

International Council for the  
Exploration of the Sea

C.M. 1980/H:8  
Pelagic Fish Committee

*Fiskeridirektoratet  
Biblioteket*

REPORT OF THE WORKING GROUP ON ATLANTO-SCANDIAN HERRING

Bergen, 12-14 May 1980

This document is a report of a Working Group of the International Council for the Exploration of the Sea and does not necessarily represent the views of the Council. Therefore, it should not be quoted without consultation with the General Secretary.

---

x) General Secretary,  
ICES,  
Palægade 2-4,  
DK-1261 Copenhagen K,  
Denmark.

LIST OF CONTENTS

	<u>Page</u>
1. Introduction and Participation .....	1
1.1 Terms of reference .....	1
1.2 Participants .....	1
2. Norwegian Spring Spawners .....	1
2.1 Catch statistics .....	1
2.2 Recordings of herring since spring 1979 .....	1
2.3 Egg survey in 1980 .....	2
2.4 Larval surveys in 1980 .....	2
2.5 O-group investigations in 1979 .....	3
2.6 Tagging experiments .....	4
2.7 Stock structure and migration .....	4
2.8 Abundance estimates of the spawning stock .....	5
2.9 Stock size by age in 1977-80 .....	7
2.10 Management advice .....	10
3. Faroese spring spawning herring .....	11
4. The Icelandic spring and summer spawning herring .....	12
4.1 The fishery .....	12
4.2 Stock abundance and mortality rates .....	12
4.3 State of the stock and advice of TAC .....	15
References .....	16
Tables 2.1 - 4.5 .....	17-23
Figure 1 - Figure 9 .....	24-32

## 1. Introduction and Participation

### 1.1 Terms of reference

At its Statutory Meeting in Warsaw 1979, the International Council for the Exploration of the Sea (ICES) decided that the Atlanto-Scandian Herring Working Group should meet at ICES headquarters for three days from 12-14 May 1980 to assess the state of the Atlanto-Scandian Herring. Subsequently the venue of the meeting was changed and the Working Group met in Bergen.

### 1.2 Participants

A.S. Belov	USSR
J. Hamre	Norway
J. Jakobsson (Chairman)	Iceland
S.H. i Jákupsstovu	Faroes
I. Røttingen	Norway
V.N. Shleinik	USSR
J.P. Wheeler	Canada

## 2. Norwegian Spring Spawners

### 2.1 Catch statistics

Table 2.1 gives the catch north of 62°N of Norwegian spring spawners in tonnes since 1972. Table 2.2 gives the catches of 3 years and older in number. In the latter table unreported catches are included.

### 2.2 Recordings of herring since spring 1979

In June and July schools of herring were reported from Vesterålen and Røstbanken (Fig. 1). The herring formed separate schools, clearly visible on the surface. Stomach analysis showed that the herring were feeding on Calanus. The age distribution of the samples from this area showed approximately the same age distribution as the herring from

Lofoten which were analyzed for tag returns in March 1979. However, the percentage of the 1976 yearclass was a little higher in the samples from June - July.

In autumn the herring formed very dense schools mainly at two localities, in Øyhellesund in Lofoten and in Vinjefjord/Auresundet in Møre. Figs. 2 and 3 show echogrammes of these concentrations. The herring seem to have migrated from these localities to the spawning grounds in February 1980. In autumn and in winter concentrations of younger herring (mainly of the 1976 yearclass) were reported from Sølasundet.

In autumn and winter experiments with underwater photography were carried out on these herring schools (OLSEN 1980). Densities up to 45-50 herring per m<sup>3</sup> were observed. This is a considerably higher estimate than that of earlier reports of densities in herring schools.

The Norwegian investigations on the spawning grounds are referred to later in this report in connection with the tagging project. Soviet driftnet stations in March - April 1980 gave only 22 specimens of pre- and postspawning herring, mostly of the 1973 and 1976 yearclasses. Fig. 4 gives the date, number of herring, and location of each station.

### 2.3 Egg survey in 1980

A survey on the spawning grounds of Møre in March 1980, using a Petersen grab, was unfortunately suspended after a few days due to technical breakdown on the chartered survey vessel. However, herring eggs were found on Buagrunnen. In addition, stomach samples of haddock from Vestfjorden containing herring eggs were sent to the Institute in Bergen by local fishermen in the latter half of April.

### 2.4 Larval surveys in 1980

The previous Working Group report gives larval distribution charts for 1972 - 1979.

Figs. 5-7 give larval distribution charts in March - April 1980 based on the Norwegian investigations with a modified Gulf III plankton sampler. The larvae sampled prior to 20.4. were mostly less than 10 mm in length, and there were also many larvae of that size during the sampling period 22.4. - 29.4. This indicates an extended spawning season. Based on the reports of herring eggs in Vestfjorden, sampling for larvae will continue throughout May in that area.

Large larvae (mean length 38.38 mm, n = 10) were caught off Svinøy during the Soviet larval investigations this year (5.4. - 9.4. and 11.4. - 15.4.). It is difficult to tell where these larvae originated. During the period 11. - 15. April, smaller larvae (mean length 8.34 mm) were caught in the same area in deeper waters (100-150 m).

#### 2.5 0-group investigations in 1979

Some 0-group herring were recorded in the Barents Sea during the international 0-group surveys in August - September 1979. Fig. 8 shows the distribution of the 0-group herring.

0-group herring were recorded in the coastal areas of Norway and an acoustic estimate was made on a survey during the period 5.11. - 14.12. 1979. The acoustic abundance estimates are shown in Table 2.3. The table also compares the estimate for 1979 with similar estimates for the years 1975 - 1978. In earlier Working Group reports the data on abundance of 0-group herring also included estimates from Trondheimsfjorden. However, according to an unpublished Norwegian report, biochemical investigations on 7 different muscle enzymes show that the herring in Trondheimsfjorden belong to a separate stock.

Other data support this conclusion. The age structure of this stock is different from the main stock, with approximately 80% of the adult herring belonging to the 1975 yearclass. The 1975 yearclass in Trondheimsfjorden has a reduced growth rate, the mean weight of that yearclass as 4

year olds was only 151 grammes. Further, a tagging experiment was made in the autumn of 1978 (8999 tags). No returns have been reported from outside Trondheimsfjorden, but 6 returns have been reported from experimental fishing within Trondheimsfjorden.

On the basis of this, the herring in Trondheimsfjorden are regarded as a local stock, and estimates of 0-group herring in that area are excluded from Table 2.3.

## 2.6 Tagging experiments

The herring tagging project described in a previous Working Group report has been continued. Herring have been internally tagged and released at various localities along the Norwegian coast and catches from experimental fishing during the spawning season have been analysed for recoveries using a tag indicator retaining internally tagged fish. The tagging is done in April-May.

In the winter 1980, 879 tons of adult herring were screened for tags and 96 tagged herring were recovered. The efficiency of the tag detector was estimated to 85%.

## 2.7 Stock structure and migration

The data reported to the previous Working Group meeting provided evidence to separate this herring stock into two spawning components, a southern component spawning on the coast of Møre (south of 63°N) and a northern one, spawning north of 63°N. The herring did remain in Norwegian coastal waters after spawning and did not migrate to the feeding area off Iceland as prior to 1970. The herring were feeding in the coastal waters between Møre and Lofoten during summer and autumn and overwintered in the fjords of Lofoten (northern component) and Møre.

There have not been any changes observed in this behaviour pattern in 1979-80.

2.8 Abundance estimates of the spawning stock

The tagging programme was started in May 1975, and based upon the recoveries from the experimental catches in 1977-79, the previous Working Group assessed the total spawning stock to be 170 000 tonnes in 1979. The southern stock component was found to be the smaller, 10-15 percent of the total stock. The average annual total mortality rate (Z) for the years 1975-78 was estimated at 0.37. This Z-value gave a 20% decrease in the biomass of the northern stock component in the years 1977-79 due to poor recruitment from the 1975 yearclass. The abundance of the southern stock component was found to be more or less unchanged from 1977 to 1979.

