

Fol. 41 H

This Report not to be quoted without prior reference to the Council^{x)}

International Council for the
Exploration of the Sea

C.M.1981/H:11
Pelagic Fish Committee

*Fisheridirektoratet
Biblioteket*

ATLANTO-SCANDIAN HERRING AND CAPELIN WORKING GROUP REPORT

Part I

Copenhagen, 12 - 14 May 1981

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.

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

TABLE OF CONTENTS

	<u>Page</u>
1. INTRODUCTION AND PARTICIPANTS	1
1.1 Terms of Reference	1
1.2 Participants	1
2. NORWEGIAN SPRING SPAWNING HERRING	1
2.1 Catch Statistics	1
2.2 Regulation of the Autumn Fishery	1
2.3 Review of the Autumn Fishery	2
2.4 By-catches and Unreported Catches	2
2.5 Recordings of Herring since Spring 1980	2
2.6 Larval Surveys in 1981	2
2.7 O-Group Investigations in 1980	3
2.8 Tagging Experiments	3
2.9 Estimate of Mortality	3
2.9.1 Northern component	3
2.9.2 Southern component	5
2.10 Abundance Estimates of the Spawning Stock	6
2.10.1 Northern component	6
2.10.2 Southern component	7
2.11 Conclusions	8
3. FAROESE SPRING SPAWNING HERRING	9
4. THE ICELANDIC SPRING AND SUMMER SPAWNING HERRING	9
4.1 The Fishery	9
4.2 Stock Abundance and Mortality Rates	10
4.2.1 The catch in number, mean weights and age at first maturity	10
4.2.2 The acoustic abundance surveys in 1980 ...	11
4.2.3 The fishing mortality in 1980	11
4.2.4 The results of VPA	12
4.3 State of the Stock and Advice of TAC	13
REFERENCES	13
Tables 1 - 4.6	14
Figures 1 - 5	22



ATLANTO-SCANDIAN HERRING AND CAPELIN WORKING GROUP REPORT - PART I

1. INTRODUCTION AND PARTICIPANTS

1.1 Terms of Reference

At the Statutory Meeting of ICES in 1980 the Atlanto-Scandian Herring Working Group was transformed into the Atlanto-Scandian Herring and Capelin Working Group and consequently the terms of reference for 1981 were:

- (i) to assess the state of the Atlanto-Scandian herring,
- (ii) 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.

In order to carry out these tasks it was subsequently decided that the Working Group should meet twice in 1981, i.e. 12-14 May to assess the herring stocks, and 28-30 October to assess the capelin stocks. This report (i.e. Part I) only deals with the assessment of the herring stocks.

1.2 Participants

J Hamre	Norway
J Jakobsson (Chairman)	Iceland
H l Jakupsstovu	Faroe Islands
P Kannevorff	Denmark
V Ryzhov	USSR
I Røttingen	Norway
V Shleinik	USSR

2. NORWEGIAN SPRING SPAWNING HERRING

2.1 Catch Statistics

Table 1 gives the catch north of 62°N of the Norwegian spring spawners since 1972. Table 2 gives the catches of 3 year olds and older in number. In the latter table unreported catches are included.

2.2 Regulation of the Autumn Fishery

The total catch quota of the fishery in 1980 was set to 100 thousand hectolitres (9 300 tonnes). Of this, 60% (or 5 580 tonnes) was allocated to the seine fishery (land and purse seining), and 40% (or 3 720 tonnes) to the gill net fishery.

The land seine fishery was opened 3 September, the purse seine fishery 25 September, and the gill net fishery 20 October. The closing date for all gear categories was set to 13 December.

A minimum landing size of 25 cm, with allowance of 15% undersized fish (in weight) has been in force. Three areas, Øyhellesund in Lofoten (approx. 68°30'N), Sølasund in Helgeland (approx. 66°N) and Auresundet-Vinjefjord in Møre (approx. 63°N) were closed for all herring fishery in 1980 (Figure 1). In these areas very dense concentrations of herring were recorded from September to February in previous years (Anon., 1980), and the areas were closed for fishing herring in order to avoid mortality due to release of excess catches.

The herring in Trondheimsfjord is assumed to belong to a separate stock (Anon., 1980). A catch quota of 8 000 hectolitres or 744 tonnes was set for the herring fishery in the Trondheimsfjorden, but this catch is not included in Tables 1 and 2.

2.3 Review of the Autumn Fishery

As described elsewhere in the report, there is a difference in the age and length distributions of the northern and southern stock component. The northern stock component is dominated by large and old herring, and since the price is proportional to the size of the herring, most of the fishing effort was concentrated on the northern stock component. Approximately 75% of the catch was from this component.

In the southern part of Møre most of the herring were caught in Tresfjord, Romsdal (approx. 62°30'N), approx. 840 tonnes. Samples from these catches showed that the age distribution of the herring in this area is similar to that of the herring in the Trondheimsfjorden. The fishery in Tresfjord was not administered as a local fishery, but due to the particular age distribution, the catches have not been included in Tables 1 and 2.

2.4 By-Catches and Unreported Catches

Fishermen are allowed to fish herring for bait and own consumption with gill nets (maximum length 60 m) throughout the year (except at the time of the fishery). These catches are not reported, but they are judged by the Working Group to be approximately 10 000 tonnes and are included in Table 2. By-catches of herring can, moreover, be landed if the weight of herring does not exceed 15% of the weight of other fish in the catch. Control measurements of these by-catches may be difficult.

By-catches of 0-group herring in the sprat fishery occur very frequently. Catches containing until 50% of 0-group herring can be landed in the sprat fishery. These by-catches may also be underestimated although the price paid for sprat is usually higher than that paid for 0-group herring.

2.5 Recordings of Herring since Spring 1980

A survey of the feeding grounds along the Norwegian coast was carried out in August 1980. Herring schools with an age distribution similar to that of the southern stock component were recorded as far north as Bodø (approx. 67°15'N). Herring with age distribution similar to the northern stock were recorded in Vestfjorden. In February and March 1981, five specimens of herring were caught off the Murman coast by Soviet capelin scouting and research vessels. The herring were of the 1978, 1977 and 1976 year classes. However, the length at age for these specimens were less than the corresponding length at age of the main stock of Norwegian spring spawners. Soviet drift net stations on the Norwegian shelf in March 1981 gave only three specimens of pre-spawning herring.

2.6 Larval Surveys in 1981

Figures 2&3 give larval distribution charts from April 1981. Larvae distribution for 1980 is included in Figure 4 for comparison. No increase in density of herring larvae is observed. The temperature of the waters on the coastal banks north of 64°N are well below average in spring 1981. The larvae found north of 64°N were newly hatched, and there may be some increase in larvae in these areas in May. From 11 April to 19 April a Soviet research vessel took 28 stations on the Norwegian shelf area, but no herring larvae were recorded.

