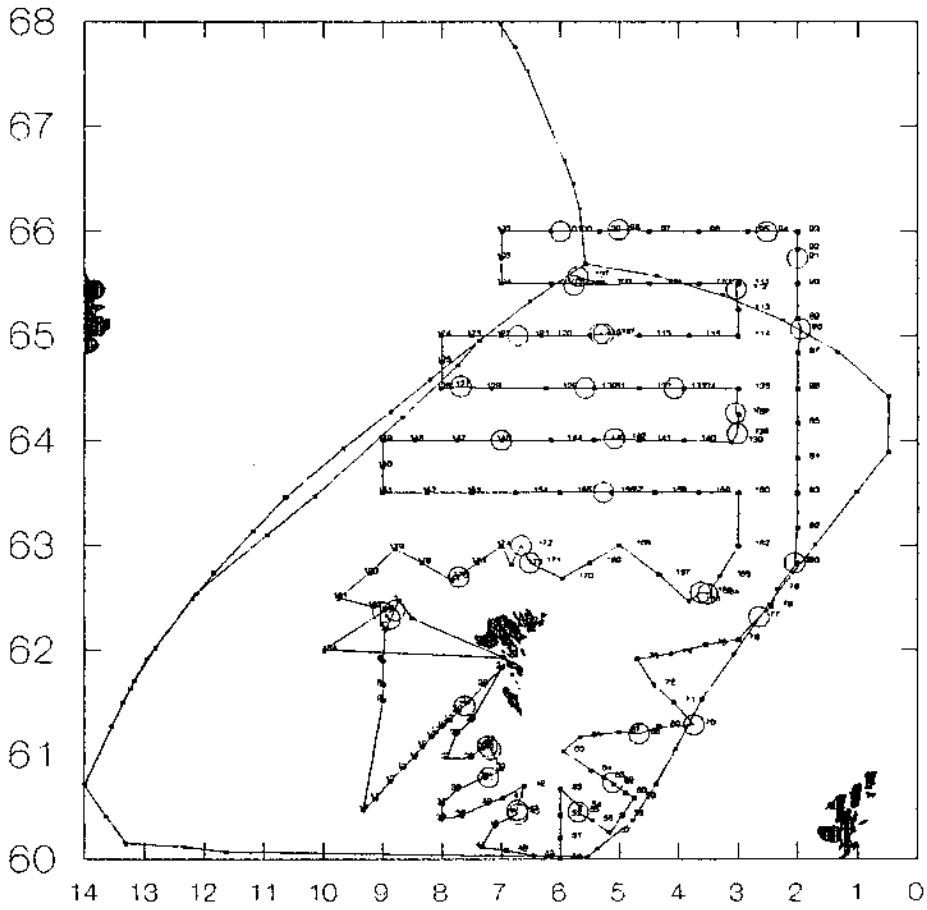

Fig. 3.5. Cruise tracks, stations and the Faeroese EEZ, RV Magnus Heinason, 3/5-21/5 1996

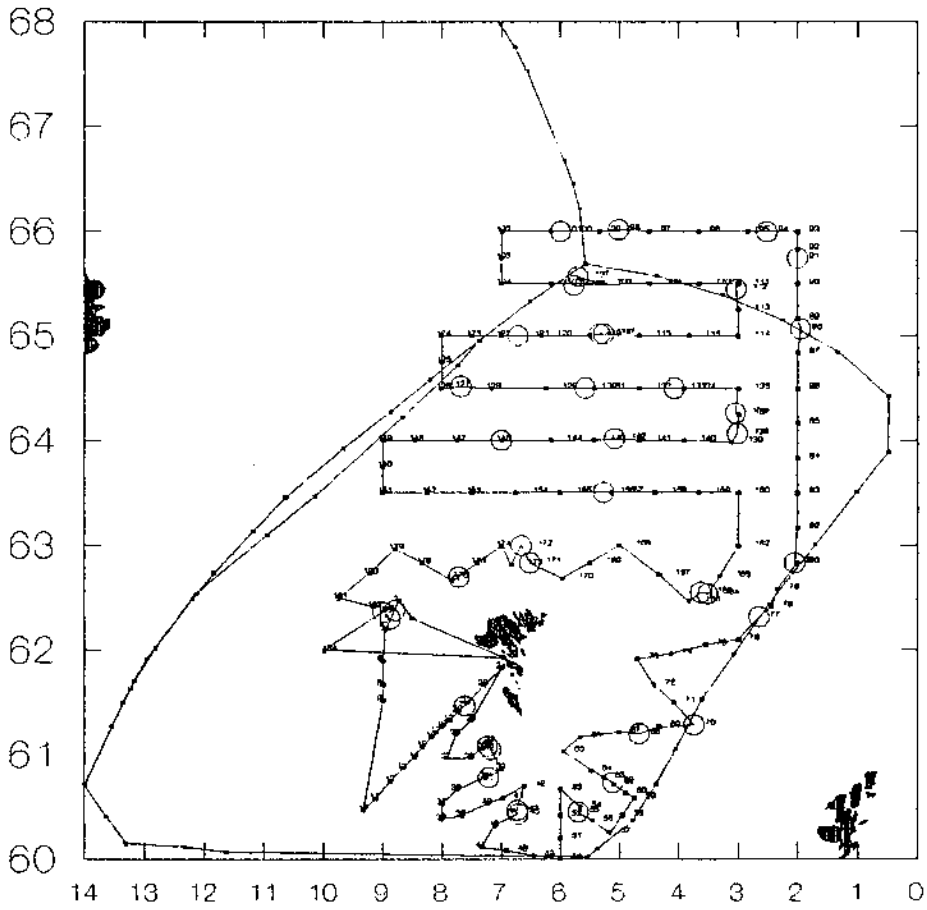

Fig. 3.5. Cruise tracks, stations and the Faeroese EEZ, RV Magnus Heinason, 3/5-21/5 1996

Fig. 3.7. Cruise tracks and stations, R/V Fridtjof Nansen, 19/5-5/6 1996

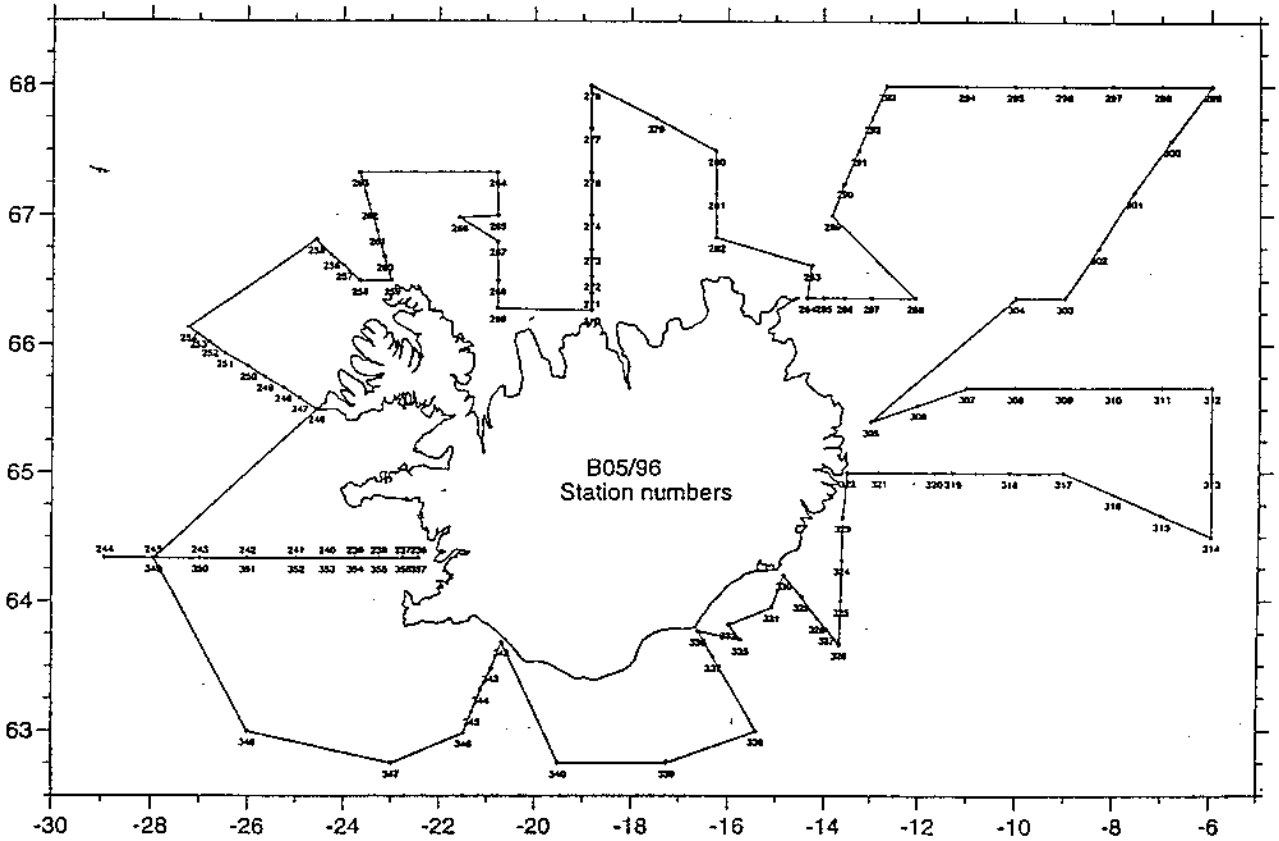

Fig. 3.8. Cruise tracks and stations, R/V Bjarni Sæmundsson, 21/5-11/6 1996.

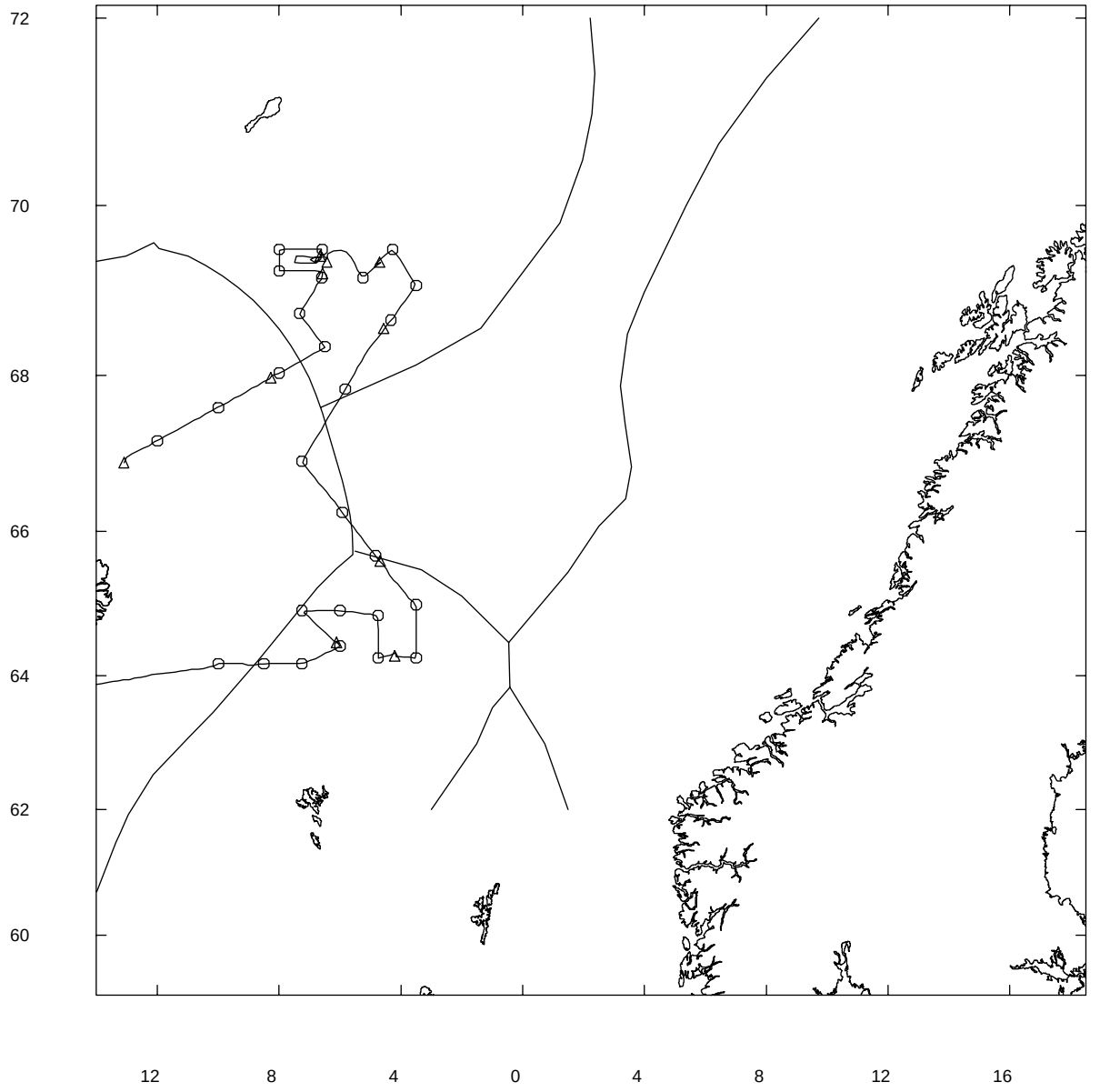

Figure 3.9. Cruise tracks, R/V `rni Fri riksson, 3/6 - 14/6 1996

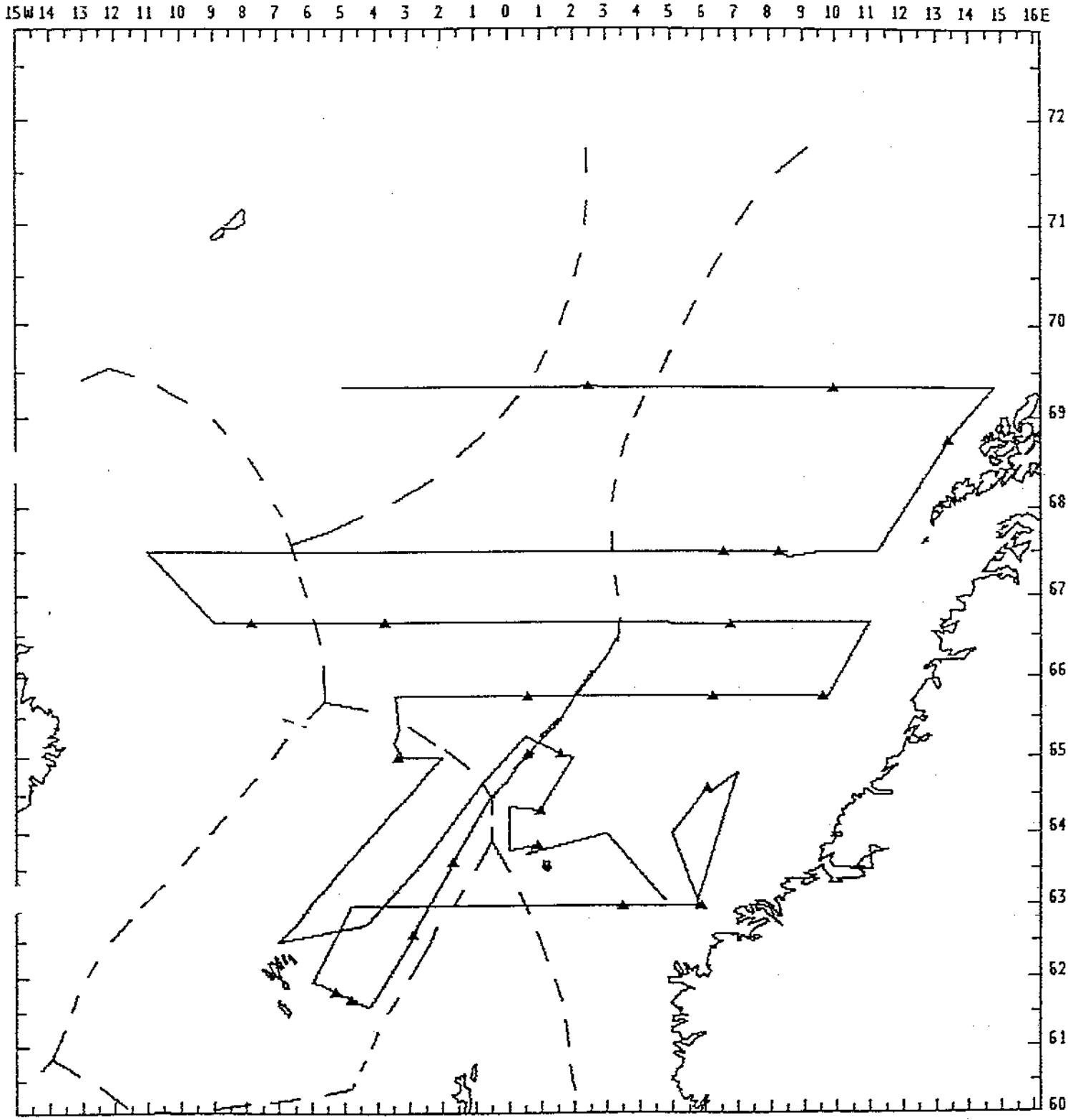

Fig. 3.10. **Cruise track with fishing stations, R/V "F. Nansen", 12/6-11/7 1996.**