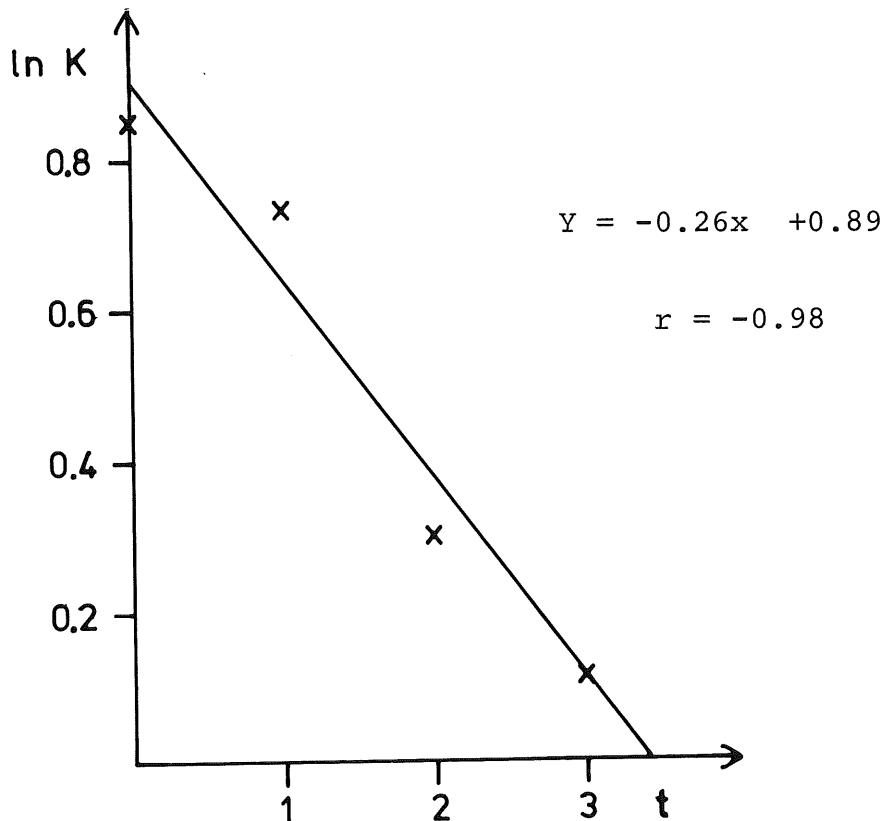
In the table below are summarized the releases by years in 1975-78 and corresponding recoveries from the experimental catch in 1980. The 1979 releases, which gave 18 recoveries in 1980 have been excluded, in order to avoid error in the estimate due to incomplete mixing of the tagged fish in the maturing stock.

Years	Northern component				Southern component			
	$m_t$	$r_{80}$	$K \cdot 10^{-3}$	$\ln K$	$m_t$	$r_{80}$	$K \cdot 10^{-3}$	$\ln K$
1975	20991	9	2.33	0.85	5000	2	2.5	0.92
1976	20744	10	2.07	0.73	3200	0	-	-
1977	23989	18	1.33	0.29	16044	12	1.34	0.29
1978	25997	23	1.13	0.12	5999	4	1.50	0.41
Sum	92671	60			30242	18		

In the previous Working Group report a selected group of releases including herring from the yearclasses older than the 1975 yearclass were used in the assessment of the stock. In the present assessment all the releases of herring older than the 1977 yearclass are included with the exception of 4 releases of tagged herring in the fjords of

northern Norway in 1975 and 1976. These releases have given very few recoveries.

The fraction  $K = m_t / r_{80}$  is proportional to the stock size at the time when the tagged fish was released. A plot of  $\ln K$  against time of liberty of the tagged fish should thus yield a straight line with slope equal to the instantaneous mortality rate  $Z$ , provided that the mortality rate due to the tagging does not vary by year. The plots are shown in the figure below, referring to the data from the northern stock component.



The regression line yields an average  $Z$  for the years 1975-78 of 0.26. Since the numbers of recoveries for the southern stock component are so few, the Working Group agreed to use this  $Z$ -value in the assessment of the total stock. This calculated  $Z$ -value is substantially smaller than the  $Z$  estimate made by the previous Working Group meeting. This is mainly due to the very high recovery rate in the latter estimate from the 1977 and 1978 releases as within season recoveries (i.e. less than one year at liberty). This



resulted in an average Z-estimate from 1975 to 1977 of 0.45, whereas the Z-value 1977/78 is 0.22.

The state of the stock in 1980 was then calculated by assuming the same Z in 1979 as estimated for the 4 previous years. Disregarding tagging mortality the number of surviving tagged herring in the winter 1980 are:

Year of release	$0.26 \cdot t$	Northern $m_{80}$	Southern $m_{80}$
1975	1.30	5720	1363
1976	1.04	7314	1131
1977	0.78	10971	7354
1978	0.52	15456	3566
	$\Sigma m$	39487	13414

Assuming 30% tagging mortality as in previous reports the stock size in number in early 1980 is:

Northern component:

$$N = \frac{39487 \cdot 0.7 \cdot 1537 \cdot 10^3}{60} = 708 \cdot 10^6$$

Southern component:

$$N = \frac{13414 \cdot 0.7 \cdot 587 \cdot 10^3}{18} = 306 \cdot 10^6$$

The catch in number effectively screened for tags in 1980 were  $1537 \cdot 10^3$  and  $587 \cdot 10^3$  for the two stock components respectively.

## 2.9 Stock size by age in 1977-80

### 2.9.1 Northern component

The percent age composition of the northern spawning stock component is given in the following table:

Yearclasses %

Year	1977	1976	1975	1974	1973	1972	1971	1970	1969	No. of her- ring aged
1977				24	56	3	0	0	17	390
1978				32	52	3	0	0	13	392
1979		3	4	31	47	2	0	0	13	389
1980	6	28	4	20	33	2	0	0	7	581

On the basis of the age composition, the total mortality  $Z=0.26$  and the mean weight by age, the spawning stock size in number and total weight were calculated for the years 1977-80. In this calculation it was assumed that a yearclass was fully recruited to the spawning stock at an age of 4 years.

Yearclasses

Year	1977	1976	1975	1974	1973	1972	1969	No. $\cdot 10^{-6}$	Tons $\cdot 10^{-3}$
1977				211	493	26	150	880	200
1978				242	393	23	99	757	235
1979		18	25	194	295	13	82	627	230
1980	42	197	29	142	233	15	50	708	235

The new estimate shows a larger stock level than estimated last year. However, the new estimate shows that there has been no growth in this stock component over the last three years. This is due to the very low recruitment, especially from the yearclass 1975.

2.9.2 Southern component

The table below shows the percent age composition of the southern spawning stock component in the years 1977-80.

Year	Yearclasses %						No. of herring aged	
	1977	1976	1975	1974	1973	1972		1969
1977				15	72	5	8	100
1978			7	54	38	1		195
1979		19	20	35	25	1		192
1980	14	37	13	20	16			99

Assuming that 4 year old herring are fully recruited to the spawning stock and that  $Z=0.26$  is valid throughout the period 1977-80, the stock size in number and total weight were calculated from the estimated total number in 1980, the age composition and the observed average weight by age.

Year	Yearclasses %						No. $\cdot 10^{-6}$	Tons $\cdot 10^{-3}$	
	1977	1976	1975	1974	1973	1972			1969
1977				18	86	6	10	120	30
1978			14	110	77	2		203	50
1979		46	48	84	60	2		240	65
1980	43	113	40	61	49			306	90

The back-calculated stock size in 1977 is 25% larger than the 1977 stock estimate of the previous Working Group. The latter estimate was based upon 17 recoveries, of which 7 were within season recoveries. With so few recoveries and with the possible systematical errors to which these estimates may be subjected, the differences observed in the two estimates are within the range of expectation. The new estimate is thus in agreement with the conclusion drawn last year, that the southern stock component was far the smaller one in 1977.

The growth in stock size since 1977 has been considerable. This is obvious from the low tag recovery rate in 1980 compared to previous years, and from the change in the age composition, particularly since the winter of 1978. The recruitment to the southern spawning stock component has been much better in relation to the parent stock than that observed in the northern component. In the latter the yearclasses older than the 1974 yearclass constituted 42% of the total stock in 1980, whereas the same yearclasses only constituted 16% of the stock in the south. In the southern component the 1974 and 1976 yearclasses are both stronger than the 1973 yearclass, and judging from the contribution of the 3 year olds, the 1980 stock assessment indicates that the 1977 yearclass is of similar strength. These observations make future prospects of the development in the southern stock component much more promising than that in the northern component.

#### 2.10 Management Advice

As described in the section on the Abundance estimates (2.8) there are two components of the spawning stock. The age distribution clearly shows that the recruitment to the northern component has been poor in recent years. As regards the southern component some improvement in the recruitment has been observed. According to the present assessment the total spawning stock i.e. herring 4 years and older is estimated to about 320 000 tons. in 1980. It is estimated that the northern component is about 230 000 tons while the southern one is about 90 000 tons. It is noted that according to this estimate the northern component has been at this same level of abundance during the last three years while there has been a considerable increase in the abundance of the southern component. The over all abundance as well as the recruitment is however still at a very low level as compared with earlier periods.

At the meeting of the Advisory Committee for Fisheries Management in July 1979 it was agreed that a substantial increase in the spawning stock, as well as much higher level of recruitment must be confirmed before even a limited fishery can be recommended.

Care should then be taken that such a fishery only generates a very low fishing mortality, less than  $F_{0.1}$ , and that it does not appreciably delay further rebuilding of the stock.

On this basis the Working Group can only repeat its advice from last year and recommend that there should be no directed herring fishery in 1980 and 1981. It is further recommended that by-catches (e.g. in the sprat fishery should be limited as far as possible and that these catches should be more adequately sampled.