2.7 O-Group Investigations in 1980

Figure 5 shows the distribution of the O-group herring in the Barents Sea during the international O-group surveys in August-September 1980. The number of O-group herring in the Barents Sea is less than in 1979. O-group herring were recorded in the coastal areas of Norway and an acoustic estimate was made on a survey during the period 6.11 - 11.12 1980. The acoustic abundance estimates are shown in Table 3. The acoustic abundance estimate of O-group herring in 1980 is the lowest recorded since the investigations started in 1975. This was not expected since the number of herring larvae in spring 1980 was about the same as in spring 1979. Further, O-group herring were recorded on several locations along the coast on a survey of the herring feeding grounds in August.

2.8 Tagging Experiments

The internal tagging project as described in previous Working Group reports has been continued. Experimental fishing for recoveries was done in the overwintering area of adult herring in the autumn 1980 and on the spawning grounds in the winter 1981. 792 tonnes of herring were caught and screened for tags and 94 tagged herring were recovered. In the winter 1980, 879 tonnes were fished and 96 tags recovered (Anon., 1980).

The age composition of the catches are given in the text tables on p.6-7. The recoveries by areas of release demonstrate the occurrence of two separate spawning components as observed in previous years. One southern component spawning on Møre south of 63°N, and a northern one spawning north of that latitude. Due to this, the state of the stock is assessed as two independent stock units.

2.9 Estimate of Mortality

2.9.1 Northern component

In 1980 the Working Group meeting assessed the state of the northern stock component based on 60 recovered tags from the winter catches in that year. These recoveries were obtained from 92 671 tagged herring released in the years 1975-78. Recoveries from the 1979 releases (18 tags) were excluded in order to avoid error in the estimate due to incomplete mixing of the tagged fish. The average total mortality rate (Z) was estimated to 0.26.

In the text table on p.4 are summarised the recoveries by releases of the winter fishery in 1980 and the recoveries obtained in the experimental catches in the autumn 1980 and in the winter 1981. These same releases were used for the mortality estimate last year, with the exception of one batch released in 1978. This batch consists of 5 999 tagged herring, mainly from the 1976 year class. The batch yielded 5 recoveries in 1980 in a catch of pre-spawners taken north of 63°N and therefore supposed to originate from the northern component. This year recoveries show, however, that the tagged fish belong to the southern stock.

At the bottom of the table are given the recoveries from the 1979 releases, supposed to belong to the northern stock.

Year of release	m	r ₈₀	r	Σr	K•	ln K•
1975	20 991	9	6	15	14.0	2.64
1976	20 744	10	6	16	13.0	2.56
1977	23 993	18	6	24	10.0	2.30
1978	19 998	18	10	28	7.1	1.97
1979	29 986	11	7	18	16.7	2.81
Catch		1 362	900			

m = number of releases

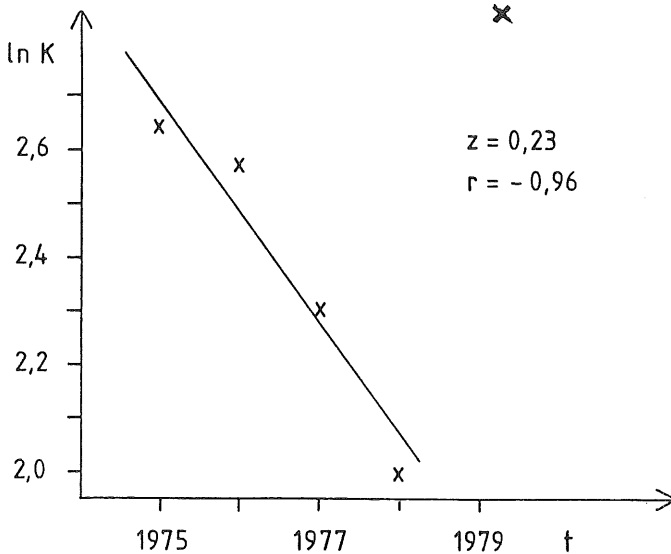
r₈₀ = recoveries winter 1980

r = recoveries autumn 1980 - winter 1981

K = $\frac{m}{\Sigma r} \times 10^{-2}$

Catch in thousand individuals effectively screened.

The plots of the natural logarithms of number (in units of hundred fish) released per tag recovered (index of stock size) against time of release of the tagged fish are shown in the text figure below:



It is seen from this text figure that the 1979 sample of tags fell outside the annual trend in the correlation between the stock index $\ln K$ and the year of release. The 1979 releases have given an extraordinary low recovery rate in 1980 and in 1981 as well. All the tagged fish belong to year classes older than the 1977 year class and should thus have been recruited to the spawning stock, at least in 1981. It seems also unlikely that this is due to extraordinary high tagging mortality in 1979. The failure of obtaining recoveries from the 1979 releases may therefore be a matter of incomplete mixing of the tagged fish in the part of the population sampled this year. Future sampling programmes may, however, give an answer to this problem.

Omitting the 1979 releases for the time being, the regression line of the plots of $\ln K$ against time of release yields an average Z for the years 1975-78 of 0.23. This is slightly lower than the estimate obtained last year ($Z = 0.26$).

2.9.2 Southern component

At last year's meeting the Working Group agreed to accept the mortality estimate of the northern stock component to be valid also for the southern one. This was done because the recoveries related to the southern component were too few to make a separate mortality estimate. The catch of herring on the spawning grounds south of 63°N were therefore increased in 1981, in order to improve the assessment data of the southern stock. Releases, recoveries and corresponding catch (in 1 000 individuals) from the spawning grounds south of 63°N are summarised in the text table below.

Year of release	m	r ₈₀	r ₈₁	Σr	K*	ln K*
1975	5 000	2	9	11	4.55	1.51
1976	3 200	0	1	1	32.0	3.47
1977	16 044	12	9	21	7.64	2.03
1978	11 998	9	8	17	7.06	1.95
1979	5 995	7	14	21	2.85	1.05
Catch		695	1209			

- m = number released
- r₈₀ = recoveries in winter 1980
- r₈₁ = recoveries in winter 1981
- K = $m / \Sigma r \times 10^{-2}$

Catch in thousand individuals from year classes older than the 1977 year class effectively screened.

The plots of $\ln K$ against year of release yields no linear correlation acceptable for mortality estimates. This is mainly due to relatively few recoveries from the releases in 1977-78 compared to those from 1975 and 1979. No obvious explanation to this variance other than random, is available.

2.10 Abundance Estimates of the Spawning Stock

2.10.1 Northern component

The percent age composition of the northern spawning stock component in 1980 and 1981 is given in the text table below:

Year	Year classes									n
	1977	1976	1975	1974	1973	1972	1971	1970	1969	
1980		8	3	27	47	3	0	0	12	287
1981	1	12	3	22	48	1	1		12	500

The age composition in 1980 is slightly different from the age composition given in last year's Working Group report. As mentioned previously, this is because one sample dominated by the 1976 year class has been transferred to the samples of the southern stock component.

The table shows that the age composition in 1981 is more or less the same as that observed in 1980. It is noted that this component has received very few recruits from the year classes younger than the 1974 year class.

Applying $Z = 0.23$ as total mortality rate for the period 1975-80, the state of the tagged population is calculated and given in the text table below. The table includes the releases in 1975-78 and refers to the state of stock in early 1981, disregarding tagging mortality.