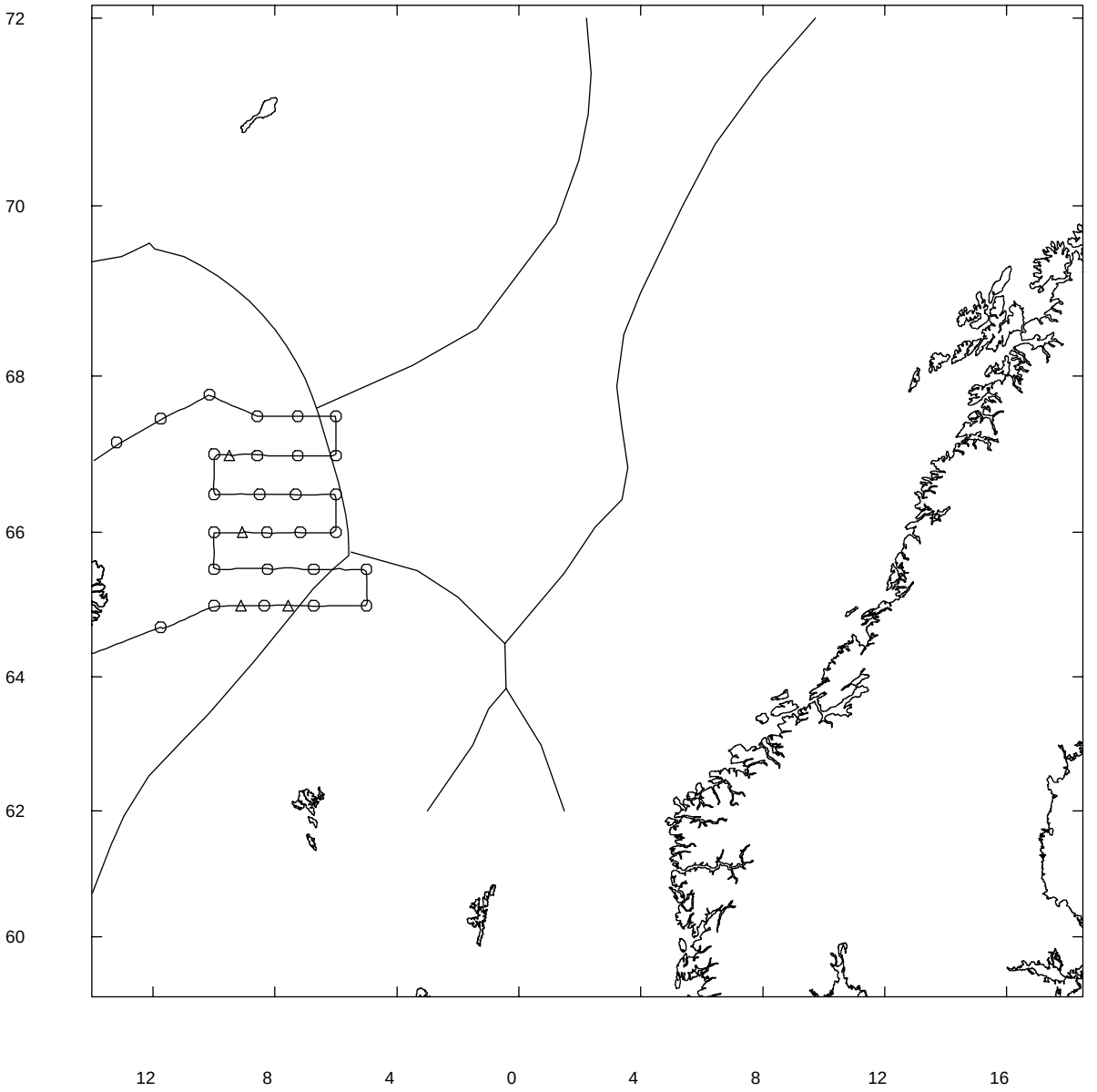

Figure 3.11. Cruise tracks, R/V `rni Fri riksson, 8/7 - 15/7 1996

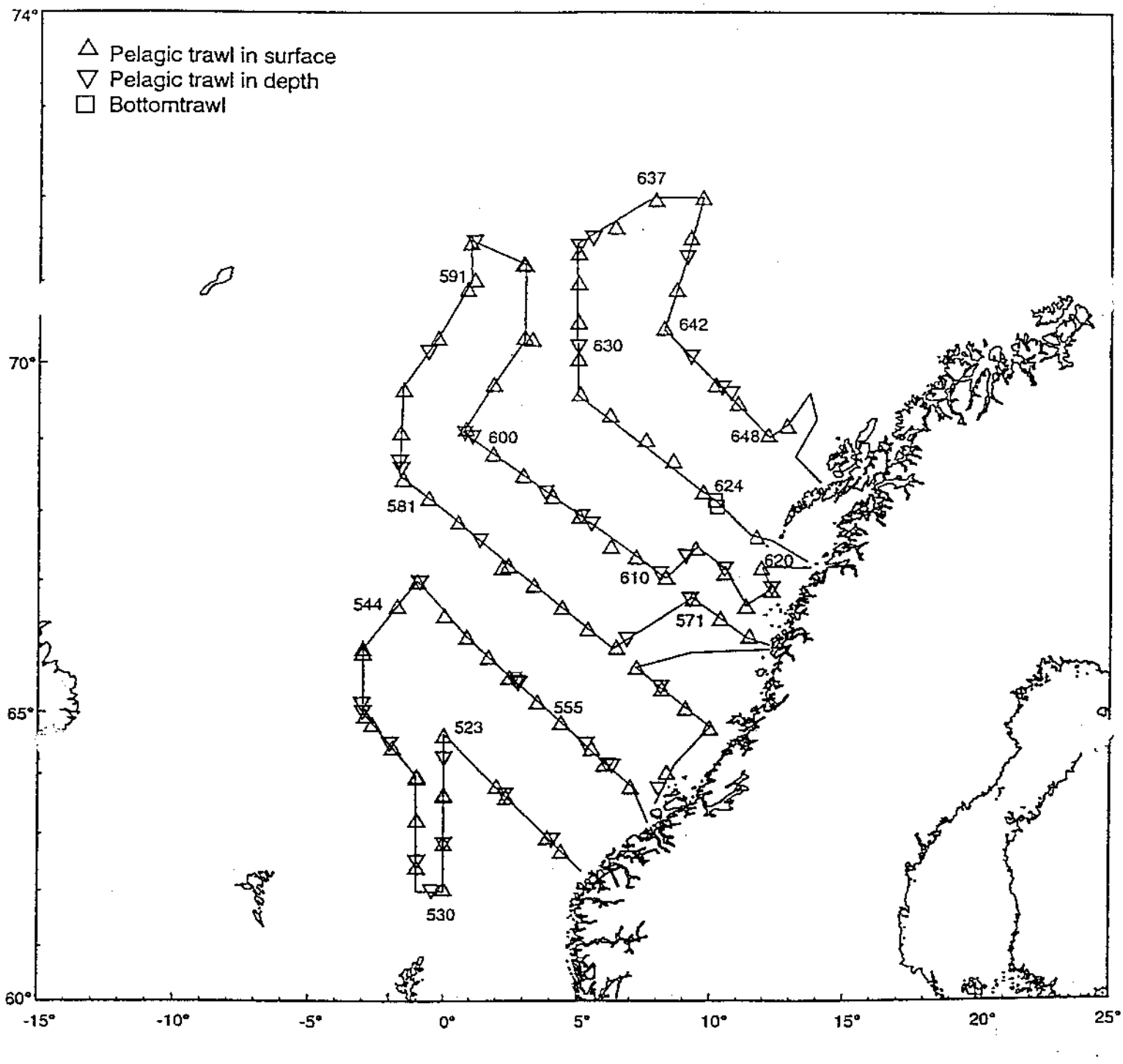

Fig. 3.12. Cruise tracks and trawl stations, R/V G.O.Sars, 19/7-15/8 1996

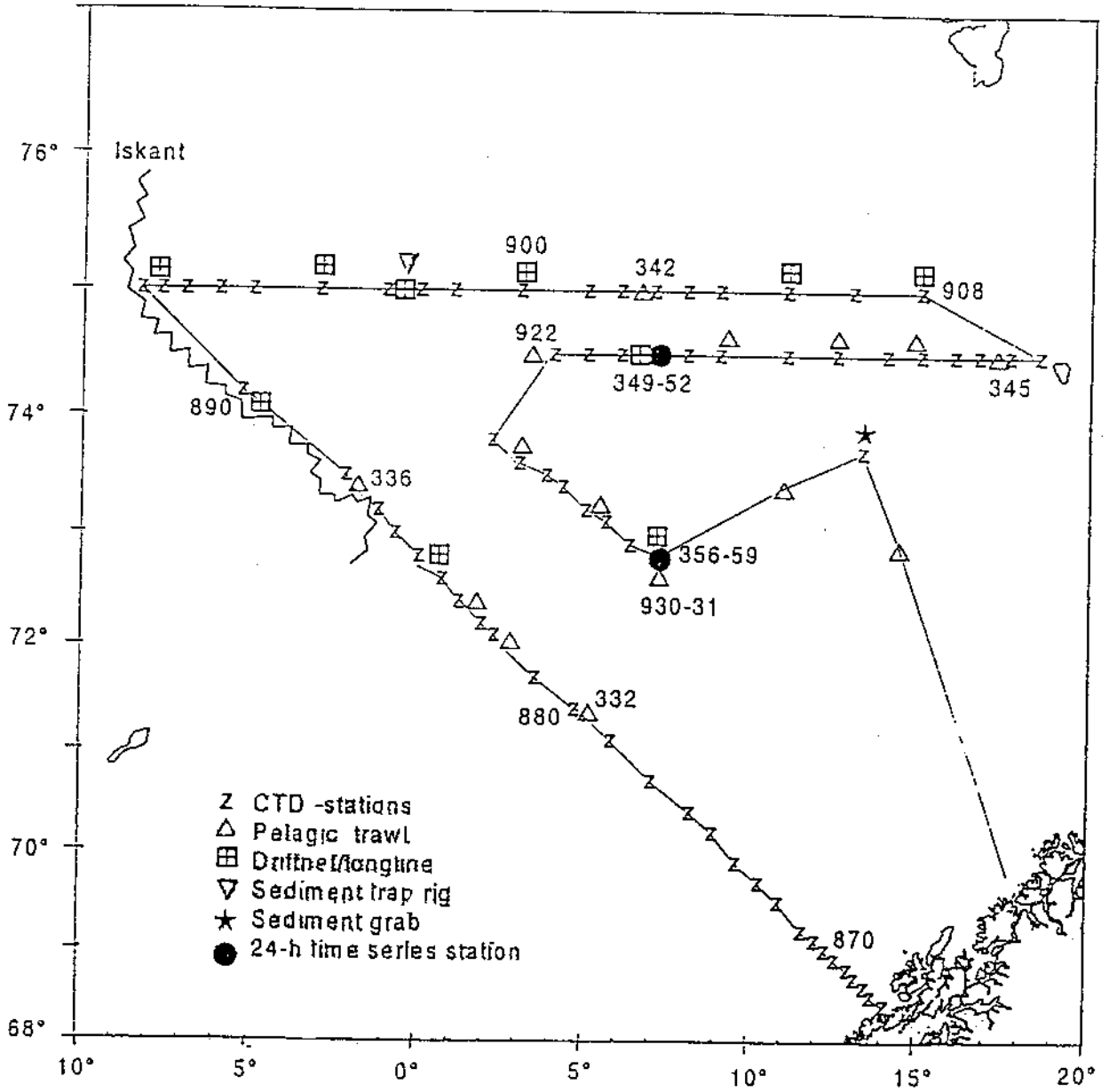

Fig. 3.13. Cruise tracks and stations, R/V Johan Hjort, 20/7-5/8 1996.

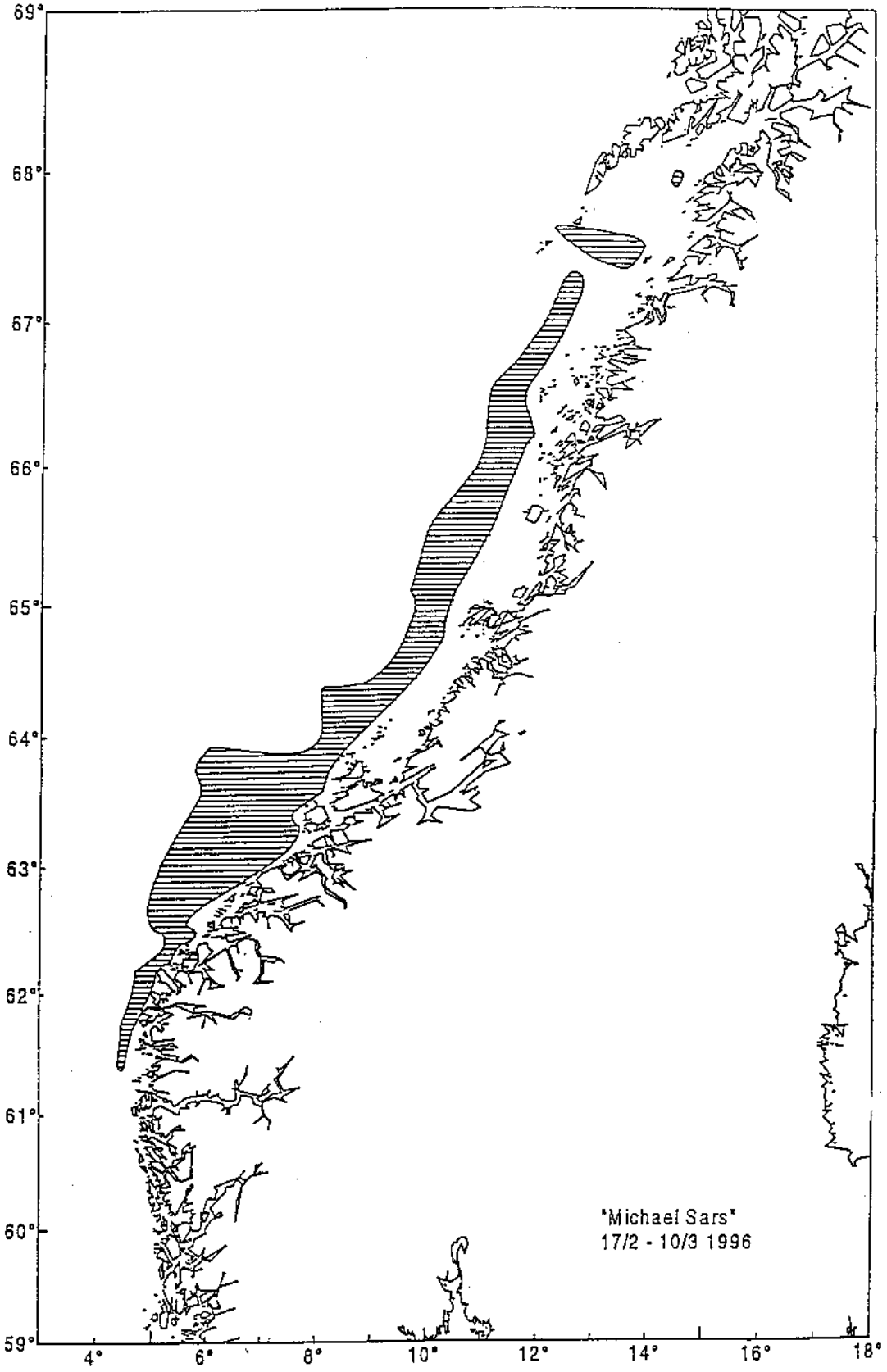

Fig. 4.1. Distribution of adult, nature herring,17/2-10/3 1996.