3. Faroese spring spawning herring

In 1979 herring were occasionally reported as by-catch in the trawl fishery indicating that a small amount of herring stayed on the plateau throughout the year. An experimental fishery using gill nets north of the Faroes in August - September was totally negative and yielded no herring. In the Faroese 0-group survey in 1979 98 0-group herring were caught compared to 262 in 1978 and 7 in 1977.

Number of 0-group herring caught in the Faroese 0-group surveys from 1977 to 1979.

	1977	1978	1979
Total catch in number	7	262	98
No. of Stations	93	94	93
Negative Stations	90	79	84

The results of investigations on the bank spawning herring at The Faroes in 1978 and 1979 show this component to be at a very low level and the Working Group recommends that a directed fishery for this component should be totally prohibited.

4. The Icelandic spring and summer spawning Herring

4.1 The Fishery

No signs of a recovery of the Icelandic spring spawning herring have been observed, and the fishery in 1979 was entirely based (99.5%) on Icelandic summer spawners.

The landings of summer spawning herring for 1970 - 1979 are given in Table 4.1. The 1979 landings were about 44 900 tons. The catches were taken with purse seines and driftnets as shown in the text table below:

Landings and TAC's in tons ( $\times 10^{-3}$ ) of Icelandic summer spawners 1976 - 1979 by gear.

---

	Purse seine		Driftnets	
	Landings	TAC's	Landings	TAC's
1976	10.0	10.0	7.8	10.0
1977	15.6	15.0	13.1	10.0
1978	20.2	20.0	17.1	15.0
1979	25.5	20.0	19.4	15.0

It is noted that the purse seine catches exceeded the TAC by 28% and that the driftnet catches exceeded the TAC by just over 29%.

4.2 Stock abundance and mortality rates

The assessment of the stock and the exploitation is based on acoustic stock abundance estimates and catches by age using a VPA.

4.2.1 The catch in number, mean weights and the age at first maturity

The catches in number by age for the Icelandic summer spawners are given in Table 4.2 for the period 1969 - 1979. During 1975 - 1977 the catches were predominated by the

1971 yearclass. In 1978 and 1979 this yearclass was still important to the catch contributing 25% and 13% in number and 33% and 19% in weight. However, in 1979 the catches were predominated by the 1974 and 1975 yearclasses (Table 4.2). The weight at age in grams is given for each year in Table 4.3 and is used for calculating biomass. It should be noted that in 1979 there was a continuation of the general trend in declining mean weights.

Thus the mean weights of 3-ringers were:

	1974	1975	1976	1977	1978	1979
Weight in g	262	241	243	217	196	182

The declining mean weights may indicate a density dependent growth. The mean weight of 3-ringers in 1979 was in fact similar to that of 2-ringers during the period 1972 - 1976.

During the period of low abundance about 95-98% of the 3-ringed herring were mature and spawned at that age. In 1979 about 33% of the 3-ringed herring in the catches were immature. Thus a considerable proportion of the 1975 year class will not spawn for the first time until 1980.

During the period of high abundance in the 1960's, about 50% of the 3-ringers were immature.

#### 4.2.2 The Fishing mortality in 1979

As in previous years an echo abundance survey was carried out on the wintering grounds at southeast Iceland in 1979. The integrator values per nautical mile and the area of the main wintering concentration are shown in Fig. 9. Using the estimate given by Jakobsson (1978) the echo abundance values obtained in this survey correspond to about 210 000 tons. of herring. The mean weights and the age distribution obtained from sampling the wintering concentration was then used to calculate the abundance of each age group. The

fishing mortality for 1979 was then calculated from these survey results and the catch data from the previous fishing season using the equation with  $M = 0.1$ .

$$\frac{N_{\text{Dec 1979}}}{C_{1979}} = \frac{e^{-Z}}{(1 - e^{-Z}) \frac{F}{Z}}$$

Rings	Age distribution (%)	Echostock in millions Dec. 1979	Catch in no. 1979 in millions	$F_{1979}$
1	2	18.2	0.9	
2	16	186.3	14.9	0.07
3	34	368.6	47.0	0.11
4	27	262.5	69.0	0.22
5	5	52.7	16.3	0.26
6	4	42.2	7.9	0.16
7	10	90.2	25.7	0.24
8	1	6.0	3.0	0.38
8+	1	4.8	2.8	0.44

$n = 688$   $\bar{w} 202.8$  g Weighted mean  $F_{4+} = 0.23$

#### 4.2.3 The results of the VPA

A VPA was run with the input  $F$ s obtained from the catch in number data in 1979 and the results of the echo abundance survey, as described above using  $M = 0.1$ . The results are given in Tables 4.4 and 4.5.

During the most recent years 1975 - 1978 the adult  $F$  has increased from 0.08 to 0.23. The adult stock biomass increased sharply in 1975 to about 150 000 tons. In 1978 there appeared to be a further increase to about 200 000 tons. However, it should be stressed that these estimates are all highly dependant on the results of the echo abundance survey.

As shown in Table 4.5 the 1971 yearclass is now estimated to have been about  $470 \times 10^6$  herring as 1-ringers. The 1972 and 1973 yearclasses were both weak (102 and 187 million) while the 1974 and 1975 yearclasses are estimated to have



been about 550-600 millions as 1-ringers.

The 1976 yearclass appears to be poor, about  $200 \times 10^6$  herring as 1-ringers. It was noted with some concern that 1- and 2-ringers appeared in much lower proportions in the catches in 1979 than in 1978. This may indicate two poor yearclasses, but on the other hand a changed recruitment pattern resulting from reduced growth rate may at least partly be responsible for the reduced proportion of 1- and 2-ringers in the south coast catches.

#### 4.3 State of the stock and advice of TAC

Based on the echo abundance estimate from December 1979 the adult stock biomass will be just above 200 000 tons. in 1980. This level of stock abundance is well within the range of stock biomasses during the 1954 - 1963 period of high and steady recruitment (Jakobsson 1978).

A TAC for 1980 has been set at 45 000 tons. This will generate an F on the adult age groups in 1980 close to the  $F_{0.1}$  which for this stock for the present fishing pattern and weight by age in 1979 (Table 4.3) is about  $F = 0.22$ .

The Working Group recommends that for 1981 the TAC should be calculated on the basis of the results of 1980 echo abundance survey and using an F close to  $F_{0.1}$ . However, if a severe reduction in recruitment is detected, the TAC should be set well below this level.

References

Jakobsson, J. 1978. Exploitation of the Icelandic Spring and Summer Spawning Herring in Relation to Fisheries Management 1947 - 1977. ICES/Symposium on the Biological Basis of Pelagic Fish Stock Management, Aberdeen, July 1978. Contribution no. 2.: 1-43 [Mimeo].

Olsen, K. 1980. Echo Surveying and Fish Behaviour. ICES Fish Capture Committee, Fish Reaction Working Group, Reykjavik May 1980. [Mimeo].

Table 2.1. Catches north of 62°N of Norwegian Spring  
Spawning herring (Tonnes) since 1972.

Year	Catches of adult herring in winter <sup>1)</sup>	Mixed herring fishery in autumn <sup>2)</sup>	Bycatches of 0- and I-group herring in the sprat fishery
1972	0	9895	3266 <sup>3)</sup>
73	139	6602	276
74	906	6093	620
75	53	3372	288
76	0	247	189
77	374	1.1834	498
78	484	9151	189
79	691	1866	307
1980	877		

1) Mostly experimental fishing

2) Includes also bycatches of adult herring in other fisheries

3) In 1972 there was also a directed herring 0-group fishery

Table 2.2. Catch in numbers, millions, Norwegian Spring Spawners, 3 years and older. Unreported catches are included. N= northern stock component. S= southern stock component T= total.

Age	1972	1973	1974	1975	1976
3	35.376	2.389	0.100	3.268	23.248
4	3.476	25.220	0.241	0.132	5.436
5	3.583	0.651	24.505	0.910	0.000
6	2.481	1.506	0.257	30.667	0.000
7	0.694	0.278	0.196	0.005	13.086
8	1.486	0.178	0.000	0.002	0.000
9	0.198	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000
11	0.494	0.000	0.000	0.000	0.000
12	0.593	0.000	0.000	0.000	0.000
13	0.593	0.000	0.000	0.000	0.000
14	0.000	0.178	0.000	0.000	0.000

	Age	N	S	T
1977	3	9.514	12.589	22.103
	4	18.551	5.044	23.595
	5	0.232	0.143	0.336
	6	0.000	0.000	0.000
	7	0.419	0.000	0.419
	8	10.765	0.001	10.766

	Age	N	S	T
1978	3	0.934	2.085	3.019
	4	7.692	4.472	12.164
	5	17.259	3.056	20.315
	6	0.637	0.233	0.870
	7	0.000	0.000	0.000
	8	0.622	0.000	0.620
	9	4.798	0.229	5.027

	Age	N	S	T
1979	3	1.682	4.670	6.352
	4	0.605	1.261	1.866
	5	4.489	2.376	6.865
	6	9.794	1.422	11.216
	7	0.193	0.133	0.326
	8	0.000	0.000	0.000
	9	0.000	0.000	0.000
	10	2.534	0.000	2.534

Table 2.3. Abundance ( $N \times 10^{-6}$ ) of 0-group herring in 1975-79. Estimates of 0-group herring in Trondheimsfjorden are excluded.