Released	Number released	Survived in 1981	r
1975	20 991	5 281	6
1976	20 744	6 568	6
1977	23 993	9 562	6
1978	19 998	10 031	10
		31 442	28

Assuming 30% tagging mortality as in the previous report, the stock in number in early 1981 is:

$$N_{81} = \frac{31\,442 \times 0.70 \times 900 \times 10^3}{28} = 707 \times 10^6$$

This is close to the abundance estimate obtained from the 1980 catch and recoveries data:

$$N_{80} = \frac{31\,442 \times e^{0.23} \times 0.7 \times 1\,362 \times 10^3}{55} = 686 \times 10^6$$

Distributed on year classes according to the age distribution given above, the stock in number and weight in early 1980 and 1981 is calculated as follows (in million individuals):

Year	Year classes									Σ1977+	tonnes x 10 ³
	1977	1976	1975	1974	1973	1972	1971	1970	1969		
1980		55	21	185	322	21	0	0	82	686	250
1981	7	86	21	157	343	7	7		86	714	270

Taking into account the variance which may be expected in such estimates it is fair to conclude that no substantial growth has occurred in the northern stock component in 1980. The recruitment in the year classes older than 1977 has more or less balanced the mortality rate and the 1977 year class is negligible.

2.10.2 Southern component

The recoveries obtained from the releases related to the southern stock component are not adequate for mortality estimate. It is therefore assumed that the estimated $Z = 0.23$ of the northern component is also valid for the southern one. The state of the tagged population in 1981 disregarding tagging mortality may thus be calculated as follows:

Released	Number released	Survived in 1981	r ₈₁	r ₈₀
1975	5 000	1 258	9	2
1976	3 200	1 013	1	0
1977	16 044	6 394	9	12
1978	11 998	6 018	8	9
1979	5 995	3 785	14	7
		18 468	41	30

The abundance of the stock in number referring to the year classes older than 1977 is then calculated, assuming 30% tagging mortality:

$$N_{81} = \frac{18\,468 \times 0.7 \times 1\,209}{41} = 381 \times 10^6$$

The catch and recoveries data obtained in 1980 gives:

$$N_{80} = \frac{14\ 683 \times e^{0.23} \times 0.7 \times 695 \times 10^3}{23} = 391 \times 10^6$$

The two estimates show that the recruitment to the stock older than the 1977 year class in 1980 has been of the same magnitude as the mortality rate. The abundance estimate of 1980 is somewhat higher than that given in the last year's Working Group report. This is because a sample from the schools of young herring (1976 year class) found north of 63°N has now been added to the southern stock component.

The age composition of the southern component in 1980 and in 1981, sampled on the spawning grounds, are given in the text table below (in percent).

Year	Year classes						Σ 1976+
	1978	1977	1976	1975	1974	1973	
1980		14	37	13	20	16	86
1981	2	25	40	7	15	11	73

Distributing the respective stock estimates according to observed age composition, the stock in number and weight in early 1980 and 1981 is calculated as follows (in mill. individuals):

Year	Year classes						Σ 1978+	t x 10 ⁻³
	1978	1977	1976	1975	1974	1973		
1980		64	168	59	91	73	455	130
1981	10	131	209	37	78	57	522	170

The estimates indicate an increase in the southern stock component in 1980 of 40 000 tonnes, i.e. about 30%.

2.11 Conclusions

As described in the section on abundance estimates, the spawning stock consists of two components, which have developed differently in recent years. The age distribution and the abundance estimate obtained from tagging clearly shows that the recruitment to the northern component has been very poor and this stock component has been on the same size level in recent years. The abundance of this component in 1980-81 is estimated to about 250 000 tonnes. The future prospects of the development in the southern stock component are, however, more promising. This component has developed from a very low level in 1977 of about 30 000 tonnes (Anon., 1980) to a size level estimated to about 170 000 tonnes in 1981. The present age composition shows that only 26% of this stock component consists of herring older than 6 years which means that the recruitment has been relatively good.

According to the present assessment the overall abundance of the Norwegian spring spawning herring stock is thus estimated to an order of magnitude of 400 - 450 thousand tonnes. The catch in 1980 is estimated to about 20 000 tonnes, in which an assumed unreported catch of 10 000 tonnes has been included. This catch may have generated a fishing mortality in 1980 of about 0.05.

Although the present assessment shows a slight increase in stock size, it should be stressed that overall abundance of the stock as well as recruitment is still at a very low level compared to earlier periods. The Working Group therefore recommends that the stock should be rebuilt to a much higher level. The rate of recovery will of course be maximised if no fishery is allowed. However, if a fishery is conducted, care should be taken that such a fishery only generates very low fishing mortality, and does not delay further rebuilding of the stock. The Working Group does stress that if the present level of exploitation rate is exceeded this may stop any further rebuilding of the stock.

3. FAROESE SPRING SPAWNING HERRING

In 1980 herring were as in 1978 and 1979 occasionally reported as by-catch in the trawl fishery indicating that a small amount of herring is staying in the plateau throughout the year. The few specimens investigated were all from the 1968 year class.

In the Faroese 0-group survey in 1980 618 0-group herring were caught which is the highest amount recorded in the most recent years.

Number of 0-group herring caught in the Faroese
0-group surveys from 1977 to 1980

	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
Total catch in number	7	262	98	618
No. of stations	93	94	93	96
Negative stations	90	79	84	84

As the surveys are aimed particularly at 0-group cod and haddock, the timing might not be adequate for 0-group herring and the indices should therefore be treated with great caution. The available data further indicate that there has been no recruitment to this spawning stock component neither in 1979 nor in 1980.

The results of the investigations in 1978 and 1979 which showed this component to be at a very low level are, therefore, still valid and the Working Group recommends that a directed fishery for this component should be prohibited.

4. THE ICELANDIC SPRING AND SUMMER SPAWNING HERRING

4.1 The Fishery

No signs of recovery of the Icelandic spring spawning herring have been observed and the fishery in 1980 was entirely based (99.7%) on Icelandic summer spawners.

The landings of summer spawning herring for 1971-80 are given in Table 4.1. The 1980 landings were about 53 300 tonnes. The catches were taken with purse seine and drift nets as shown in the text table. It should be noted that the drift net landings include 625 tonnes taken by set nets.

Landings and TACs in tonnes ($\times 10^{-3}$) of Icelandic
summer spawners 1977-80

Year	Purse seine		Drift nets		Total		
	Catch	TACs	Catch	TACs	Catch	TACs	Rec. TACs
1977	15.6	15.0	13.1	10.0	28.7	25.0	25.0
1978	20.2	20.0	17.1	15.0	37.3	35.0	35.0
1979	25.5	20.0	19.6	15.0	45.1	35.0	35.0
1980	32.6	32.0	20.7	18.0	53.3	50.0	45.0

It is noted that the catches exceeded the recommended TAC by about 18%.

4.2. Stock Abundance and Mortality Rates

The assessment of the stock and the exploitation for 1980 is as in previous years based on acoustic stock abundance estimated and catches by age using a VPA.

