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International Council for the
Exploration of the Sea

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REPORT ON THE ATLANTO-SCANDIAN HERRING AND CAPELIN WORKING GROUP

ICES Headquarters, 27-29 October 1982

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1. INTRODUCTION AND PARTICIPATION

1.1 Terms of Reference

The Atlanto-Scandian Herring and Capelin Working Group met at ICES headquarters 27-29 October 1982.

Ther terms of reference are given in the Council's resolution 1981 /2:27:15

> " the Atlanto-Scandian Herring and Capelin Working Group (Chairman: Mr J Jakobsson) should meet at ICES headquarters from 4 to 6 May 1982 to assess the state of the Atlanto-Scandian herring stocks, and from 27 to 29 October 1982 to assess the state of capelin stocks in Sub-areas I, II, V and XIV, and advise on any necessary management measures for these stocks.
> Data deficiencies should be specified".

As the Chairman J Jakobsson could not participate, the meeting was chaired by J. Hamre.

1.2 Participants

J. Carscadden	Canada
A. Dommasnes	Norway
J. Hamre (Chairman)	Norway
P. Kanneworff	Denmark
Ms T. Smolianova	USSR
N. Ushakov	USSR
H. Vilhjalmsson	Iceland

Mr K Hoydal participated in his capacity as Secretary to ACFM.

2. BARENTS SEA CAPELIN

2.1. Regulation of the Barents Sea Capelin Fishery

Since 1979, the Barents Sea capelin fishery has been regulated by a bil teral fishery management agreement between USSR and Norway. A TAC has been set for the winter fishery and for the summer/autumn fishery separately. The fishery has been closed from 1 May to 15 August. A minimum landing size of 11.0 cm has been enforced, and a minimum mesh size of 16 mm introduced.

ACFM recommended in its 1981 report that:

1. the TAC for the period 1 January to 1 May 1982 should be set at the range of 600 000 - 800 000 tonnes;

2. the TAC for the autumn fishery (15 August - 31 December 1982) should be in the order of 800 000 tonnes, this being approximately half of the expected catch in the 1982-83 season.

The USSR/Norwegian Fishery Commission recommended to their governments that the total catch of Barents Sea capelin in 1982 should not exceed 1 700 000 tonnes, out of which 800 000 tonnes were allocated to the winter fishery. The total winter catch in 1982 amounted to some 845 000 tonnes. The total autumn catch by the end of September 1982 is reported to be about 550 000 tonnes.

2.2. The Catch Statistics

The international catch by countries in the years 1965-81 is given in Table 2.1. The capelin catches in numbers (USSR + Norway) by ages and months for the period 1 August 1981 - 30 April 1982 are given in Table 2.2. It is noted that the average age of capelin in the winter catch is considerably lower in 1982 than in 1981. This is associated with an increased growth rate of capelin in recent years.

2.3. Stock Size Estimate

The assessment of the Barents Sea capelin stock has been based upon stock size estimates obtained by acoustic surveys (Nakken and Dommasnes, 1975), which have been carried out jointly by USSR and Norway since 1978. These surveys take place in the autumn (September - October) because fish behaviour is favourable for acoustic measurement and weather conditions are usually good.

The 1982 survey was carried out in the period between 7 September - 3 October and four research vessels participated. The following abundance estimates by year classes were obtained:

Year class	Number x 10^{-9}	Mean weight (g)	Biomass (tonnes x 10^{-6})
1981 (1980)	496 (385)	2.4 (2.2)	1.19 (0.85)
1980 (1979)	311 (195)	9.0 (9.4)	2.80 (1.82)
1979 (1978)	63 (48)	20.9 (17.0)	1.32 (0.81)
1978 (1977)	2 (14)	24.9 (23.3)	0.05 (0.33)

The 1981 estimates of corresponding age groups are shown in the parenthesis (Anon, 1981).

The survey results show an increase in the number of one-year-old capelin (1981 year class) compared to last year. However, the 1981 year class occurred together with 0-group capelin and 0-group Polar cod this year, and it was difficult to assess how much of the reflected echo energy from these mixed recordings was due to 1-group capelin. The strength of the 1981 year class may thus be slightly overestimated compared to the previous year's estimate of the year class 1980. On the other hand, the acoustic estimates of the 1-group capelin are usually considered to be underestimates.

The 1980 year class is abundant and the biomass of this year class constitutes the bulk of the Barents Sea capelin stock this year. The number of 2-year-old capelin this year is approximately 50% higher than last year.

The 1979 year class as 3 year olds is in number some 25% higher than 3-year-old fish last year. The mean individual weight is moreover some 20% above that of the corresponding age group last year. The 1979 year class constitutes the bulk of the adult stock.

Most of the 1978 year class (4 year olds) has disappeared; this is associated with an increased growth rate in recent years.

The total stock biomass was estimated to be 5 372 000 tonnes, compared to 3 866 000 tonnes in 1981 (Anon, 1982A). Details of the estimate are shown in Table 2.3.

The survey report is appended as Annex I.

2.4. Estimation of the Spawning Stock and Natural Mortality

Since there is no acoustic measurement of spawners during the spawning season available, the maturing stock component has been estimated from the acoustic stock measurements obtained in the previous autumn. The method of separating spawners from non-spawners is based upon the hypothesis that the maturing of the capelin is determined by fish length, i.e., that all fish above a certain length will mature and spawn during the next winter and spring (Table 2.3). This maturing length is defined as the length (marked with a line in Table 4) which divides the autumn stock into two components: a mature stock component which has an age distribution similar to the age distribution of the spawning stock observed in the spring, and a juvenile component that has an age distribution similar to the next autumn's total stock, provided that all spawners die after spawning (Anon, 1982A).
The maturing length in 1980 was calculated to be 15.03.
The Working Group in 1981 considered that a maturing length of 14.0 cm in 1980 gave the most reasonable fit between predicted and measured stock numbers in 1981. It was pointed out that this could be associated with the occurrence of late spawners. Accepting a constant maturing length of 14.0 cm for all the years, the following M-values per month for 2 to 3 year-old fish are calculated:

Years	M-values
1973-74	0.054
1974-75	0.045
1975-76	0.051
1976-77	0.043
1977-78	0.046
1978-79	0.086
1979-80	0.051
1980-81	0.090

An overall estimate of the maturing length and M for all the data combined, results in a maturing length of 13.8 cm and an M of 0.057. These estimates are achieved by minimizing the least square function:

$$L = \sum \left[\left(\frac{s_3}{m_3} - 1\right)^2 + \left(\frac{s_4}{m_4} - 1\right)^2 \right]$$

where s_3 and s_4 are the calculated number of 3 and 4-year-old capelin based on the previous years' estimate of 2 and 3 year-old fish below the maturing length, and adjusted by the catches, and m_3 and m_4 are the corresponding measured values. This method is thus based on measurements of juveniles only, and is consequently not biased by occurrence of late spawners (Hamre and Tjelmeland, 1982).

2.5. TAC Assessment

Since the capelin suffer mass mortality after spawning, information on the stock/recruitment relationship is the most important in a management context aiming at MSY. A Beverton and Holt recruitment curve (Fig.2.1)was fitted to the data points of estimated parent stock and corresponding recruitment for the year classes 1974-79 (Hamre and Tjelmeland, 1982). The parent stocks were estimated from the acoustic stock measurements derived in the autumn and adjusted by the subsequent catches of pre-spawners, using a maturing length of 13.8 cm and an M of 0.057. The corresponding recruitment strength refers to the acoustic measurement of the year classes as 2 years old.

This stock/recruitment relationship was used in a stock model for simulating the long-term yield as a function of various exploitation strategies. The mature stock was defined as all fish above 13.8 cm in the autumn, and the M-value on all ages is set to 0.057. The model assumes (a) density dependent growth according to the growth pattern observed in the late 1970's, (b) that all capelin die after spawning and (c) that the fishing pattern remains similar to that observed in recent years.

The results (Fig. 2) show that when the catches are equally distributed on the autumn and winter fishery, the MSY occurs at an equilibrium state of parent stock of 400 000 tonnes. If the exploitation is reduced so that 500 000 tonnes of capelin are allowed to spawn, this will reduce the MSY to some small extent, but it will increase the fraction of the population dying from natural causes (biomass output of M) substantially. This is of interest in valuing the capelin as food for other exploited stocks, since most of the mortality of capelin is assumed to result from predation.

Since the capelin is assumed to spawn and die in the spring, the regulation period includes the autumn fishery one year, and the winter-spring fishery the following year. A TAC recommendation for the calendar year has thus to consider two regulation periods. The TAC recommendations have therefore been given as the maximum catch allowing a minimum spawning stock of capelin to spawn two successive years ahead in time.

The input data for the TAC calculation (Anon, 1982A) for the present year were:

- the acoustic survey data of autumn 1981;
- a maturing length of 14.0 cm;
- an M-value of 0.05 per month;
- a typical fishing pattern defined by F-values by age, month and season;
- growth as observed in the previous year.

Parent stock indices for the winter 1983 were calculated by using the immature stock (smaller than 14.0 cm) measured in 1981 and reduced by M and the catches as input data for the initial autumn stock of 3 and 4-year-old fish in 1982. The calculation showed that a total catch of 1.6 - 1.8 million tonnes divided equally between the two seasons would reduce the spawning stock in 1983 to a level of 500 000 tonnes.

In the text-table below are shown the calculated stock prognosis for the autumn 1982 by ages, provided that 550 000 tonnes of the autumn catch have been taken, and the corresponding acoustic stock measurements obtained in the 1982 survey. The predicted value for the 1980 year class is derived from the stock/recruitment curve while the predicted values for the 1979 and 1978 year classes are estimates from the 1981 autumn acoustic survey results and reduced by M.

Year class	$N \times 10^{-9}$		Mean weight (g)		Biomass ($t \times 10^{-6}$)	
	Measured	Predicted	Measured	Predicted	Measured	Predicted
1980	311	18.0	9.0	9.4	2.80	1.69
1979	63	6.7	20.9	17.0	1.32	1.14
1978	2	0.2	24.9	23.3	0.05	0.05

It is seen that the model produces stocks of the year classes 1979 and 1978 which in numbers fit reasonably well to that measured. However, the biomass measured is 15% above that predicted and this is caused by an unexpectedly high individual growth rate in 1982 in the two year classes concerned. These year classes will constitute the bulk of the maturing stock component next winter. An increased growth rate increases the biomass of a year class and also the proportion which is expected to spawn (fish above 14.0 cm). The state of the maturing stock observed in 1982 is therefore considerably improved compared to last years stock prognosis.

The measured strength of the 1980 year class is more than 50% above the figure given in the prognosis (Fig.2.1). The strength of the 2-year-old capelin is however of secondary importance in adding biomass to the stock of prespawners. A large recruiting year class to the catchable stock in the autumn is on the other hand of importance for the exploitation of prespawners, since a strong juvenile year class reduces the proportion of adult capelin in the autumn catches. The strength of the 1980 year class has therefore also to some extent improved the state of the stock with respect to the 1983 winter fishery.

The improved rate of recruitment of the 1980 year class coincides with a westward displacement of the spawning localities since the winter 1979. The year classes 1974-79 from which the stock/recruitment function is calculated, were mainly spawned east of Nordkap and grew as larvae in the eastern part of the Barents Sea. The most easterly distributed year class as juveniles is the 1978 year class, which was spawned mainly at the coast of Murmansk. This year class in relation to the estimated parent stock, is the poorest one observed.

Since 1979 most of the capelin has spawned west of Nordkap, and a westward location of the main spawning area may favour the survival of the capelin larvae.

The year classes 1980-82 may thus turn out to be somewhat stronger than the average recruitment strength derived from the stock/recruitment curve in Figure 1. If the growth rate also remains high, this will increase the MSY accordingly. Based on the year classes 1974-79, the MSY in the 1970's is estimated at approximately 1.7 million tonnes (Figure 2.2).

2.6 TAC for the Winter Fishery in 1983

The stock in number by age at 1 January 1983 is calculated from the acoustic estimate in Table 2.3, and reduced by the expected catch after 1 October 1982 (350 000 tonnes) and a monthly natural mortality of 0.05. The surviving stock in numbers above 14.0 cm at 1 January 1983 is then used as the initial stock in calculating the effects of winter catches on the spawning stock. In this calculation the same M of 0.05 is used. The results (Table 2.4) show that a winter catch of 1.000 000 tonnes will reduce the stock of spawners to 530 000 tonnes whereas a winter catch of 1.100 000 tonnes will reduce the biomass of spawners to 440 000 tonnes. Based on this study, the Working Group agreed to recommend a TAC for the winter fishery in 1983 of 1.050 000 tonnes.

2.7 TAC for the Autumn Fishery in 1983

The autumn catch in 1983 is expected to consist mainly of capelin from the year classes 1980 and 1981. The 1979 year class is expected to be depleted as 4 years old fish due to the high growth rate. The change in the age structure in recent years which has resulted in fewer age groups in the catchable stock, makes the TAC calculation for the period one year ahead in time more uncertain. The TAC will to a much larger extent be dependent on the recruiting year class strength, and also on the individual growth rate used in the stock prognosis. The results of TAC calculations for this period are in fact most sensitive to variation in the expected growth. Catch quota calculations and corresponding parent stock sizes for the period 15 August 1983 to 30 April 1984 assuming different patterns of growth in 1983 are shown in Table 2.5. The parent stock indices for the winter 1984 are calculated by using the immature stock (smaller than 14.0 cm) measured in 1982 and adjusted by the catches and M as input data for the initial stock in 1983 and assuming the recruiting year class 1981 to be of the same strength as the year class 1980. The calculated catch quotas are equally divided on the autumn fishery in 1983 and the winter fishery in 1984.

Case 1 assumes the same growth rate in 1983 as observed in 1982, which is the highest one observed since the investigations started (Table 2.6). This growth rate in 1982 may moreover increase the total stock biomass to some 6 million tonnes in 1983. Since the growth rate is expected to be density-dependent, this growth pattern is considered unrealistic.

Case 2 considers a more likely growth pattern in 1983. In this case, the growth of 2 year old fish has been assumed to be similar to that observed in the years 1976 and 1977, and the growth of the older fish to that in 1980.

In case 3, a growth pattern similar to that in the late 1970s was assumed.

It is seen that if the growth pattern in case 2 and the same minimum level of spawning stock as in previous years are accepted, then the TAC for the autumn fishery in 1983 will be in the order of 1.2 million tonnes.

Based on this study, the Working Group agreed to recommend a TAC of 1.2 million tonnes for the 1983 autumn fishery on the Barents Sea capelin. The suggested TAC of 1.2 million tonnes for the winter fishery in 1984 is considered preliminary and should be re-assessed, when new stock data are available after the capelin survey in autumn 1983.

3. THE ICELANDIC CAPELIN

3.1 The Fishery

The fishery up to and including the 1982 winter season has been described by previous Working Groups (Anon 1982A and B). The total international catch from 1971 onwards is shown in Table 3.1. This includes catches from Sub-areas V-XIV and catches during summer off Jan Mayen in Division IIa.

Due to the poor state of the 1983 spawning stock, a complete fishing ban was recommended by ACFM at its meeting in July 1982, until further management advice could be given after the completion of the joint Icelandic-Norwegian acoustic stock assessment survey scheduled for October 1982.

This advice was accepted by all parties concerned, and to date there has been no further fishing conducted upon this stock of capelin.

3.2 Estimates of the 1983 Spawning Stock Abundance

As pointed out in the most recent Working Group report the 0-group index of the 1980 year class was comparatively low. Acoustic abundance estimates of this main contributor to the 1983 spawning stock, obtained in autumn 1981/winter 1982 further indicated that the 1983 spawning stock would be below 300 000 tonnes, even if no fishing was permitted.

In October 1982, Icleand and Norway carried out an acoustic survey of the distribution and abundance of the Icelandic capelin stock, as has been practice at this time of the year since 1978. The resulting stock abundance estimates, and for comparison, the comparable values from the 1981 survey (in brackets) are shown in the following text table:

Year class	Age	No. x 10^{-9}	Mean weight (g)	Biomass (t x 10^{-3})
1981 (1980)	1	68.0 (0.9)	3.8 (4.8)	260 (5)
1980 (1979)	2	16.6 (7.0)	15.7 (19.4)	262 (135)
1979 (1978)	3	1.6 (0.2)	24.1 (19.0)	39 (4)

Judging by the maturity stage, approximately 265 000 tonnes, comprising all the 1979 year class and most of the 1980 year class, were maturing. In contrast to last year's experience, general working conditions in October 1982 were good. Thus, practically no maturing capelin were recorded near the ice border, and the weather remained calm throughout most of the survey.

3.3. O-group abundance

Comparative measurements of the abundance of O-group capelin have been obtained annually since 1972. These indices, together with estimates derived from acoustic surveys of parent stock abundance since 1979, are shown in Table 3.2.

The 1982 O-group index of 13 is by far the lowest on record. The downward trend observed since 1976 coincides with the large increase in fishing effort and catches.

3.4 Abundance estimates of juvenile capelin

In the past, it has proved difficult to assess the relative or absolute abundance of the juvenile 1-2 group capelin. This is mainly because of its frequent distribution in or near areas that are periodically impassable due to drift ice.

Two independent estimates of the abundance of juvenile capelin of the 1981 year class are available. In August 1982, the Icelandic O-group survey was extended in order to include the distribution area of juvenile capelin. The acoustic abundance estimate of the 1981 year class obtained during this survey was 119 x 10^9 fish. During the October 1982 joint Icelandic-Norwegian acoustic survey, an abundance estimate of 68 x 10^9 fish of the 1981 year class was obtained.

The reports of both the August and October surveys are appended as Annexes II and III, respectively.

3.5 TAC for the autumn fishery 1982- winter fishery 1983

The Working Group calculated the expected maturing stock at 1 January 1983 from the acoustic stock estimates of maturing fish in the October survey (265 000 tonnes), reduced by an M value of 0.04 per month. The stock at 1 January 1983 was then reduced by an M of 0.08 per month until 1 April 1983 (Anon., 1982B). The surviving stock at 1 April 1983 was calculated to be approximately 190 000 tonnes. In the light of the previously accepted minimum level of spawning stock (400 000 tonnes), the Working Group recommends that the complete fishery ban in force at present be continued for the autumn 1982 and winter 1983 fisheries.

3.6 TAC for the autumn fishery in 1983

The autumn catch in 1983 would be expected to consist mainly of the 1981 year class, and a small contribution from the 1980 year class. Existing estimates of the abundance of juvenile 1-2 group capelin are difficult to compare, because of varying ice and weather conditions during the surveys, and uncertainties about mortality rates. Consequently, the abundance estimates of juvenile year classes cannot be used as indices by comparing them with corresponding abundance estimates of other year classes.

In order to demonstrate that the two estimates would mean in terms of catch quotas, the Working Group calculated the expected maturing stock by 1 September 1983 by taking the 1-group estimates from August and October 1982 and reducing them by an M value of 0.04 per month. These estimates were then used as initial stocks in calculating the effects of autumn and winter catches on the spawning stock. The results are summarised below:

August survey

Initial stock August 1982:	119×10^9 in numbers
Calculated stock 1 Sept.1983:	74×10^9 - " -
Catch quota autumn 1983:	300 000 tonnes
Catch quota winter 1984:	300 000 tonnes
Spawning stock 1984:	400 000 tonnes

October survey

Initial stock October 1982:	68×10^9 in numbers
Calculated stock 1 Sep. 1983:	45×10^9 - " -
Catch quota autumn 1983:	80 000 tonnes
Catch quota winter 1984:	80 000 tonnes
Spawning stock winter 1984:	400 000 tonnes

Based on this study and due to the uncertainty in the acoustic estimate of 1 year old capelin, and taking into account the grave situation of this stock at present, the Working Group recommends that a decision on a TAC for the autumnfishery 1983 is deferred until a new stock estimate is available. Acoustic surveys of the abundance of the 1983 spawning stock, as well as the immature capelin are planned for January/February 1983. In the light of the results of this survey, it must be possible to assess stock and TAC for the 1983 autumn fishery.

4. DEFICIENCIES IN THE DATA BASE

In Anon.1982B the Working Group recommended necessary improvements in the data base.

One of the recommendations concerned estimates of the recruiting year classes in the Icelandic capelin fishery.

It should be noted that this year Iceland has carried out an acoustic survey in August in order to achieve this, and furthermore the extent of the joint Icelandic-Norwegian acoustic stock assessment survey in 1982 meant that also this survey covered the juvenile part of the stock.

It should also be noted that the design of the Icelandic 0-group survey is being changed in order to tackle the same problem. A progress report on this will be presented at the next Statutory Meeting of ICES.

The estimates of the juvenile part of the stock still have a high degree of uncertainty about them, but it is hoped that in the future this will be reduced, thus allowing a prediction on stock and eventual catches one to one and a half years ahead.

REFERENCES

Anon 1982 A Atlanto-Scandian Herring and Capelin Working Group Report. Part I. C.M.1982/Assess:12

1982 B Ibid. Part II. C.M.1982/Assess:2

J Hamre and S Tjelmeland 1982: Sustainable Yield Estimates of the Barents Sea Capelin Stock. C.M.1982/H:45

O Nakken and A Dommasnes 1975: The application of an echo integration system in investigations on the stock strength of the Barents Sea capelin 1971-74. C.M.1975/B:25.

Table 2.1 International catch of Barents Sea capelin (1000 tonnes) in the years 1965-81.

Year	Norway	USSR	Other	Total
1965	217	7		224
1966	380	9		389
1967	403	6		409
1968	522	15		537
1969	679	1		680
1970	1 301	13		1 314
1971	1 371	21		1 392
1972	1 556	37		1 593
1973	1 291	45		1 336
1974	987	162		1 149
1975	943	431	43	1 417
1976	1 949	596		2 545
1977	2 116	822	2	2 940
1978	1 122	747	25	1 894
1979	1 109	669	5	1 783
1980	999	641	9	1 649
1981 *	1 238	721	28	1 987

* Preliminary

Table 2.2 CAPELIN catches in the Barents Sea in August-December 1981 and in January-April 1982 in numbers.

	August-December 1981					January-April 1982			
	Numbers x 10^{-9}					Numbers x 10^{-9}			
Age	August	September	October	November	December	January	February	March	April
1	0.14	1.12	0.41	0.13	0.20	0.01			
2	6.92	15.07	1.30	1.92	0.76	0.09	0.01	0.37	
3	6.40	7.42	0.72	0.56	0.55	2.69	4.54	3.69	0.36
4	1.62	1.43	0.28	0.14	0.20	4.52	6.73	4.73	0.58
5	0.06	0.06	0.01	0.02		1.51	1.90	1.40	0.22
6+						0.03	0.05	0.03	0.01
Sum	15.08	25.04	2.71	2.75	1.71	8.85	13.23	10.22	1.17

Table 2.3 Acoustic estimate autumn 1982.

Total length (mm)	AGE GROUP					Total number x 10^{-7}	Biomass tonnes x 10^{-3}	Biomass (Cumulative)
	1	2	3	4	5			
6.5- 6.9	4631					4631	46.1	
7.0- 7-4	6164					6164	61.8	
7.5- 7.9	7089					7089	78.4	
8.0- 8.4	3852					3852	62.2	
8.5- 8.9	4418					4418	92.0	
9.0- 9.4	5449	71				5520	151.7	
9.5- 9.9	5992	108				6100	191.2	
10.0-10.4	5542	429				5971	224.0	
10.5-10.9	3682	1826				5508	243.4	
11.0-11.4	1549	3123				4672	248.0	
11.5-11.9	913	4872				5785	357.1	
12.0-12.4	315	5359	6			5680	417.1	
12.5-12.9	30	4787	26			4843	408.8	
13.0-13.4	4	3366	46			3416	339.8	
13.5-13.9		2638	168			2806	319.5	
14.0-14.4		1421	654			2075	273.3	2131.5
14.5-14.9		1229	685	3		1917	283.2	1858.2
15.0-15.4		654	1047	14		1715	292.5	1575.0
15.5-15.9		336	1011	54		1401	265.2	1282.5
16.0-16.4		110	731	47		888	188.9	1017.3
16.5-16.9		199	631	32		862	213.7	824.4
17.0-17.4		190	558	19		767	214.0	614.7
17.5-17.9		300	307	20		627	194.7	400.7
18.0-18.4		42	259			301	103.8	206.0
18.5-18.9		26	57			83	29.8	102.2
19.0-19.4			87	14		101	40.7	72.4
19.5-19.9		14	29	14		57	24.7	31.7
20.0-20.4			14			14	7.0	7.0
20.5-20.9								
Number x 10^{-7}	49630	31100	6316	217	0	87263		
Number > 14.0 cm	0	4521	6070	217	0	10808		
Biomass (tonnes x 10^{-3})							5372.2	
Biomass fish > 14.0 cm							2131.5	

Table 2.4 TAC estimates (in 1000 tonnes) and corresponding spawning biomass. ℓ_s = maturing length, M = natural mortality per month.

TAC winter 1983	1983 spawners
	ℓ_s = 14.0 cm ; M = 0.05
800	711
900	621
1000	531
1100	442
1200	353

Table 2.5 TAC estimates (in 1000 tonnes) and corresponding spawning biomass in 1984 for the different cases of expected growth in 1983 (for further explanation see text).

TAC autumn 1983	TAC winter 1984	1984 spawners		
		Case 1	Case 2	Case 3
900	900	1150	960	453
1000	1000	1013	825	327
1100	1100	877	690	202
1200	1200	741	556	
1300	1300	607	424	
1400	1400	473	294	

Table 2.6 Acoustic estimates of the capelin stock (in million tonnes) by age in autumn 1973-82. Average weight (grammes) of each age group given in paranthesis.

Year	AGE				SUM 2 years and older
	2	3	4	5	
1973	2.3 (5.6)	0.8 (18.6)	0.4 (23.3)	0.006 -	3.5
1974	3.1 (5.6)	1.6 (9.1)	0.07 (21.2)	0.002 -	4.8
1975	2.5 (6.8)	3.3 (10.4)	1.5 (16.0)	0.01 (19.0)	7.3
1976	2.0 (8.2)	2.1 (12.4)	1.4 (16.4)	0.3 (18.2)	5.8
1977	1.5 (8.1)	1.7 (16.8)	0.9 (20.9)	0.2 (23.0)	4.2
1978	2.5 (6.7)	1.7 (16.5)	0.3 (20.7)	0.02 (23.1)	4.5
1979	2.5 (7.4)	1.5 (13.5)	0.1 (21.1)	0.0005 -	4.1
1980	1.9 (9.4)	2.8 (18.2)	0.8 (24.7)	0.006 -	5.5
1981	1.8 (9.4)	0.8 (17.0)	0.3 (23.3)	0.008 (28.7)	3.0
1982	2.8 (9.0)	1.3 (20.9)	0.05 (24.9)		4.2

Table 3.1

The total annual and seasonal catch from the Icelandic capelin stock 1971-1982 (tons x 10^{-3})

	Winter season		Summer and autumn season				
Year	Iceland	Faroes	Iceland	Norway	Faroes	EEC	Total
1971	182.9	-	-	-	-	-	182.9
72	276.5	-	-	-	-	-	276.5
73	440.9	-	-	-	-	-	440.9
74	461.9	-	-	-	-	-	461.9
75	457.6	-	3.1	-	-	-	460.7
76	338.7	-	114.4	-	-	-	453.1
77	549.2	25.0	259.7	-	-	-	833.9
78	468.4	38.4	497.5	154.1	-	-	1.158.4
79	521.7	17.5	441.9	126.0	2.5	-	1.109.6
1980	392.0	-	367.2	118.6	24.4	14,3	916.5
81	156.0	-	484.6	91.4	16.2	20.8	769.0
82	13.0	-					

Table 3.2 O-group indices 1972-1982 and spawning stock (tonnes) 1979-1982.

Year	O-group index	Spawning stock
1972	89	
1973	116	
1974	134	
1975	89	
1976	60	
1977	43	
1978	31	
1979	49	600 000
1980	41	300 000
1981	29	160 000
1982	13	140 000

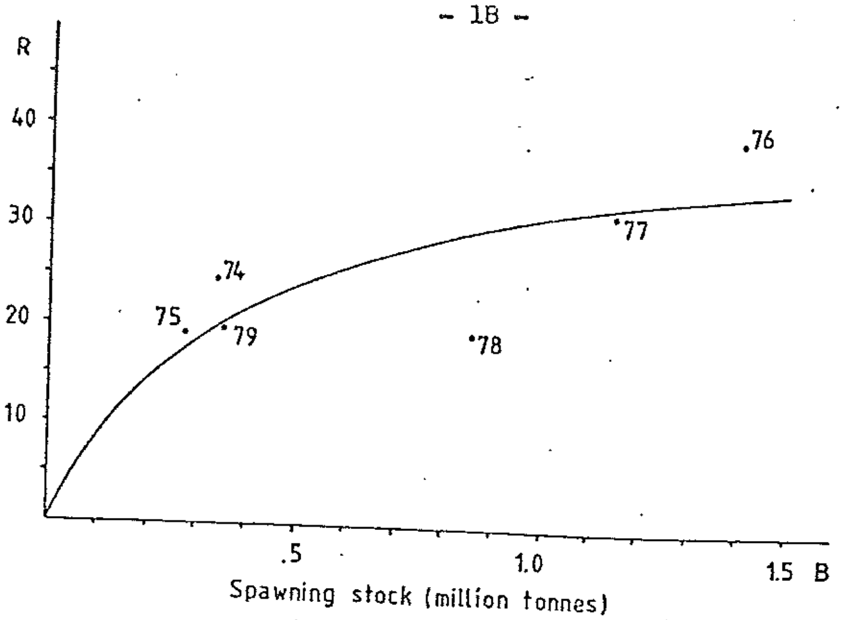


Figure 2.1 Stock-recruitment relation of Barents Sea capelin. The solid line shows the function $R = \frac{44,5 \cdot B}{0,43 + B}$ where R = recruited individuals x 10^{10} and B = spawning stock biomass in mill. tonnes.

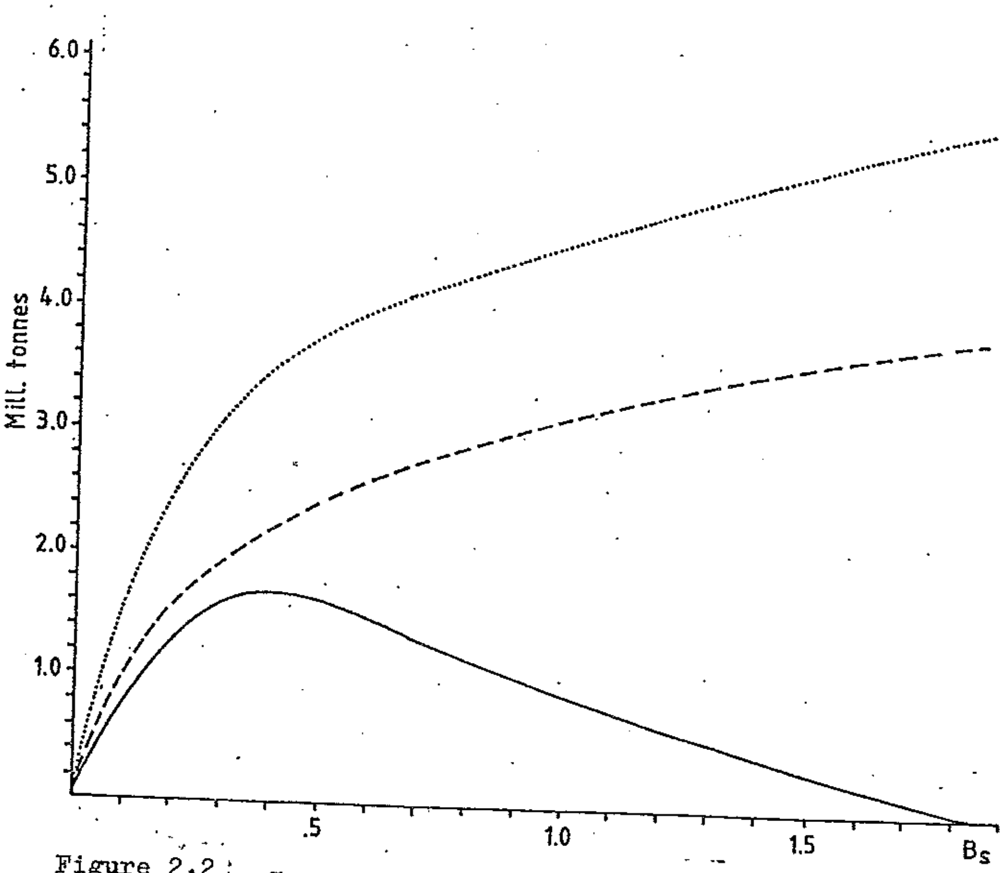


Figure 2.2 Sustainable yield (solid line), M-output biomass (broken line) and autumn stock (dotted line) for Barents Sea capelin at different levels of spawning stock (B_s) when the annual catch is equally allocated to the autumn and winter season.

REPORT ON THE NORWEGIAN/USSR ACOUSTIC SURVEY OF THE BARENTS SEA CAPELIN STOCK IN SEPTEMBER/OCTOBER 1982

Introduction

The survey was carried out during the period September-October 1982. Four research vessels participated:

Vessel	Institute	Cruise leader	Date
"Persey III"	PINRO, Murmansk	N. Ushakov	10 Sept. - 3 Oct.
"Poisk"	PINRO, Murmansk	V. Mamylov	10 Sept. - 10 Oct.
"G.O. Sars"	IMR, Bergen	I. Røttingen	7 Sept. - 3 Oct.
"Johan Hjort"	IMR, Bergen	S. Tjelmeland	7 Sept. - 3 Oct.

Observations were exchanged daily between the three vessels. All data were processed onboard "G.O.Sars", and L. Korol from PINRO who was onboard the vessel between 27 September and 2 October participated in the work. R. Pedersen and J. Røttingen, IMR, were onboard "Persey III" during the intercalibration which took place 26-27 September.

Material and Methods

Courselines and stations are given in Fig. 1 and 2. The vessels started their work in the eastern part of the Barents Sea and covered the area with transects along every second degree longitude. The transects surveyed by "Persey III" were placed between those of "G.O.Sars" so that the main distribution area of capelin was covered with transects of one degree longitude apart. "Johan Hjort" and "Poisk" covered the southern and southeastern part of the distribution area. The north- and southward extension of the courselines was adjusted according to the distribution of capelin.

All four vessels were operating digital echo integrators. Echo intensities were integrated continously, and mean values per nautical mile were recorded for each 5 nautical mile.

The echogrammes, with their corresponding integrator values, were scrutinized every day. Contribution from bottom, false echoes and noise were deleted. The corrected values for integrated echo intensity were distributed to species according to the trace patterns on the echogramme and the composition of the trawl catches. Trawling was carried out whenever the recordings of the traces on the echogrammes changed their characteristics and/or when the need for biological data made it necessary. Trawl stations were thus carried out both for identification purposes and in order to obtain observations on length, weight or volume, maturity stage, stomack content, and age of capelin.

Conversion factors for the integrated echo intensities, M, sampled by the different vessels, were obtained by intercalibrations. The results of these intercalibrations were:

$$M_{G.O.Sars} = 0.7\ M_{Persey\ III}$$

$$M_{G.O.Sars} = 1.0\ M_{Johan\ Hjort}$$

$$M_{Johan\ Hjort} = 5\ M_{Poisk}$$

The echo intensities recorded by "Persey III", "Poisk" and "Johan Hjort" were converted to "G.O.Sars" values using these relations. A work note on the intercalibrations is given as an appendix to this survey report.

The computations of number of individuals and biomass in length- and age groups were made onboard "G.O.Sars" using the same computer programme as in previous years. The method is described by Nakken and Dommasnes (1975).

Results and discussion

An estimte based on integrator values and biological samples from all four vessels are given in the text table below:

Yearclass	Number x 10^{-11}	Mean weight g	Biomass, tonnes x 10^{-6}
1981	4.96	2.4	1.19
1980	3.11	9.0	2.80
1979	0.63	20.9	1.32
1978	0.02	24.9	0.05

In the southern part of the distribution area I-group capelin occurred together with O-group capelin. Under such circumstances it is very difficult to assess how much of the reflected echo intensity is due to I-group capelin. This age group (1981-yearclass) may be overestimated in this area. In the eastern and southeastern part of the distribution the capelin was mixed with O-group polar cod. This might have caused an error to the capelin estimate.

Fig. 3 shows the geographical distribution of the capelin stock. The distribution is similar to the distribution observed in 1980 and 1981, with little capelin in the northeastern part of the Barents Sea. Figs. 4-7 show the geographical distribution of the different yearclasses.

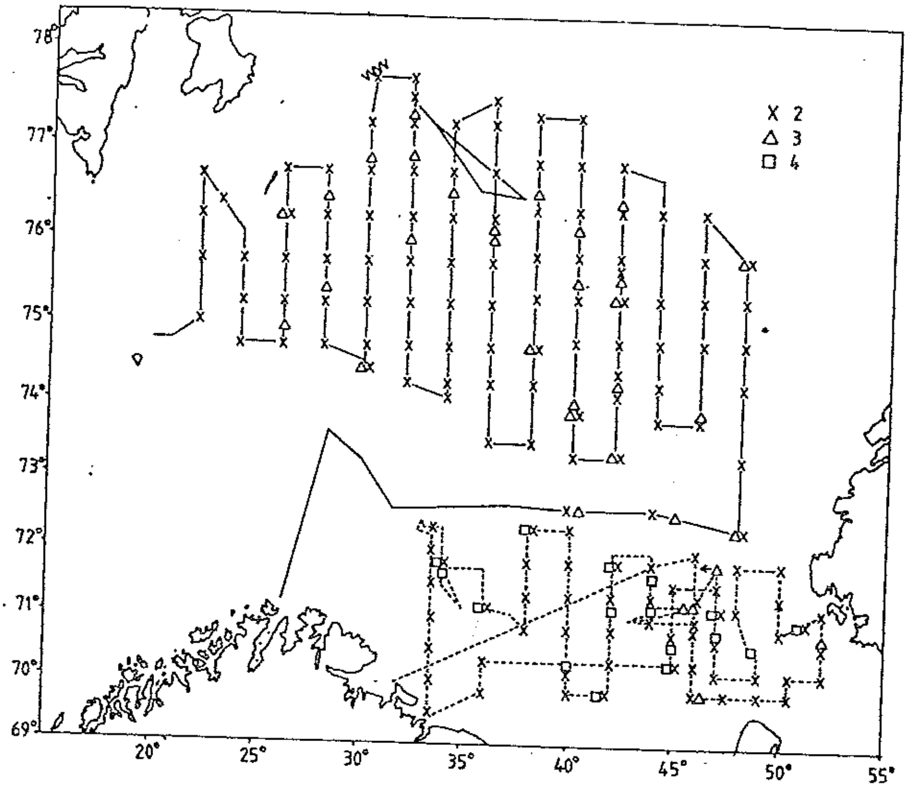
Fig. 8 shows the age distribution, mean lengths and mean volumes in the five sub-areas used for computations of age-length and age-weight relations. The calculated length frequencies for the different age groups and for the total stock are given in Fig. 9.

Hydrography

Figs. 10 - 13 show the horizontal distribution of temperature in various depths. In general, temperature conditions were close to long-term average level. In the western part of the sea there were weak positive anomalies, while weak negative anomalies remained in the eastern part of the sea.

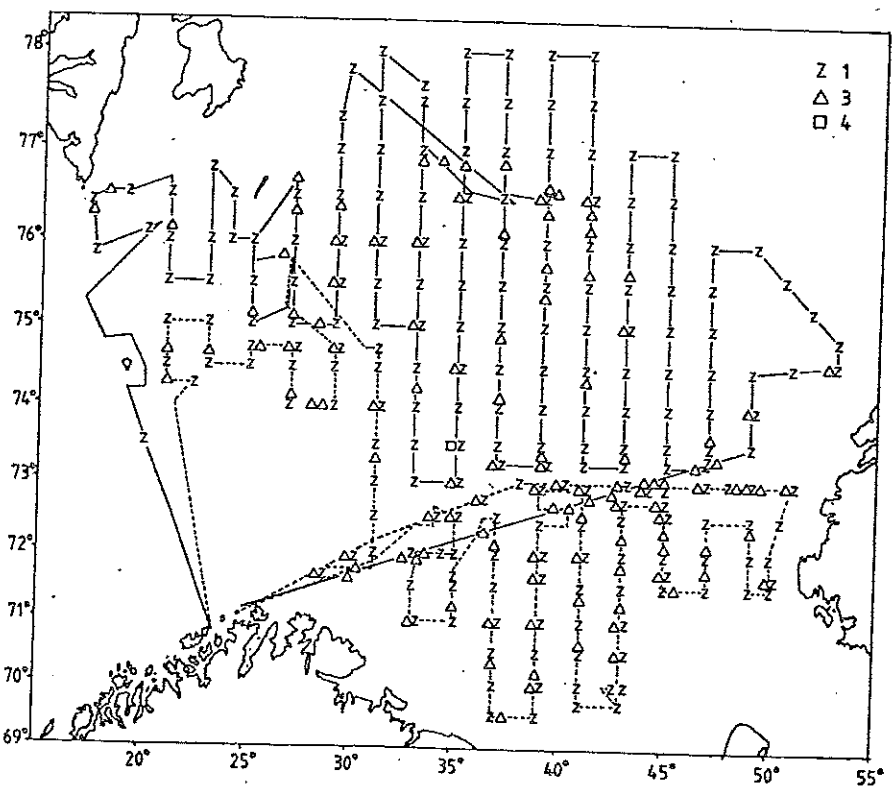
Polar cod

Fig. 14 shows the geographical distribution of polar cod observed during the survey. The biological and acoustical data of polar cod which was collected during the survey will be made available to the joint USSR/Norwegian Working Group on polar cod. The Working Group will make further analysis of the data.

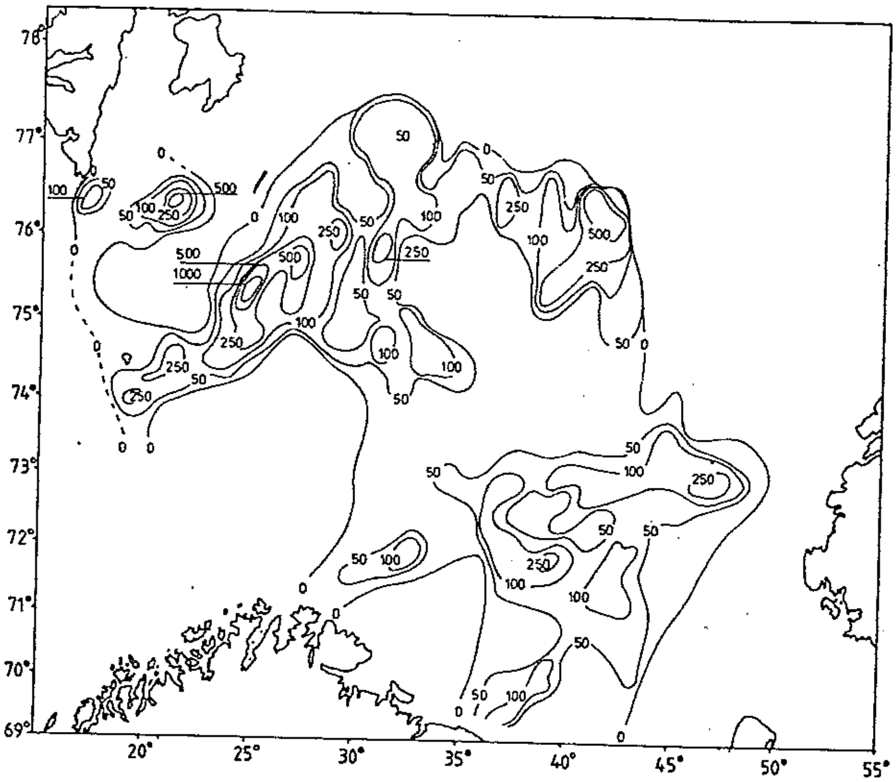


Annex 1, Figure 1. Survey routes and stations for "Persey III" (solid line) and "Poisk" (broken line).

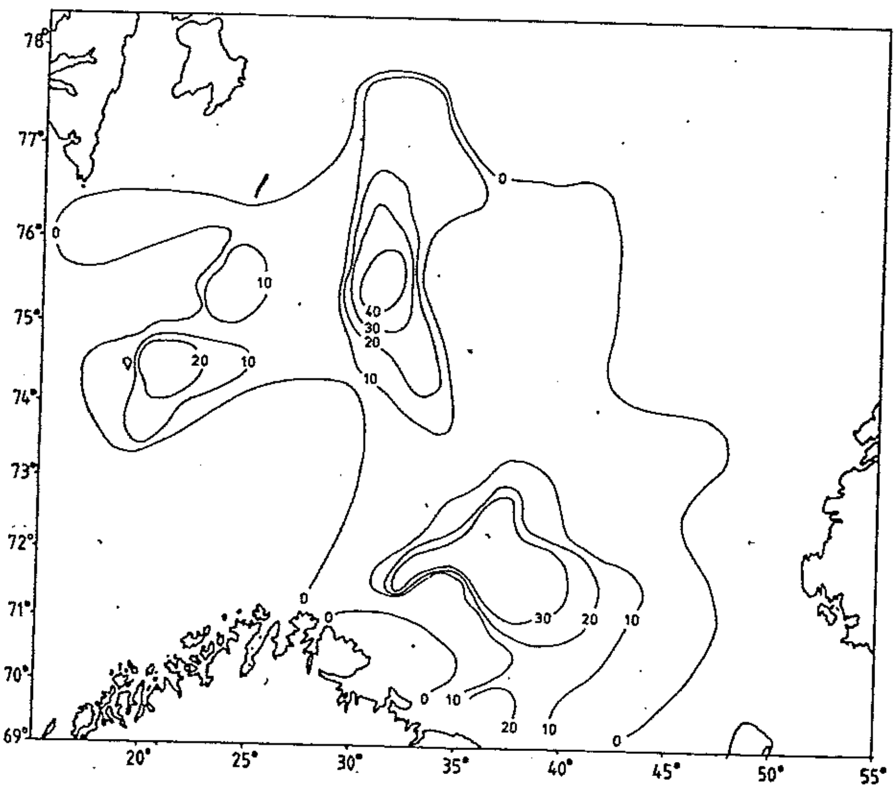
1) hydrographic station with CTD-sonde
2) hydrographic station with "Nansen-bottles"
3) bathythermograph
4) pelagic trawl station
5) bottom-trawl station



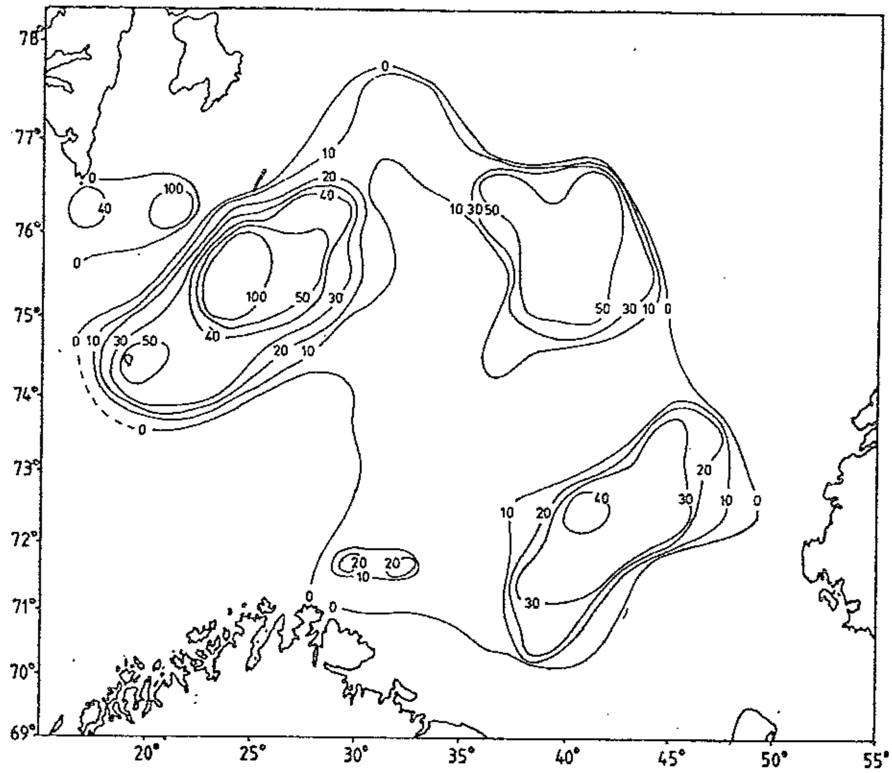
Annex 1, Figure 2. Survey routes and stations for "G.O.Sars" (solid line) and "Johan Hjort" (broken line). Legend as in Fig. 1.



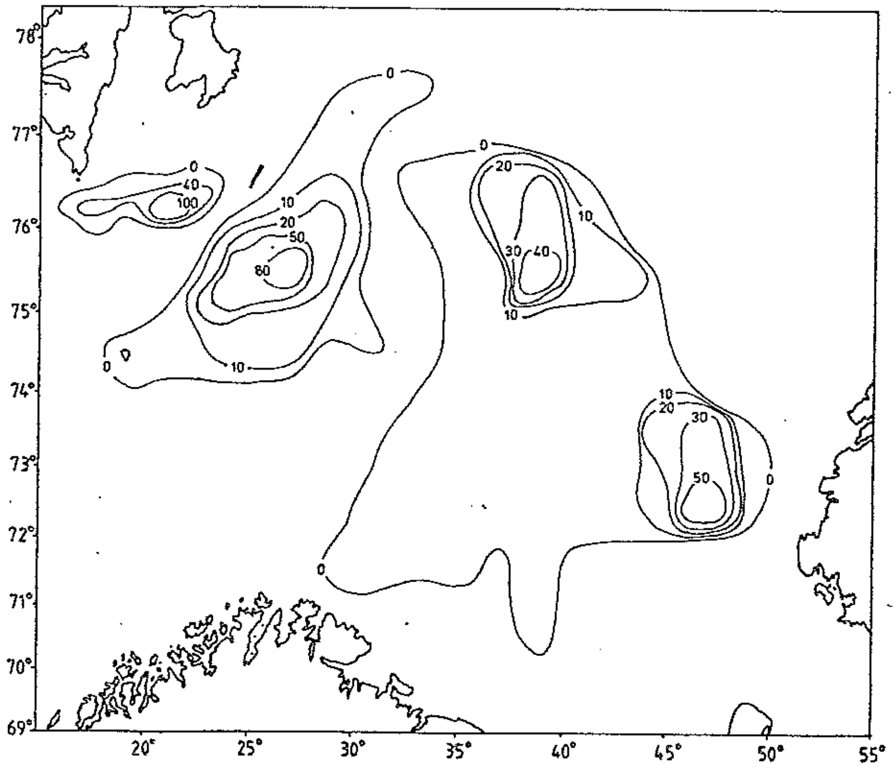
Annex 1, Fig.3. Geographical distribution of the capelin stock, integrated echo intensity (mm deflection/nautical mile).



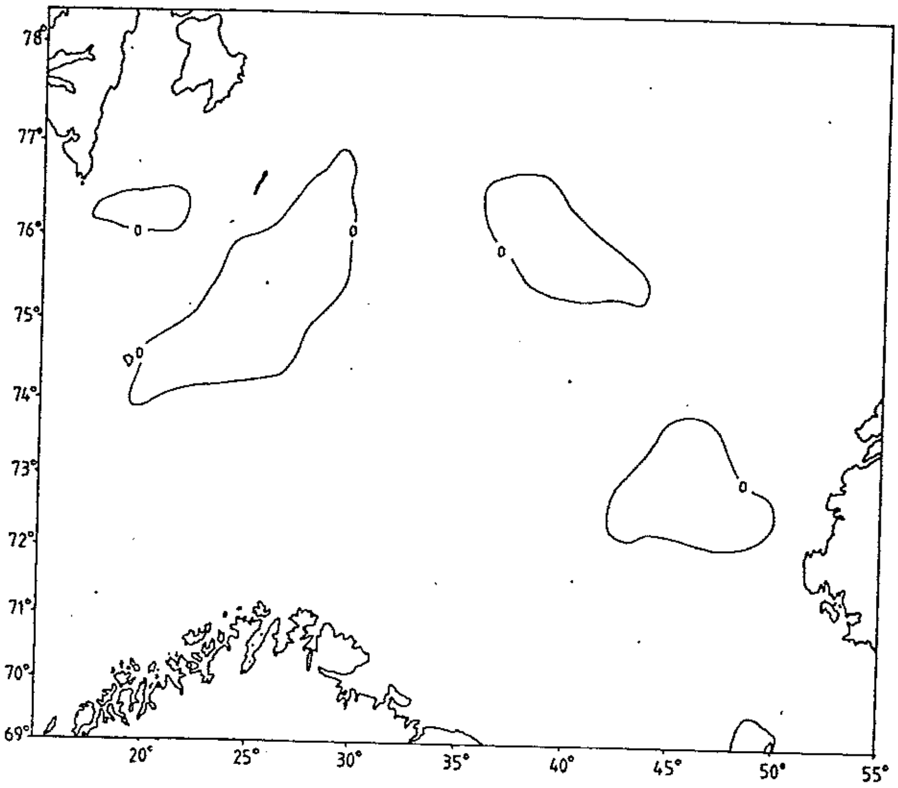
Annex 1, Figure 4. Estimated density distribution of 1-year old capelin (tonnes/(nautical mile)^2).



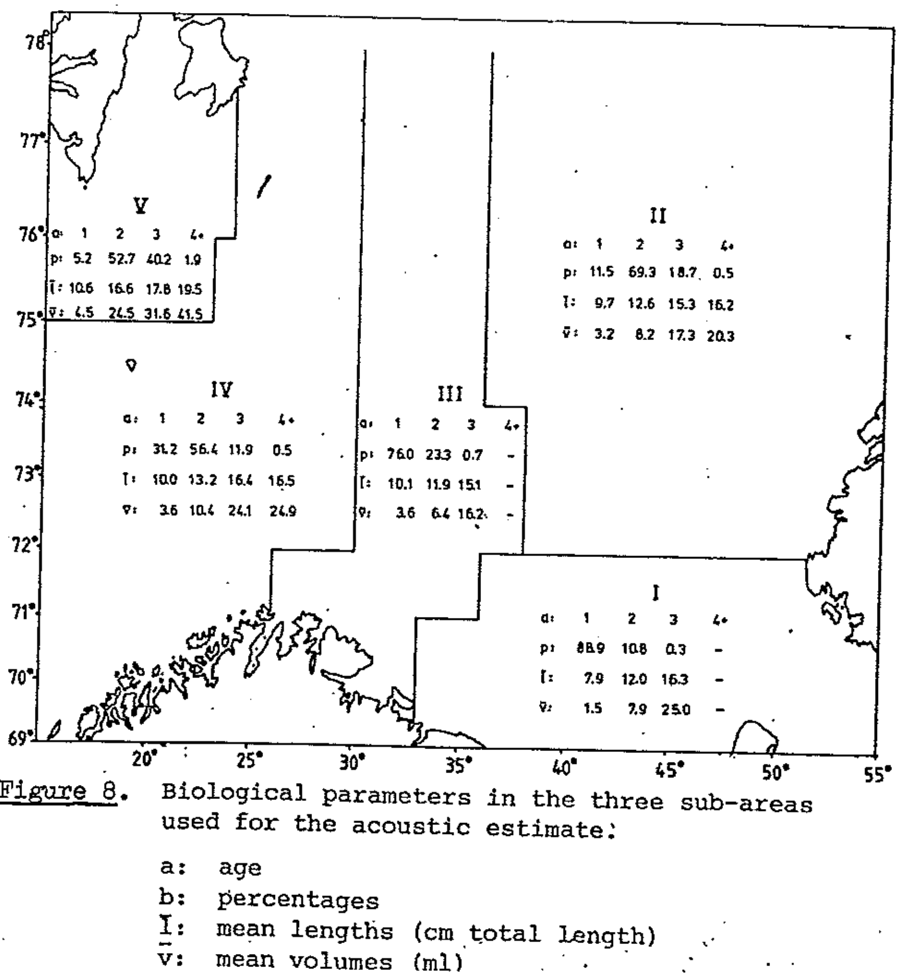
Annex 1, Figure 5. Estimated density distribution of 2 years old capelin (tonnes/(nautical mile)^2).



Annex 1, Figure 6. Estimated density distribution of 3 years old capelin (tonnes/(nautical mile)^2).

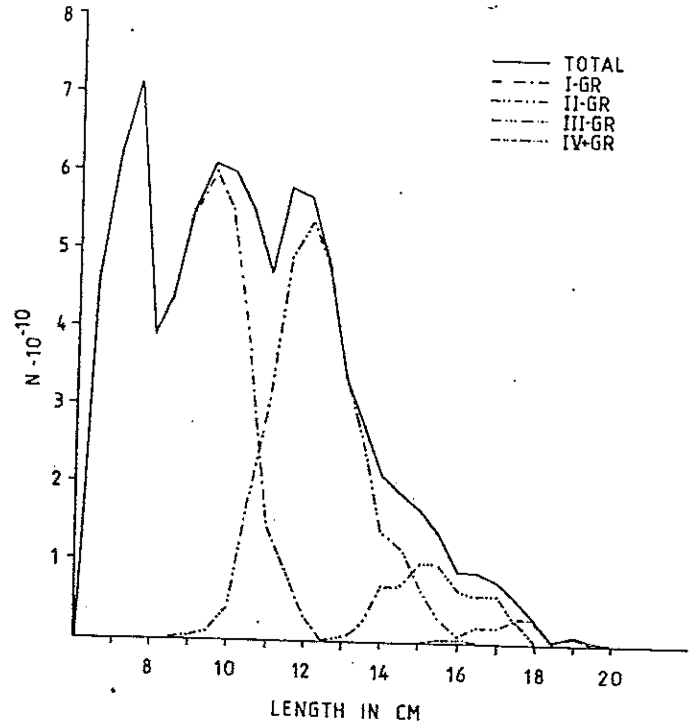


Annex 1, Figure 7. Estimated density distribution of 4 years old capelin (tonnes/(nautical mile)^2).

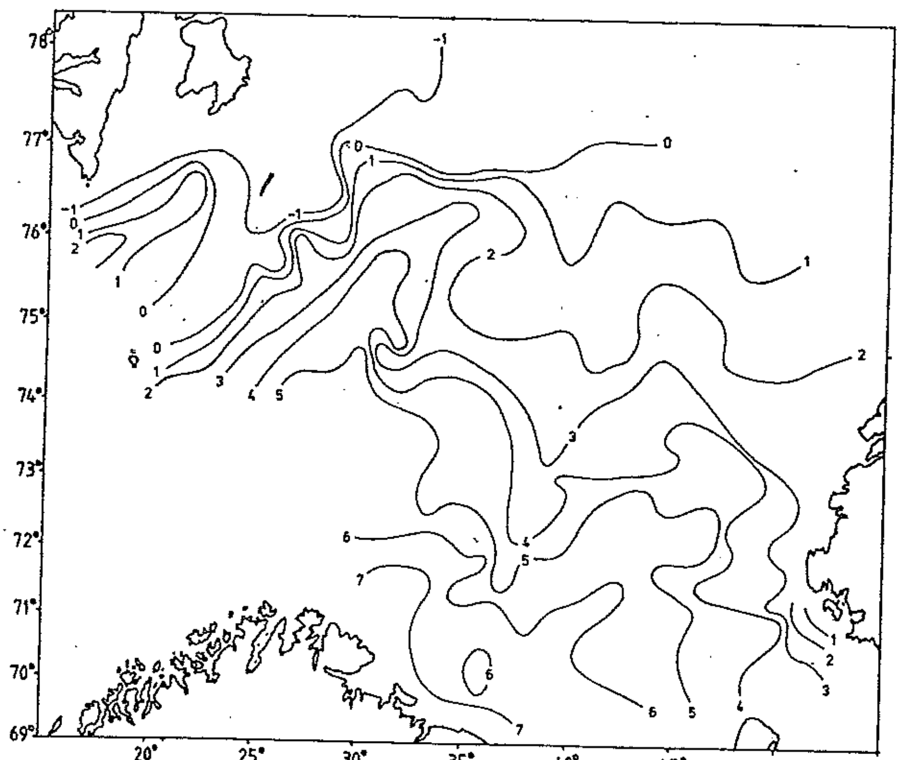


Annex 1, Figure 8. Biological parameters in the three sub-areas used for the acoustic estimate:

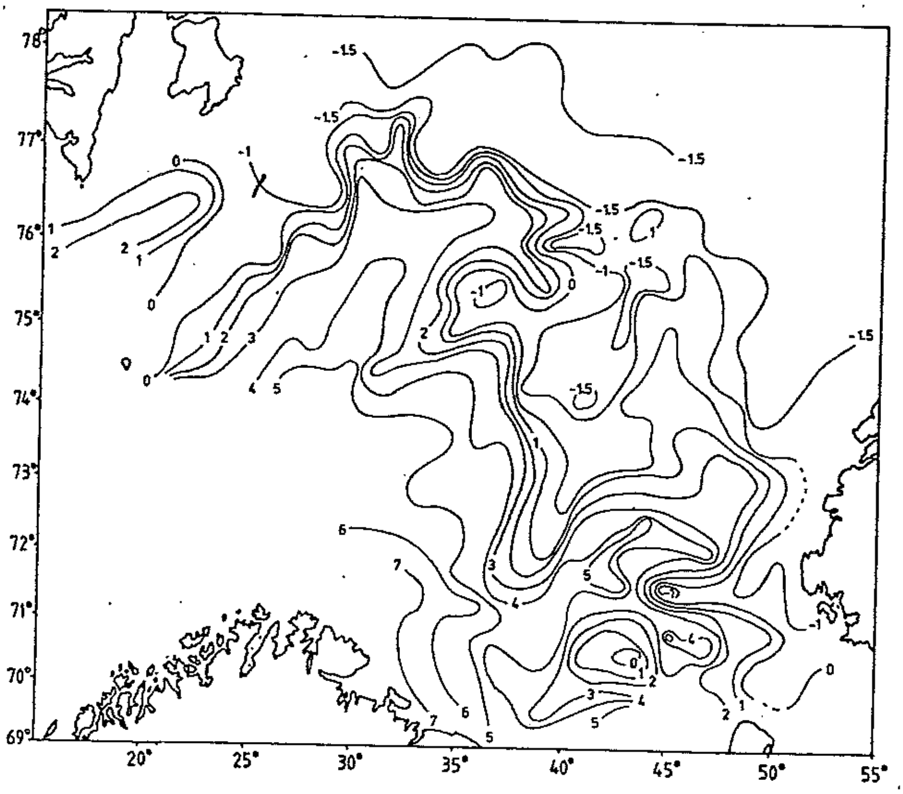
a: age
b: percentages
$\bar{l}$: mean lengths (cm total length)
$\bar{v}$: mean volumes (ml)



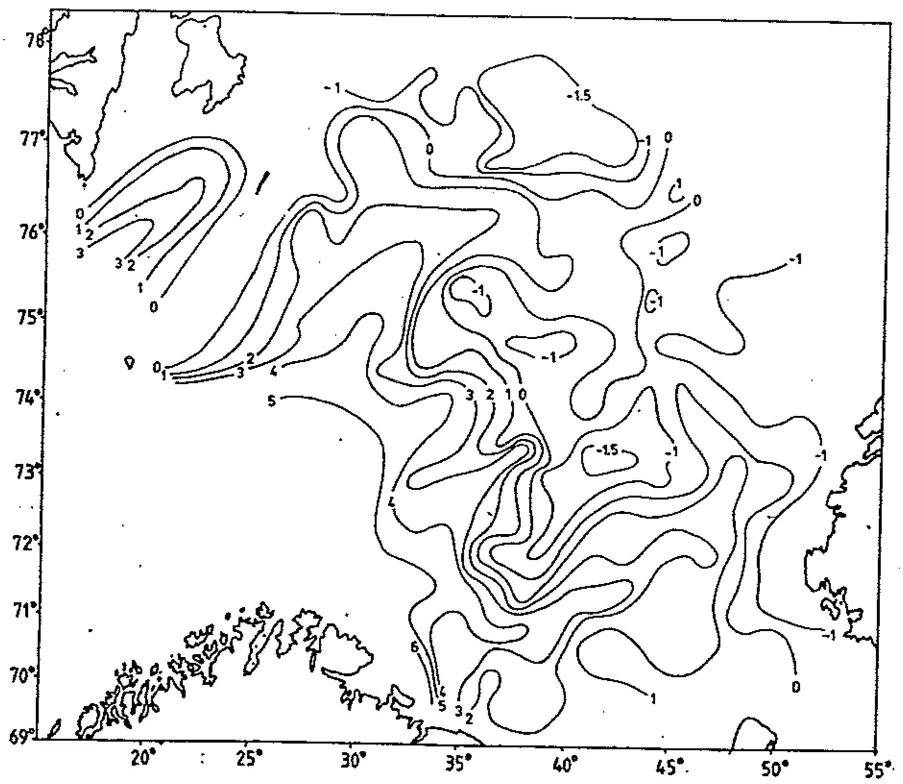
Annex 1, Fig.9. Length distribution of 1, 2, 3 and 4 years old capelin.



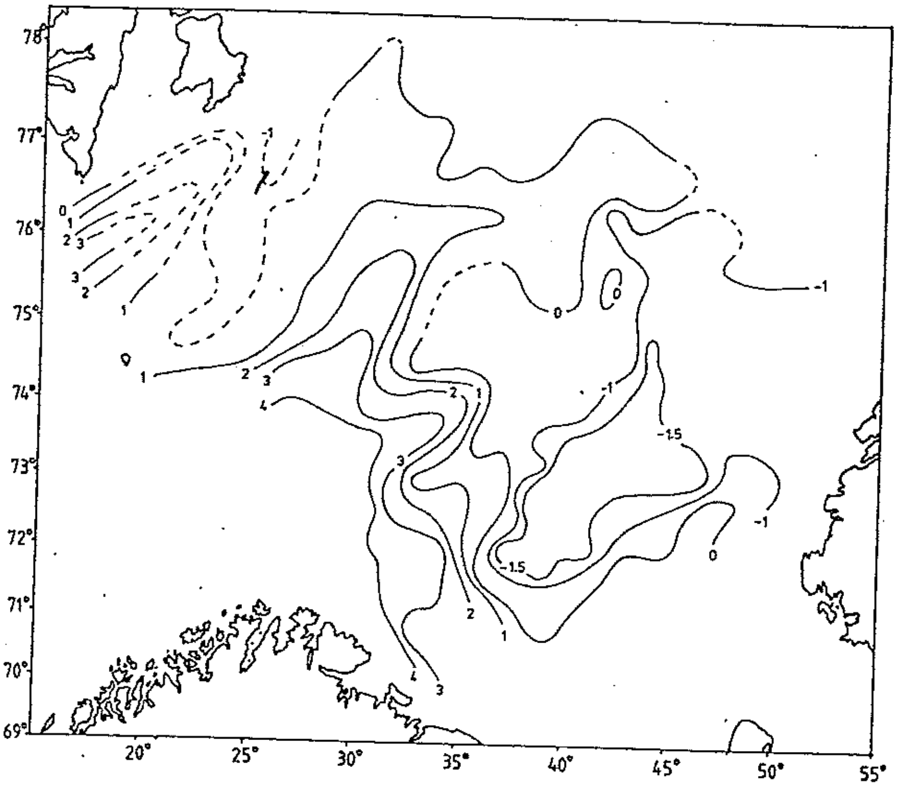
Annex 1, Figure 10. Distribution of temperature (t°C) at surface.



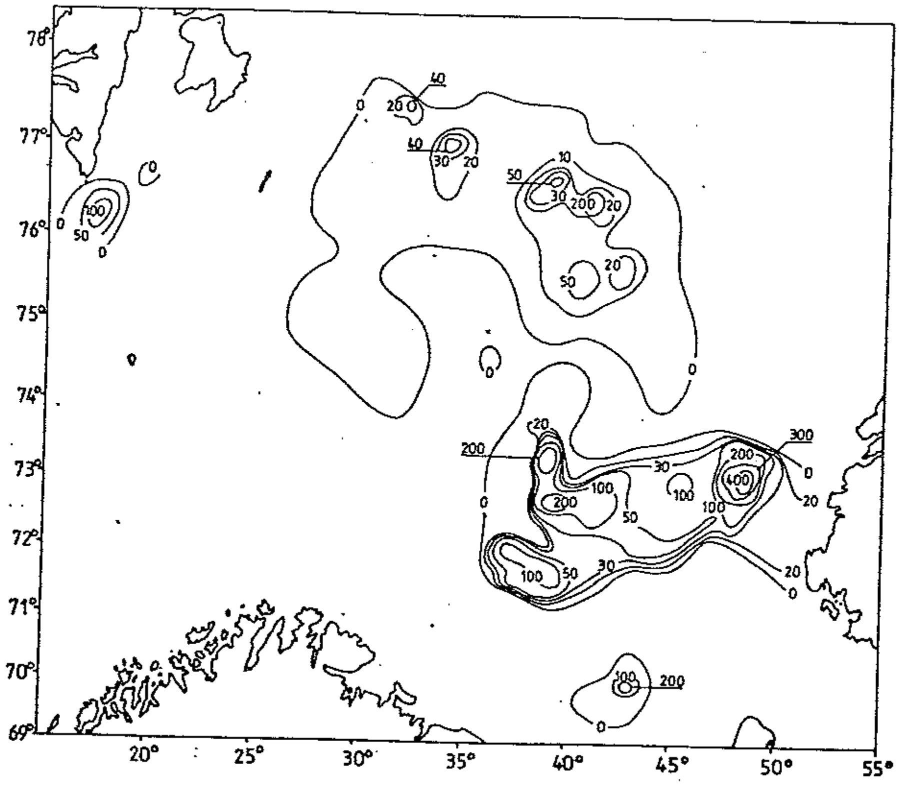
Annex 1, Figure 11. Distribution of temperature (t°C) in 50 m depth.



Annex 1, Figure 12 Distribution of temperature (t°C) in 100 m depth.



Annex 1, Figure 13. Distribution of temperature (t^{o}C) in 200 m depth.



App.1, Fig.14. Geographical distribution of polar cod (mm integrator deflection, ref. "G.O.Sars" values). Data from "Persey III", "Poisk", "G.O.Sars" and "Johan Hjort" are included.

APPENDIX 1
to Annex 1

Intercalibrations during the joint USSR/Norwegian survey on the Barents Sea capelin in september-October 1982

The following intercalibrations were carried out:

Date	Vessels	Pos	Depth of scattering layer
22.09	"Johan Hjort"-"Poisk"	72°30'N-34°00'E	0 - 60 m
26.09-27.09	"G.O.Sars"-"Persey III"	76°30'N-37°00'E	0 - 100 m
29.09	"G.O.Sars"-"Johan Hjort"	75°45'N-27°00'E	0 - 100 m

During the intercalibration between "Johan Hjort" and "Poisk" there was increasing wind and sea, and the intercalibration had to be terminated after sailing 12 n.miles. The other intercalibrations were carried out under good weather condiditions.

The intercalibrations were carried out as in 1981, the vessels sailed 0.5 n.miles apart, the vessel astern positioned 10° to the side of the other vessel. The log of one of the vessels were used as a reference log, and the integrator reset manually after a signal (by VHF-communication) from the vessel with the reference log. The corresponding integrator values were utilized without further adjustments.

The results are given in Figs. 1-3 and the instrument settings are given in Table 1. The following conversion factors for integrator values were used:

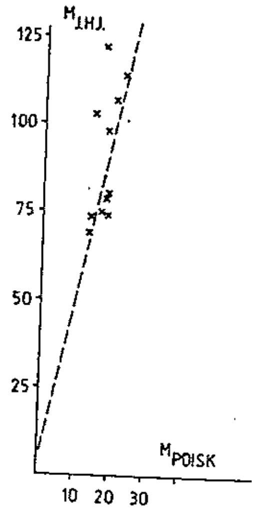
$$M_{Johan\ Hjort} = 5.0 M_{Poisk}$$

$$M_{G.O.Sars} = 0.7 M_{Persey\ III}$$

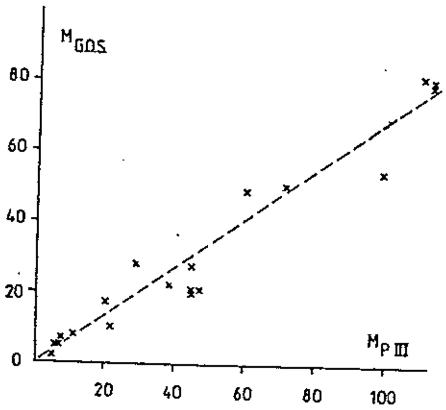
$$M_{G.O.Sars} = 1.0 M_{Johan\ Hjort}$$

Appendix 1 to
Annex 1 - Table 1. Instrument characteristics and settings during the joint USSR/Norwegian capelin survey in the Barents Sea in September - October 1982.

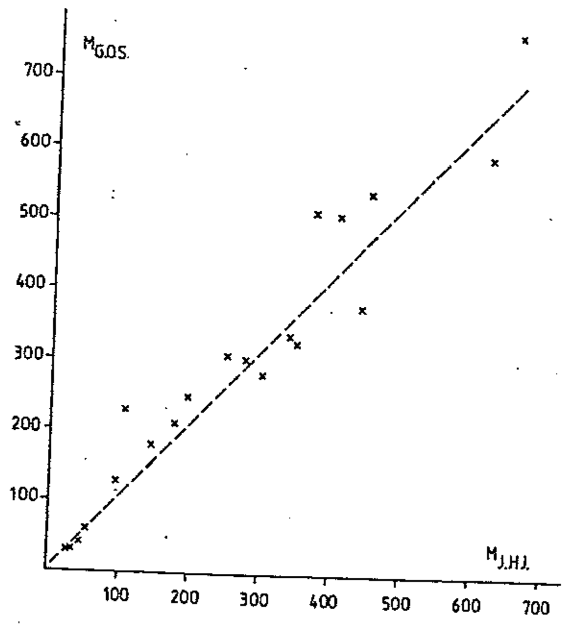
Vessel:	"G.O.Sars"	"Johan Hjort"	"Persey III"	"Poisk"
Echo sounder:	EK 400 (38 kHz)	EK 38	EK 38	EK 38
Transducer:	Nickel, 45 x 48 cm 5 x 5.5° (stab.)	Cheramic, 30 x 30 cm 8° x 8°	Cheramic, 30 x 30 cm 8° x 8°	Cheramic, 30 x 30 cm 8° x 8°
Power:	6.2 kw transm.		4 kw transm.	
TVG Gain:	20 log R -10 dB	20 log R -20 dB	20 log R -0 dB	20 log " -20 dB
Bandwith:	3.3 kHz	3 kHz	3 kHz	3 kHz
Pulse length:	1 ms	0.6 ms	0.6 ms	0.6 ms
Range:	0-250 m	0-250 m	0-250 m	0-250 m
Integration:	Digital N-10	Simrad QD	Digital AIS 8	Digital AIS 8
Gain (ref. output):	40 dB	40 dB	10 dB	
Threshold:	17mV - 28 mV		35 mV	10 mV - 15 mV
SL + VR:	134.6 (ref - 0 dB)	120.7 (ref -20 dB)	133.2	121.4



App. 1 to Annex 1, Fig. 1. Intercalibration "Johan Hjort"-"Poisk"



App. 1 to Annex 1, Fig. 2. Intercalibration "G O Sars"-"Persey III"



App. 1 to Annex 1, Fig. 3. Intercalibration "G O Sars"-"Johan Hjort"

Due to a technical error, the performance of the echosounder/integrator system on the "G O Sars" was too low during the survey. Although this has been compensated for in the calculations of stock size, it had not yet been realized, when the charts with integrated densities were drawn.

In order to bring the integrated densities in agreement with the total stock size, densities in the charts should be multiplied with a factor of 3.

ANNEX 2

Report on the Icelandic-Norwegian Acoustic Survey of the Icelandic Capelin Stock in October 1982

During the last 2-3 years the abundance of the Icelandic capelin has declined at an alarming rate, as indicated by O-group indices and acoustic estimates of stock size.

The 1980 yearclass will be the main component of the 1983 spawning stock. The above research has strongly indicated a low level of abundance of this yearclass, a continuation of the observed decline in stock size.

Consequently a complete fishing ban was recommended by the ACFM of ICES as its meeting in July 1982 until further management advice could be given after an acoustic survey in the autumn of 1982. This advice was accepted by all parties concerned.

Through previous surveying by Iceland and Norway it has been established that the earliest opportunity to obtain an acoustic estimate of the abundance of the spawning stock of the Icelandic capelin is in October. In some years it may, however, be difficult to obtain an estimate of stock abundance until later in the autumn due to the distribution and behaviour of the capelin.

In order to take the earliest possible opportunity the present survey was carried out during 2 - 20 October. Two vessels participated:

R/V "Bjarni Sæmundsson", Marine Research Institute, Reykjavik

and

R/V "G.O. Sars", Institute of Marine Research, Bergen

Exchange of personnel took place at sea during the survey and information on data collected was exchanged daily. Due to generally good weather and favourable ice conditions there was only need for slight adjustments in cruise plans as work progressed.

Final processing of the data was handled on board R/V "G.O. Sars". The following scientists participated:

On board R/V "Bjarni Sæmundsson"

H. Vilhjalmsson
P. Reynisson

On board R/V "G.O. Sars"

A. Dommasnes

Material and methods

Courselines and stations are shown in Fig. 1.
Surveying began off NW Iceland and by 10 October the area between 30°W and 20°W, south of the ice border, had been covered. During the following 10 days the rest of the distribution area from 72°N to the north coast of Iceland was surveyed.

Echo intensities were integrated continuosly with digital integrators on both vessels. Mean values per 1 n.m. were recorded for each 5 n.m. sailed. Echograms and corresponding integrated echo intensities were scrutinized daily and contributions from bottom, false echoes and noise deleted. The remainder was attributed to species according to trace pattern and catch composition. Trawling was carried out whenever neccessitated by changes in the characteristics of the echograms or when needed in order to ensure adequate biological sampling, i.e. to obtain information on length, weight, maturity stage, stomach content and age of the capelin. Hydrographic observations were carried out by means of a CTD sonde and bathythermograph.

To compare the integrator values from the two vessels an intercalibration on O-group capelin was carried out on 21 October along 66°15'N, between 12°40'W and 14°W. In addition, recent calibration data based on standard 60 mm copper spheres were available for both vessels. A report on these calibrations is appended. It was decided to use the following relationship between integrator values from the two vessels:

$$M_{\text{Bjarni Sæmundsson}} = 1.2 \times M_{\text{G.O.Sars}}$$

Integrated densities from "G.O. Sars" were recalculated using this formula. By comparing copper sphere calibrations on instruments onboard the "G.O. Sars" in October 1981 and October 1982, a new conversion factor ("C-value") was calculated. This factor multiplied by the above equation gives the following value for converting integrated echo intensities referred to "Bjarni Sæmundsson" into number of capelin:

$$C = 1.6 \times 10^6 \times L^{-1.91} \text{(number of fish/(n.m.)}^2\text{/n.m.)}$$

Results

Capelin were recorded in two main areas (Fig. 2):

1) From 68°45'N to 72°00'N, mainly between 16°00'W and 13°00'W but with some recordings as far east as 7°00'W to the N and NW of Jan Mayen.

2) Off NW- and N-Iceland from 30°00'W to 16°30'W, mainly between 66°40'N and 68°00'N the northwestern border of the distribution in this area being, however, the cold polar waters of the East-Greenland Current. It should be noted that zero or very low values only were recorded near the ice border in the Greenland Strait as well as further north.

In the NE area capelin belonging to the 1983 spawning stock (2-3 ringers) were recorded almost exclusively. Elsewhere this stock component was mainly found off the eastern N-coast of Iceland east of 19°00'W as well as further offshore (N of 67°45') between 19° and 22°W.

Immature capelin of the 1981 yearclass were the main contributors to the echo abundance in the area west and north of NW Iceland as well as in more coastal regions off the western N-coast, i.e. west of 19°W and south of 67°45'.

A local patch of immature capelin was further recorded at the edge of the continental shelf 50-70 n.m. NE of Langanes.

Thus, the maturing stock, including both its northern and southern components, was now recorded in much the same geographical areas as in 1981. This is a distinctly more northerly as well as easterly distribution than observed before, especially in 1978 and 1980.

The immature capelin exhibited a distribution pattern which is frequently observed at this time of the year. It appears to be fairly well represented during the present survey. Its location was approximately known through a previous survey in August 1982, and relatively favourable ice conditions and weather conditions allowed a more comprehensive survey to be carried out than often before.

The total abundance estimate in weight of 1-3 years old capelin amounted to 560 000 tonnes distributed by areas 1-3 as 469 000, 82 000 and 9 000 tonnes respectively. Maturing capelin amounted to approximately 265 000 tonnes. Details of the total stock abundance estimate are given in Table 1. An abstract is given in the text table below together with corresponding values for the years 1979-81.

Age	1982 Number $\times 10^{-9}$	1982 Tonnes $\times 10^{-3}$	1981 Number $\times 10^{-9}$	1981 Tonnes $\times 10^{-3}$	1980 Number $\times 10^{-9}$	1980 Tonnes $\times 10^{-3}$	1979 Number $\times 10^{-9}$	1979 Tonnes $\times 10^{-3}$
1	68.0	260	0.9	5	23.6	171	22.3	141
2	16.6	262	7.0	135	19.6	378	42.4	639
3	1.6	39	0.2	4	4.8	128	7.9	167
Sum	86.2	561	8.1	144	48.0	677	72.6	947

Hydrography

Temperatures at the surface and in 100 and 200 m depth are given in Figs. 3,4 and 5.

The figures reflect the main features of the general water circulation in the area: The Icelandic coastal water of relatively high temperature enters the area from the south and flows eastwards bordered in the north by the polar water of the East Greenland Current and its branch which forms the East Icelandic Arctic Current.

Discussion

When comparing acoustic estimates of spawning stock abundance of the Icelandic capelin obtained in October surveys to those obtained in January/February in the following year a consistent underestimate is apparent in most years. In 1981 however, ice conditions were exceptionally unfavourable in October resulting in an underestimate of stock abundance of unpredecented magnitude.