Year	Area			Total
	62°N - 65°N	65°N - 68°N	North of 68°30'	
1975	328	692	55	1075
1976	415	2610	750	3775
1977	70	305	37	412
1978	302	511	392	1205
1979	909	2260	288	3457

Table 4.1. Landings of Icelandic Summer spawning herring 1970-1979 in tonnes x 10<sup>-3</sup>.

1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
15.9	11.5	0.3	0.2	1.2	12.8	17.8	28.7	37.2	44.9

Table 4.2. Catch in numbers, millions, Icelandic Summer Spawners 1969 - 1979.

RINGS	1969	1970	1971	1972	1973	1974	1975
1	4.520	2.003	8.774	0.176	0.001	0.001	1.465
2	78.410	22.344	13.071	0.385	0.172	3.681	1.977
3	8.274	33.965	5.439	0.157	0.734	0.814	30.855
4	5.178	4.500	13.688	0.195	0.113	0.972	6.266
5	10.015	2.734	3.040	0.316	0.018	0.090	7.628
6	2.841	4.419	1.563	0.056	0.014	0.045	0.833
7	1.389	1.145	3.276	0.033	0.006	0.002	0.427
8	1.179	0.531	0.748	0.029	0.006	0.001	0.333
9	0.609	0.604	0.250	0.016	0.003	0.001	0.110
10	0.424	0.195	0.103	0.011	0.003	0.001	0.004
11	0.286	0.103	0.120	0.004	0.001	0.001	0.001
12	0.139	0.076	0.001	0.001	0.001	0.001	0.001
13	0.109	0.061	0.001	0.004	0.001	0.001	0.001
14	0.074	0.051	0.001	0.001	0.001	0.001	0.001
SUM 1- 2	82.930	24.347	21.845	0.561	0.173	3.682	3.442
SUM 3-14	30.517	48.384	28.230	0.823	0.901	1.930	46.460
TOTAL	113.447	72.731	50.075	1.384	1.074	5.612	49.902

RINGS	1976	1977	1978	1979
1	0.632	0.683	2.607	0.919
2	10.136	18.266	22.318	14.932
3	4.022	23.400	50.469	47.038
4	35.142	10.080	13.703	68.968
5	7.214	44.913	8.648	16.270
6	5.641	6.525	39.085	7.915
7	1.076	5.252	7.178	25.753
8	0.451	1.352	6.288	3.016
9	0.305	0.508	1.599	1.848
10	0.138	0.351	0.916	0.489
11	0.095	0.026	0.396	0.434
12	0.001	0.124	0.017	0.032
13	0.001	0.001	0.025	0.053
14	0.001	0.001	0.050	0.006
SUM 1- 2	10.768	18.949	24.925	15.851
SUM 3-14	54.087	92.533	128.374	171.822
TOTAL	64.855	111.482	153.299	187.673

Table 4.3. Weight at age, in grams, Icelandic Summer Spawners  
1969 - 1979.

RINGS	1969	1970	1971	1972	1973	1974	1975
1	82.0	85.0	88.0	96.0	90.0	80.0	110.0
2	157.0	169.0	165.0	177.0	199.0	189.0	179.0
3	195.0	216.0	237.0	278.0	257.0	262.0	241.0
4	264.0	263.0	273.0	332.0	278.0	297.0	291.0
5	284.0	312.0	301.0	358.0	337.0	340.0	319.0
6	304.0	329.0	324.0	379.0	381.0	332.0	339.0
7	339.0	338.0	346.0	410.0	380.0	379.0	365.0
8	379.0	357.0	368.0	419.0	397.0	356.0	364.0
9	379.0	414.0	390.0	470.0	385.0	407.0	407.0
10	390.0	425.0	412.0	500.0	450.0	410.0	389.0
11	390.0	451.0	420.0	500.0	450.0	410.0	430.0
12	423.0	464.0	435.0	500.0	450.0	423.0	416.0
13	441.0	471.0	446.0	500.0	450.0	423.0	416.0
14	481.0	459.0	420.0	500.0	450.0	423.0	416.0

RINGS	1976	1977	1978	1979
1	103.0	84.0	73.0	75.3
2	189.0	157.0	128.0	145.3
3	243.0	217.0	196.0	182.4
4	281.0	261.0	247.0	230.9
5	305.0	285.0	295.0	284.7
6	335.0	313.0	314.0	315.7
7	351.0	326.0	339.0	333.7
8	355.0	347.0	359.0	350.4
9	395.0	364.0	360.0	366.7
10	363.0	362.0	376.0	368.3
11	396.0	358.0	380.0	370.6
12	396.0	355.0	425.0	350.0
13	396.0	400.0	425.0	350.0
14	396.0	420.0	425.0	450.0

Table 4.4. Calculated fishing mortality, Icelandic Summer Spawners  
1969 - 1979.  $M = 0.10$ , Initial  $F = 0.23$ .

RINGS	1969	1970	1971	1972	1973	1974	1975
1	0.10	0.06	0.13	0.00	0.00	0.00	0.01
2	0.86	0.87	0.64	0.01	0.00	0.01	0.02
3	0.60	1.04	0.47	0.01	0.01	0.01	0.09
4	0.66	0.68	1.67	0.02	0.01	0.02	0.12
5	0.72	0.78	1.31	0.12	0.00	0.01	0.20
6	0.83	0.72	1.34	0.06	0.01	0.01	0.09
7	0.91	0.85	1.89	0.07	0.01	0.00	0.07
8	0.89	1.00	3.07	0.06	0.01	0.00	0.20
9	0.86	1.68	2.12	0.68	0.01	0.00	0.17
10	1.15	0.66	1.70	0.45	0.22	0.00	0.01
11	1.22	0.87	0.99	0.22	0.06	0.10	0.00
12	1.11	1.20	0.02	0.02	0.07	0.07	0.12
13	0.80	3.56	0.03	0.07	0.02	0.08	0.08
14	0.70	1.00	1.00	0.04	0.02	0.02	0.10

AVERAGE WEIGHTED BY STOCK IN NUMBERS

AVE 3-13	0.71	0.95	1.25	0.03	0.01	0.02	0.10
AVE 4-14	0.75	0.77	1.65	0.05	0.01	0.02	0.15

RINGS	1976	1977	1978	1979
1	0.00	0.00	0.01	0.00
2	0.07	0.04	0.04	0.08
3	0.05	0.19	0.13	0.11
4	0.12	0.16	0.15	0.23
5	0.18	0.21	0.18	0.23
6	0.20	0.23	0.25	0.23
7	0.15	0.26	0.37	0.23
8	0.09	0.25	0.49	0.23
9	0.25	0.13	0.47	0.23
10	0.30	0.45	0.33	0.23
11	0.38	0.08	1.19	0.23
12	0.00	1.08	0.06	0.23
13	0.15	0.00	0.57	0.23
14	0.10	0.20	0.21	0.23

AVERAGE WEIGHTED BY STOCK IN NUMBERS

AVE 3-13	0.12	0.20	0.18	0.18
AVE 4-14	0.14	0.20	0.23	0.23



Table 4.5. Stock in numbers, millions, Icelandic Summer Spawners  
1969 - 1979. M= 0.10, Initial F= 0.23.

RINGS	1969	1970	1971	1972	1973	1974	1975
1	49.188	33.925	77.955	77.589	471.708	101.908	186.604
2	142.297	40.213	28.793	62.203	70.038	426.217	92.188
3	19.141	54.723	15.292	13.691	55.917	63.209	382.157
4	11.252	9.492	17.494	8.685	12.239	49.898	56.420
5	20.442	5.285	4.334	2.985	7.673	10.967	44.225
6	5.271	9.030	2.199	1.061	2.401	6.926	9.837
7	2.419	2.086	3.994	0.519	0.907	2.159	6.224
8	2.082	0.878	0.806	0.544	0.439	0.815	1.952
9	1.104	0.771	0.294	0.034	0.465	0.391	0.736
10	0.646	0.424	0.131	0.032	0.016	0.418	0.353
11	0.422	0.185	0.199	0.022	0.018	0.011	0.377
12	0.216	0.113	0.071	0.067	0.016	0.016	0.009
13	0.207	0.064	0.031	0.063	0.060	0.013	0.013
14	0.154	0.084	0.002	0.027	0.053	0.053	0.011
Adult stock weight 3-14	16.811	20.659	12.392	8.722	22.044	38.887	129.556

RINGS	1976	1977	1978	1979
1	561.802	605.681	228.142	
2	167.453	507.738	547.393	203.952
3	81.536	141.885	442.058	474.088
4	316.473	69.954	106.169	352.054
5	45.099	252.977	53.726	83.052
6	32.776	33.959	186.271	40.403
7	8.110	24.302	24.535	131.459
8	5.226	6.316	17.006	15.395
9	1.450	4.300	4.432	9.433
10	0.562	1.022	3.408	2.496
11	0.316	0.377	0.593	2.215
12	0.340	0.195	0.317	0.163
13	0.007	0.307	0.060	0.271
14	0.011	0.006	0.277	0.031