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

The catches in number by age for the Icelandic summer spawners are given in Table 4.2 for the period 1969-80. During 1975-77 the catches were predominated by the 1971 year class. In 1978 and 1979 this year class was still important but in 1980 it contributed 9% to the catch. As in 1979, the catches in 1980 were predominated by the 1974 and 1975 year classes (Table 4.2). The weight at age in grams is given for each year in Table 4.3 and is used for calculating biomass. During the period 1974-79 there was a clear trend in declining mean weights especially in the younger part of the population.

Thus, the mean weight of 3-ringers were:

	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>	<u>1979</u>	<u>1980</u>
Weight in g	262	241	243	217	196	182	202

The mean weight of 3-ringers in 1979 was in fact similar to that of 2-ringers during 1972-76. However, in 1980 this declining trend in mean weights of 3-ringers did not continue. As shown in the text table above the mean weight of 3-ringers in 1980 increased by 20 g or about 10% as compared to 1979. In a previous report it was pointed out that the declining mean weights until 1979 may indicate a density-dependent growth. The reversal of this trend in 1980 is of special interest in this context, because the 3-ringers in 1980 belong to the poor 1976 year class. Thus, the increased mean weight of 3-ringers in 1980 further supports the hypothesis that the changes in mean weights of 3-ringers of the Icelandic summer spawning herring may be influenced by density-dependent growth. It is of interest to note in this context that the mean weights of 2-ringers in 1980 were lower than in any of the previous ten years (Table 4.3). 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. Therefore a considerable proportion of the 1975 year class did not spawn for the first time until 1980. In 1980, on the other hand, only 5% of the 3-ringed herring in the catches were immature. Therefore practically all the 1976 year class spawned as 3-ringers. During

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

4.2.2 The acoustic abundance surveys in 1980

During the period 1973-79 echo abundance surveys were carried out on the wintering grounds at southeast Iceland (Jakobsson, 1980). In December 1980 no wintering concentrations assembled in the traditional wintering areas at the southeast coast. Instead the herring were located in the east coast fjords. Therefore the main survey effort was concentrated in that area. The research vessel "Arni Fridriksson" had prior to the 1980 survey been equipped with a new echo integrator system. As a result the integrator values per nautical mile could not be compared directly with those obtained in previous years. Considerable effort was therefore spent on obtaining new TS values for the various length categories, i.e. small, fat and large herring both during the November and December surveys in 1980 (Halldórsson, unpubl. data). As a result of these TS estimates it was found that for the new equipment:

$$C = 12.5 \times l^{-2.1} \times 10^6 \text{ fish/nm}^2/\text{mm elevation}$$

where C is the density coefficient and l is the length of the fish in cm.

Using this equation as well as the length and age distribution of the samples for each fjord, an estimate of the number of herring in each age group in each fjord was obtained (Table 4.4). Based on the mean weights at age from the sampling of the wintering concentrations these numbers correspond to a biomass of 235 thousand tonnes of herring. It is clear from the age distribution in Table 4.4 that the immature 1- and 2-ringers were much better represented on the new wintering grounds in 1980 than previously observed at the wintering grounds at southeast Iceland. This is especially true for two of the fjords where heavy concentrations of immature herring were observed. In addition to this development it should be mentioned that in November 1980 estimates of 0-group herring were obtained at north and west Iceland. Due to this new development it is hoped that better information on recruitment of the stock will be available in the coming years.

4.2.3 The fishing mortality in 1980

As in previous years the fishing mortality for 1980 was calculated from the survey results as given in the following text table and the catch data from the previous fishing season, using the equation with $M = 0.1$:

$$\frac{N_{\text{Dec 1980}}}{C_{1980}} = \frac{e^{-Z}}{(1-e^{-Z}) \frac{F}{Z}}$$

Rings	Age distribution (%)	Echostock in millions Dec. 1980	Catch in no.1980 in millions	F ₁₉₈₀
0	+	6.0	0.0	0.00
1	20	669.4	3.2	+
2	31	832.1	14.8	0.02
3	7	71.8	21.4	0.25
4	18	179.3	62.5	0.29
5	15	154.2	67.2	0.34
6	1	11.0	11.9	0.71
7	3	21.8	9.6	0.36
8	4	42.5	20.0	0.36
8+	1	11.5	4.0	0.30

n = 942 \bar{w} = 117.6 g Weighted mean F₄₊ = 0.33

4.2.4 The results of the VPA

A VPA was run, however, using the mean F for adult herring = 0.33 obtained from the catch in number data in 1980 and the results of the echo abundance survey as described above, using M = 0.10. The results are given in Tables 4.5 and 4.6.

The present VPA gives somewhat lower stock estimates for the earlier years than that estimated in the VPA in the 1980 report. This is due to higher F values for adult herring in 1980 which in turn result from a somewhat lower acoustic estimate of the adult stock in December 1980 than expected. It should be noted that the herring were confined to narrow fjords in 1980, where acoustic surveying was much more difficult than at the eastern south coast where the herring overwintered in previous years. The new TS values used in 1980 could not be directly compared with the previous ones, and this may also have contributed to the lower acoustic estimate in 1980.

The samples used for the age distribution were taken by a capelin trawl. It is possible that the large herring tend to avoid this gear to a larger extent than the small herring. This would also contribute to a possible underestimate of the adult population and a corresponding overestimate of the immature herring.

During the most recent years 1975-79 the adult F has increased from 0.08 to 0.23. In 1980 there appears to have been a further increase to 0.33. The adult stock biomass increased sharply in 1975 to about 120 000 tonnes. In 1978 there was a further increase to about 200 000 tonnes; the adult stock biomass appears to have been on that level during the last three years (1978-80). However, it should be stressed that these most recent estimates are all highly dependent on the results of the echo abundance survey. As shown in Table 4.6 the 1971 year class is now estimated to have been about 430×10^6 herring as 1-ringers. The 1972 and 1973 year classes are both weak (114 and 161 mill.), while the 1974 and 1975 year classes are estimated to have been 588 and 401 mill. as 1-ringers respectively.

The 1976 year class appears to be poor or only 144 millj. as 1-ringers. The estimates of the 1975 and 1976 year classes are considerably lower according to this new VPA than in that of last year. At that time it was noted with some concern that the 1- and 2-ringers appeared in much lower proportions in the catches in 1979 than in previous years. It was then explained that this might be due to two poor year classes, but on the other hand a change in the recruitment pattern was also mentioned as a possible cause. The results of the 1980 echo abundance surveys suggest that the latter was the cause of the apparent scarcity of the 1977 and 1978 year classes in 1979. These appear to be extremely strong but slow growing year classes according to the most recent surveys.

4.3 State of the Stock and Advice of TAC

Based on the echo abundance estimates from December 1980, the adult stock (3-ringers and older) will be about 240 000 tonnes in 1981. Of this adult stock biomass about 90 000 tonnes are due to the strong 1977 year class (3-ringers). Taking into account that this year class has a reduced growth (Table 4.3) it is unlikely that more than 50% of it will contribute to the spawning stock in 1981. Therefore the spawning stock will probably be about 200 000 tonnes in 1981. This level of stock abundance is within the range of stock biomass during the 1954-63 period of high and steady recruitment (Jakobsson, 1980).