This year coverage appears to be good. It was possible to cover the distribution area almost completely. The capelin were found clear of drift ice in almost the entire area, and the probability of important capelin concentrations located underneath the ice cover is negligible.

A short spell of bad weather was encountered off the N-coast of Iceland during the last days of the survey. Otherwise weather conditions were excellent and can only have influenced survey results to a small extent, if at all.

Although the distribution and behaviour of the adult capelin, especially in the northern and northeastern part of its distribution area was unfavourable for acoustic stock abundance surveying it seems highly unlikely that these factors can have affected the survey results to anywhere near the same degree as experienced in 1981.

A comparison of the abundance of immature I-group capelin is given for the years 1979-1982 in the text table on page 5. While the present figure of 68×10^9 is by far the highest on record it must be pointed out that it is doubtful to what extent the abundance figures for this stock component are comparable. There are two reasons:

1) Changes in accessibility to parts of the distribution area due to drift ice and sometimes weather, particularly apparent in October 1981 and;

2) An admixture of older stock components will affect survey results due to gear selectivity in favour of the larger fish. This possibility was especially noticeable in October 1980.

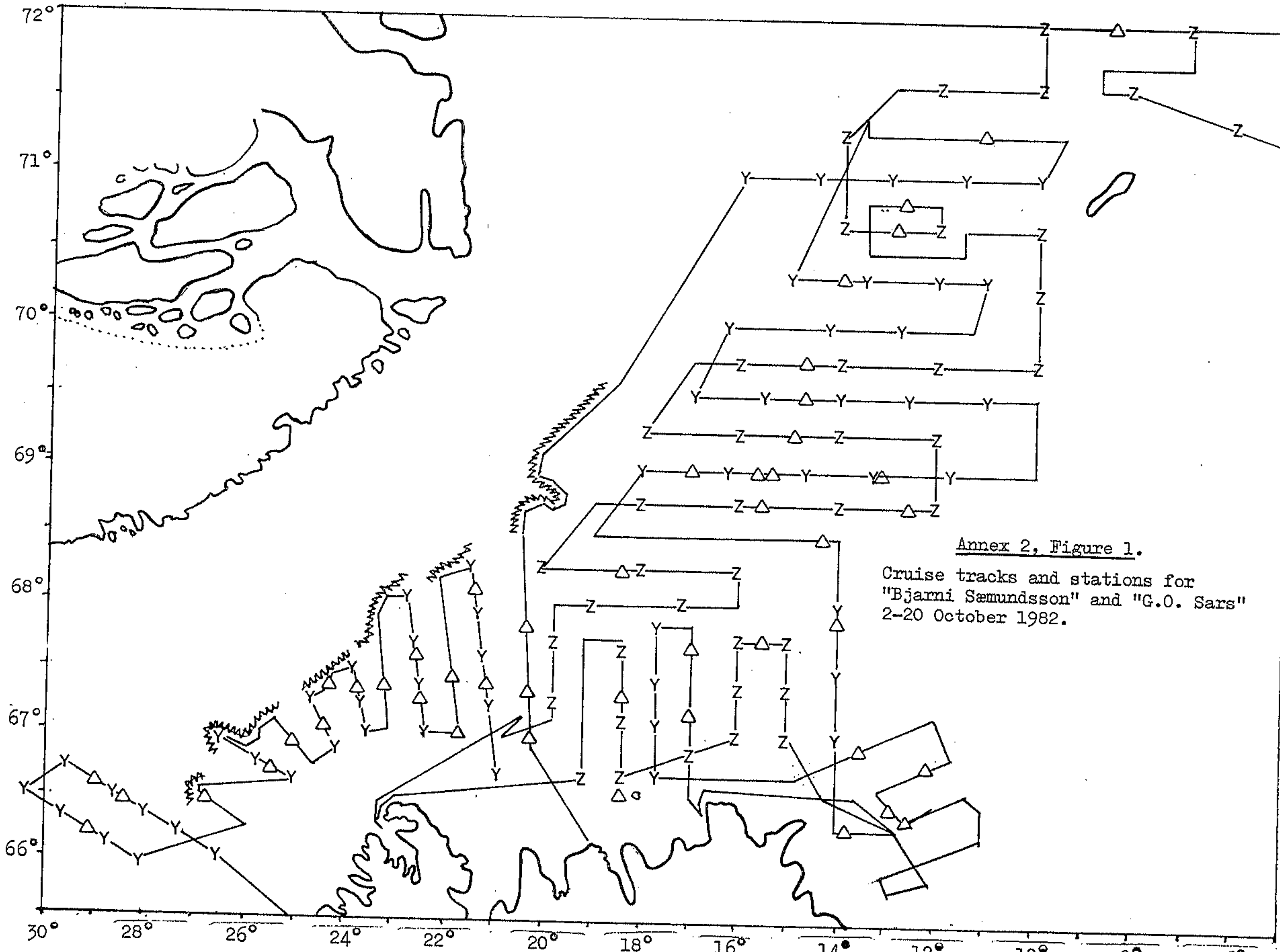
It has been stated previously that conditions during the present survey were favourable as regards coverage and weather. There was, however, some admixture of older fish in parts of the distribution area of the I-group capelin. In August 1982 the Icelandic Marine Research Institute carried out an acoustic abundance survey of the 1981 yearclass while it occurred in more or less pure concentrations off N- and NW-Iceland. The August abundance estimate is considerably higher than the present one, even when account has been taken of natural mortality during the intervening period.

Conclusions

According to the present survey results the 1983 spawning stock amounts to approximately 265 000 tonnes. It has often been pointed out, most recently by ACFM in the report from their meeting in July 1982, that it is inadvisable to reduce the spawning stock of the Icelandic capelin below the level of 400 000 tonnes.

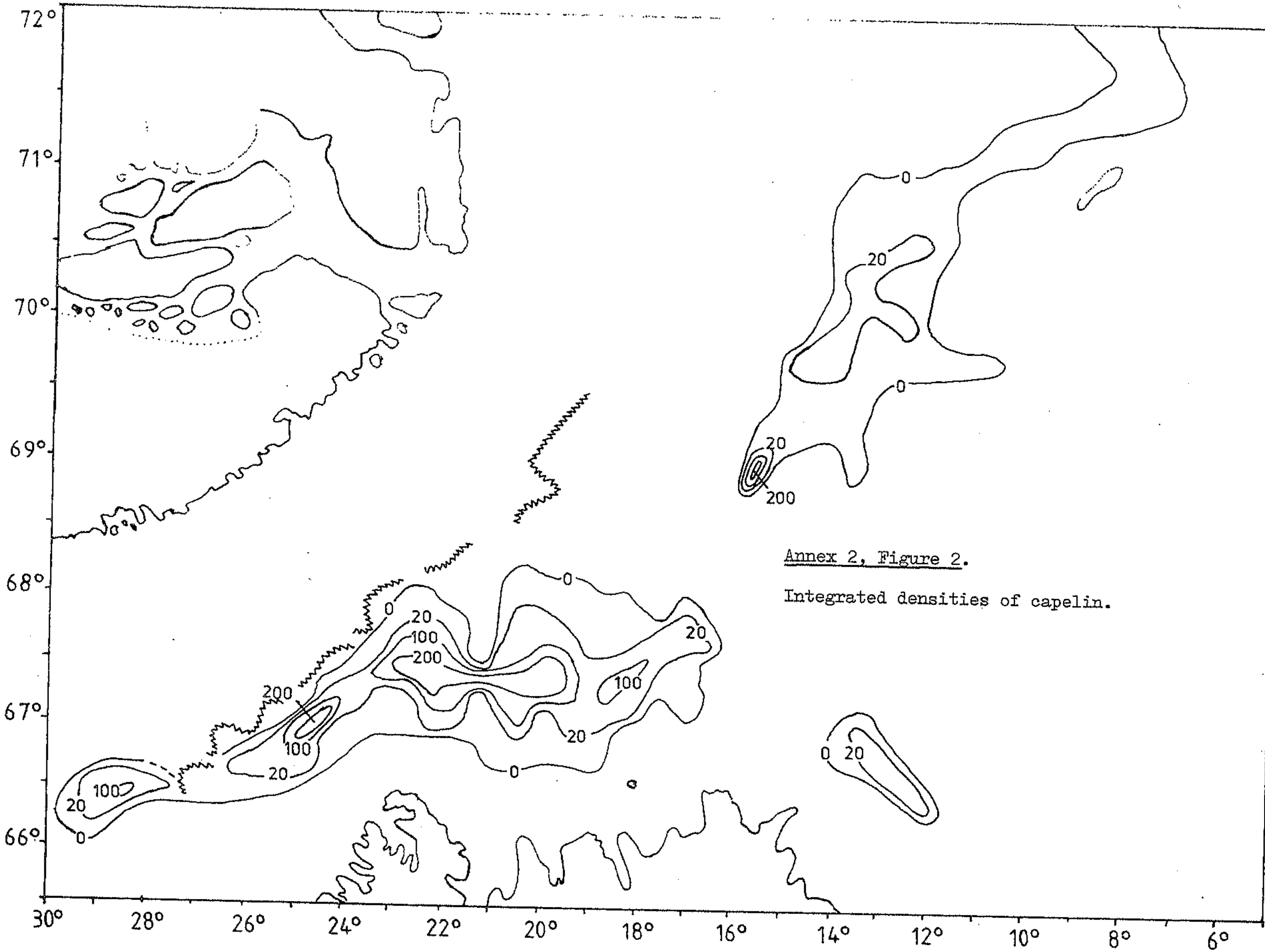
Annex 2, Table 1. Acoustic estimate of the capelin in the Iceland-Jan Mayen-Greenland area in October 1982.

Total length (cm)	Age 1	Age 2	Age 3	Age 4	Total number $x 10^{-7}$	Biomass tonnes $x 10^{-3}$	Mean volume (ml)
8.0- 8.4	2				2	0.0	1.3
8.5- 8.9	175				175	3.5	2.0
9.0- 9.4	678				678	14.6	2.2
9.5. 9.9	1471				1471	42.8	2.9
10.0-10.4	1447				1447	47.4	3.3
10.5-10.9	1306				1306	52.2	4.0
11.0-11.4	783				783	37.7	4.8
11.5-11.9	405				405	22.7	5.6
12.0-12.4	304	14			318	20.4	6.4
12.5-12.9	101	50			151	11.9	7.9
13.0-13.4	81	105			186	16.8	9.0
13.5-13.9	29	168	3		200	21.3	10.6
14.0-14.4	15	261	11		287	34.9	12.2
14.5-14.9		281	3		284	40.3	14.2
15.0-15.4	4	226	18		248	40.4	16.3
15.5-15.9		210	4		214	39.2	18.3
16.0-16.4		166	16		182	38.3	21.0
16.5-16.9		101	30		131	30.8	23.5
17.0-17.4		53	26		79	21.0	26.6
17.5-17.9		22	26		48	13.8	28.8
18.0-18.4		7	15		22	7.2	32.8
18.5-18.9			6		6	2.3	38.7
19.0-19.4			2		2	0.8	41.7
Number $x 10^{-7}$	6801	1664	160		8625		
Mean length(cm)	10.49	14.99	16.73		11.48		
Biomass (tonnes $x 10^{-3}$)	260.4	261.5	38.6			560.6	
Mean volume (ml)	3.8	15.7	24.1		6.5		



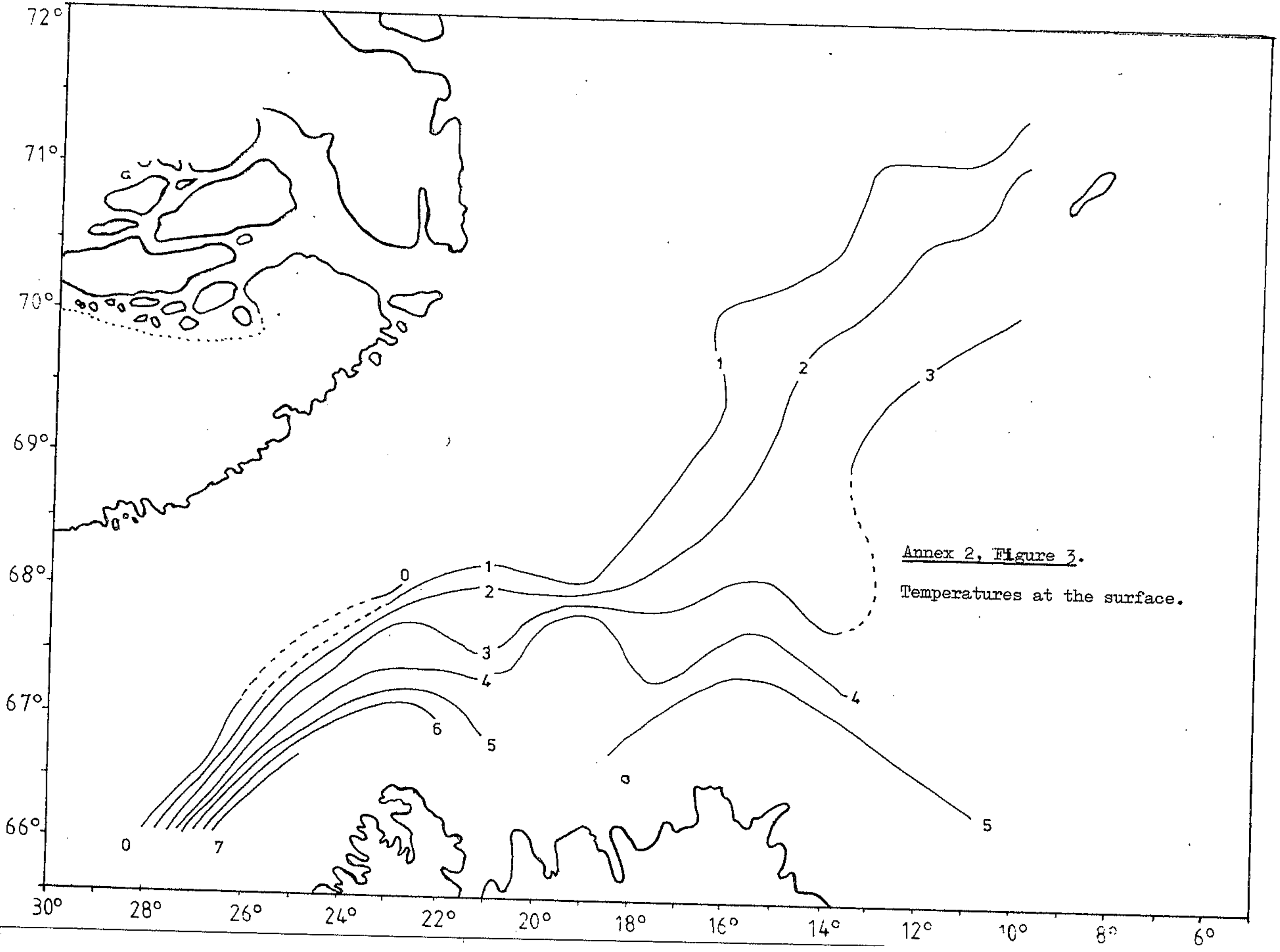
Annex 2, Figure 1.

Cruise tracks and stations for "Bjarni Sæmundsson" and "G.O. Sars" 2-20 October 1982.