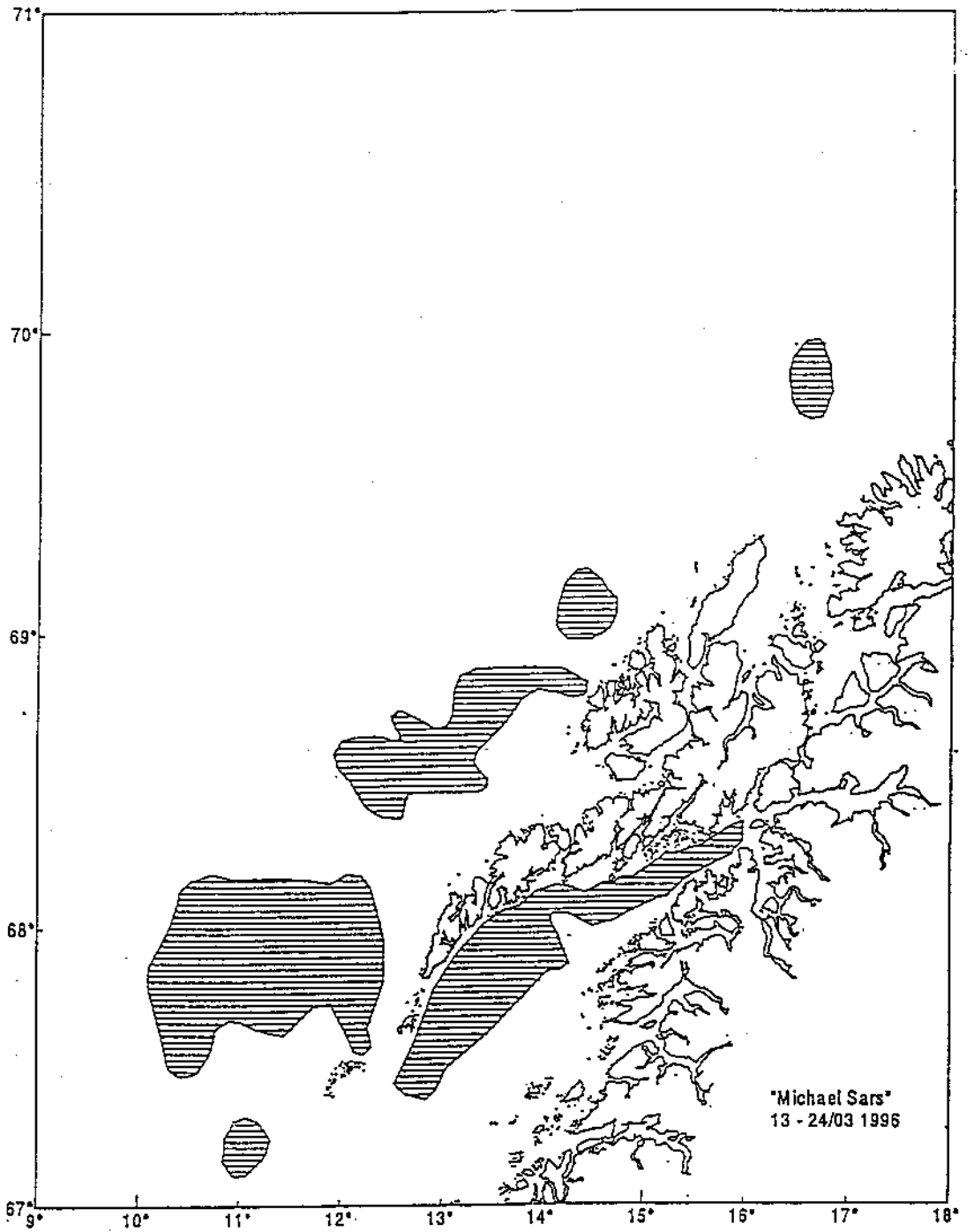

Fig. 4.2. Herring distribution 13/3-24/3 1996.

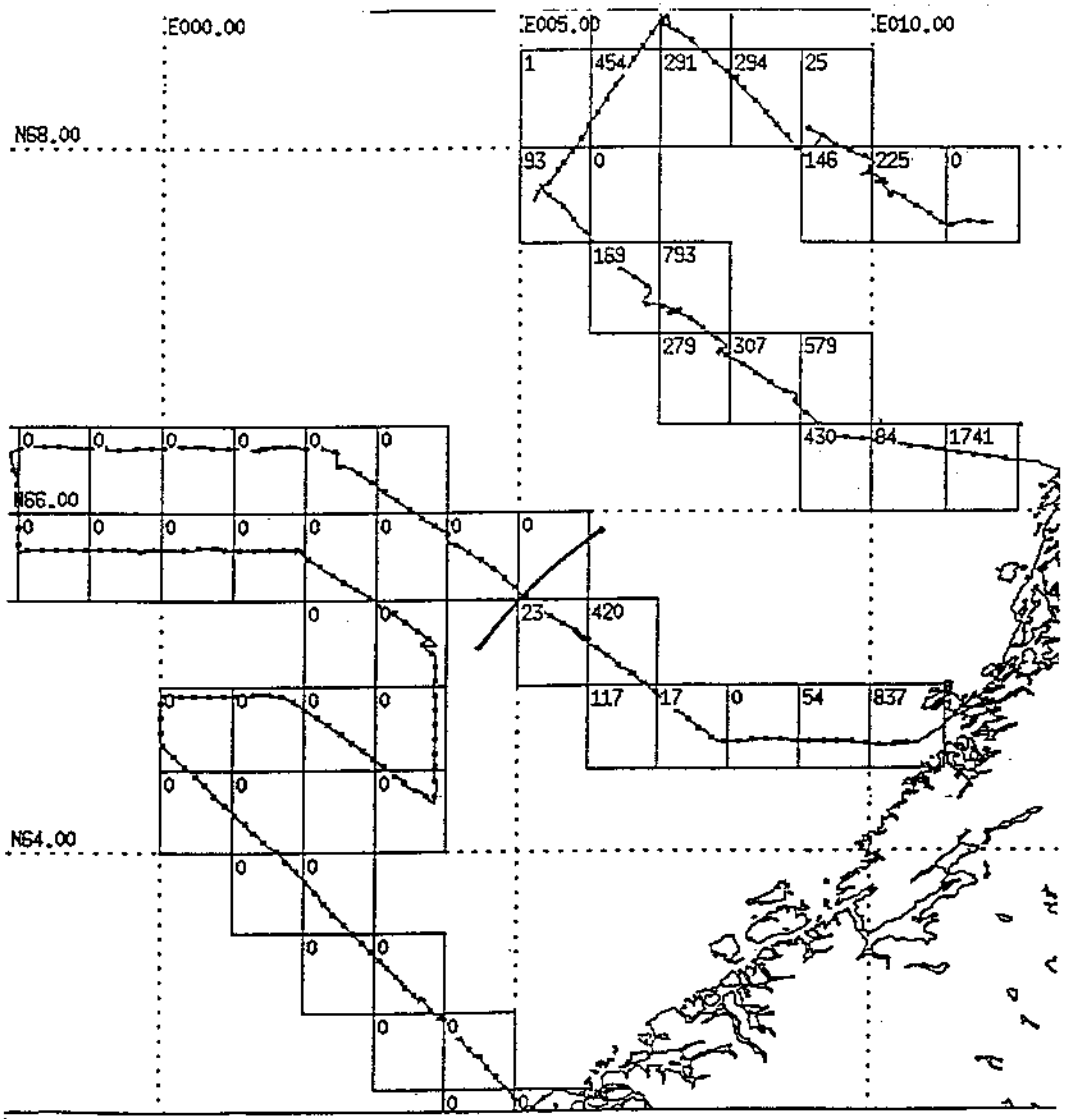

Fig. 4.3. Distribution of herring in the Norwegian Sea (SA-values), 23/3-31/3 1996.

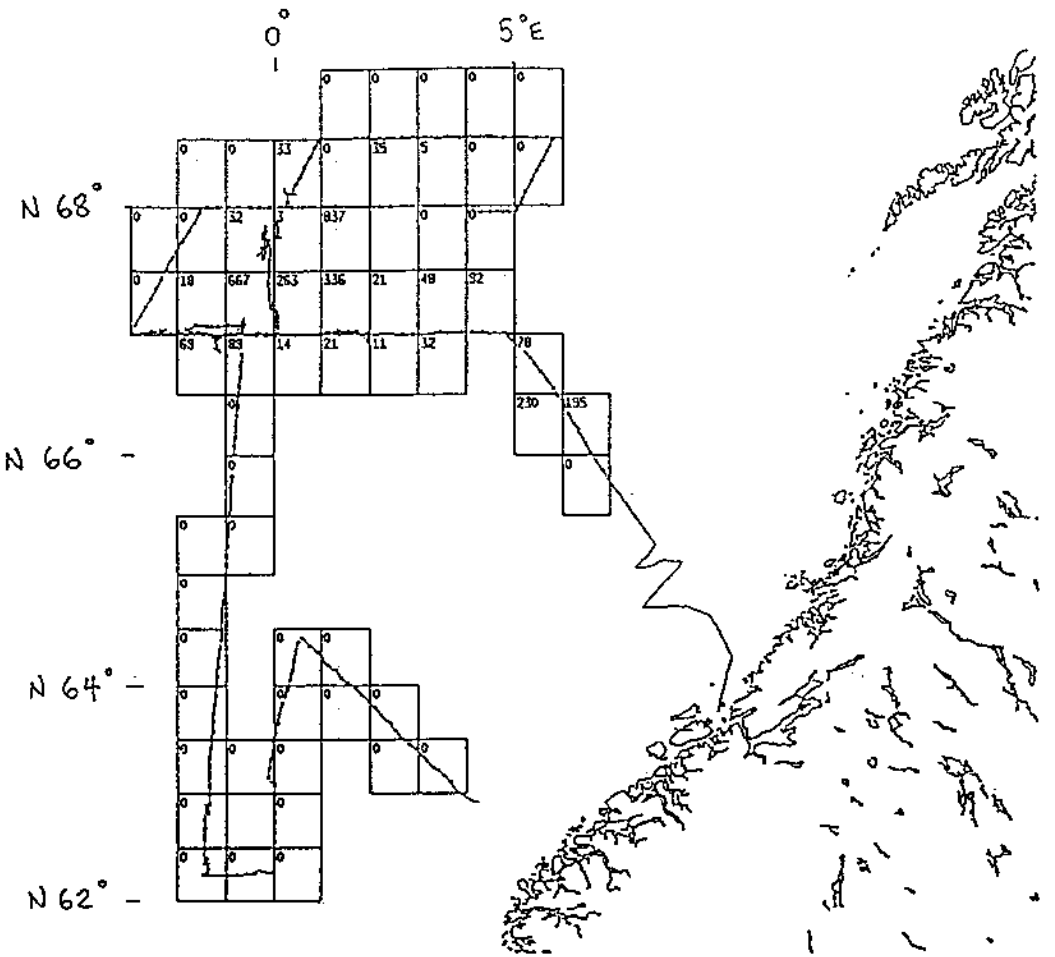

Fig. 4.4. Distribution of herring in the Norwegian Sea (SA-values), 3/4-18/4 1996