In last year's report the Working Group recommended that the advice of a TAC should be based on the results of the echo abundance survey and keeping the fishing mortality rate as close as possible to $F_{0.1}$, which for this stock at the present fishing pattern is $F = 0.22$. The Working Group recommends that this should be continued.

However, the echo abundance estimates in December 1980 gave very high values of 1- and 2-ringers. In calculating the TAC for 1981 the Working Group agreed to put a constraint on the abundance of these year classes so that as 3-ringers they would not exceed the highest level observed previously in this stock (600×10^{-6}). On this basis and using an $F = 0.22$ ($F_{0.1}$), the Working Group recommends that the TAC for the Icelandic summer spawners for 1981 should be 40 000 tonnes.

The estimated high level of recruitment in 1981 and 1982 may lead to a considerable increase in the stock if the above management will be adhered to.

REFERENCES

- Anon., 1980. Report of the Atlanto-Scandian Herring Working Group, Bergen, 12-14 May 1980". C.M.1980/H:8 (mimeo.).
- Jakobsson, J. 1980. Monitoring the recovery of the Icelandic summer spawning herring. ICES, Doc. C.M.1980/H:34 (mimeo.).

Table 1. Catches north of 62°N of Norwegian
spring spawning herring (tonnes) 1972-81.

Year	Catches of adult herring in winter ¹⁾	Mixed herring fishery in autumn ²⁾	Bycatches of 0- and I-group herring in the sprat fishery
1972	0	9895	3266 ³⁾
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
80	878	7634	65
1981	844		

- 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. Catch in numbers, millions, Norwegian spring spawners, 3 years and older. Unreported catches are included.

Age	1972	1973	1974	1975	1976	1977
3	35.376	2.389	0.100	3.268	23.248	22.103
4	3.476	25.220	0.241	0.132	5.436	23.595
5	3.583	0.651	24.505	0.910	0.000	0.336
6	2.481	1.506	0.257	30.667	0.000	0.000
7	0.694	0.278	0.196	0.005	13.086	0.419
8	1.486	0.178	0.000	0.002	0.000	10.766
9	0.198	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000
11	0.494	0.000	0.000	0.000	0.000	0.000
12	0.593	0.000	0.000	0.000	0.000	0.000
13	0.593	0.000	0.000	0.000	0.000	0.000
14	0.000	0.178	0.000	0.000	0.000	0.000

Age	1978	1979	1980
3	3.019	6.352	6.407
4	12.164	1.866	15.814
5	20.315	6.865	2.278
6	0.870	11.216	8.165
7	0.000	0.326	15.838
8	0.620	0.000	0.441
9	5.027	0.000	0.008
10	0.000	2.534	0.000
11	0.000	0.000	2.688

Table 3. Norwegian spring spawners. Abundance of 0-group herring 1975-80.

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
1980	12	4	218	234

Table 4.1 Landings of Icelandic summer spawning herring 1971-80 in tonnes x 10⁻³.

1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
11.5	0.3	0.2	1.2	12.8	17.8	28.7	37.3	45.1	53.3

Table 4.2 Catch in numbers, millions, Icelandic summer spawners, 1969-80.

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	1980		
1	0.632	0.683	2.607	0.919	3.239		
2	10.136	18.266	22.318	14.932	14.768		
3	4.022	23.400	50.469	47.038	21.370		
4	35.142	10.080	13.703	68.968	62.509		
5	7.214	44.913	8.648	16.270	67.245		
6	5.641	6.525	39.085	7.915	11.879		
7	1.076	5.252	7.178	25.753	9.557		
8	0.451	1.352	6.288	3.016	20.012		
9	0.305	0.508	1.599	1.848	1.849		
10	0.138	0.351	0.916	0.489	1.507		
11	0.095	0.026	0.396	0.434	0.718		
12	0.001	0.124	0.017	0.032	0.001		
13	0.001	0.001	0.025	0.053	0.113		
14	0.001	0.001	0.050	0.006	0.081		
SUM 1- 2	10.768	18.949	24.925	15.851	18.007		
SUM 3-14	54.087	92.533	128.374	171.822	196.841		
TOTAL	64.855	111.482	153.299	187.673	214.848		

Table 4.3 Weight at age in grams, Icelandic summer spawners, 1969-80.

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	372.0	357.0	368.0	419.0	397.0	356.0	364.0
9	379.0	378.0	390.0	470.0	385.0	407.0	407.0
10	390.0	396.0	409.0	500.0	450.0	410.0	389.0
11	376.0	408.0	412.0	500.0	450.0	410.0	430.0
12	401.0	425.0	420.0	500.0	450.0	423.0	416.0
13	409.0	430.0	442.0	500.0	450.0	423.0	416.0
14	414.0	450.0	450.0	500.0	450.0	423.0	416.0
RINGS	1976	1977	1978	1979	1980		
1	103.0	84.0	73.0	75.3	68.9		
2	189.0	157.0	128.0	145.3	115.3		
3	243.0	217.0	196.0	182.4	202.0		
4	281.0	261.0	247.0	230.9	232.5		
5	305.0	285.0	295.0	284.7	268.9		
6	335.0	313.0	314.0	315.7	316.7		
7	351.0	326.0	339.0	333.7	351.6		
8	355.0	347.0	359.0	350.4	360.4		
9	395.0	364.0	360.0	366.7	379.9		
10	363.0	362.0	376.0	368.3	382.9		
11	396.0	358.0	380.0	370.6	392.7		
12	396.0	355.0	425.0	350.0	390.0		
13	396.0	400.0	425.0	350.0	390.0		
14	396.0	420.0	425.0	450.0	390.0		

Table 4.4 Echo abundance estimates (millions of herring)
in 5 fjords at East Iceland, December 1980.

Winter rings	Seyðis- fjörður	Mjóí- fjörður	Reyðar- fjörður	Stöðvar- fjörður	Beru- fjörður	Total	\bar{w}	\bar{l}
0		6.0				6.0		
1	16.3	341.1	5.9		306.1	669.4	52	18.7
2	38.	379.0	28.6	0.7	385.0	832.1	91	22.3
3	5.3	4.5	11.0	1.6	49.4	71.8	186	28.5
4	13.7	11.5	38.8	6.7	108.6	179.3	224	30.2
5	9.7	10.7	37.4	8.3	88.9	154.2	262	31.7
6	0.9	0.8	2.9	0.5	5.9	11.0	305	33.6
7	0.4	1.8	6.6	1.1	11.8	21.8	328	34.2
8	3.1	2.8	13.2	1.8	21.7	42.5	354	35.3
9		0.2	0.7	0.2	3.0	4.2	365	36.0
10		0.3	1.5	0.2	4.9	6.9	370	36.0
11		0.1		0.2		0.4	370	37.0
Total weight in 000 tonnes	12.5	60.6	31.9	6.2	124.0	235.2		

Table 4.5 Calculated fishing mortality, Icelandic summer spawners, 1969-80. $M = 0.10$, initial $F = 0.33$.