Adult stock weight 3-14	139.223	144.154	205.008	258.791
----------------------------	---------	---------	---------	---------

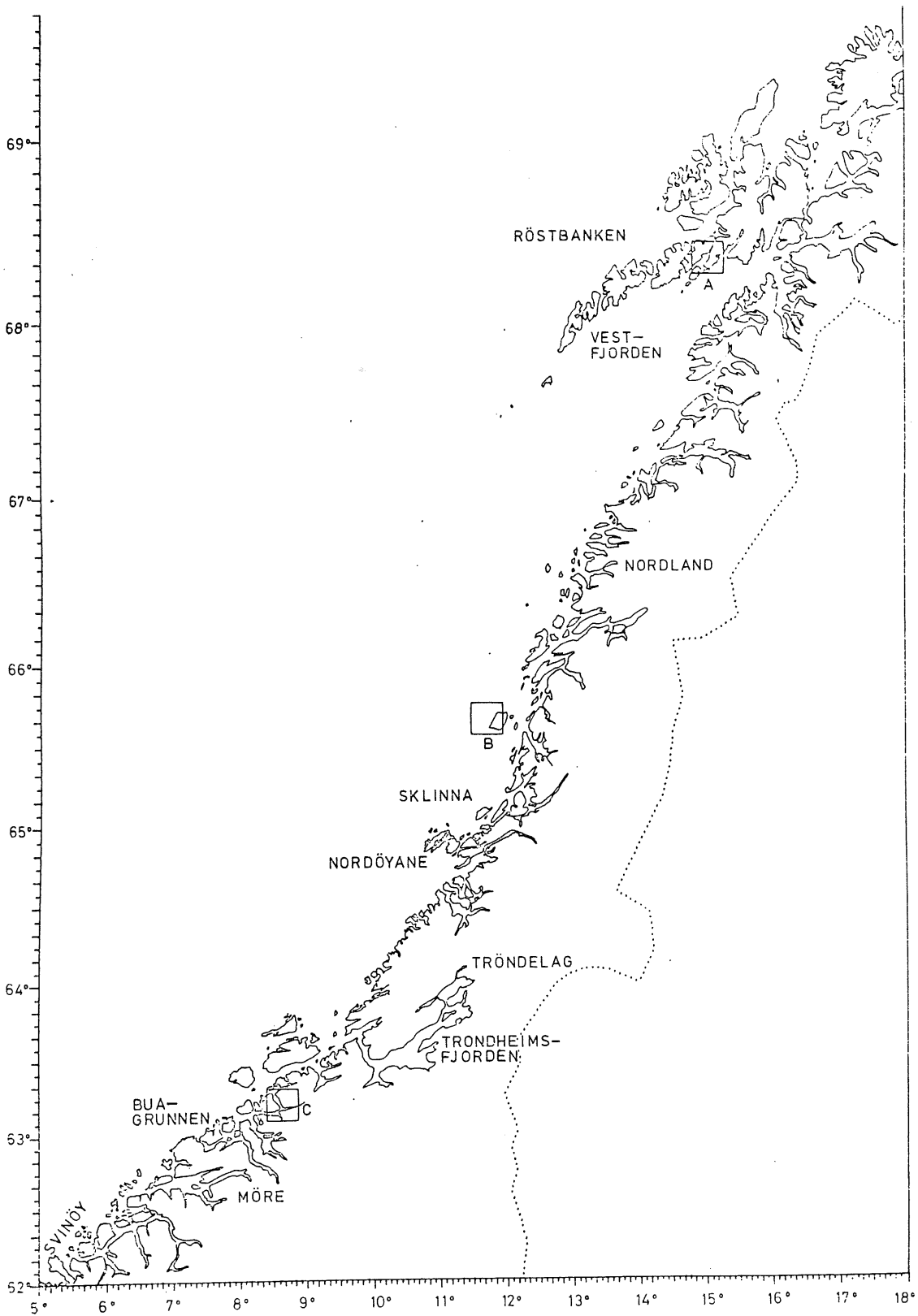


Fig. 1. Map showing localities mentioned in the report.  
A) Øyhellesundet, B) Sølasundet, C) Auresundet  
and Vinjefjord.

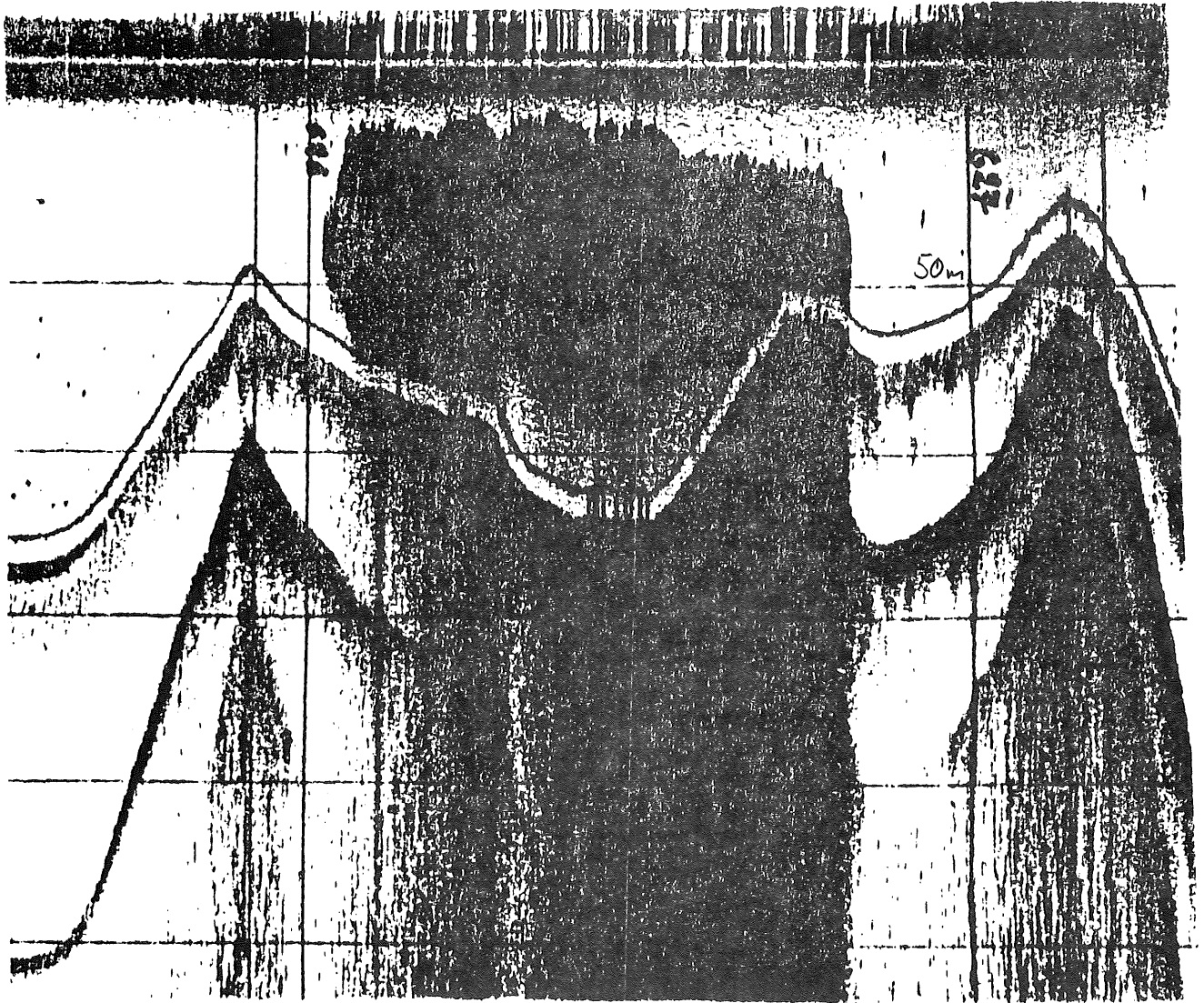


Fig.2. Echo recordings, Norwegian spring spawning herring.  
Øyhellesund, 27.11 1979 kl. 1930 GMT. 38 kHz, speed  
7 knots.