Herring distribution in May 1996

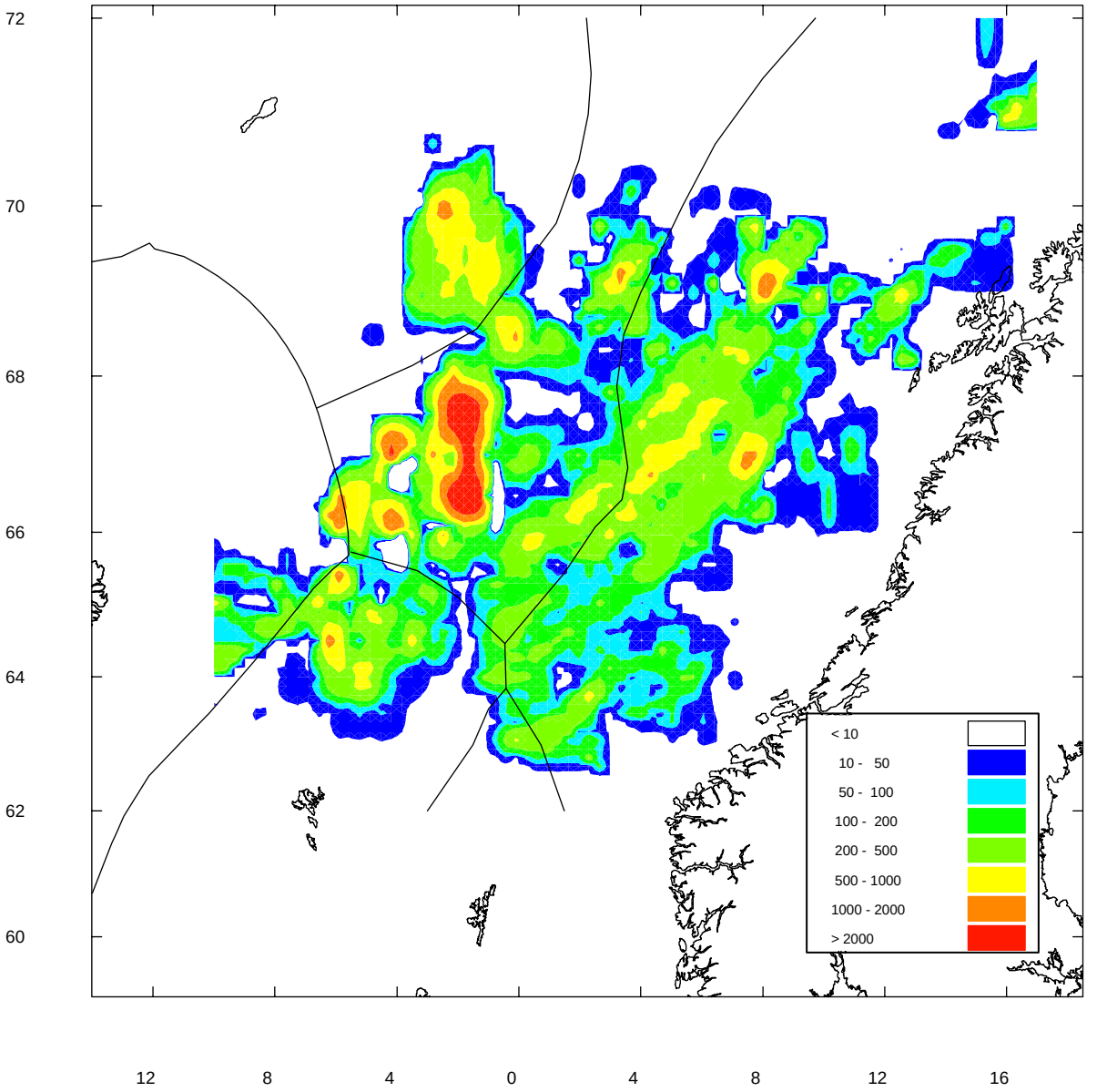

Fig.4.5 Distribution of herring in the Norwegian Sea in May 1996

Mean length of herring in May 1996

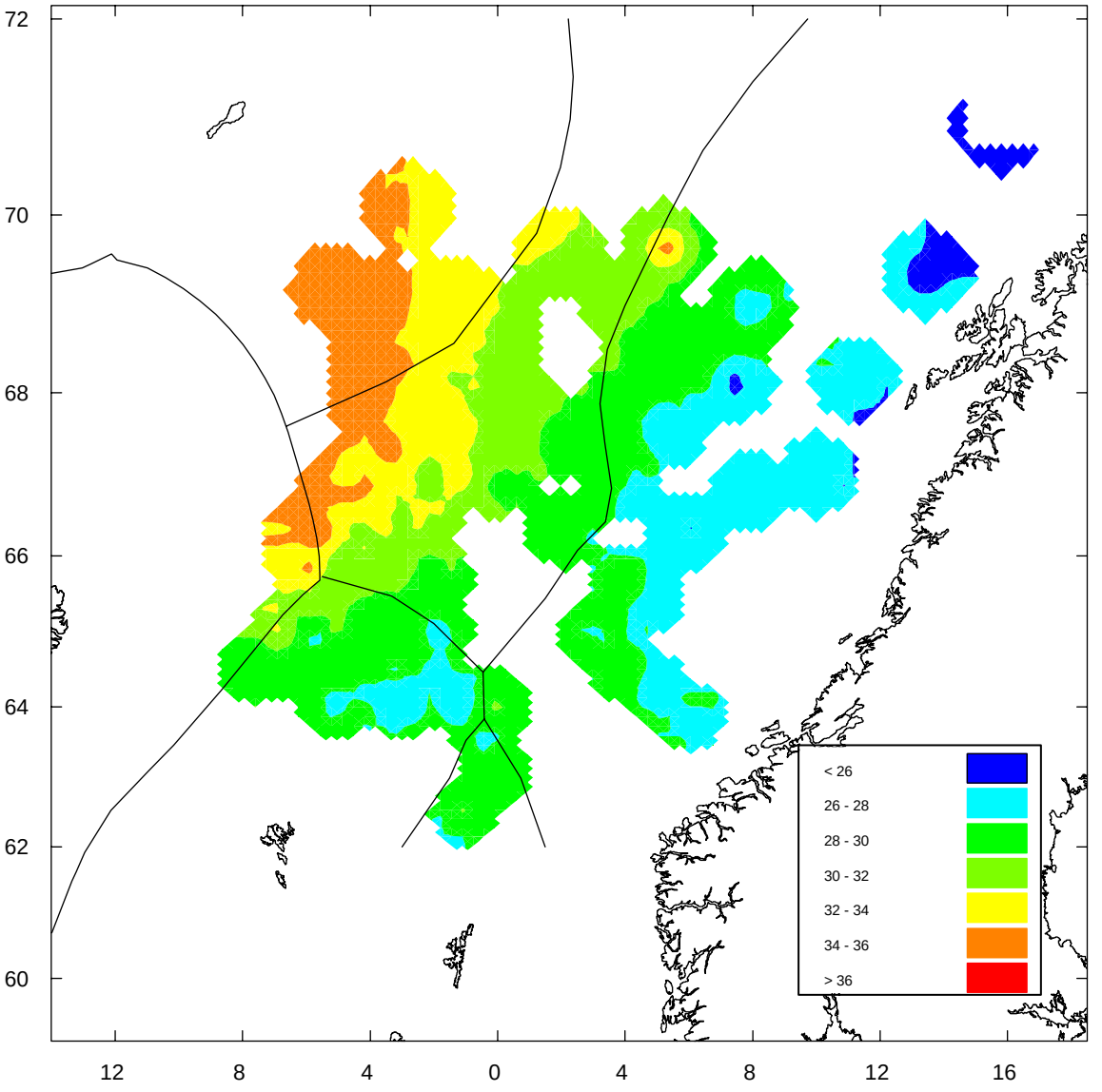

Fig.4.6. Size distribution of herring in the Norwegian Sea in May 1996

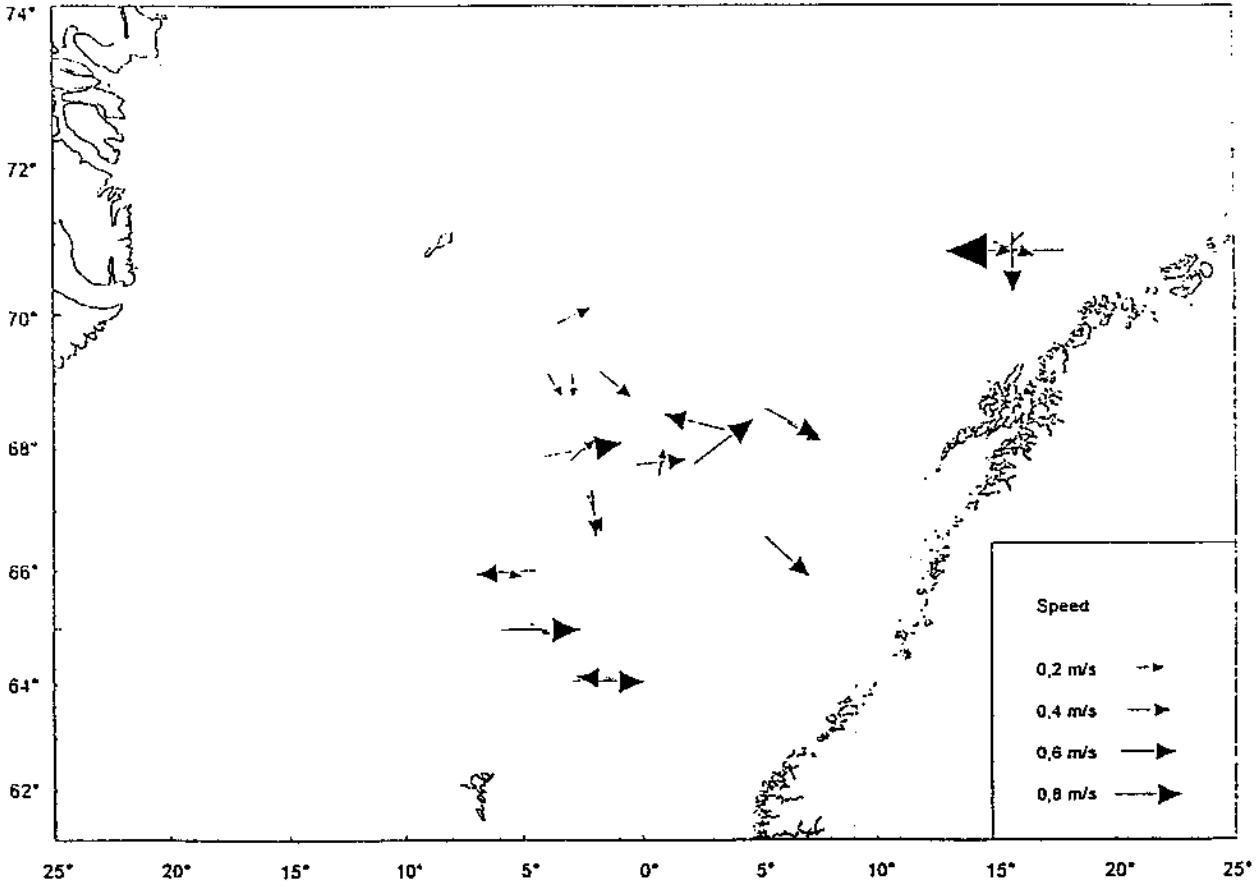

Fig. 4.7a. *Migration direction and speed of selected herring schools tracked for 30 minutes.*

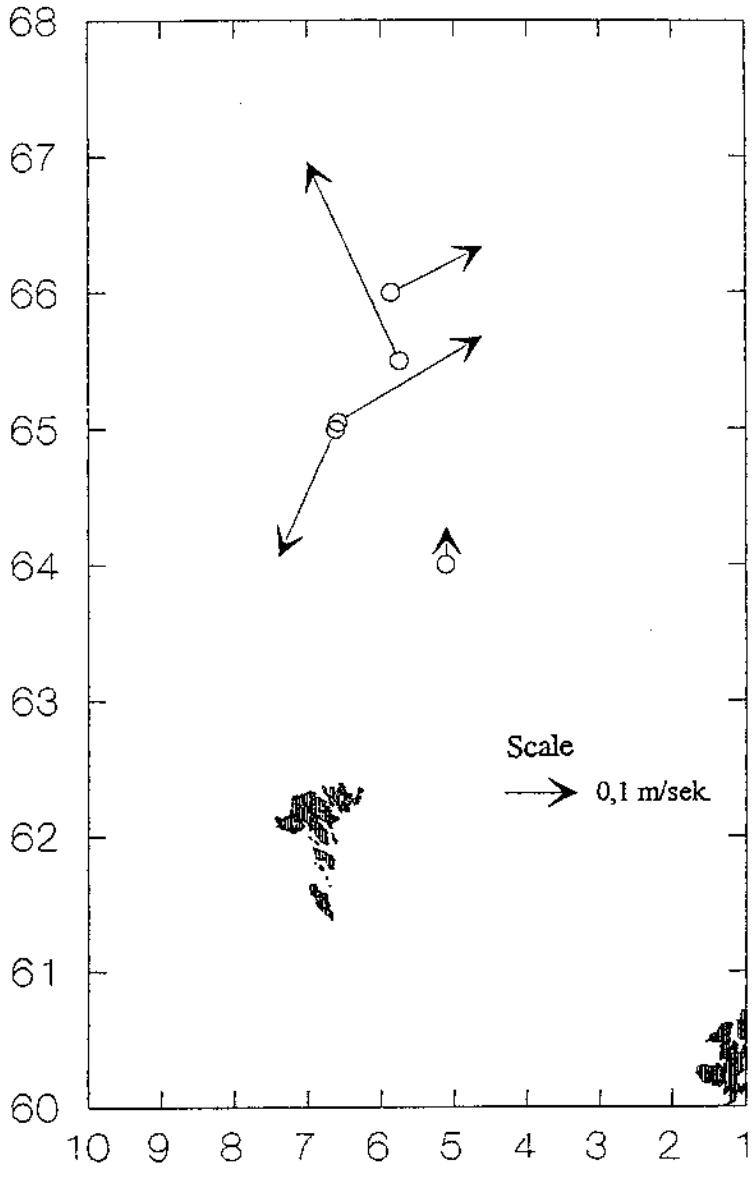

Fig. 4.7b. Direction and relative speed of individual schools

Herring distribution in June 1996

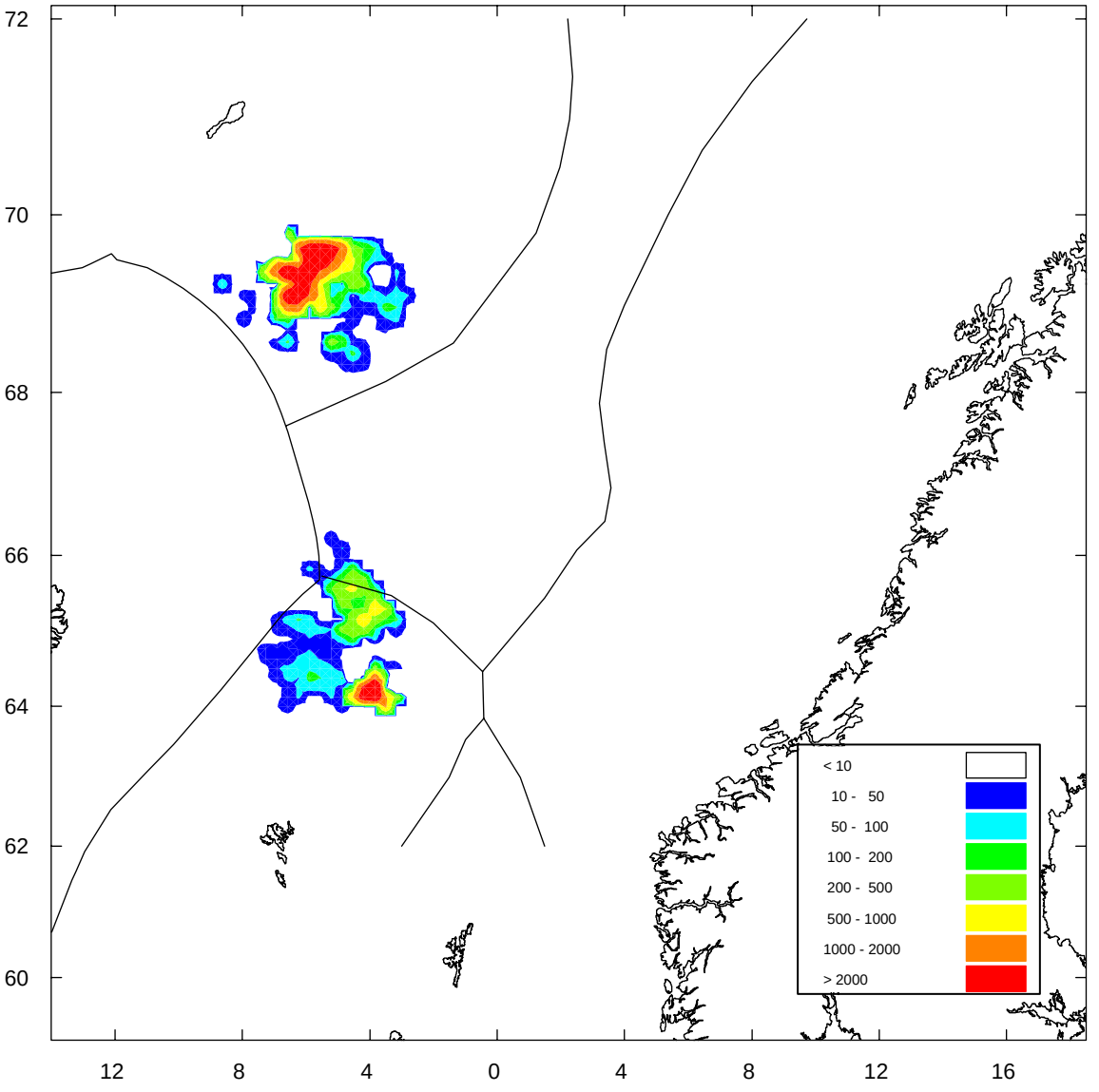

Fig.4.8. Distribution of herring (SA-values) in the Norwegian Sea in June 1996

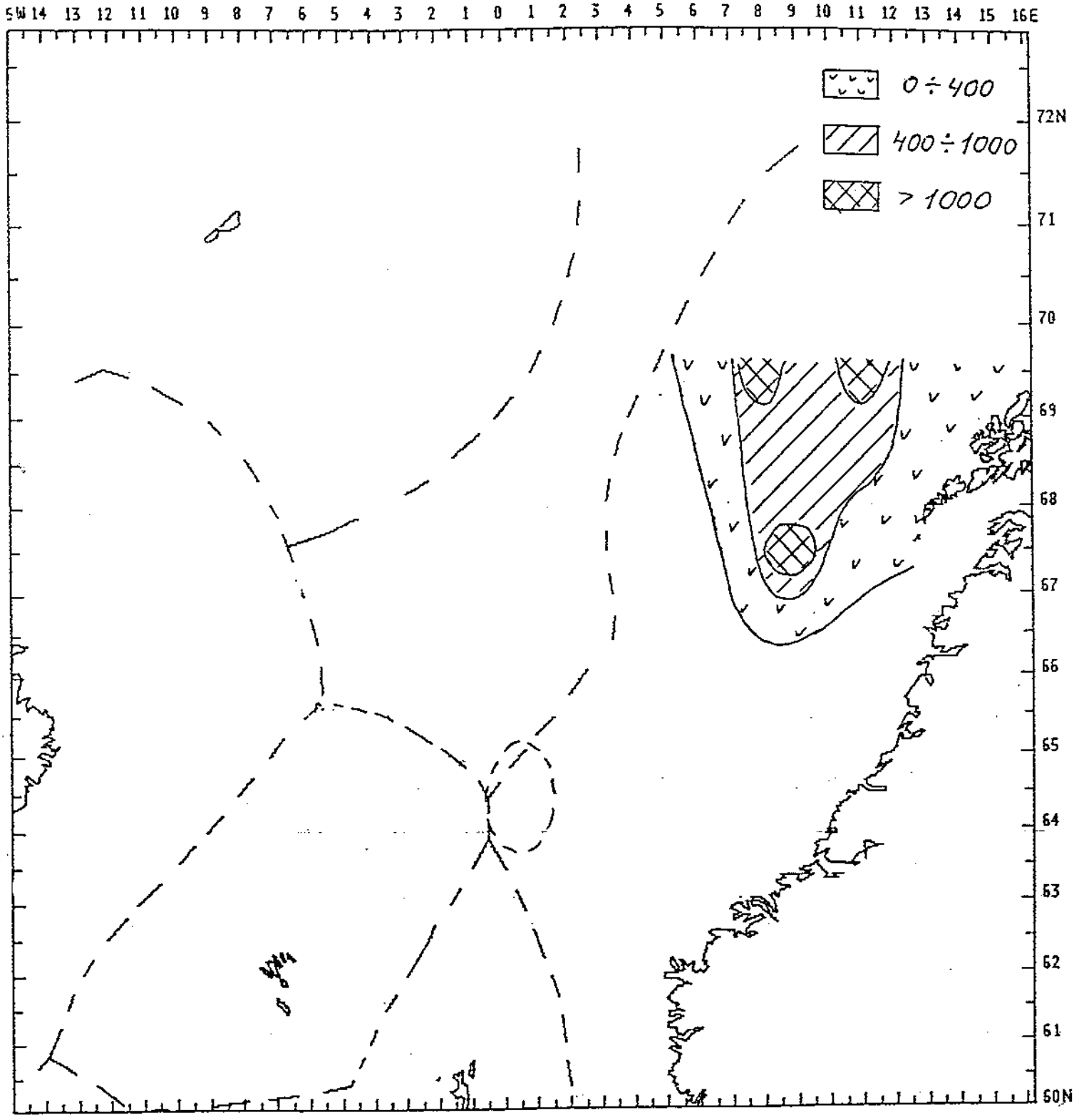

Fig. 4.9. Distribution of herring (SA-values) in the Norwegian Sea 1/7-11/7 1996.