RINGS	1969	1970	1971	1972	1973	1974	1975
1	0.113	0.060	0.131	0.003	0.000	0.000	0.010
2	0.847	1.050	0.582	0.007	0.003	0.010	0.020
3	0.588	1.013	0.696	0.011	0.015	0.016	0.097
4	0.657	0.655	1.506	0.041	0.009	0.022	0.143
5	0.727	0.781	1.164	0.095	0.004	0.008	0.210
6	0.828	0.736	1.362	0.046	0.005	0.012	0.081
7	0.920	0.852	2.140	0.071	0.006	0.001	0.134
8	0.901	1.015	3.116	0.077	0.015	0.001	0.153
9	0.857	1.727	2.373	0.730	0.009	0.003	0.135
10	1.149	0.655	2.038	0.652	0.253	0.003	0.012
11	1.219	0.867	0.989	0.343	0.097	0.112	0.004
12	1.110	1.204	0.015	0.016	0.120	0.120	0.141
13	0.799	3.564	0.035	0.069	0.018	0.152	0.152
14	0.700	1.000	1.000	0.040	0.020	0.020	0.200
AVERAGE WEIGHTED BY STOCK IN NUMBERS							
AVE 3-13	0.705	0.930	1.331	0.034	0.012	0.016	0.113
AVE 4-14	0.756	0.769	1.568	0.066	0.008	0.017	0.161
RINGS	1976	1977	1978	1979	1980		
1	0.001	0.002	0.019	0.001	0.005		
2	0.077	0.039	0.067	0.131	0.019		
3	0.047	0.227	0.129	0.175	0.250		
4	0.138	0.144	0.180	0.232	0.330		
5	0.217	0.234	0.159	0.299	0.330		
6	0.212	0.277	0.292	0.191	0.330		
7	0.128	0.277	0.489	0.283	0.330		
8	0.183	0.209	0.548	0.347	0.330		
9	0.184	0.287	0.362	0.272	0.330		
10	0.224	0.296	1.076	0.160	0.330		
11	0.392	0.054	0.560	4.687	0.330		
12	0.004	1.165	0.041	0.070	0.330		
13	0.183	0.005	0.680	0.154	0.330		
14	0.200	0.250	0.300	0.300	0.330		
AVERAGE WEIGHTED BY STOCK IN NUMBERS							
AVE 3-13	0.132	0.222	0.191	0.225	0.319		
AVE 4-14	0.153	0.221	0.268	0.251	0.330		

Table 4.6 Stock in numbers, millions, Icelandic summer spawners 1969-80. $M = 0.10$, initial $F = 0.33$.

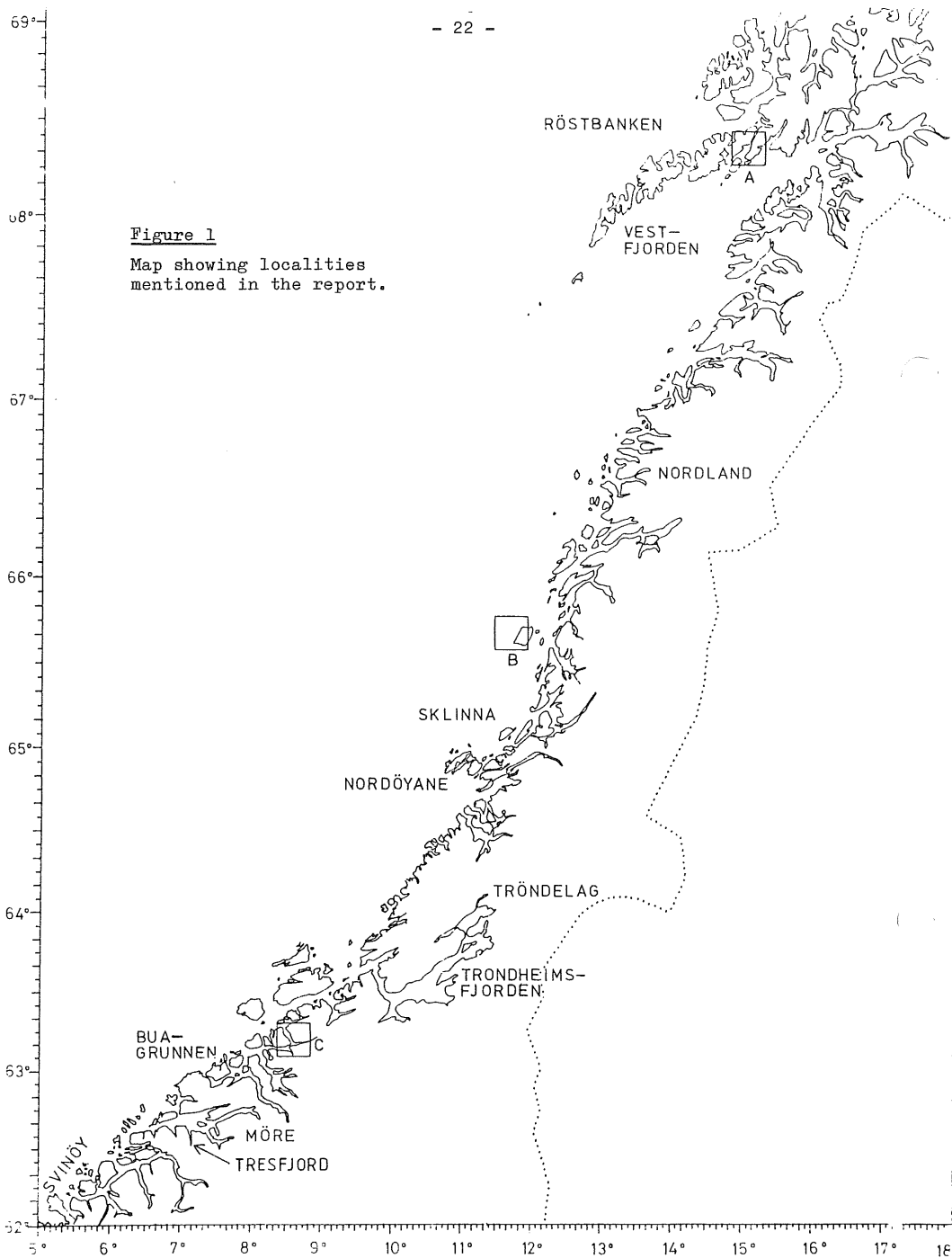
RINGS	1969	1970	1971	1972	1973	1974	1975
1	44.313	36.337	75.082	68.269	431.317	113.927	161.152
2	143.252	35.803	30.976	59.603	61.605	389.898	103.055
3	19.471	55.582	11.331	15.659	53.565	55.579	349.295
4	11.234	9.789	18.264	5.111	14.020	47.770	49.516
5	20.249	5.268	4.602	3.666	4.439	12.578	42.300
6	5.268	8.857	2.184	1.301	3.017	4.000	11.296
7	2.408	2.084	3.837	0.506	1.124	2.717	3.576
8	2.071	0.868	0.804	0.408	0.427	1.011	2.456
9	1.104	0.761	0.285	0.032	0.342	0.380	0.914
10	0.646	0.424	0.123	0.024	0.014	0.307	0.343
11	0.422	0.185	0.199	0.014	0.011	0.010	0.276
12	0.216	0.113	0.071	0.067	0.009	0.009	0.008
13	0.207	0.064	0.031	0.063	0.060	0.007	0.007
14	0.154	0.084	0.002	0.027	0.053	0.053	0.006
SUM 1- 2	187.565	72.140	106.057	127.872	492.923	503.825	264.207
SUM 3-14	63.450	84.079	41.732	26.880	77.081	124.422	459.994
TOTAL	251.015	156.219	147.789	154.752	570.004	628.246	724.201
Adult stock weight 3-14 ^{x)}	16.776	20.797	11.675	8.347	21.104	36.058	118.745

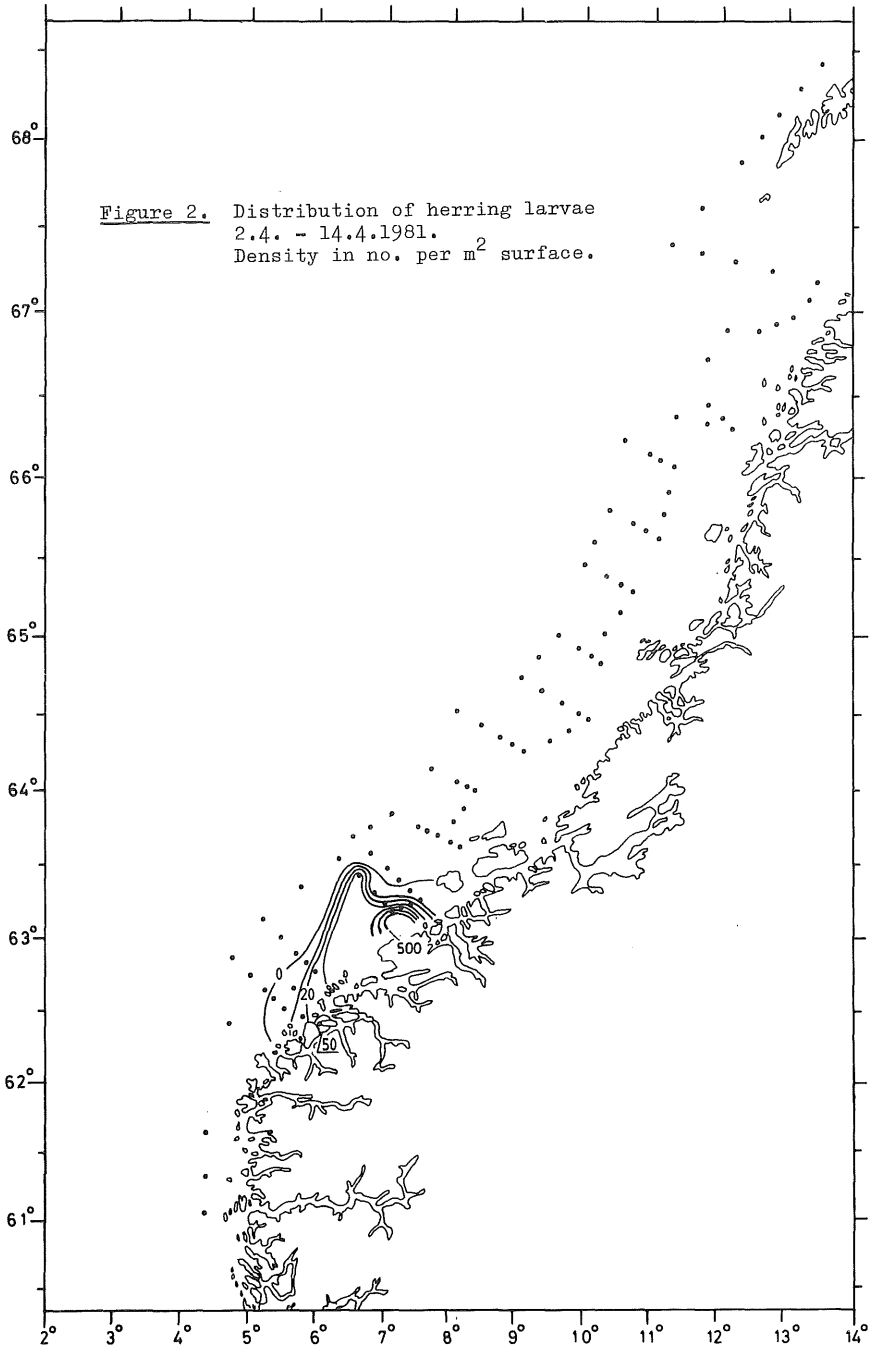
RINGS	1976	1977	1978	1979	1980
1	558.238	401.500	143.802	912.097	710.768
2	144.423	504.515	362.643	127.639	824.428
3	91.368	121.048	439.142	306.924	101.310
4	286.741	78.851	87.321	349.416	233.056
5	38.853	226.078	61.774	66.002	250.714
6	31.034	28.309	161.942	47.684	44.289
7	9.429	22.727	19.425	109.458	35.632
8	2.831	7.510	15.582	10.779	74.612
9	1.906	2.133	5.512	8.147	6.894
10	0.722	1.435	1.448	3.472	5.619
11	0.307	0.523	0.966	0.447	2.677
12	0.249	0.188	0.448	0.499	0.004
13	0.006	0.225	0.053	0.389	0.421
14	0.006	0.005	0.202	0.024	0.302
SUM 1- 2	702.662	906.015	506.445	1039.735	1535.196
SUM 3-14	463.453	489.030	793.815	903.241	755.530
TOTAL	1166.115	1395.046	1300.260	1942.976	2290.727
Adult stock weight 3-14 ^{x)}	130.578	131.797	192.087	215.564	201.617

x) Stock in weight in 1 000 x tonnes.

Figure 1

Map showing localities mentioned in the report.





