International Council for the
Exploration of the Sea

C.M.1982/Assess:12

ATLANTO-SCANDIAN HERRING AND CAPELIN WORKING GROUP REPORT

Part 1

Copenhagen, 4-6 May  1982

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.

---

## TABLE OF CONTENTS

ATLANTO-SCANDIAN HERRING AND CAPELIN WORKING GROUP REPORT - PART 1


1. INTRODUCTION AND PARTICIPANTS

1.1 Terms of Reference

The Atlanto-Scandian Herring and Capelin Working Group met at ICES headquarters from 4-6 May 1982 in order to:

(i) assess the state of the Atlanto-Scandian herring stocks, and

(ii) assess the state of the capelin stock in Sub-areas V and XIV and advise on any necessary management measure for that stock.

Another meeting of the Working Group is scheduled to take place from 27-29 October 1982 to assess the state of the capelin stock in Sub-areas I and II and re-assess the capelin stock in Sub-areas V and XIV.

1.2 Participants

| | |
|---|---|
| A Dommasnes | Norway |
| J Jakobsson (Chairman) | Iceland |
| H í Jakupsstovu | Faroes |
| P Kanneworff | Denmark |
| V Ryzhov | USSR |
| I Røttingen | Norway |
| S Shleinik | USSR |


2. NORWEGIAN SPRING SPAWNING HERRING

2.1 Catch Statistics

Table 2.1 gives the catch north of 62°N of the Norwegian spring spawners since 1972. Table 2.2 gives the catches in number. For 3 year old and older herring unreported catches are included.

2.2 Autumn Fishery in 1981

The total catch quota of the fishery in 1981 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 25 August, the purse-seine fishery 28 September, and the gill-net fishery 19 October. The closing date for all gear categories was set at 21 December. A minimum landing size of 25 cm, with allowance of 15% undersized fish (in weight) has been in force. The same areas as in 1980 were closed to fishing (Anon., 1981a).

The reported catch in the autumn fishery in 1981 amounted to 7 814 tonnes. The herring in the inner part of the Trondheimsfjord are assumed to belong to a local stock (Anon., 1980). An additional catch of 1 425 tonnes from this stock is not included in Tables 2.1 and 2.2.

Table 2.2 shows that a relatively large amount of 2 year old herring (1979 year class) was caught in the autumn fishery. The reason for this was that in the Møre area, few adult herring were found outside the closed area in Aure-Vinjefjorden. The recordings of herring in Møre, at which the purse seining was aimed, consisted of smaller herring, mainly of the 1979 year class.

2.3 <u>By-Catches and Unreported Catches</u>

Unreported catches may occur from various sources (Anon., 1981). The Working Group has earlier judged these catches to be approximately 10 000 tonnes. However, due to lower prices and saturation of the international herring market, it is reasonable to assume that the unreported catches have decreased in 1981. In Table 2.2 the extra catches for 1981 are, therefore, reduced to 5 000 tonnes.

By-catches of 0-group herring in the sprat fishery occur frequently. Catches containing up to 50% of 0-group herring can be landed in the sprat fishery. However, the sprat fishery north of 62°N has decreased. Table 2.3 gives the catches of sprat and herring north of 62°N since 1978, together with the corresponding acoustic estimate of 0-group herring. The table indicates that the by-catches of 0-group herring are of secondary importance to the magnitude of the total mortality rate.

2.4 <u>Larval Surveys in 1982</u>

Figures 1 and 2 give larval distribution charts from April 1982. No increase in herring larvae has been observed since 1981. The temperature of the waters on the coastal banks north of 62°N is below average, and there may be some increase of herring larvae in May. From 15-18 April, a Soviet research vessel took 17 stations in the Norwegian shelf area, but no herring larvae were recorded.

2.5 <u>0-Group Investigations in 1981</u>

The results from the joint international 0-group survey in the Barents Sea show no increase in the abundance of 0-group herring in that area in 1981 (Anon., 1981b). An acoustic survey of 0-group herring distributed in the coastal area of Norway was conducted in November-December 1981. The estimate for 1981 is shown in Table 2.4, and it is of the same order of magnitude as in 1980, and indicates that the 1981 year class will be weak.

2.6 <u>Acoustic Investigations on the Spawning Grounds in 1982</u>

An acoustic survey was carried out on the spawning grounds of the southern stock component in February-March 1982. The results were not dealt with by the Working Group, but it is planned to submit a report of the survey techniques and the results to the ICES Statutory Meeting 1982. The survey will be repeated in 1983.

2.7 <u>Tagging Experiments</u>

The internal tagging project and experimental fishing for recoveries, as described in previous reports, have been continued. In the winter of 1982, 759 tonnes of herring were caught and screened for tags, and 104 tagged herring were recovered. Most of the catches were taken on the spawning grounds of the southern stock component.

2.8 <u>Mortality Estimate</u>

In previous years most of the experimental catches originated from the northern stock component, which is the largest one. The samples of recaught tags from that component were therefore used to estimate the total annual mortality rate in the tagged population, because the data from the southern component were not found adequate for a separate mortality estimate. Based on 83 recoveries obtained from catches taken in 1980-81, the Working Group estimated last year an average Z-value of 0.23 for the period 1975-78. This Z-value was then accepted as an average total annual mortality estimate of all tagged fish.

In 1982, the bulk of the catch and recoveries originate from the southern component. Details of releases and recoveries are given in the text table below:

| