International Council for
the Exploration of the Sea

Pelagic Fish Committee
C.M. 1997/H:3

REPORT OF THE
ICES PLANNING GROUP ON SURVEYS ON
THE PELAGIC FISH IN THE NORWEGIAN SEA (PGSPEN)

Bergen, Norway,

20-21 February 1997

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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1. TERMS OF REFERENCES

According to the Resolutions adopted at the 1996 Annual Science Conference 84th Statutory Meeting, a Planning Group on Surveys on Pelagic Fish in the Norwegian Sea [PGSPEN] (Chairman: Dr. O.A. Misund, Norway) will be established and meet in Bergen, Norway for two days in February 1997 to:

a) plan and coordinate the national surveys on the pelagic resources and the environment in the Norwegian Sea in 1997, and, in particular;

b) plan a coordinated survey on Norwegian spring-spawning herring in May 1997.

The Planning Group will describe the procedures for acoustic, hydrographic, planktonic and fish sampling to be used on the surveys. The Planning Group will report to WGNPBW and to the 1997 Annual Science Conference.

2. PARTICIPANTS

Sergei Belikov	Russia
Eckhard Bethke	Germany
Johan Blindheim	Norway
Vladimir Borokov	Russia
Jens Cristian Holst	Norway
Hjalti í Jákupsstovu	Faroe Islands
Ole Arve Misund	Norway
Johan Modin	Sweden
Ingolf Røttingen	Norway
Valery Shleinik	Russia
John Simmonds	Scottland
Svein Sundby	Norway
Hjálmar Vilhjálmsson	Iceland

A full list of participants, addresses, telephone numbers and fax information is given in Appendix 1.

3. INTRODUCTION

In the early 1990s, after more than 20 years of abscense, the Norwegian spring-spawning herring reoccupied the Norwegian Sea as its main feeding area. From 1994, an international fishery has taken place during summer in this area. The catch in 1996 exceeded 1.2 million tonnes.This is now a typical straddling and highly migratory

stock. The migration route (and the fishery) crosses the borders of several national EEZ's, and this stock also appears in international waters.

In 1995 and 1996, Norway, Russia, Iceland and the Faroes coordinated their survey effort on this and other pelagic fish stocks in the Norwegian Sea with the aim to assess and describe the distribution of the pelagic resources, the general biology and behaviour in relation to the physical and biological environment (Anon. 1995a; Anon. 1995b; Anon. 1996a; Anon. 1996b).

From 1950, based on an ICES recommendation from 1948 (this can be considered the first initiative for joint international herring surveys), to the late 70s, similar surveys were conducted under the auspecies of ICES. At the 1996 Annual Science Conference, the Pelagic Committee recommended that the ICES cooperation should be reintroduced on the planning and conducting of future surveys on herring and the environment in the Norwegian Sea.

4. INTERSHIP COMMUNICATION

The Planning Group agreed that it was not advisable to develop procedures for exchange of detailed data on echo abundance, biological samples and hydrograpy between survey vessels in operation in the Norwegian Sea in summer 1997. Still, the group agreed that it is of vital importance that the survey vessels which are working in the Norwegian Sea at the same time establish contact by telex or radio. The respective cruises where such contact should be established are identified in Table 1. As for the 1995 and 1996 cruises in the Norwegian Sea, the radio contacts between the vessels should be established at 2182 kHz at 0900 or 2100 UTC.

The information to be exchanged between the survey vessels should be rather concentrated. The topics to be focused are the area covered by own survey vessel, recordings of herring and other important pelagic fishes, hydrograpic conditions, and observations or information of activity by fishing vessels.

5. CRUISE REPORT

From all cruises in the Norwegian Sea identified in Table 1, there should be prepared a cruise report. This report should be prepared during the respective surveys, and normally be finished when the respective cruise is ended. Each cruise leader for the respective cruises is responsible for preparing the cruise report. Within one week after the end of the cruises identified in Table 1, the cruise report should be mailed to Hjalmar Vilhjalmsson at Hafrannsoknastofnunin in Iceland.

The cruise report should give a brief overview of the area investigated, the recordings obtained, and the sampling conducted. As a minimum, the cruise report should contain the standard information as given in Cruise Report Table (Appendix 2).

6. DATABASE

The data base should contain the most vital information regarding sampling activity, acoustic recordings, biological samples of fish, hydrograpy, and plankton. The information should be prepared in a standard format that makes the data accessible to the participating institutions. An important motivation for establishing such a database, is that maps of fish distribution, plankton abundance and hydrographic regime could be easily prepared during annual evaluation meetings. Another motivation for a common database on a standard format is that this will increase the amount of available data on the Norwegian Sea ecosystem substantially. This will enable future special studies on the dynamics and interactions of this ecosystem that can be based on more complete informations obtained by more complete surveying of the Norwegian Sea in space and time.

7. DATABASE WORKSHEETS

The 1996 planning group agreed to develop standards for EXCEL worksheets that should contain the most vital information gathered during the respective cruises in the Norwegian Sea in 1996 (Anon. 1996a). The planning group developed standards for a **Logbook** worksheet, an **Acoustic** worksheet, a **Length Distribution** worksheet, a **Temperature** worksheet, and a **Plankton** worksheet. The standards of these worksheets are given in Appendix 3.