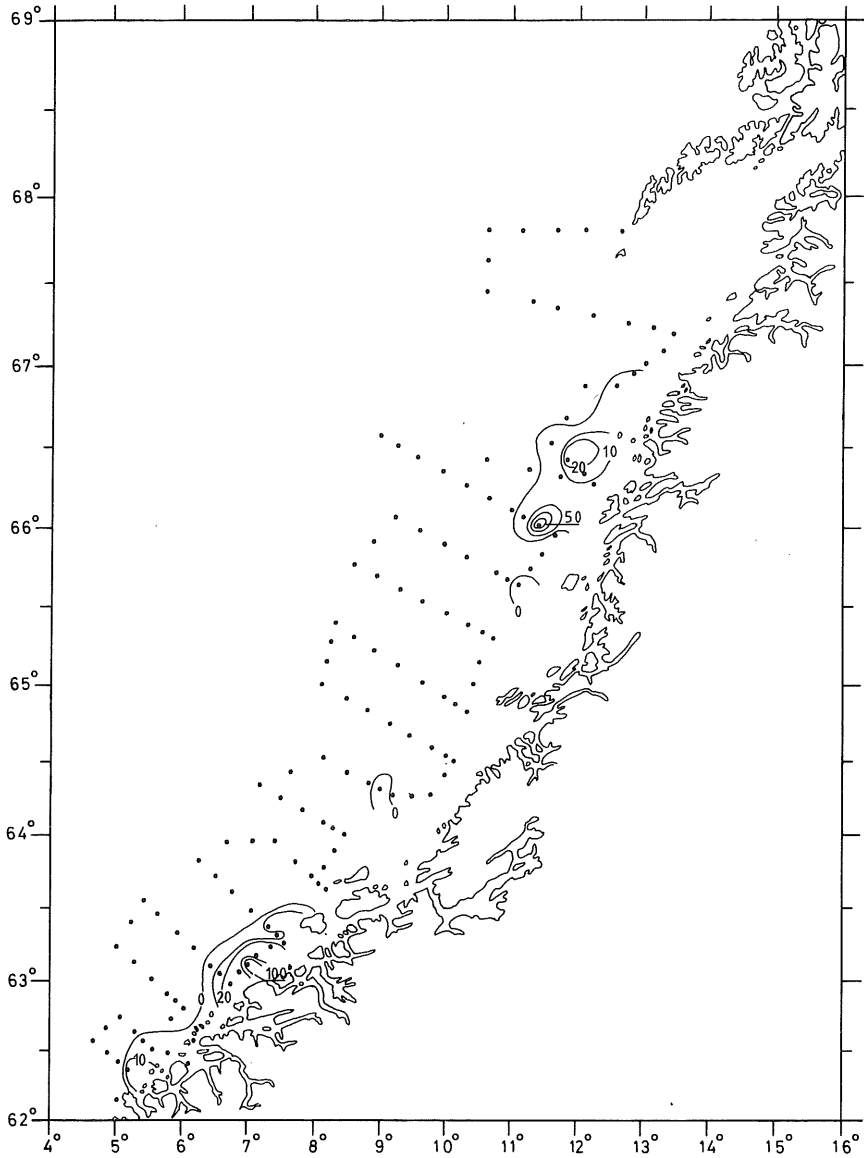


Figure 3. Distribution of herring larvae; 22.4. - 30.4.1981.
Density in number per m² surface.

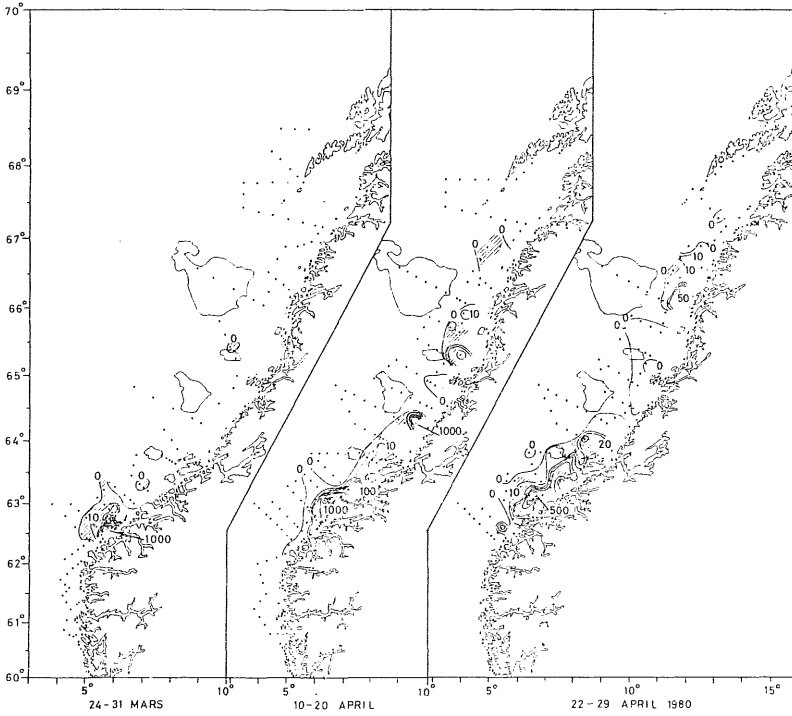


Figure 4. Distribution of herring larvae in April 1980.
Density in number per m² surface.

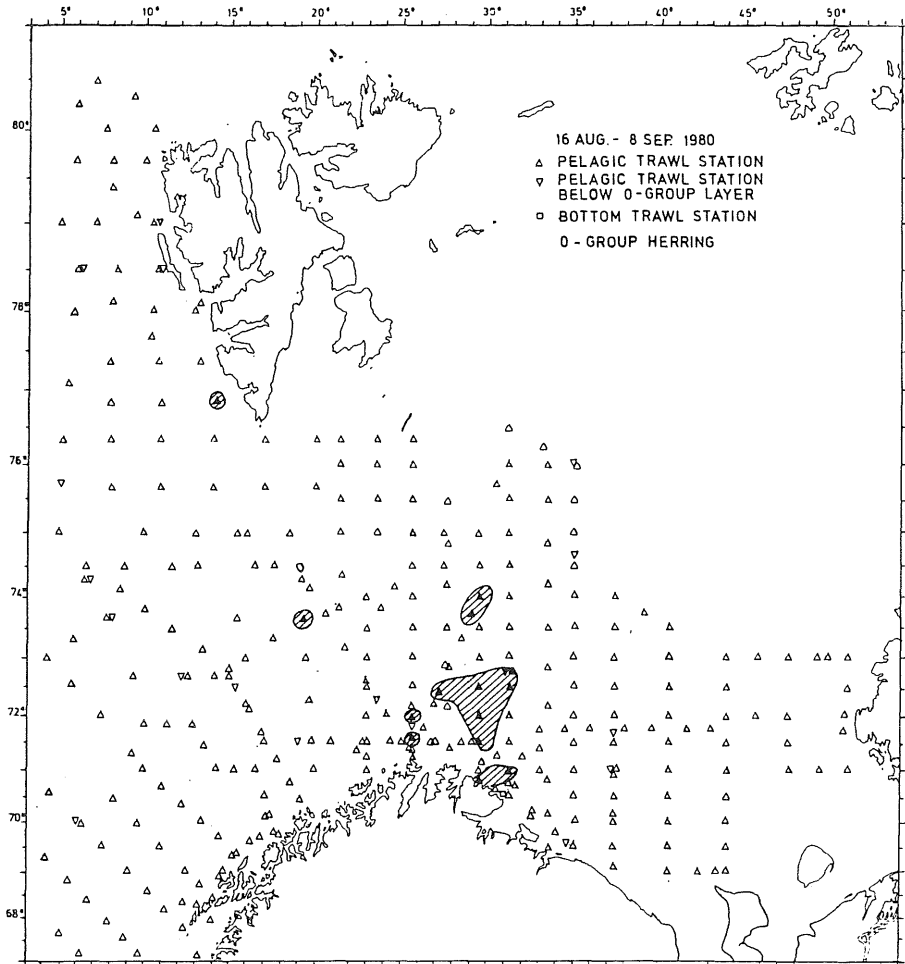


Figure 5. Distribution of 0-group herring.