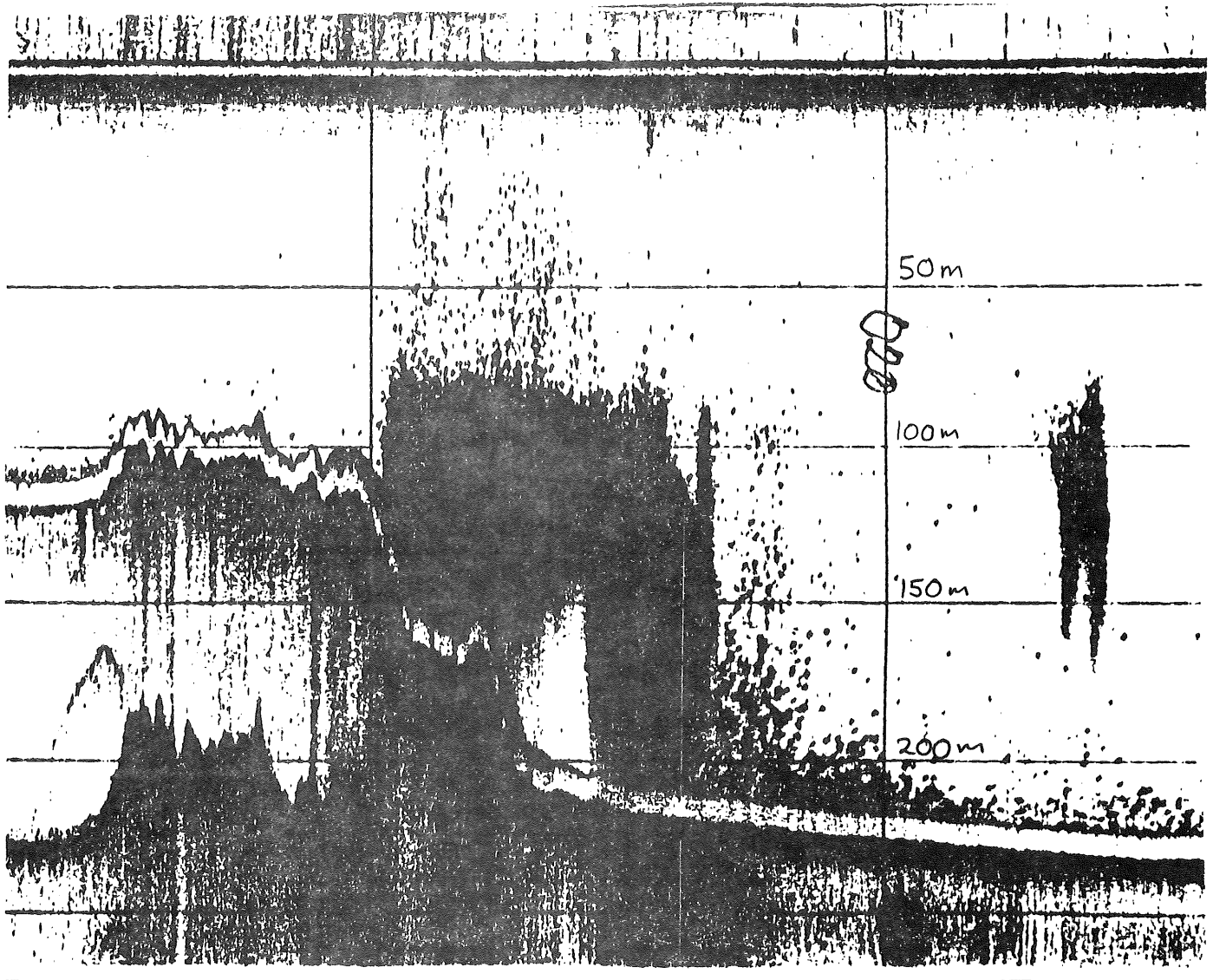


Fig. 3. Echo recordings, Norwegian spring spawning herrring, Auresundet, 16.11. 1979 kl. 1900 GMT. 38 kHz, speed 10 knots.

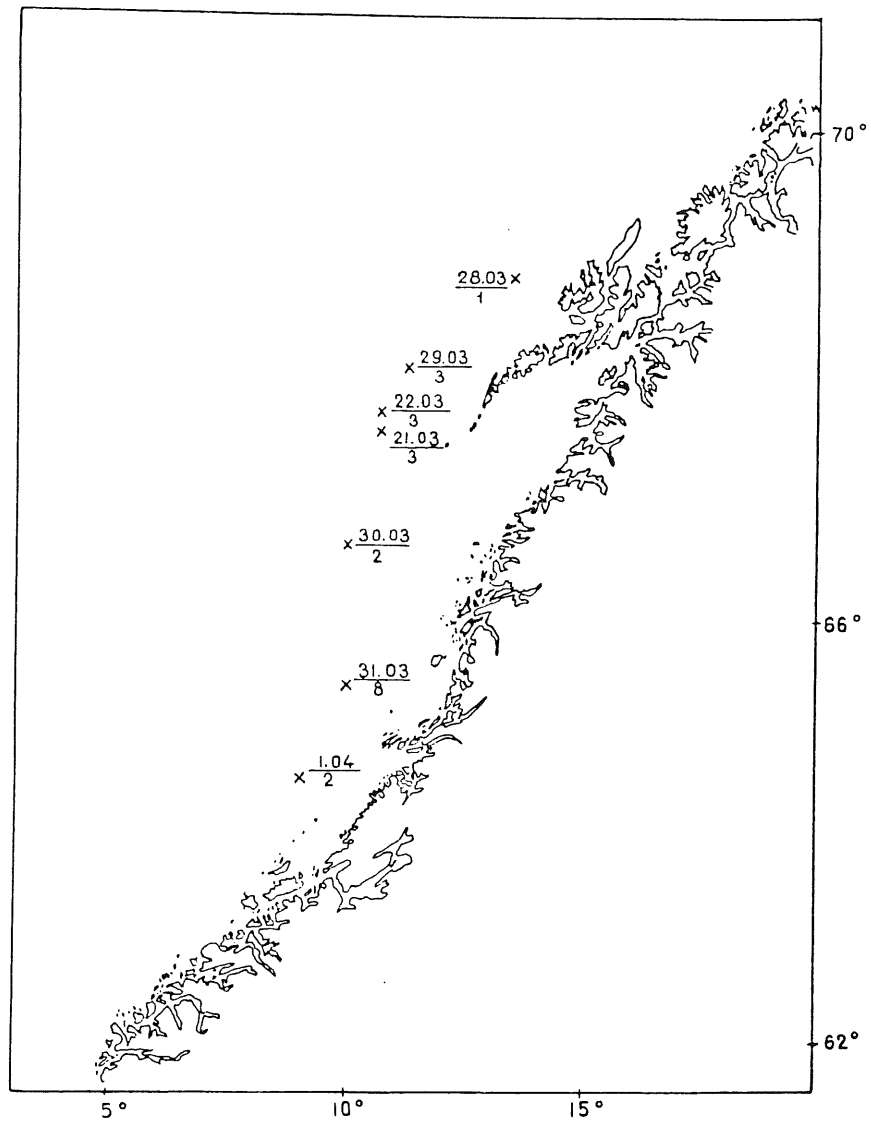


Fig. 4. Soviet driftnet experiments March-April 1980. The numbers refer to date and number of herring caught.