The respective worksheets should be prepared during the Norwegian Sea cruises in 1997 also. After each cruise, the worksheets should be copied on disks and sent along with the cruise report to Hjalmar Vilhjalmsson. A list of content should be taped to each disk. The cruise leaders of the respective cruises should have the responsibility to prepare the worksheets and copy them on disks.

8. DATABASE LOCATION

The original set of the database will be systemized and kept at the Hafrannsoknastofnun, Reykjavik, under the responsibility of Hjalmar Vilhjalmsson. The database will be available to all contributing partners.

9. USE OF SONAR FOR MAPPING DISTRIBUTION OF SCHOOLS

In summer, the main part of the herring is feeding in the near surface layer of the Norwegian Sea, often in the upper blind zone of the echo sounder. A traditional echo integrator survey will thus underestimate the stock, both in biomass and distribution surveys. However, sonar recordings seem to have the potential to give a correct picture of the distribution of Norwegian spring spawning herring during the summer period (Misund et al., 1996).

As in 1995 and 1996, the planning group recommends that sonar is used regularly to count schools during the surveys in the Norwegain Sea in 1997. The working procedure is as follows:

1) *The sonar is set at a fixed position at 90^{o} to the ships course*
2) *All schools along a 5 nautical mile distance and within a range of 50 - 300 m from the vessel should be counted. The recordings should be filled in the SCHOOLS-cloumn of the ACOUSTIC worksheet (Appendix 3).*
3) *As a basic rule, a tilt angle of half the vertical beam width should be applied.*

10. SURVEYS

The surveys given in the following text table have been planned for 1997.

Country	Vessel	Period	Cruise leader	Contact
N1	"G.O. Sars"	05.04 - 22.04	Misund	
N2	"G.O. Sars"	01.05 - 01.06	Holst	S1, I1, F1
N3	"Johan Hjort"	19.06 - 16.07	Ellertsen	
N4	"G.O. Sars"	19.07 - 17.08	Monstad	
R1	"Atlantida"	15.05. - 31. 05.	Krysov	
R2	"Atlantida"	01.06. - 17.06.	Krysov	
I1	"Arni Fridriksson"	02.05. - 27.05.	Vilhjalmsson	F1, S1, N1
I2	"Arni Fridriksson"	03.06. - 16.06.	Vilhjalmsson	
I3	"Bjarni Sæmundsson"	20.05. - 10.06.	Malmberg	
G1	"Walter Herwig III"	21.03. - 07.04.	Bethke	
F1	"Magnus Heinasson"	01.05. - 21.05.	Jákupstovu	I1, S1, N2
S1	"Argos"	28.04. - 23.05.	Håkanson	N2, I1, F1

The main objects and areas covered during the above surveys are listed below:

N1: The survey will cover the spawning grounds off Lofoten and the edge of the continental shelf of western Norway (Fig. 1).

N2, I1, F1, S1: The main objective will be to conduct coordinated surveys to map the distribution and measure the abundance of herring in the Norwegian Sea (Fig. 2).

N3, R2, I3: The main objective of the surveys will be to monitor environmental parameters and map the distribution of herring in the Norwegian Sea (Fig. 3).

N4 The survey will cover the eastern Norwegian Sea between 62° N and 72° N to map the distribution of herring and monitor environmental parameters (Fig. 2).

G1 The objects of the survey are to study the migration of the herring and their reactions to vessel noise (Fig 5).

R1 The survey will cover transects in the Barents Sea and off the Finnmark coast (Fig. 6).

11. SURVEY AREA AND STRATEGY FOR THE MAY COORDINATED SURVEYS (N2, I1, F1, S1).

The distribution of the stock in May 1995 and 1996 has been used to define an overall area within which the spring spawning herring can be expected to be found. The boundaries of this area are:

62N to 70N
10W to 5E (the Norwegian coast) at 62N
10W to 15E at 70N

Four vessels are available for the survey. There are a number of strategies for the four vessels that may be used to obtain estimates of abundance and to map the stock. The main aims of the strategy are to minimise the effects of migration, minimise the variance of the estimate and provide a strategy that will be robust to missing data due to failure of a vessel or poor fishing performance. In addition there are a number of administrative requirements that suggest that both Norway and Faeroes need to start the survey in the south.

Within this area, the distribution cannot be predicted with any great certainty, as the distribution is effected by the timing of the migration, which is expected to be variable, and the Icelandic cold front, which is thought to affect the westward limit of the stock. Both the shelf break and the Icelandic front are believed to influence the stock, and both these are features that have greater continuity in a north-south direction, giving anisotropic fish distribution with greater range of autocorrelation in the same north-south direction. This anisotropy is supported by the continuity of the observed major concentrations in 1996.

On this basis, greater survey precision is obtained by use of a survey with transects in an east-west direction, the direction with the shortest range of autocorrelation. The use of a systematic survey strategy of equally spaced transects provides a minimum variance estimate of the stock assuming statistical stationarity; the location of the major abundance is unknown and may be anywhere dependant on the timing of the migration. The stock follows a migration first westwards off the shelf southwards and then northwards at the end of the survey period. Any bias in the survey due to a migration in the east west direction is minimised by the selection of east-west transects.

There is a need to maximise the rate of progress of the survey in the north-south direction in order to minimise the influence of any possible migration in this direction. There is also a need to minimise the influence of any disparity between any of the four vessels. The choice of an east- west split in the area reduces vessel steaming time to and from the area as two vessels are deployed from the east and two from the west. The use of an interlaced survey track of east west transects progressing northwards from the southern boundary provides the fastest northwards rate of survey progress and a robust method of using two vessels surveying the same area. One pair of vessels in the east and one pair in the west.

A small overlap in survey area is suggested to reduce problems with any difference in timing of the two parts of the survey. Strictly a random starting point is preferable for the whole survey grid if the aim of the survey is to provide an abundance estimate rather than an index. It would be preferable if the transects in the east and western sections were at the same latitude. This would allow the survey to obtain estimates of variance from the simple 1D. transitive method.

The two survey regions are:

East Region	62 N to 70N 10 E to 0
West Region	3W to 5E at 62N to 3W to 15E at 70N

A survey with 30 Nm spacing between transects 15' and 45' North, using full length transects with inter-transects which would not be included in the survey gives:

		Eastern Survey	Western Survey
Distance	(Nm)	5770	4351
Days @ 150Nm/day		38.5	29.0

The survey will commence at the southern boundary and progress in a northerly direction using east west transects. The vessels will maintain close contact and on completion of a transect will carry out the next

available transect to the north, this will be the next northerly transect unless this transect is already being surveyed by the other vessel.

As the survey progresses care should be taken to check on general use of time:

If more time is available, the possibility of surveying further north or of carrying out a replicate transect should be considered.

If time is short, transects may be omitted and values for the missing transects obtained by interpolation.

The acoustic and fishing data from survey should be used to estimate:

The abundance (number) of spring spawning herring for each ICES statistical rectangle.
The proportion of fish at age for each ICES statistical rectangle
The mean weight at age for each ICES statistical rectangle
The biomass in each statistical rectangle (for a check)

This data should be provided in an EXCEL 5 file.

Column 1		Column 3	Columns 4-16	Cols 17-29
ICES Stat sq	Number	Biomass	Prop at Age	Mean Weight
	Million	Thousand T	13 columns	13 columns
			2, 3,...14.	2,3,....14.

12. FUTURE MEETINGS

The participants of the Bergen meeting unanimously agreed that an evaluation meeting for the Nowegian sea surveys in question, conducted by the Faroes, Iceland, Norway, Russia, and the EU should be held in Reykjavik during the period 20-22 August 1997. The main tasks to be adressed will be to evaluate the quality and usefulness of the acoustic estimate, to consider the migration pattern of the herring stock during 1997, and to evaluate the experiences gained during the 1997 season. Finally the meeting will plan and coordinate the surveys to be carried out during 1998.

13. PUBLICATIONS

The report from the joint surveys will be submitted to the ICES 1997 Annual Science Conference. Hjalmar Vilhjalmsson will inform the ICES Secretariat on this before 28 April. The report will be finalised and sent to the annual science meeting after the evaluation meeting in Reykjavik in August.

14. REFERENCES

Anon. 1995a. Report of the planning group for surveys on Norwegian spring spawning herring and the environment in the Norwegian Sea in summer 1995. Bergen, 2-3 March 1995.

Anon. 1995b. Report on surveys of the distribution and migrations of the Norwegian spring spawning herring and the environment of the Norwegian Sea and adjacent waters during spring and summer of 1995. Reykjavík, 11-13 September 1995.

Anon. 1996a. Report of the planning group for surveys on the Norwegian spring spawning herring and the environment of the Norwegian Sea and adjacent waters during spring and summer of 1996. Torshavn, 13-14 March 1996.

Anon. 1996b. Report of the 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. Reykjavik, 24-26 September 1996.

Misund, O. A., A., Aglen., J. Hamre, E. Ona, I. Røttingen, D. W. Skagen and J. W. Valdemarsen 1995. Improved mapping of schooling fish near the surface: comparison of abundance estimates obtained by sonar and echo integration. ICES J, mar. Sci., 53: 383-388.

APPENDIX 1. PARTICIPANTS

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APPENDIX 2. CRUISE REPORT CONTENT

Name of ship	Comments
Call sign	
Cruise number	
Responisible laboratory	
Cruise leader	
Cruise period	
Echo sounder equipment	
Echo integrator equipment	
Instrument calibration date	
Sampling equipment (trawl)	
Sampling equipment (plankton)	
Type of CTD sonde	
Number of trawl stations	
Number of CTD stations	
Cruise lines and stations	On map (including EEZ) and Database
Echo integrator values (9 groups, see Appendix)	Distribution maps and worksheets
Sonar recordings	Database
Length distributions	Table and worksheets
Age distribution	Table and worksheets
Temperature	Horizontal distribution maps: Surface, 20, 50, 100, 200, 400, 500m, and worksheets
Plankton	Plankton biomass distribution map and worksheets

APPENDIX 3. DATABASE WORKSHEETS

HEADING	DESCRIPTION
Loogbook sheet:	
VESSEL	ICES-list
STATION	National st. numbers
STTYPE	Geartype/activity: one line per activity at the same station
LOG	min 4 digits
DATE	YYMMDFD
TIME	GMT our dfidgits TTMM
LAT	Decimal degrees
LON	Decimal degrees
WINDIR	Compas deg. or N, NNE, NE (give units in heading)
WINFORCE	m/s or beaufort (give units in heading)
STDEPTH	metres
TOWTIME	minutes
WIRELENGTH	metres
HERRING	Species catch list: Always start with herring (Catch in kg)
BLUE WHITING	
CAPELIN	
MACKEREL	
HMACKEREL	
SALMON	
LUMPSUCKER	
MESOPEL	
Acoustic sheet:	
VESSEL	ICES list
LOG	min 4 digits
DATE	YYMMDD
TIME	GMT four digits TTMM
LAT	Decimal degrees
LON	Decimal degrees, negative LON west of 0
SCHOOLS	No. of schools counted each interval
HESUM	Species list: Always start with herring
HE1	sa value channel 1: 10 - 50 m
HE2	sa value channel 2: 50 - 100 m
HE3	sa value channel 3: 100 - 150 m
HE4	sa value channel 4: 150 - 200 m
HE5	sa value channel 5: 200 - 250 m
HE6	sa value channel 6: 250 - 300 m
HE7	sa value channel 7: 300 - 350 m
HE8	sa value channel 8: 350 - 400 m
HE9	sa value channel 9: 400 - 500 m
BWSUM	blue whiting
BW1 - BW9	sa blue whiting channel 1 - 9 as for herring
Temperature sheet:	
VESSEL	ICES-list
STATION	National station numbers
LAT	Decimal degrees
LON	Decimal degrees, negative LON west of 0
SURFACE	Temperature at standard depths, starting from the surface
T20	
T50	
T100	
T200	
T400	
T500	

Plankton sheet:

VESSEL	ICES-list
STATION	National station numbers
STTYPE	Geartype/activity: one line per activity at the same station
LAT	Decimal degrees
LON	Decimal degrees, negative LON west of 0
PLSUM	Plankton mg dry weigth/m3 (or mg wet weigth/m3) in each interval
PL 0-50	
PL 50 -200	

Length sheet:

VESSEL	ICES list
STATION	Station number
SPECIES	Species - se other worksheets
CM group	No of fish in each cm group
MEANL	Mean length in the sample
MEANWT	Mean weight in the sample

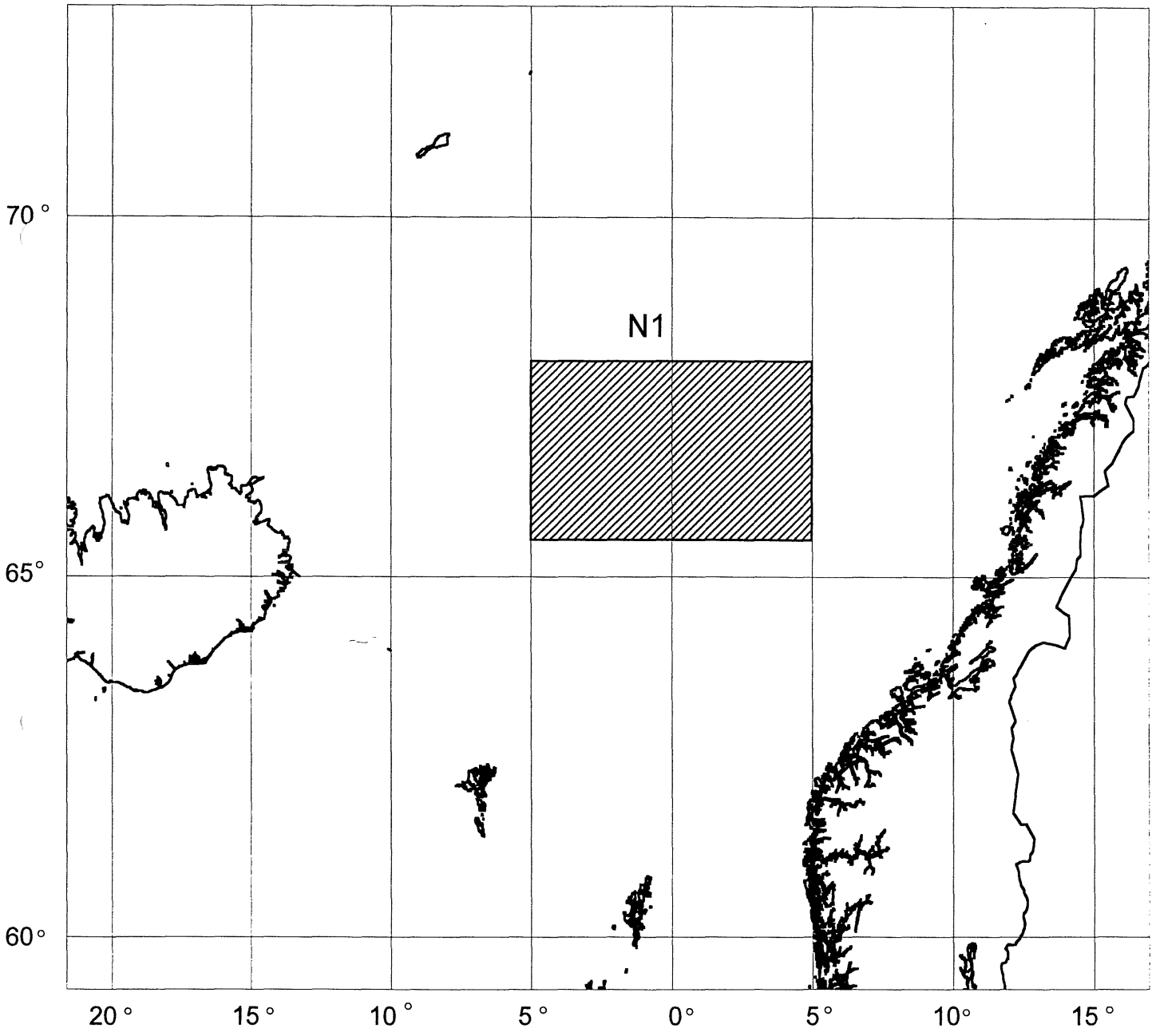

Figure 1. Planned survey area for "G.O. Sars", 05.04.-22.04.97 (**N1**).

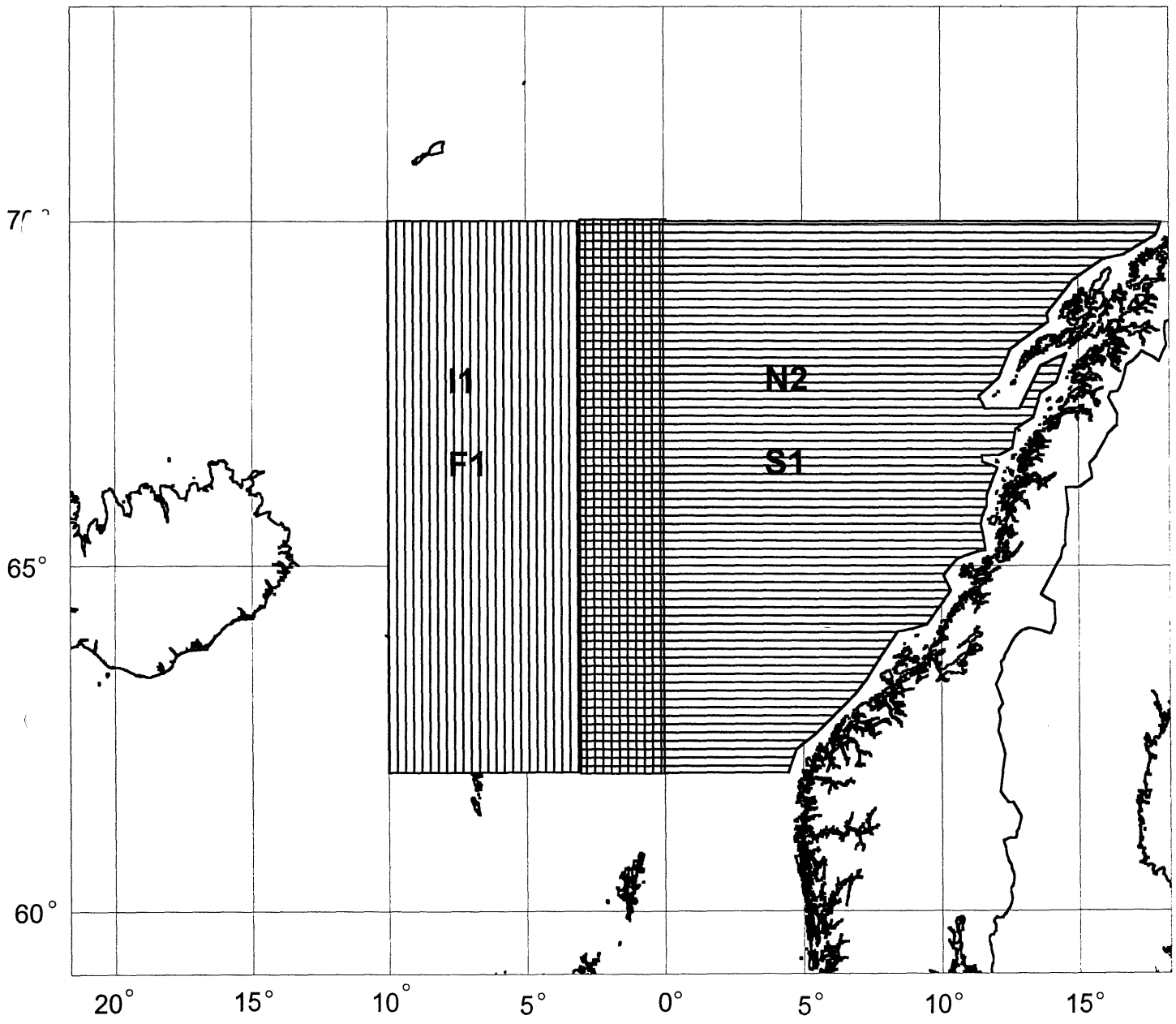

Figure 2. Planned survey area for "G.O. Sars", 01.05. - 01.06.97 (**N2**), "Magnus Heinasson", 01.05. - 21.05.97 (**F1**), "Arni Fridriksson", 02.05. - 27.06.97 (**I1**), and "Argos", 28.04. - 23.05.97 (**S1**).