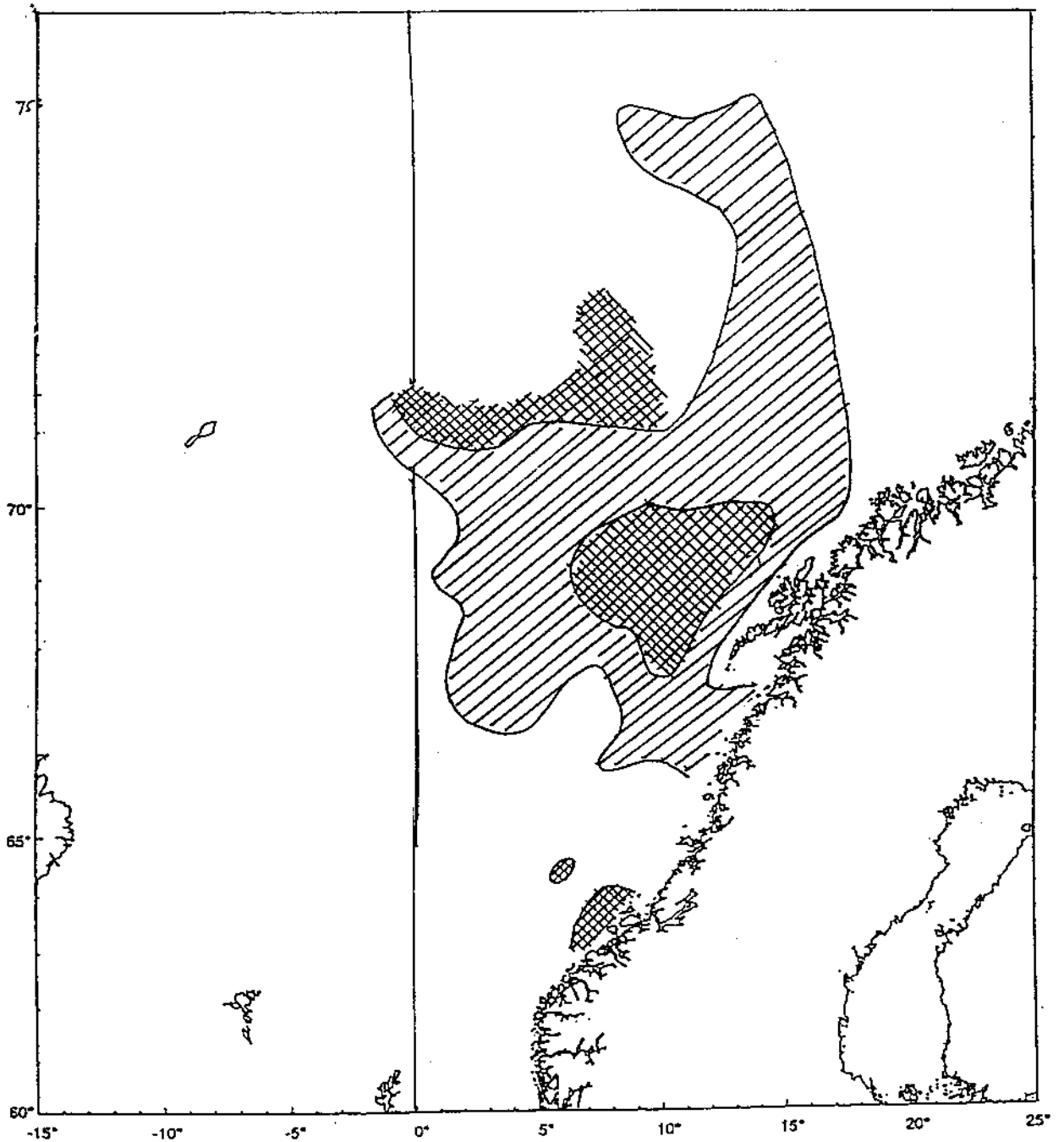

Fig. 4.10. Distribution of herring from mid July-mid August (combined recordings of echo sounder and sonar)

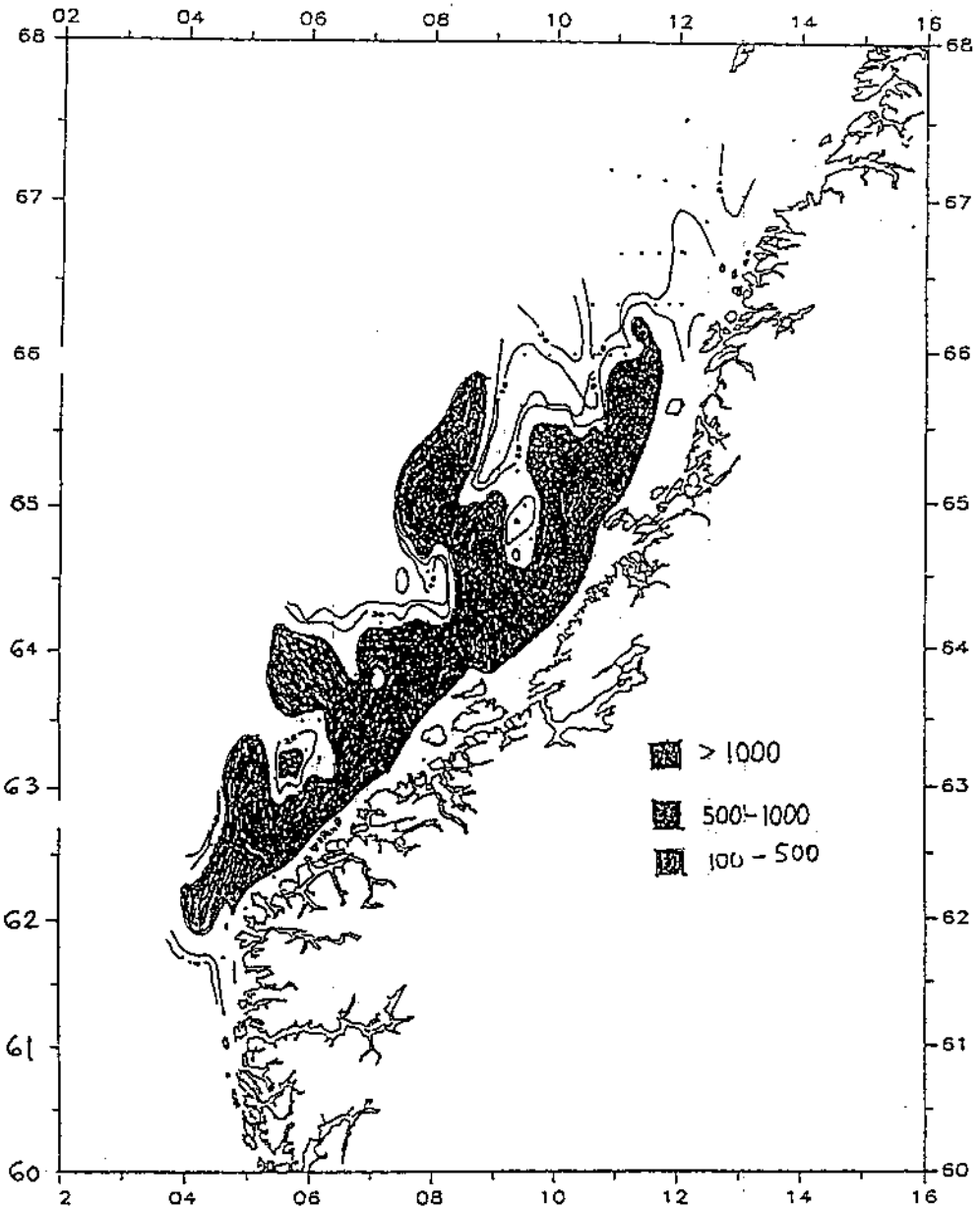

Fig. 4.11. Norwegian spring spawning herring. Distribution of larvae , April 1996

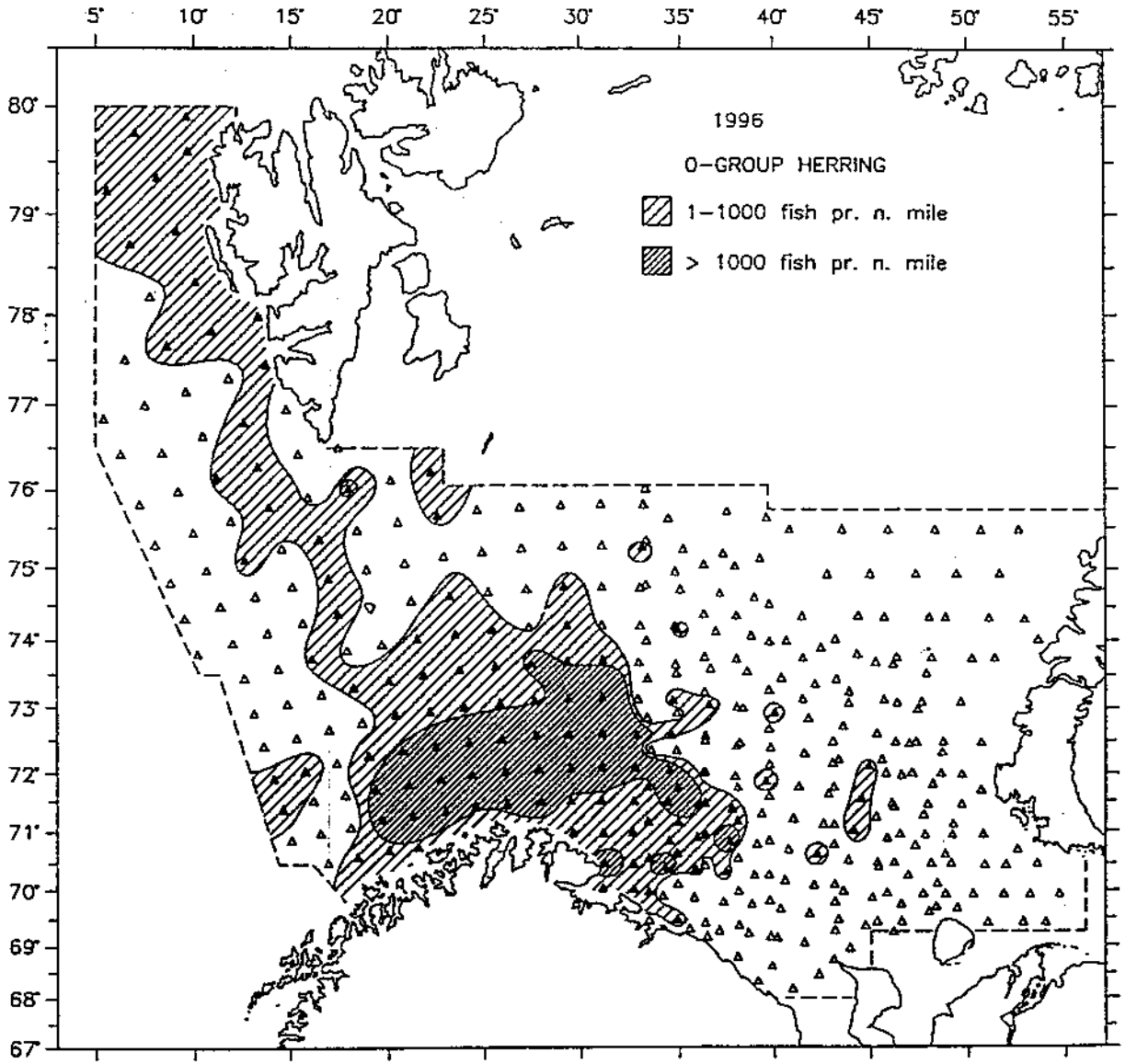

Fig. 4.12. Distribution of 0-group herring in 1996.

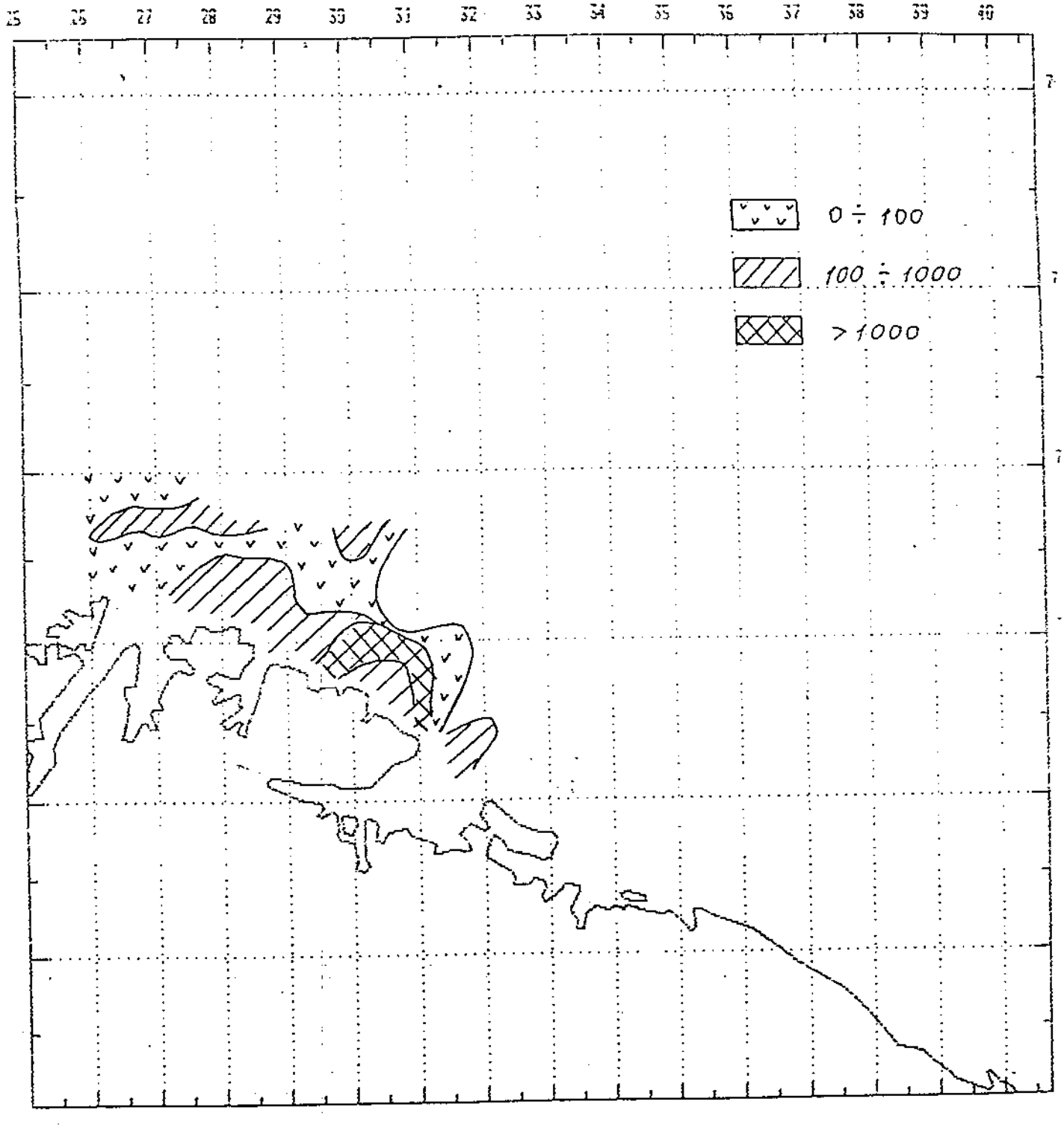

Fig. 4.13. Distribution of immature herring in the Barents Sea (1-4 years old) in May and June 1996.