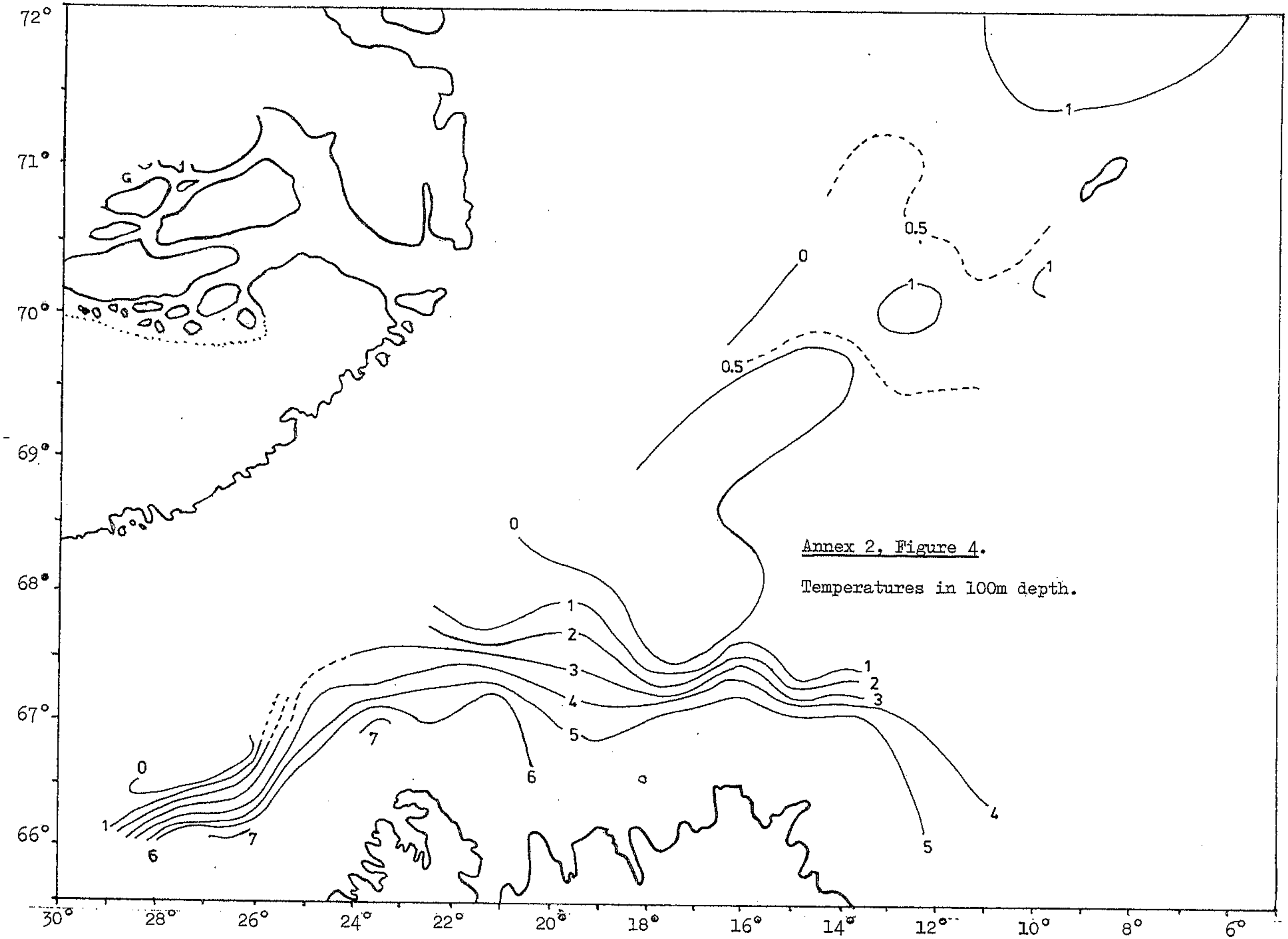
Annex 2, Figure 2.

Integrated densities of capelin.



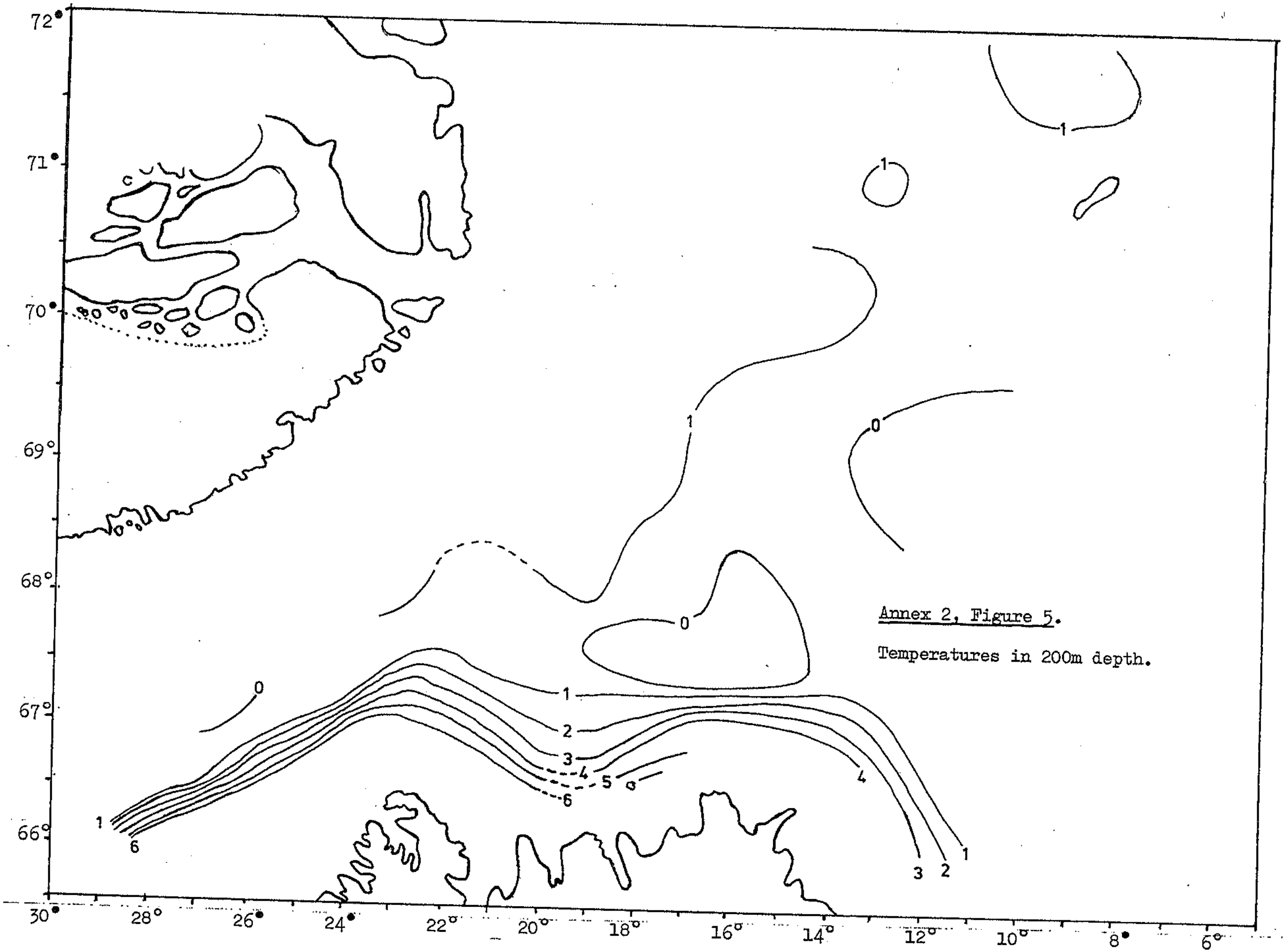
Annex 2, Figure 3.

Temperatures at the surface.



Annex 2, Figure 4.

Temperatures in 100m depth.



Annex 2, Figure 5.

Temperatures in 200m depth.

Calibration of hydroacoustic instruments

The performance of the acoustic instruments onboard the participating vessels were measured by help of a standard target reference sphere (Cu 60) before the survey started on 2nd and 3rd of October.

Details are given in Table 1.

In order to establish a conversion factor for the integrator output of the vessels, an intercalibration was carried out on October 21 in the area between longitude 12°40' and 13°50' West on latitude 66°15' North. The sailed distance was 26 nautical miles. The prevailing weather conditions were favourable with light breeze and little swell.

The intercalibration was performed in the traditional way, with G.O. Sars" steaming 0.5 nautical mile ahead and 10° to port side of "Bjarni Sæmundsson". The navigational log counter on "Bjarni Sæmundsson" was used as a reference of distance, and the integrator reset function on "G.O. Sars" was operated manually each nautical mile on a radio signal from "Bjarni Sæmundsson".

Contributions from echo recordings were integrated in two channels covering the depth interval from 10 to 100 metres. It is assumed that the echo recordings consisted mainly of O-group capelin. The integrator output gave from 15 to 1800 milimetres per nautical mile on varying densities of fish recordings. The settings of the instruments during the intercalibration were the same as used during the survey. Particulars are given in Table 2.

After the intercalibration a meeting was held omboard the "G.O. Sars", where the obtained echo recordings and related integrator output were closely studied. Since the registrations on each mile on the recording paper of the vessels showed great conformity, it was decided to apply all integrator values in a regression analysis. Examples of the echo recordings are shown in Fig. 3.

Fig. 1 shows the integrator deflections (mm) of "G.O. Sars" and "Bjarni Sæmundsson" during the intercalibration.

By use of the least mean square method the following relation between integrator output of the vessels was found

$$M_{BS} = 1,21 \ M_{GOS} - 21,3$$

with the correlation coefficient of $r^2 = 0.99$.

Fig. 2 shows particulars of the established regression line.

Since the equation above corresponds very well with the results from the mentioned standard reference sphere calibrations, it is recommended that this equation is used for the integrator data obtained during the cruise.

Reykjavik, 23.10.82

Kaare A. Hansen

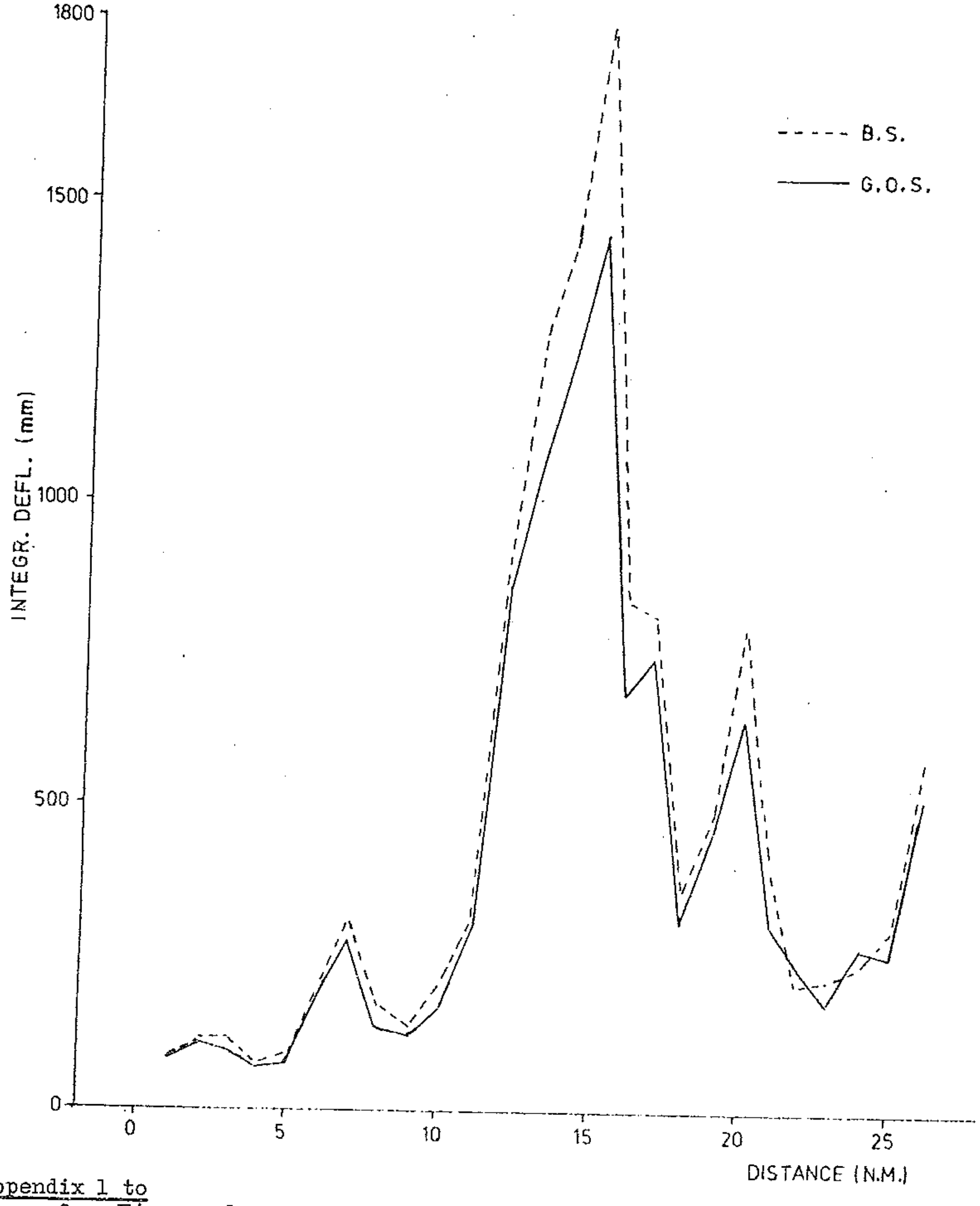
Páll Reynisson

Appendix 1 to
Annex 2, Table 1. Results from Standard Reference Target Calibrations:

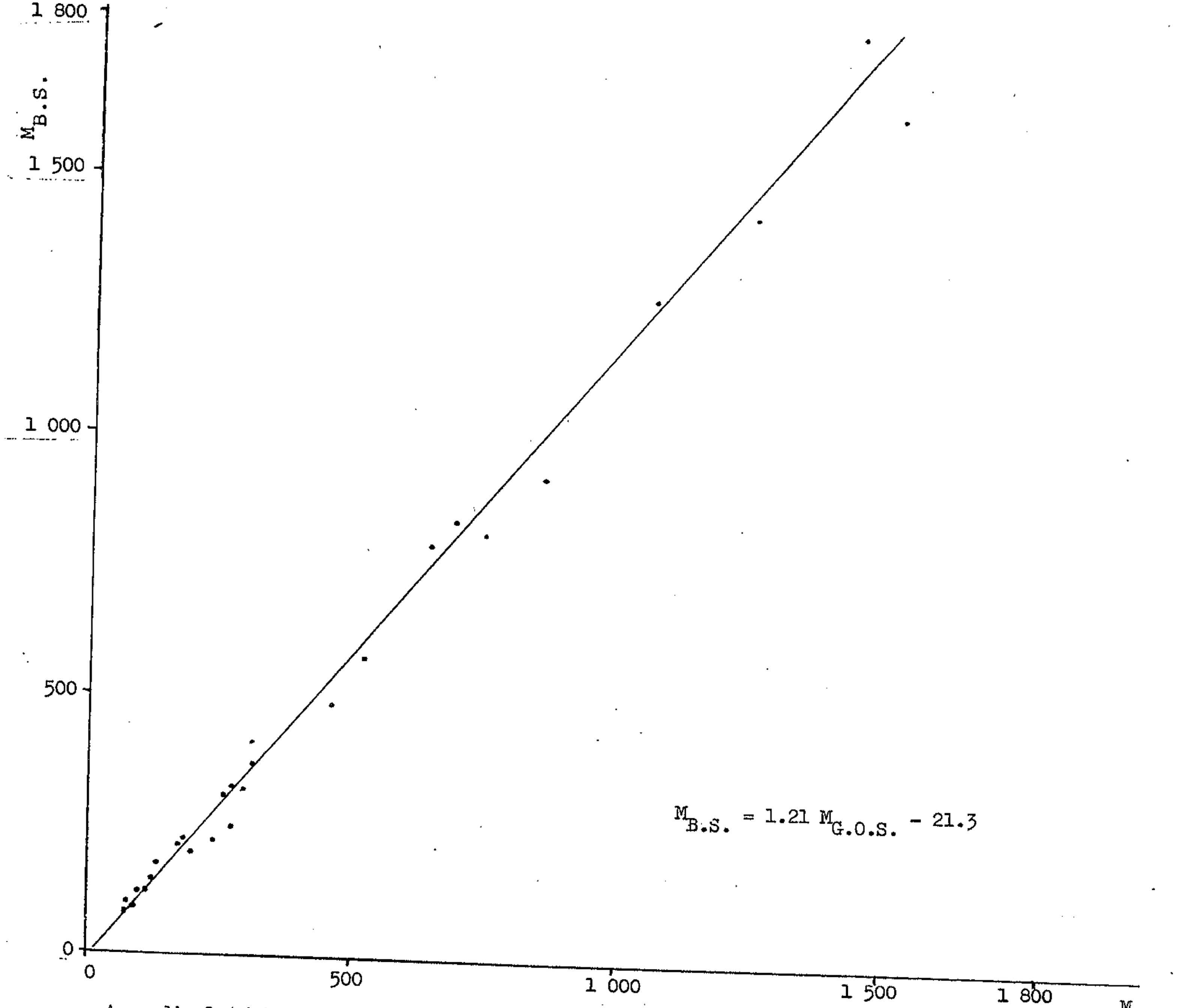
	"G.O. Sars"	"B. Sæmundsson"
Date	02.10.82	03.10.82
Transducer Impedance	76	69
Transmitter Power	6600 W	2450 W over dummy load
Receiver Gain, ref. o dB att.	85.1 dB	85.3 dB
Performance (SL+VR), ref. o dB att.	134.8 dB	136.3 dB
Integral, ref. 1m depth, 1m distance, ref. 10 dB attenuation	2170 mm	3072 mm

Appendix 1 to
Annex 2, Table 2. Instrument settings during the survey and the intercalibration