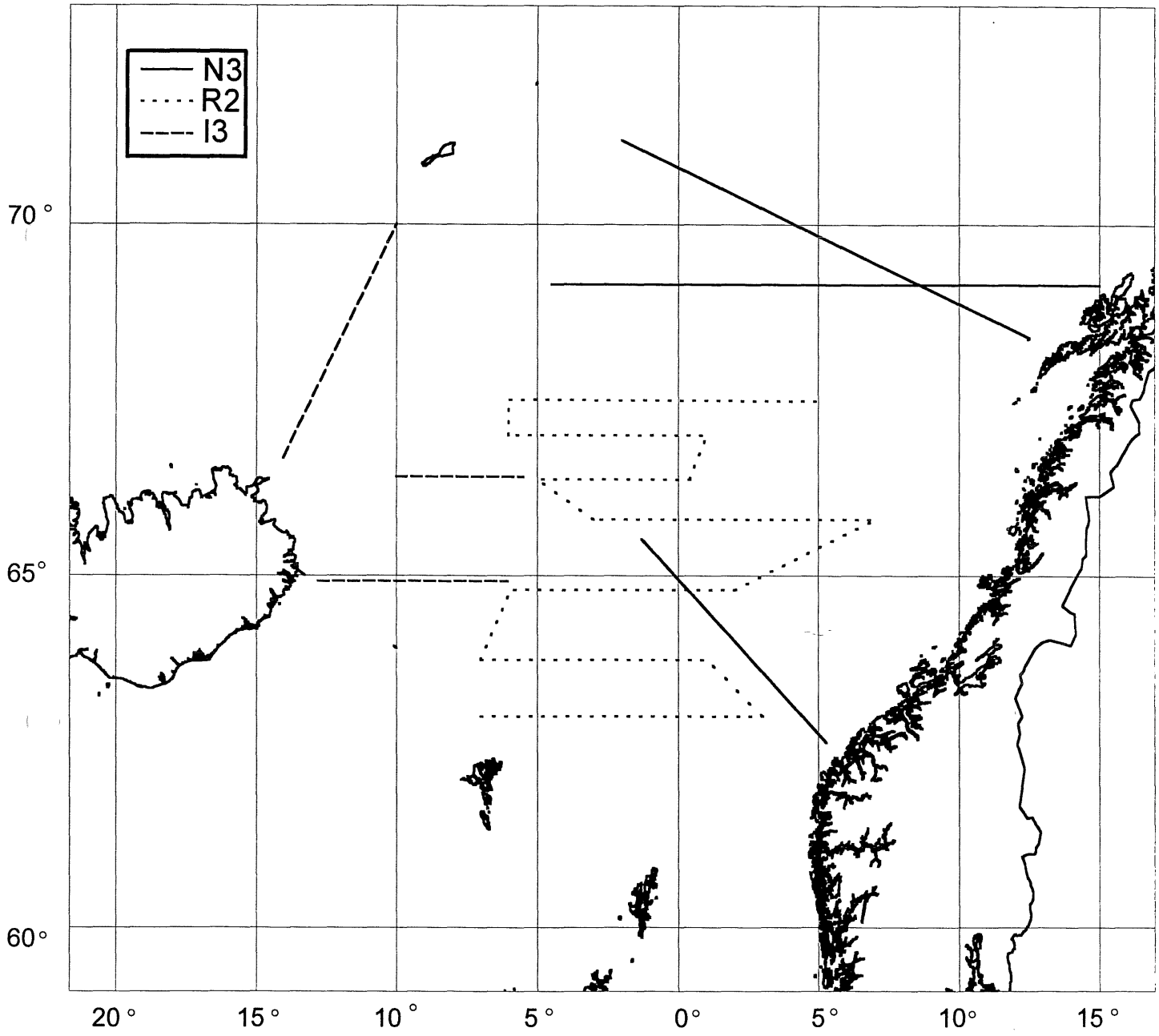

Figure 3. Planned survey area for "Johan Hjort" (**N3**), "Atlantida", 01.06. - 17.06.97 (**R2**) and "Arni Fridriksson", 03.06. - 16.06.97 (**I3**).