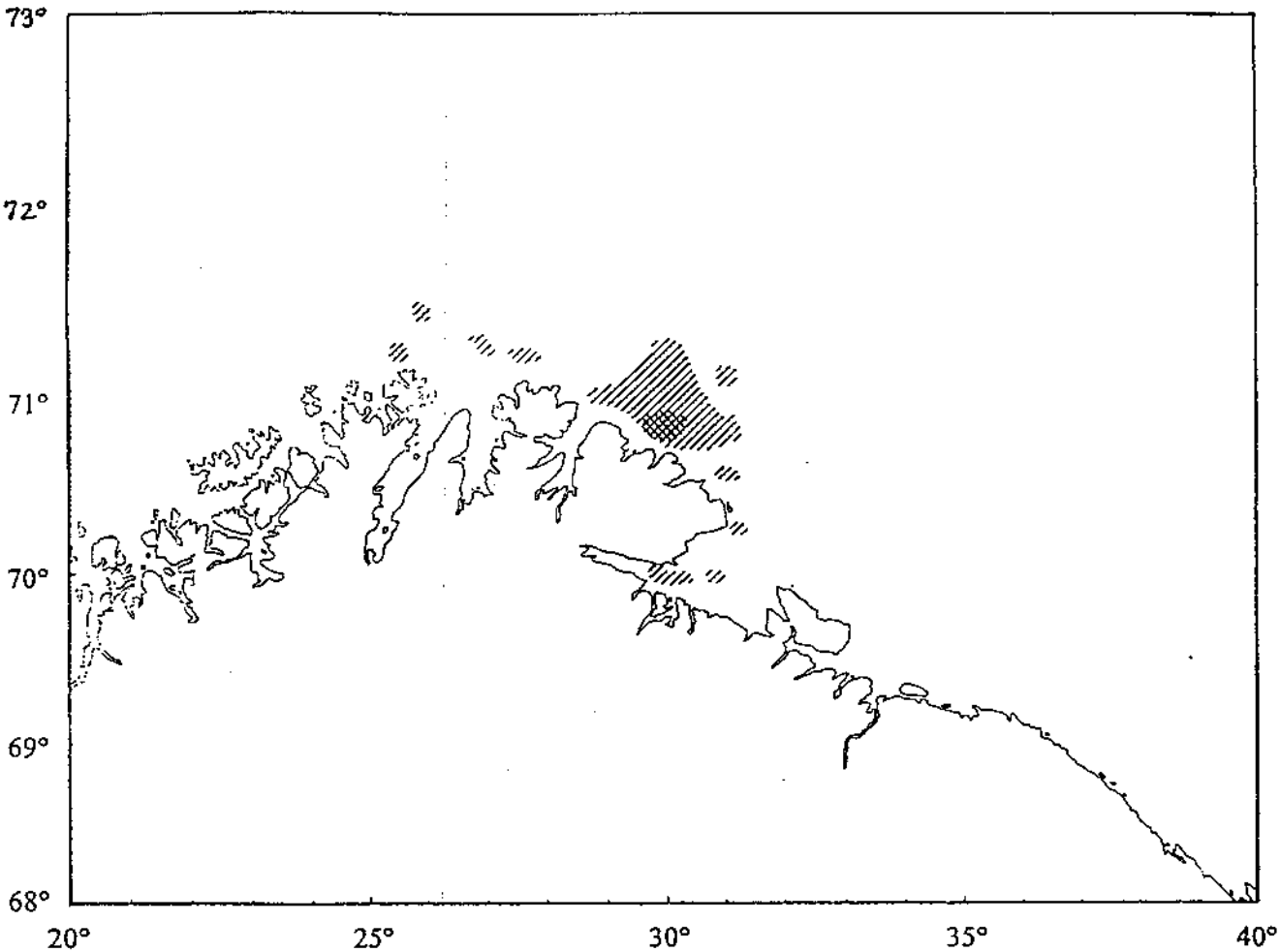

Fig. 4.14. Distribution of juvenile herring in the Barents Sea in June 1996.

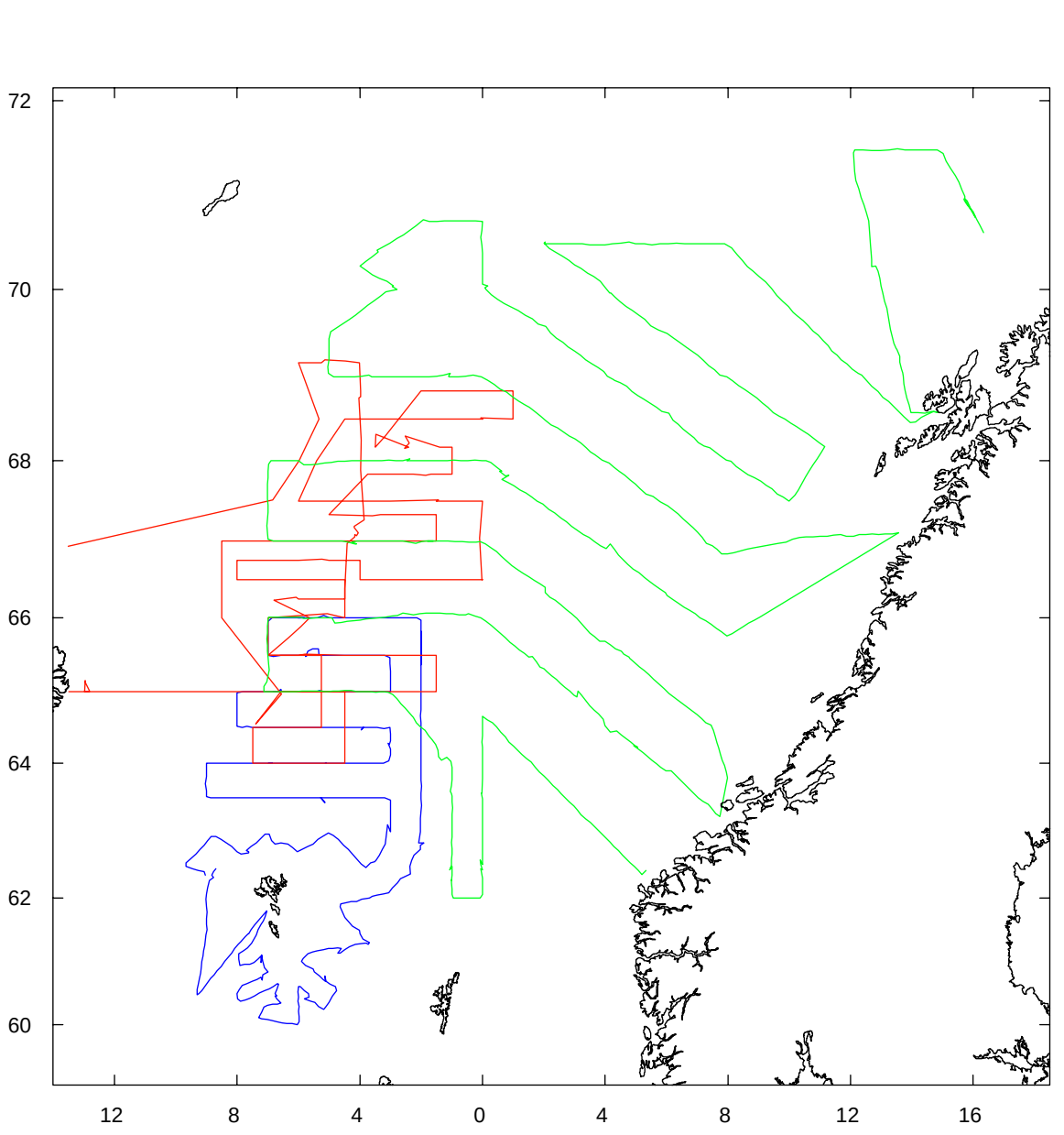

Fig.5.1. Cruise tracks of all participating vessels during the May surveys in 1996

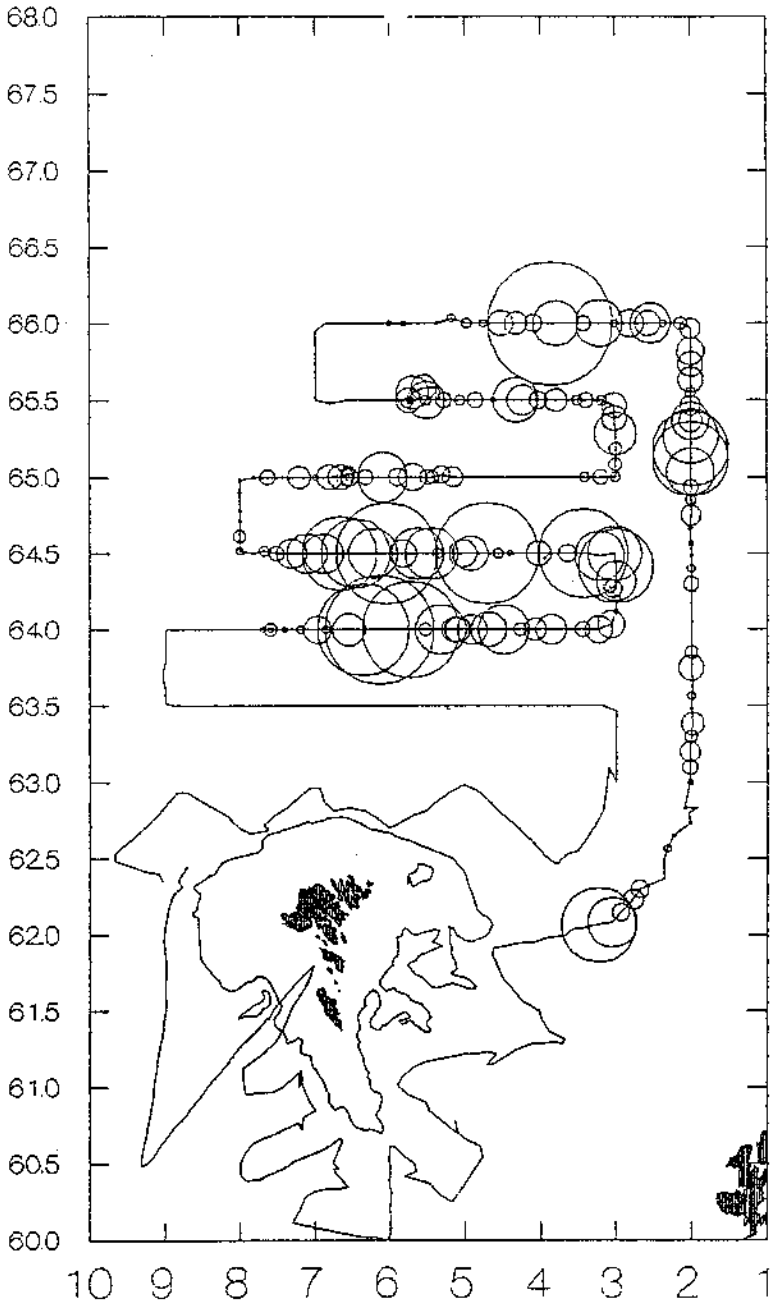

Fig. 5.2. Number of schools in the surface layers in May 1996

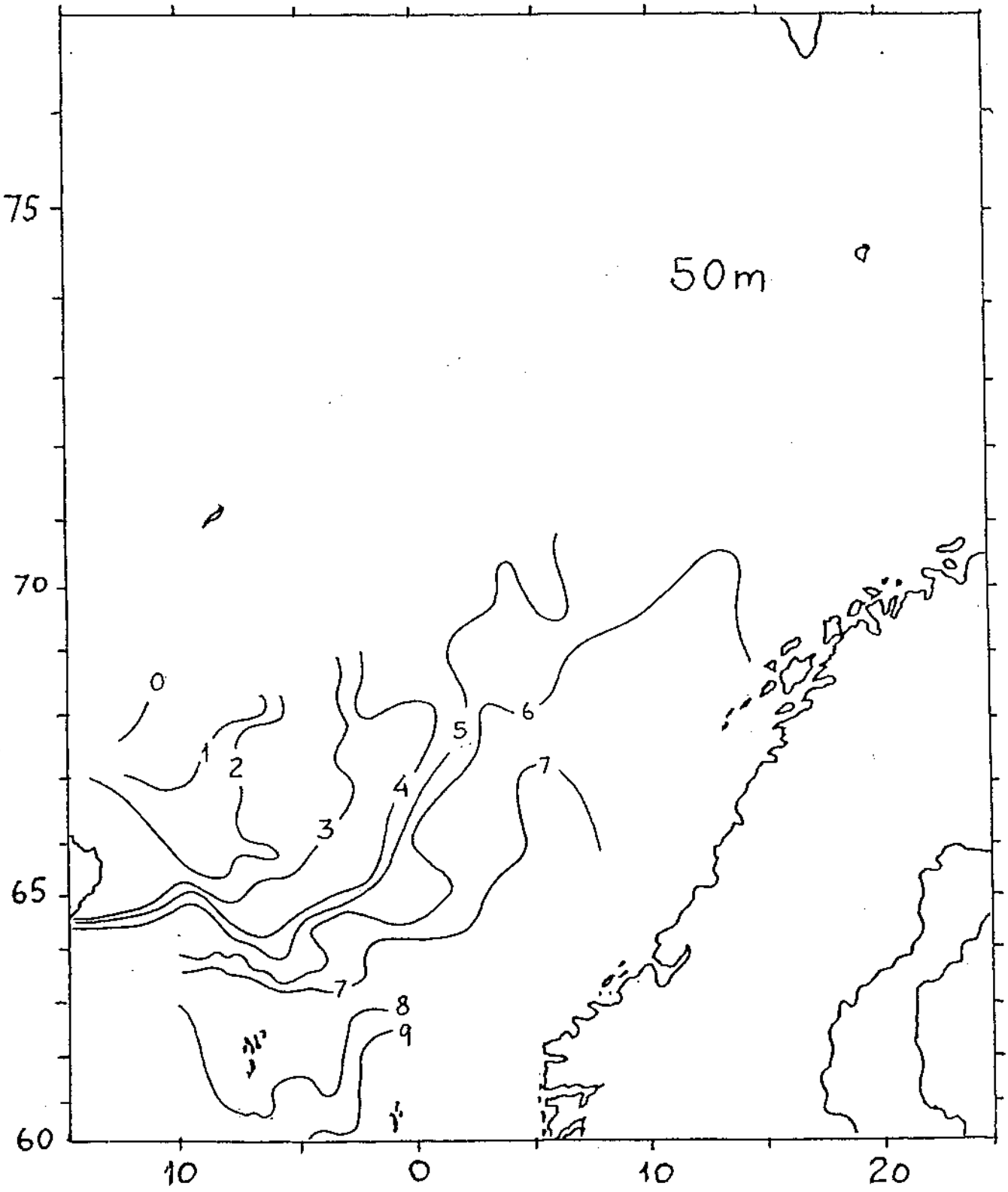

Fig.6.1. Temperature distribution (t°C) at 50m in the Norwegian Sea and adjacent waters in May/June 1996

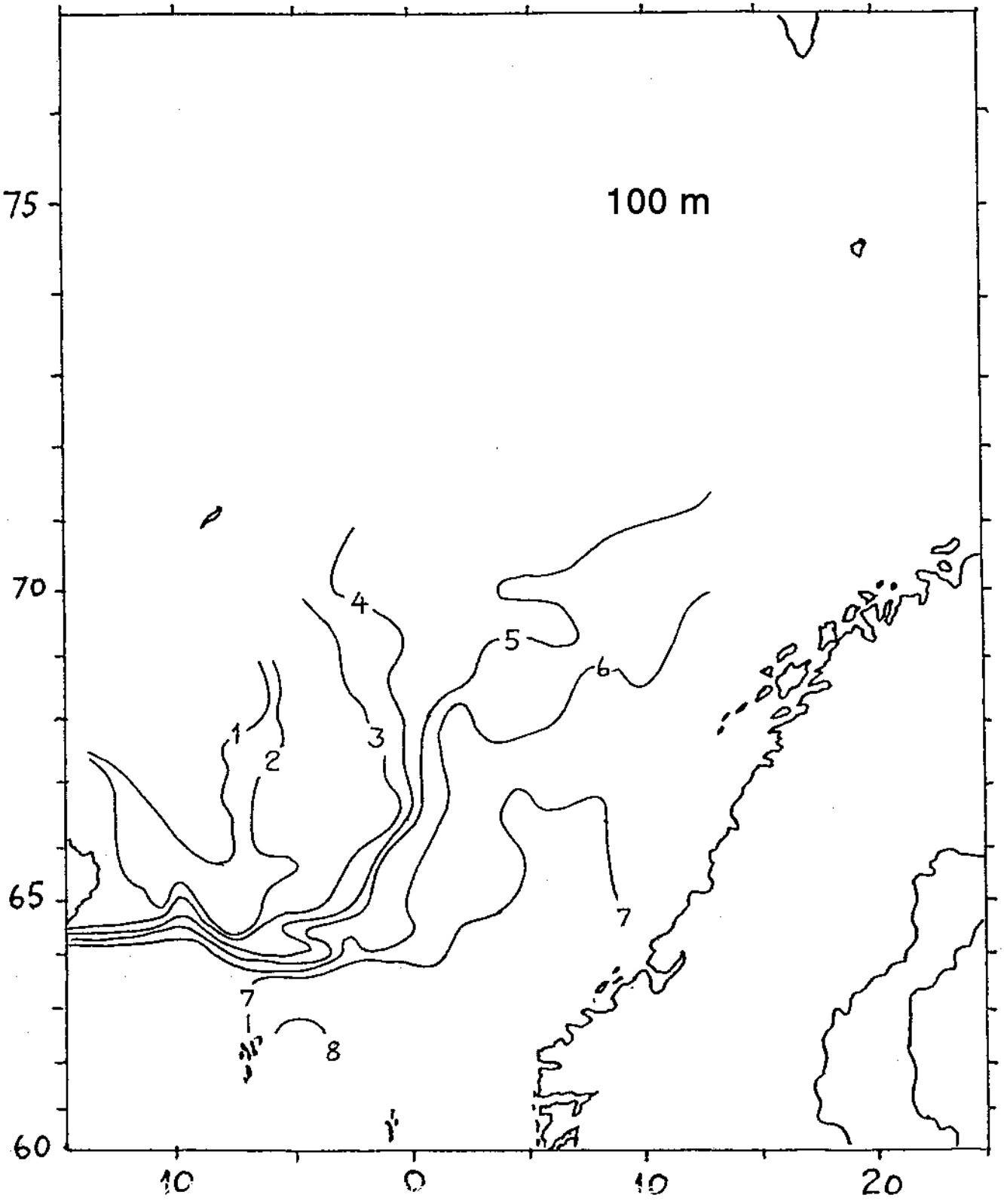

Fig. 6.2. Temperature distribution (t°C) at 100m in the Norwegian Sea and adjacent waters in May/June 1996