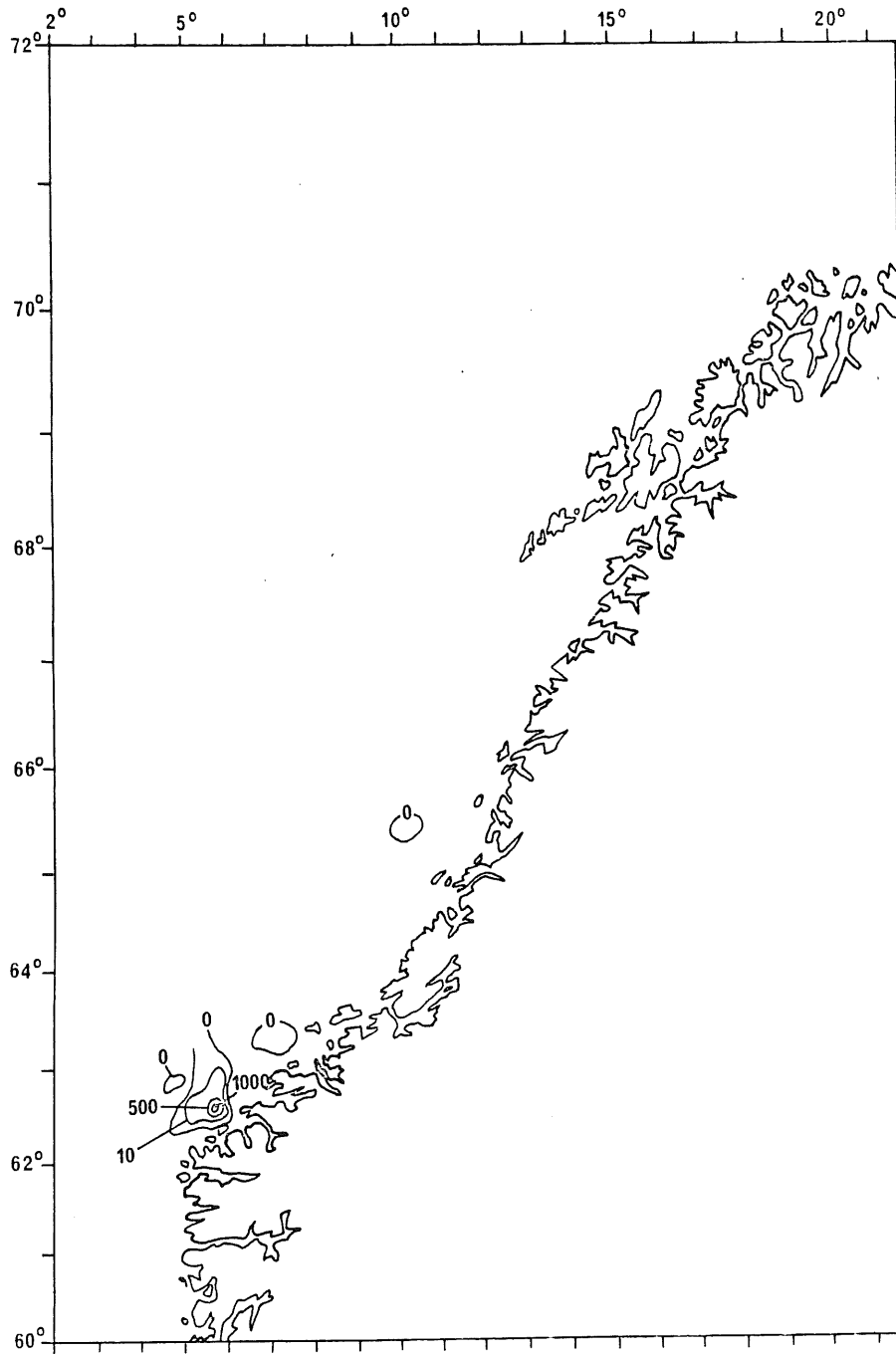


Fig. 5. Distribution of herring larvae, 23,3 ~ 31,3 1980.  
Number of larvae per  $m^2$  surface.

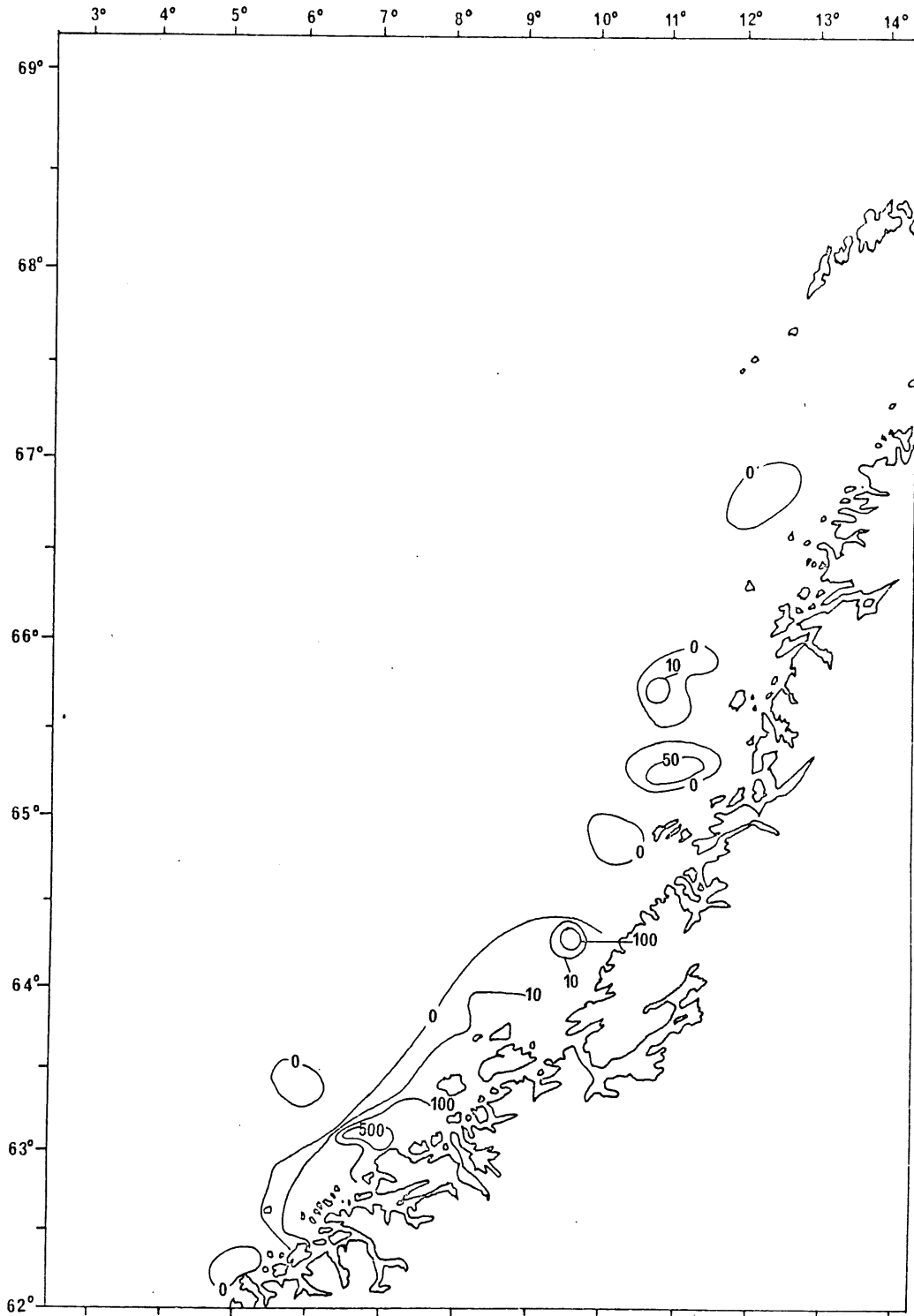


Fig.6. Distribution of herring larvae, 11.4 - 20.4 1980.  
Number of larvae per m<sup>2</sup> surface.

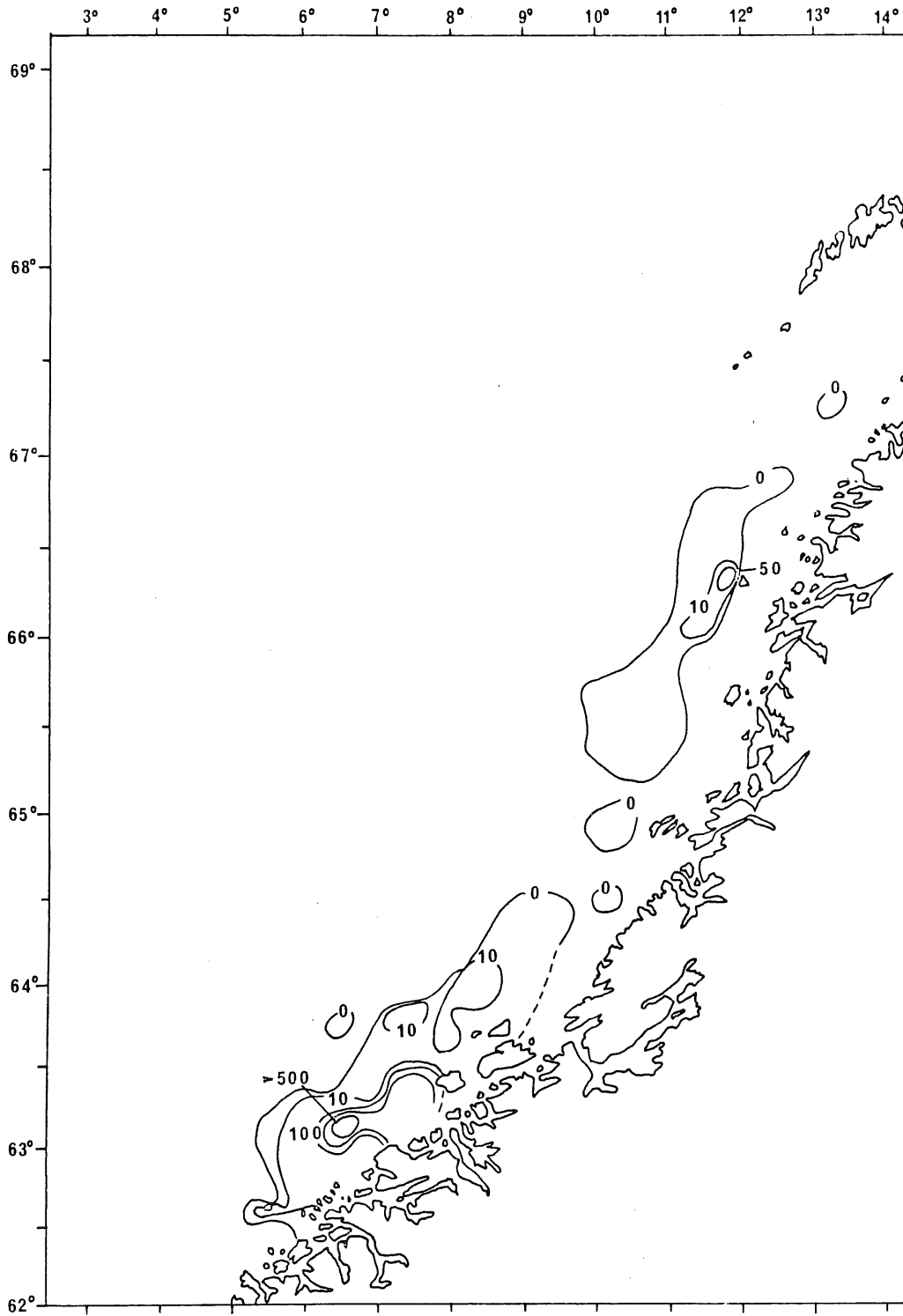


Fig. 7. Distribution of herring larvae, 22.4 - 29.4 1980.  
Number of larvae per m<sup>2</sup> surface.