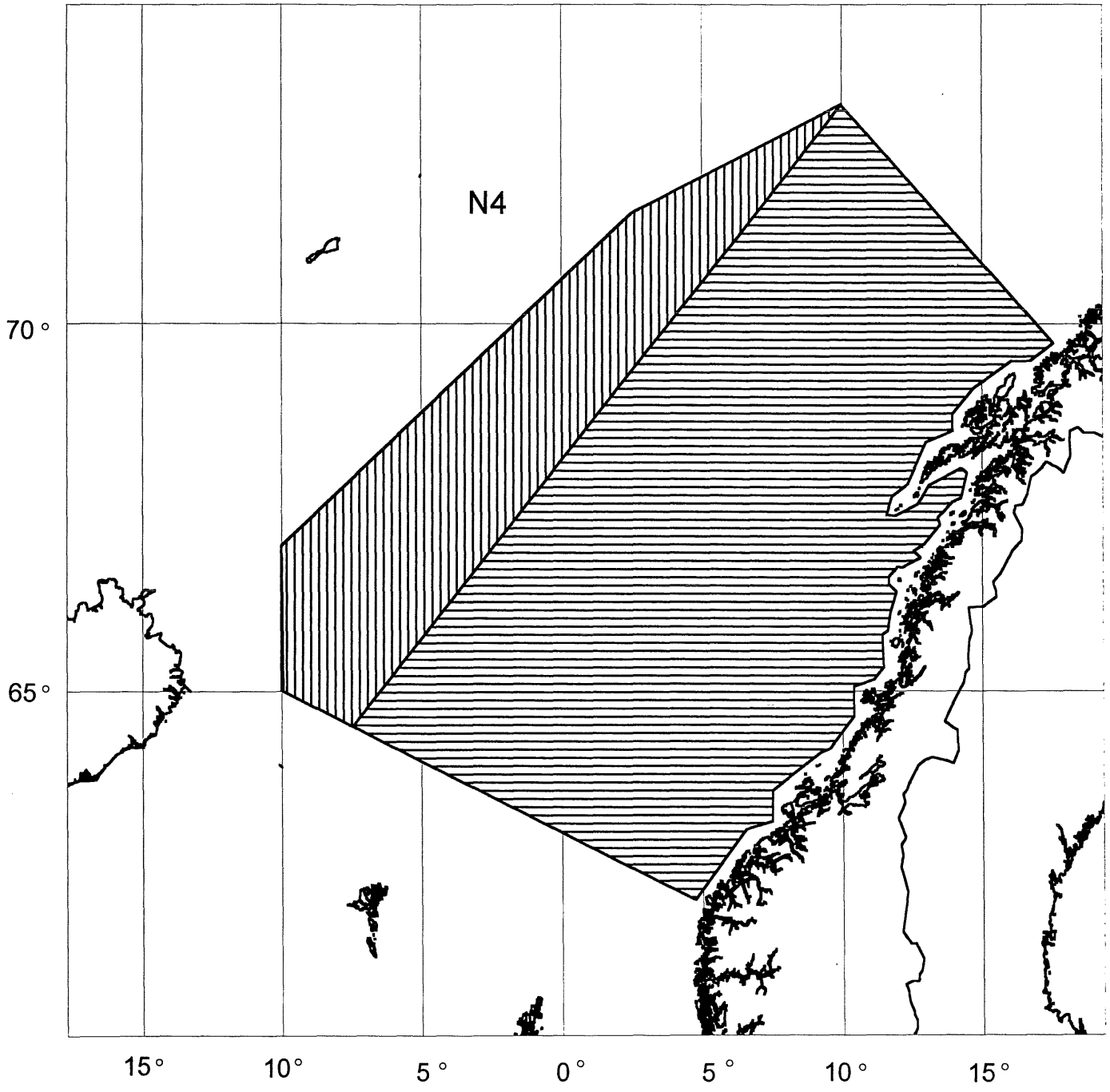

Figure 4. Planned survey area for "G.O. Sars", 19.07 - 17.08.97 (**N4**). The survey will begin in the south of the area and proceed northwards. Eventual trancets farther to the west are indicated by broken lines.