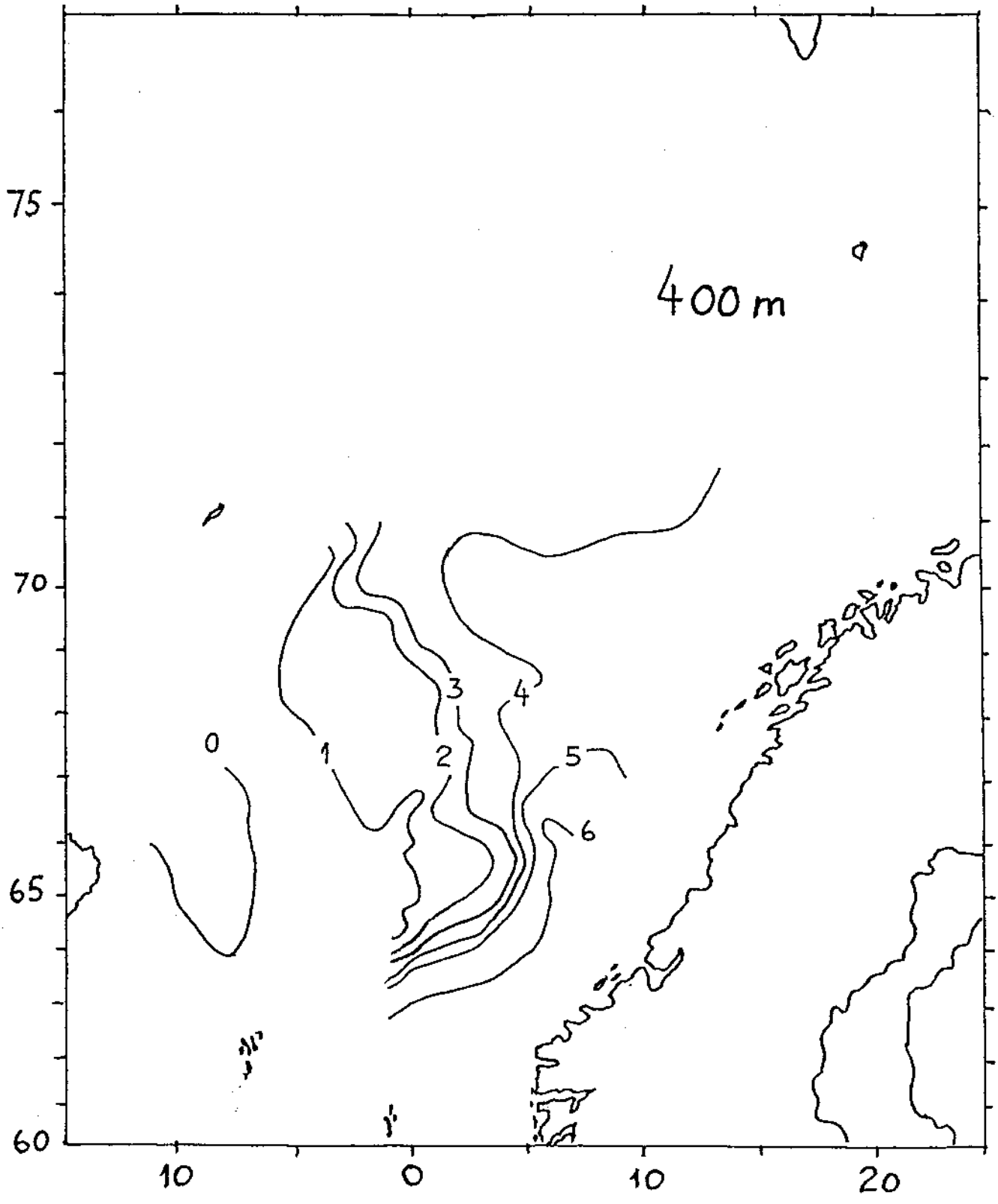

Fig. 6.3. Temperature distribution (t° C) at 400 m. in the Norwegian Sea and adjacent waters in May/June 1996.

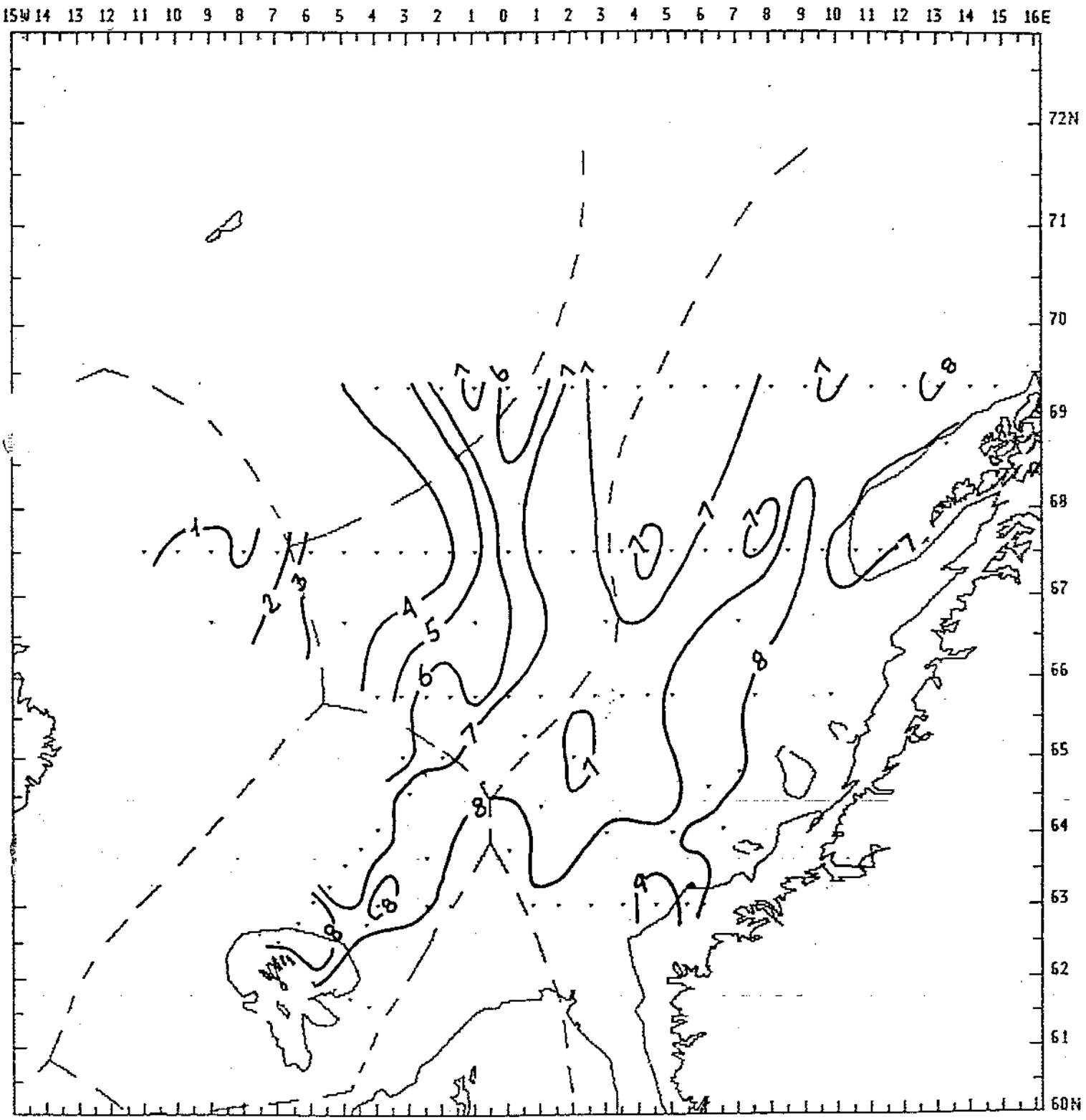

Fig. 6.4. Temperature distribution (t° C) at 50 m. in the Norwegian Sea in June/July 1996

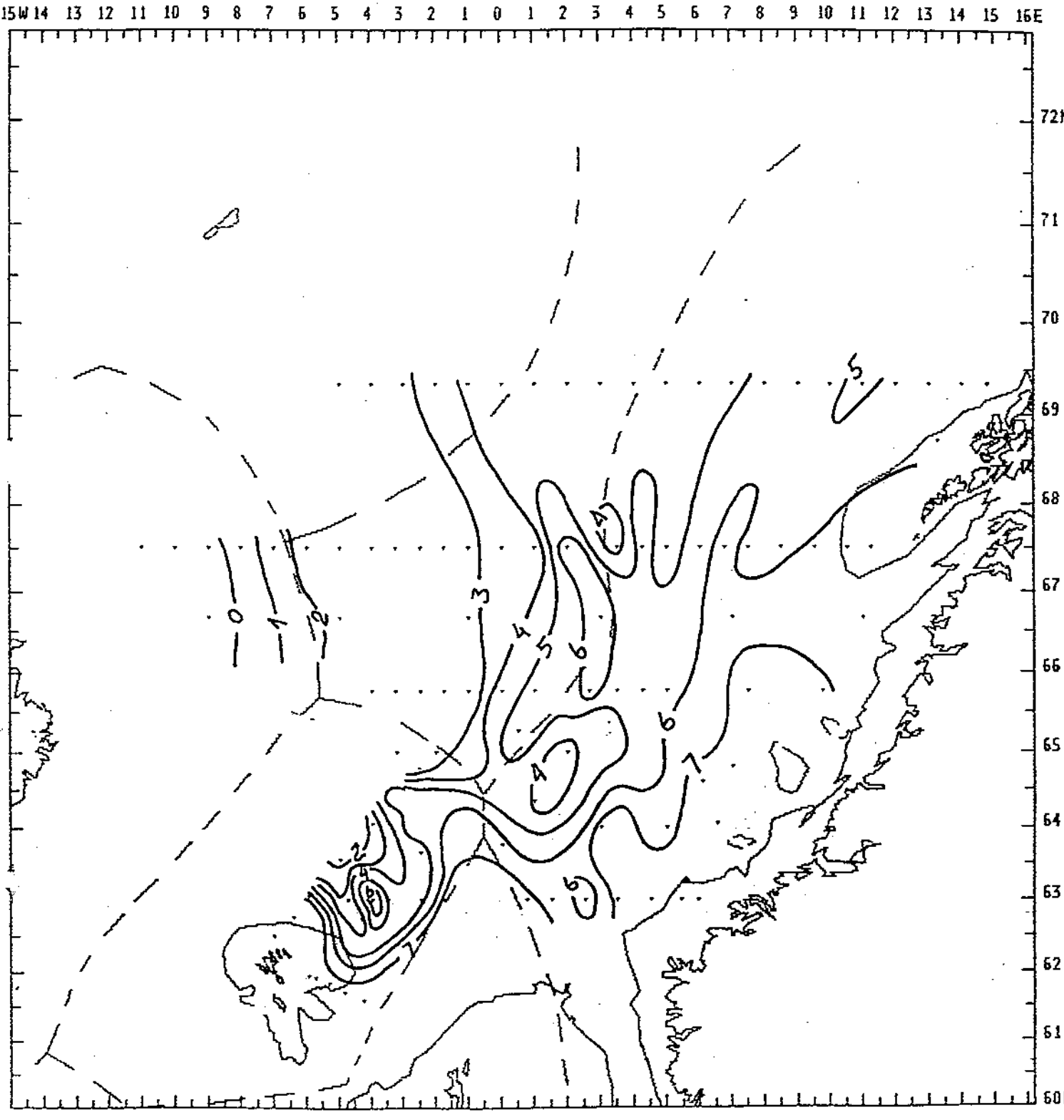

Fig. 6.5. Temperature distribution (t° C) at 100 m. in the Norwegian sea in June/July 1996.

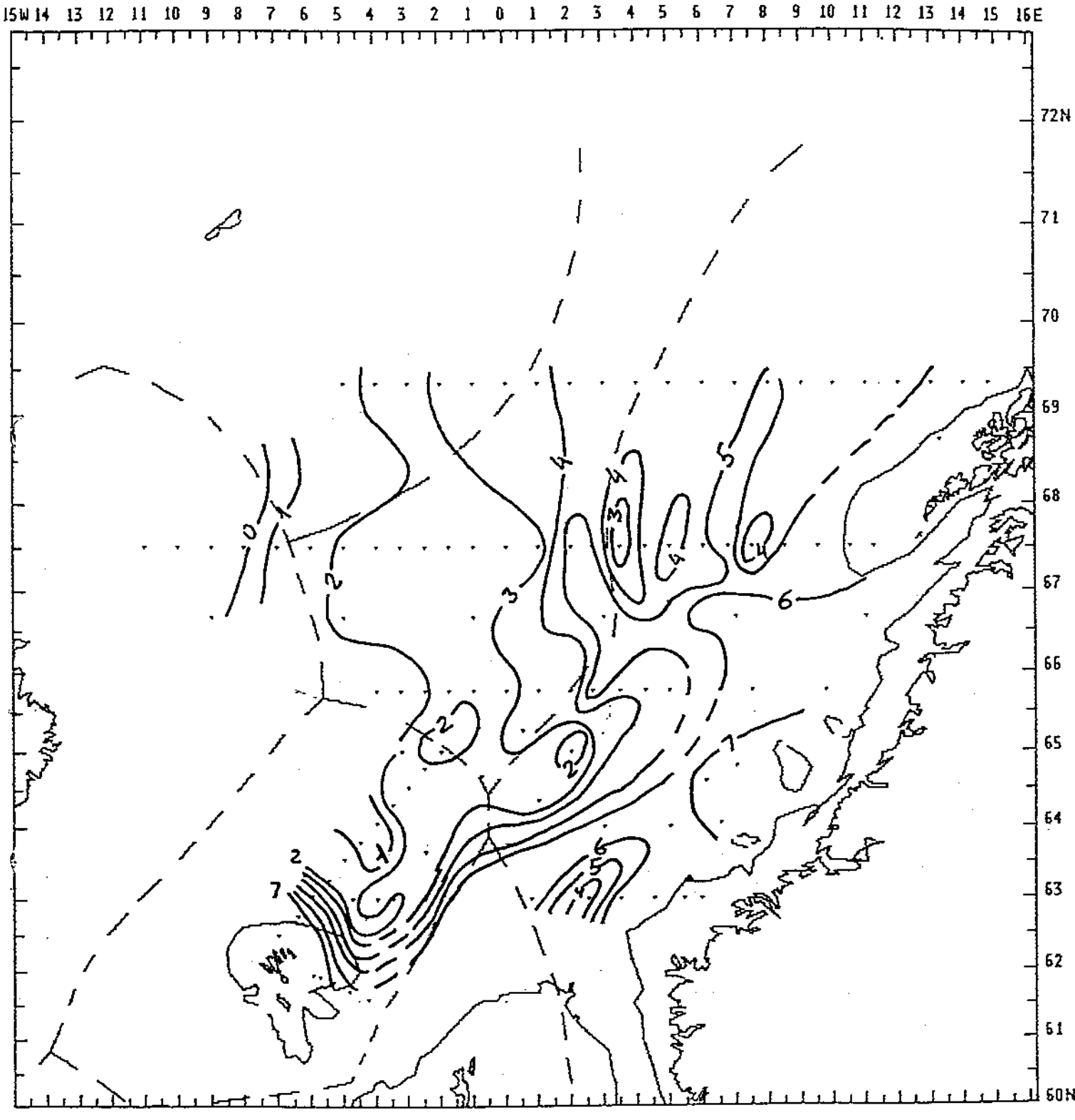

Fig. 6.6. Temperature distribution (t° C) at 200 m. in the Norwegian Sea in June/July 1996.