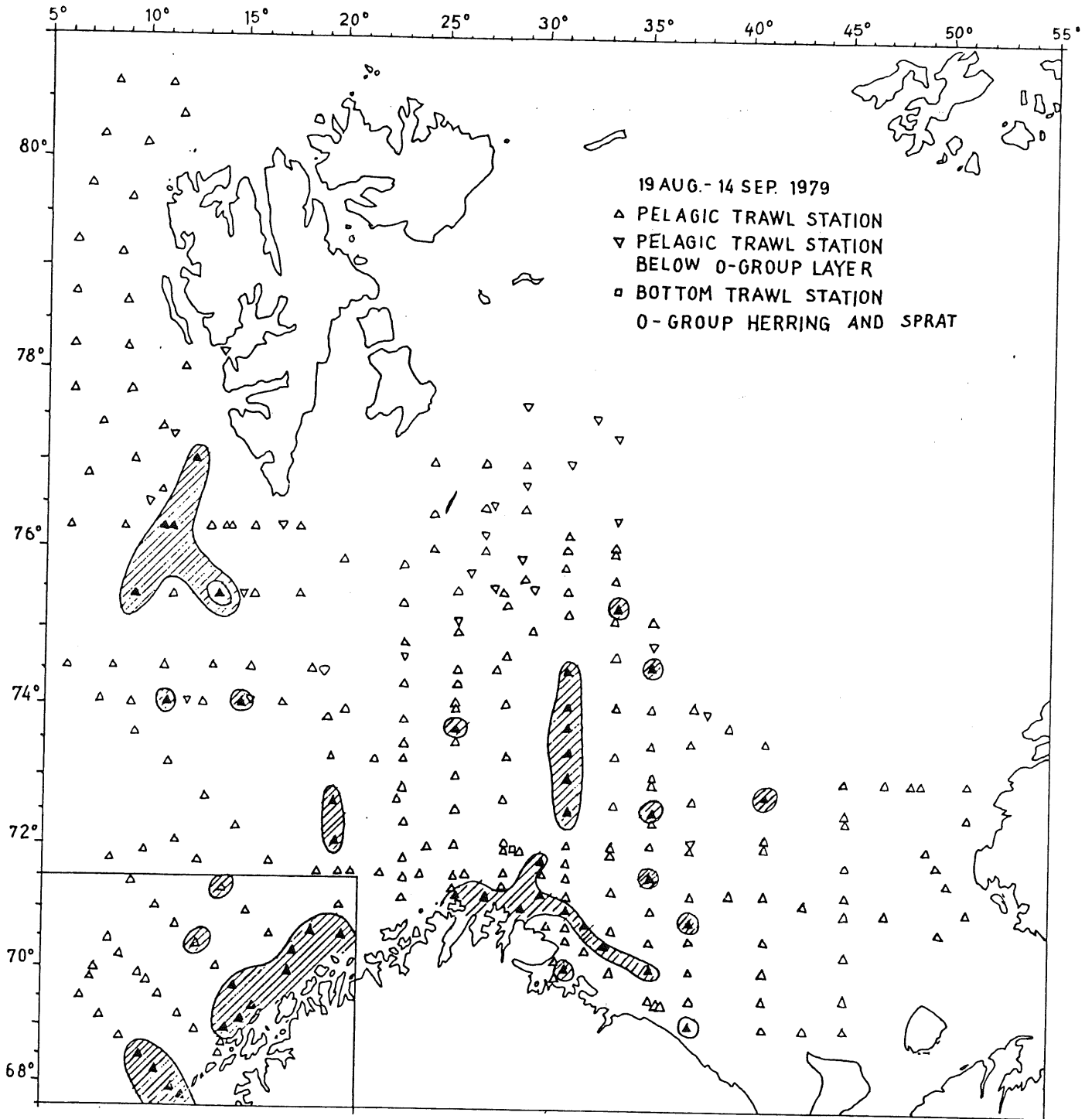


Fig. 8. Recordings of O-group herring and O-group sprat during the international O-group surveys in August-September 1979. The recordings south of  $71^{\circ}30'N$  and west of  $20^{\circ}E$  consist of O-group sprat.

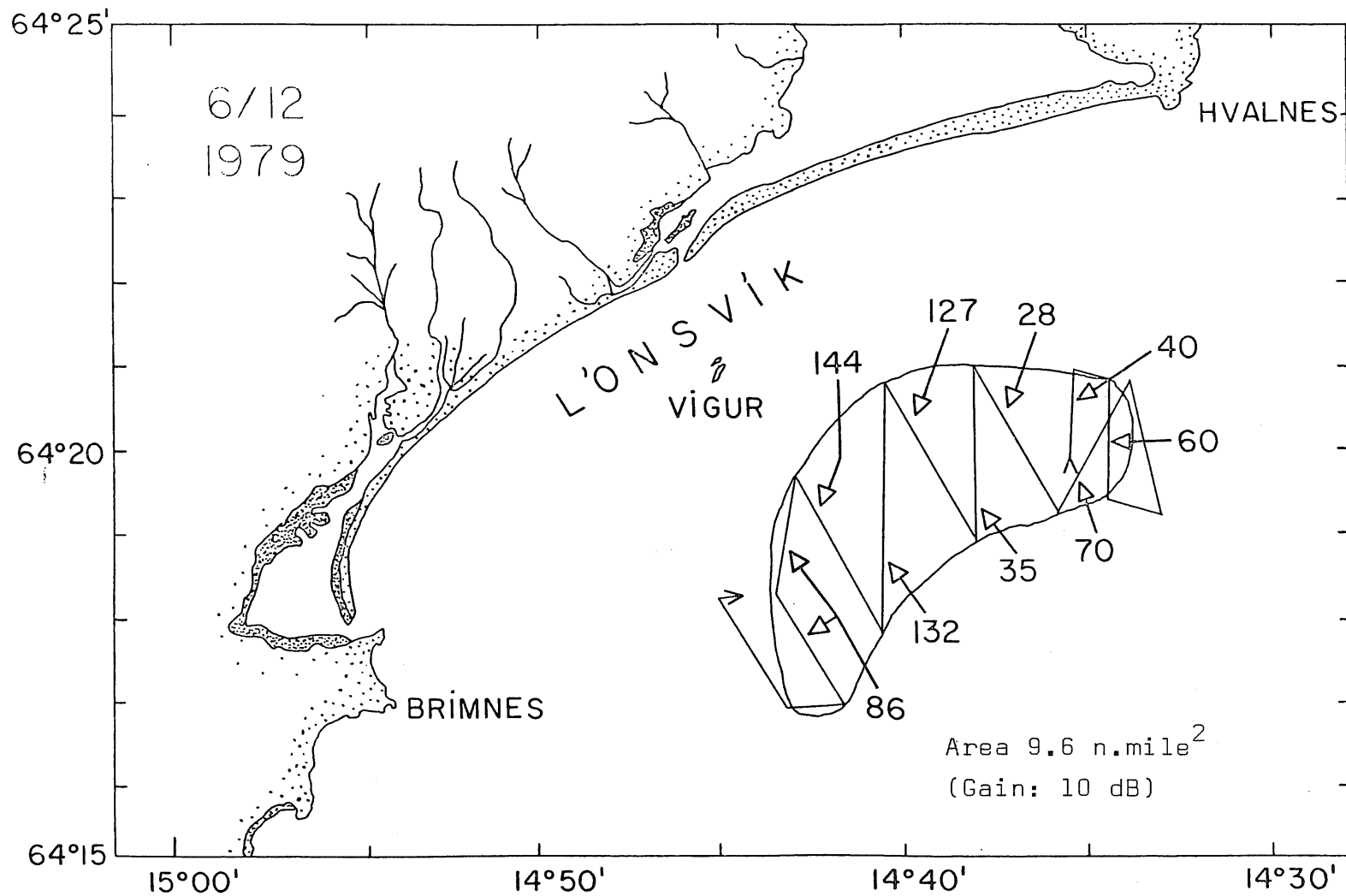


Fig. 9. Echo abundance survey carried out 6.12. 1979 on the wintering concentration of the Icelandic Summer Spawning Herring at South East Iceland. The numbers inserted along the course lines give integrator elevation in mm per sailed nautical mile.