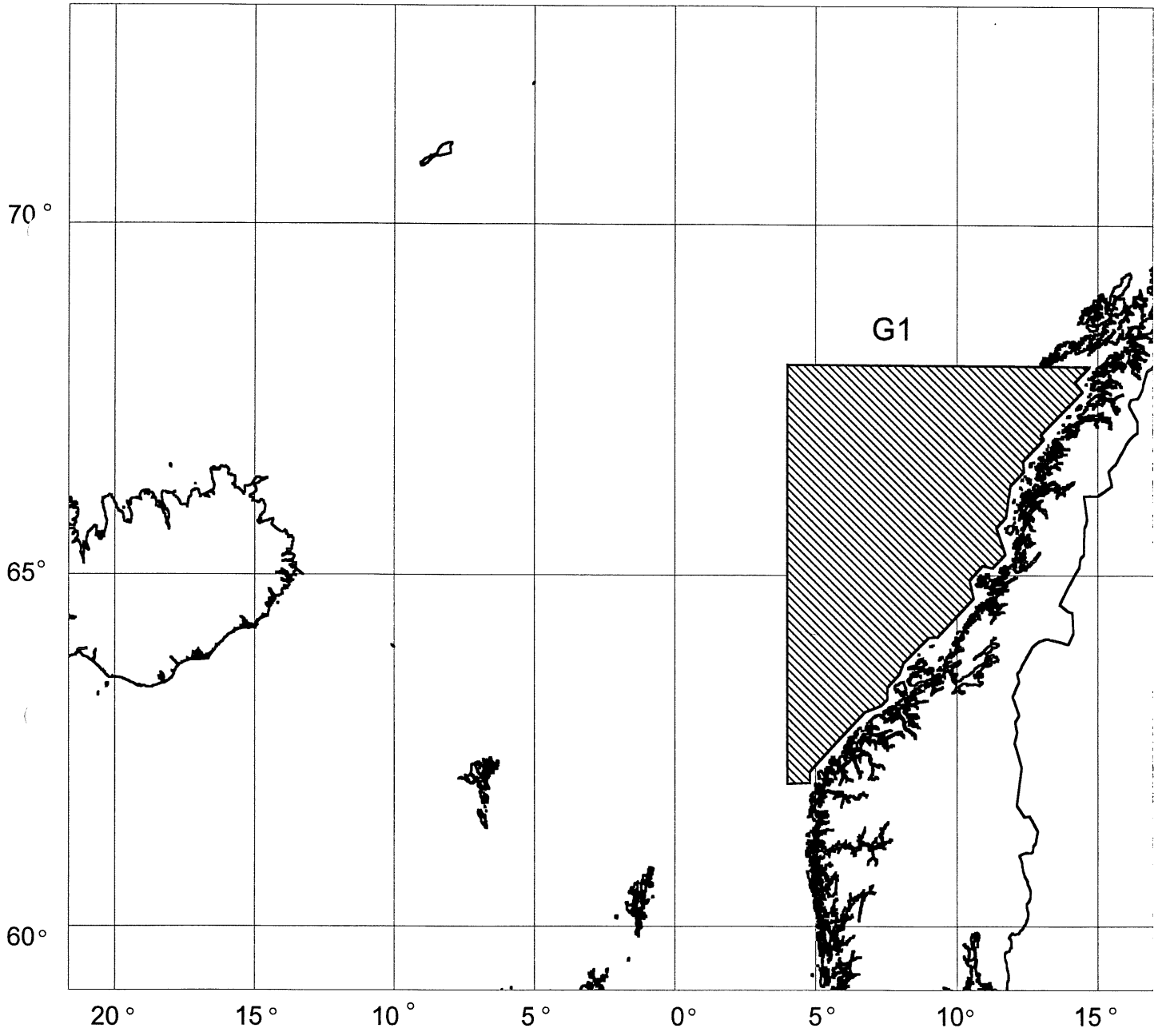

Figure 5. Planned survey area for "Walter Herwig III", 21.03. - 07.04.97 (**G1**).

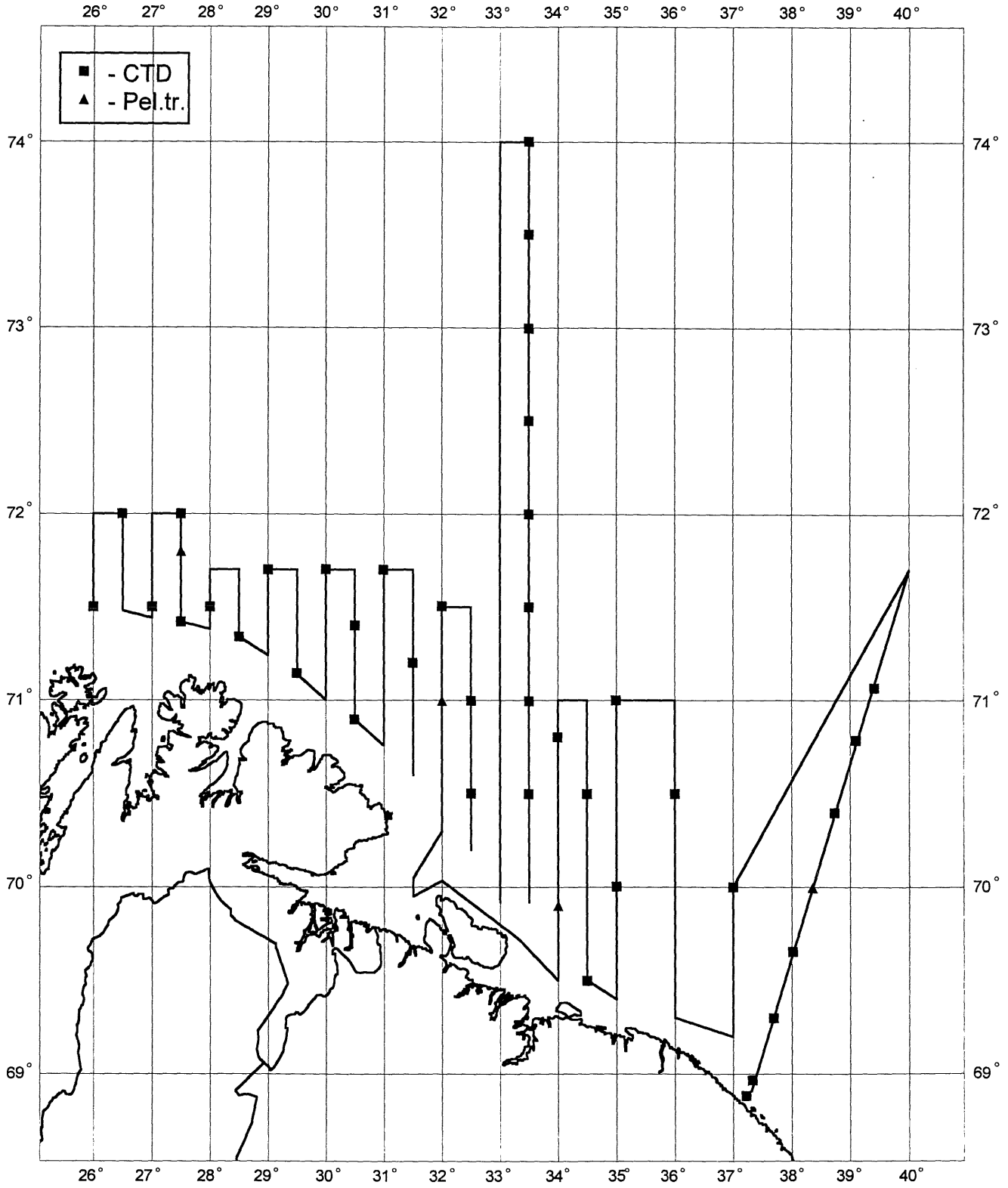

Figure 6. Planned survey tracks for "Atlantida", 15.05. - 31. 05.97 (**R1**).