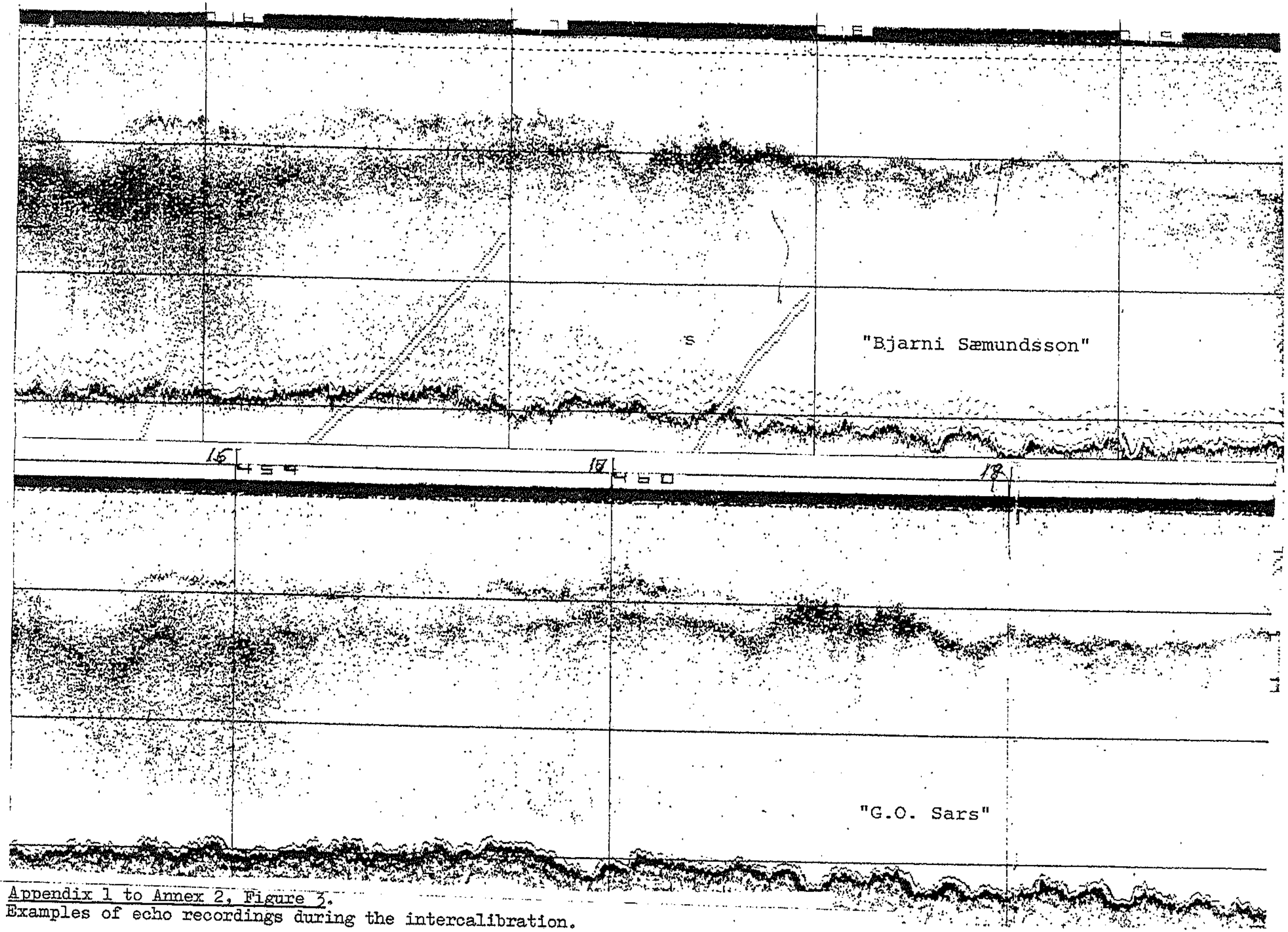
	"G.O.S."	"Bj.Sæm."
Echo sounder	EK 400	EK 400
Frequency	38 kHz	38 kHz
Transducer	69C(5^ox5,5^ostab.)	69C(4,5^ox5^o)
Transmitter Power	5,0 kw	2,5 kw
TVG/Gain	20 logR-10dB	20 logR -10dB
Bandw./Pulslength	3,3kHz-1,0ms	3,3kHz-1ms
Recordergain	8	8
Range	0-250 m	0-250 m
Integrator	N-10	QD
Gain (ref output)	40 dB	40 dB
Threshold	16 mV	15 mV
Intervall	10-100 m	10-100m



Appendix 1 to
Annex 2, Figure 1. Intercalibration between R.V. "G.O.Sars" and R.V. "Bjarni Sæmundsson" 21.10.82.



<u>Appendix 1 to Annex 2, Figure 2</u>. Regression line from intercalibrat_on.



Appendix 1 to Annex 2, Figure 3.
Examples of echo recordings during the intercalibration.

ANNEX 3

Report on an Acoustic Abundance Survey of the Juvenile Component of the Icelandic Capelin Stock, August 1982

Introduction

In July 1982 ICES recommended that further experiments, aiming at obtaining evidence on the abundance of immature 1- and 2-group capelin early enough to enable the Atlanto-Scandian Herring and Capelin Working Group to carry out an assessment of spawning stock abundance prior to the fishing season, should be undertaken.

In view of earlier survey results, both on 0-group and adult, it was concluded that the most likely time period in which to obtain such data would be the month of August. By extending the coverage off N- and NW-Iceland during the 1982 0-group survey it seemed likely that at least much of the 1-2 group immatures could be included as well.

The 1982 0-group survey took place during 7-31 August, the distribution area of the 1-2 group immatures being covered during the last two weeks of the month.

The vessel employed was R/V "Bjarni Sæmundsson". During the last stages of the survey she was, however, joined by R/V "Árni Friðriksson" in order to extend and improve coverage in more northerly regions.

Scientists in charge were H. Vilhjálmsson and P. Reynisson, Marine Research Institute, Reykjavik.

Material and Methods

As regards the 1-2 group capelin the survey covered the area from 65°30'W to 69°00'N between 10°W and 31°W. In the Greenland Strait, however, the NW border was determined by the absence or extreme scarcity of capelin recordings generally observed soon after entering the cold polar waters of the East Greenland Current.

The cruise tracks were mostly spaced at an interval of 20-30 n.m. in areas of high capelin density. Elsewhere cruise tracks were occassionally more sparsely spaced. Courselines and stations are shown in Figure 1.

Echo intensities were integrated continously using a digital integrator on board R/V "B. Sæmundsson" and an analog one on board R/V "Árni Friðriksson". Mean values per 1 nautical mile were recorded for each 5 nautical miles sailed. Integrated values of each intensities and echograms were scrutinized daily and contributions from bottom, false echoes and noise deleted. The remainder was then attributed to species according to the trace pattern of the catch composition.

Trawling was carried out when neccessiated by changes in the characteristics of the echograms or when needed in order to obtain information on biological parameters of the capelin. Hydrographic observations were carried out along standard sections and in various other localities and are included in the 0-group survey report presented to the ICES C.M. 1982.

Established calibration procedures employing standard targets were carried out on both ships prior to and at the end of the survey. Further intercalibration between the two vessels was carried out on recordings of O-group capelin and krill during the cruise. The echo intensities recorded by R/V "Árni Friðriksson" were then converted to "B. Sæmundsson" values.

Conpilations of numbers of individuals by age groups were obtained by a similar method as used during Icelandic and Norwegian autumn and winter surveys of this capelin stock.

There was no interruption of survey work due to weather and no drift ice was encountered although reported a short way further to the NW in the Greenland Strait.

The convertion factor used for obtaining the present abundance estimate is the same as established in the joint Icelandic and Norwegian autumn survey of the Icelandic capelin stock in October 1982.

Results and discussion

The main concentrations of juvenile capelin were recorded off the western N-coast of Iceland south of 68°N as well as north of the NW-peninsula. Lesser quantities were observed off the eastern N-coast as well as off NE-Iceland. Only minor quantities were recorded farther west in the Greenland Strait as well as in the Dohrn Bank region.

Almost everywhere the juvenile capelin, consisting almost entirely of the 1981 yearclass, when recorded during daytime appeared as a scattering layer, generally at a depth between 150 and 200 m. Frequent sampling by pelagic trawl showed a near complete absence of older maturing capelin.

The only other important scatterer in the area of this time of the year is 0-group capelin, which almost always is recorded in the uppermost 50-100 m of the water column only. Except during the few hours of darkness when the I-group capelin tended to ascend to shallower depths, the echo intensities recorded needed very little adjustment if any.

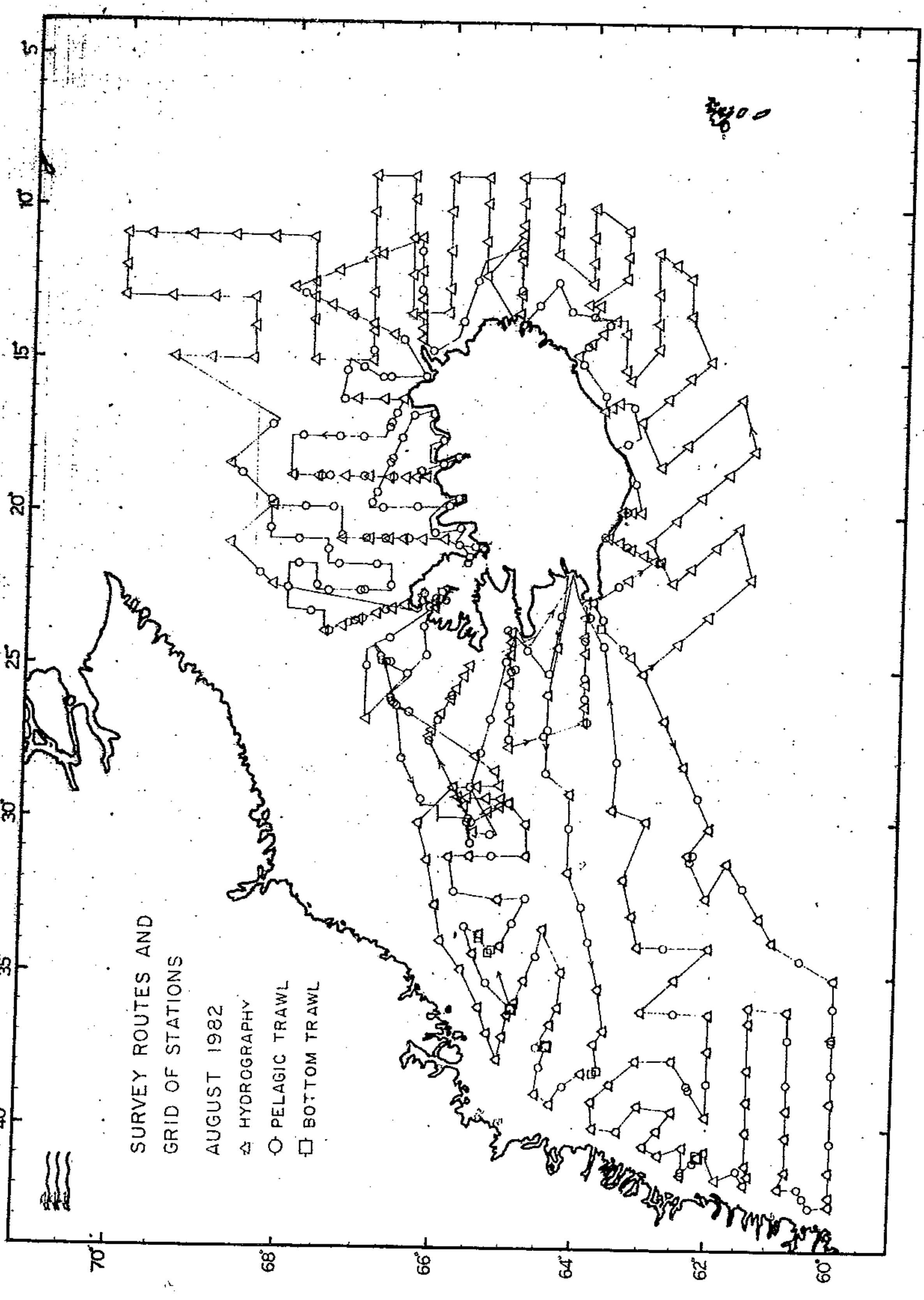
Considering the good weather, absence of drift ice as well as the above behaviour pattern of the juvenile I-group capelin, the present survey of this stock component appears to have been carried out under near ideal conditions.

The total observed echo abundance of I-group capelin in August 1982 was 119 x 10^9 fish. The distribution of the echo intensity recorded is shown in Figure 2.

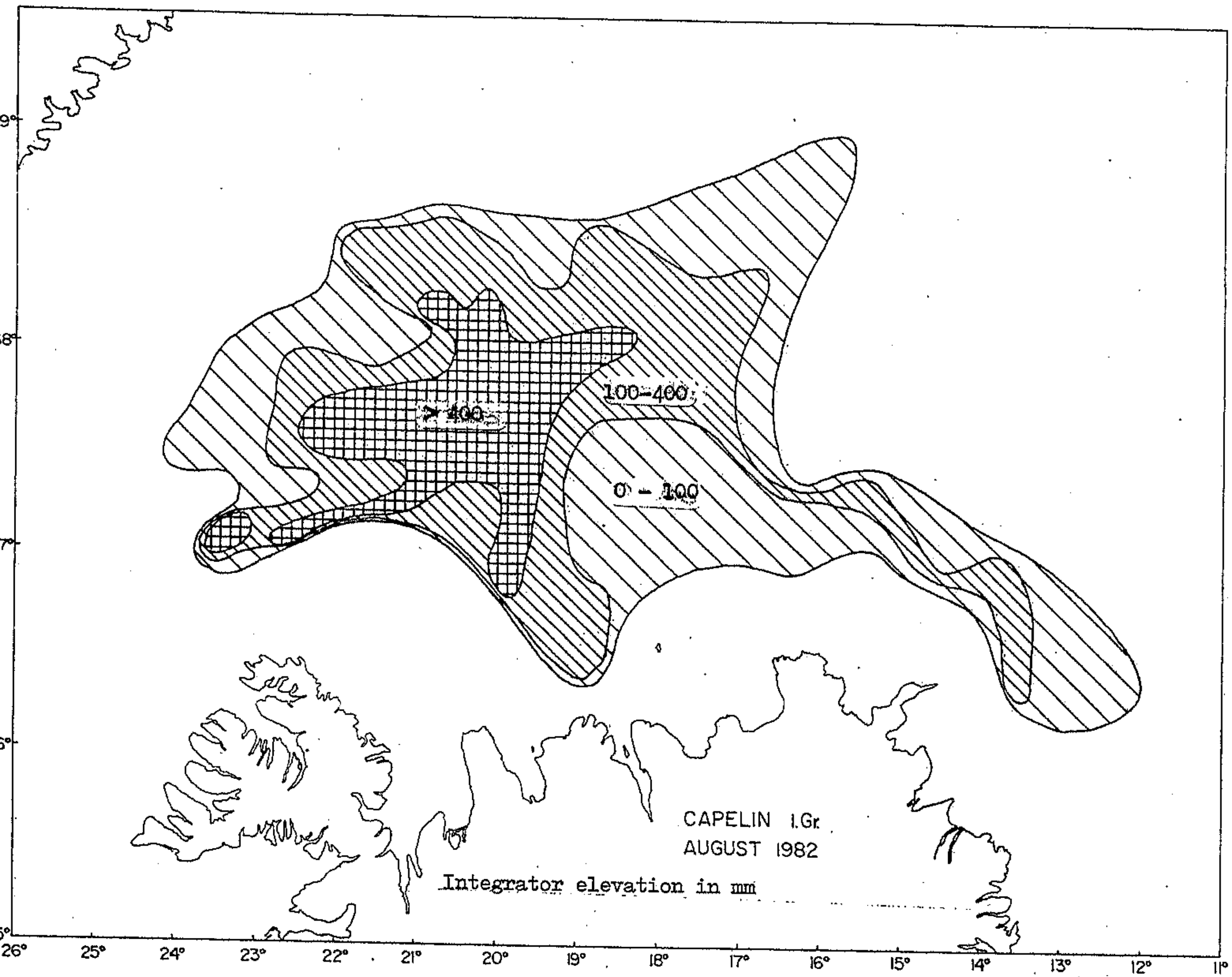
Conclusion

In the absence of comparative data the validity of the above abundance figure in absolute terms is difficult to judge.

In view of the apparent success of the experiment surveying of this stock component during the latter half of August and possibly in early September should certainly be continued.



1. mynd. Leiðarlínur og togstöðvar. Ágúst 1982.



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CAPELIN I.Gr.
AUGUST 1982
Integrator elevation in mm