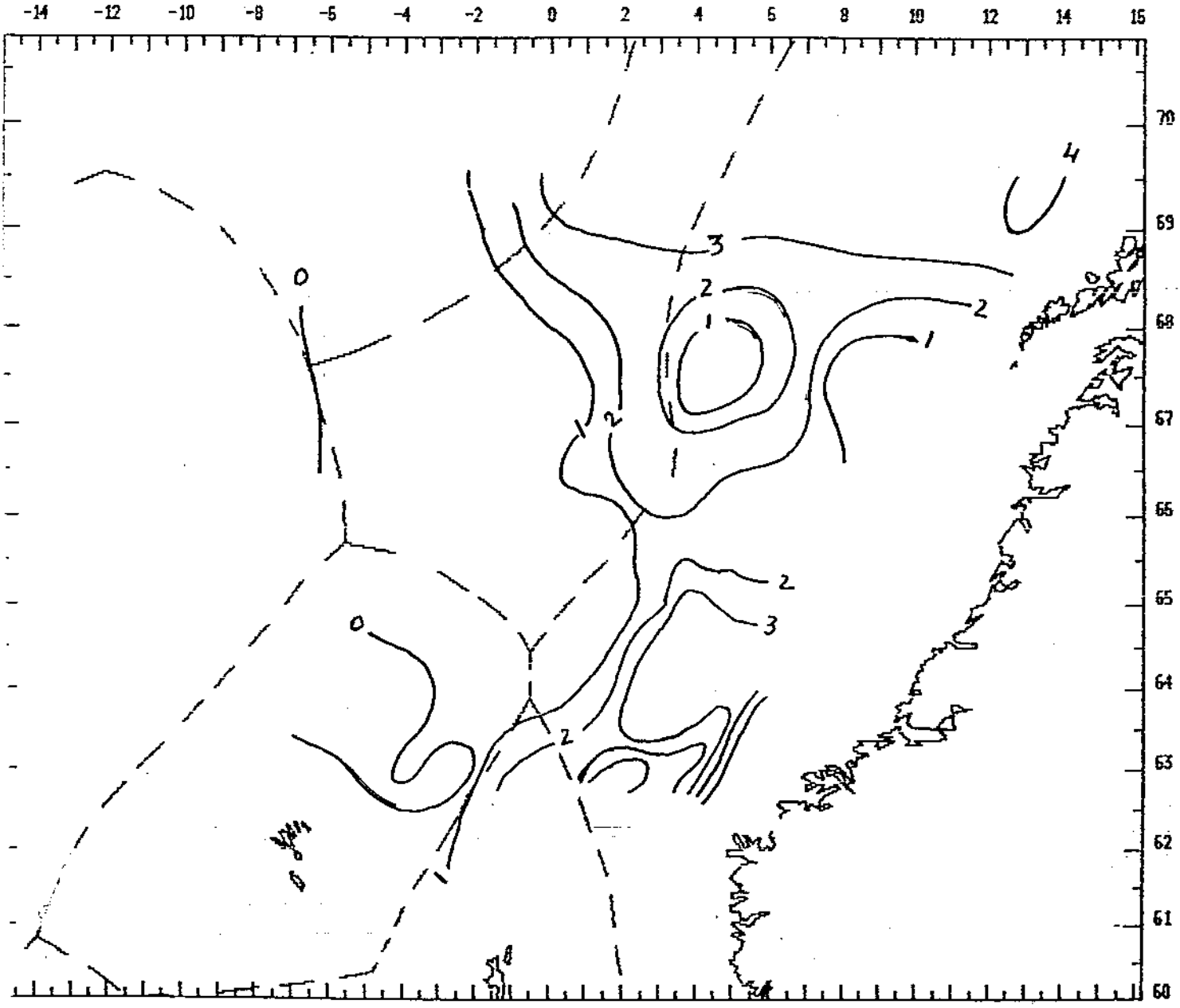

Fig. 6.7. Temperature distribution (t°C) at 500 m. in the Norwegian Sea in June/July 1996

Zooplankton density

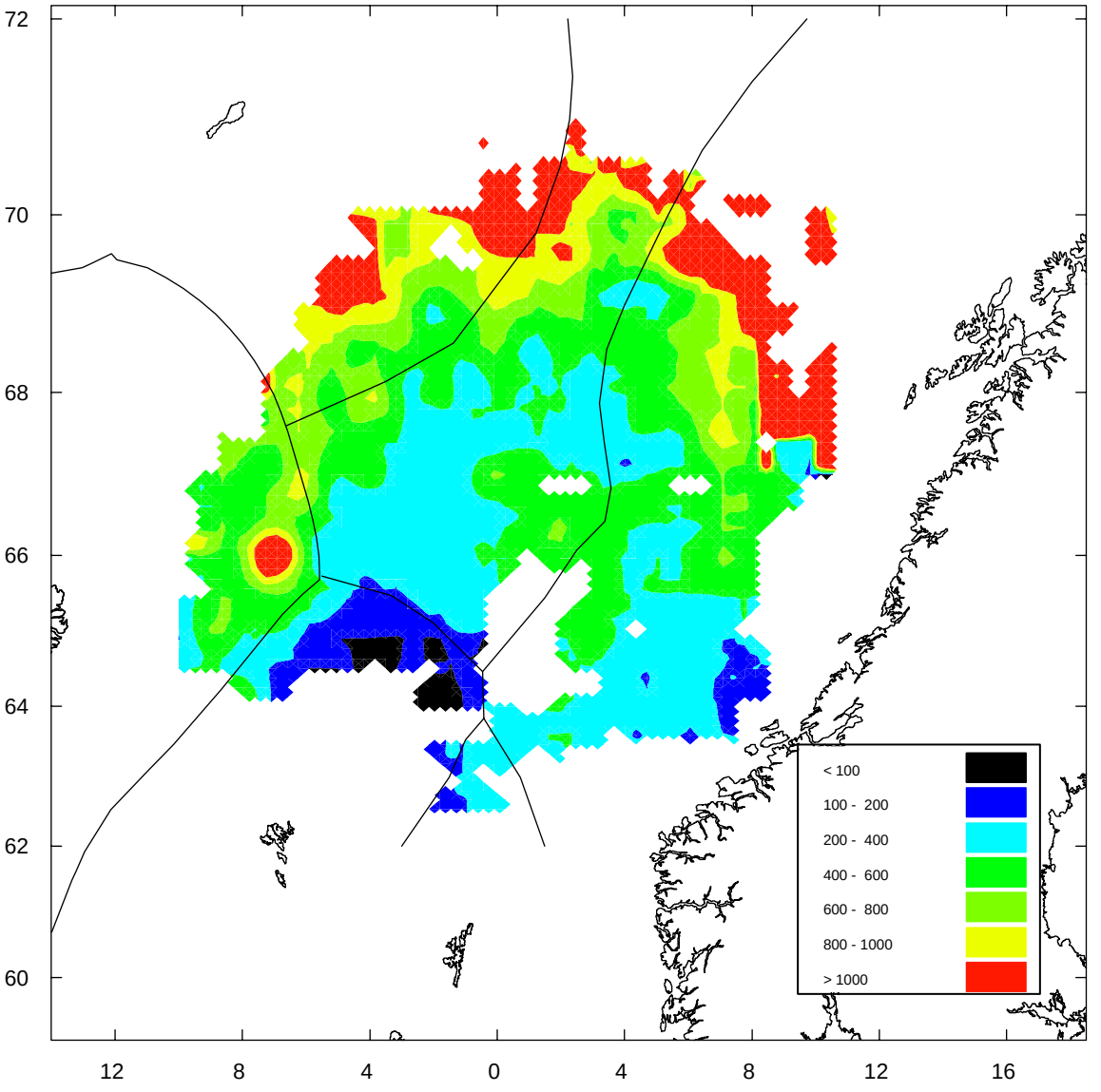

Fig.7.1. Zooplankton density in the norwegian Sea in May 1996 (mg dry weight / m^3)

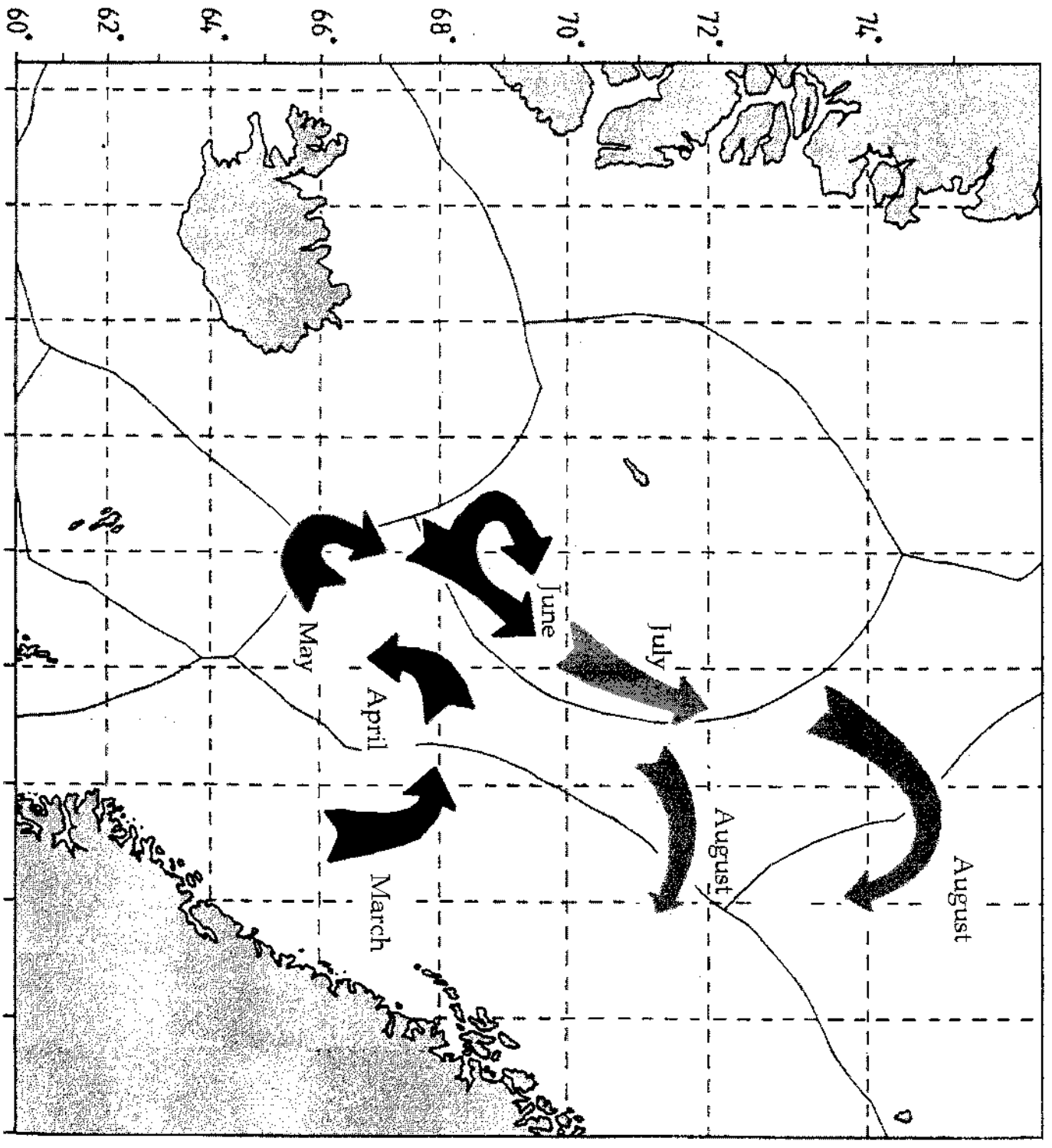

Fig. 8.1. Schematic presentation of the migration pattern of the older part of the adult population.

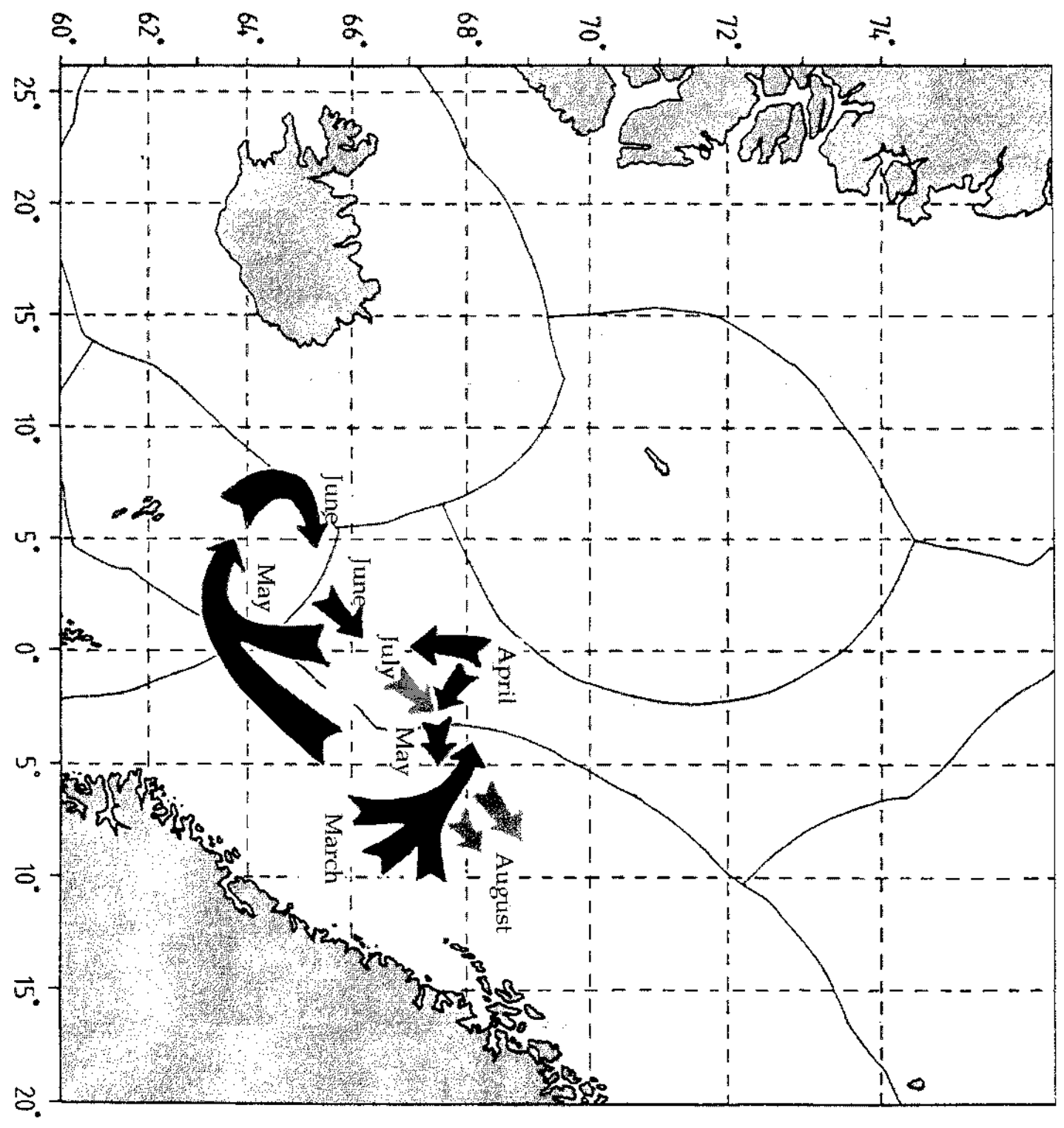

Fig. 8.2. Schematic presentation of the migration pattern of the younger part of the adult population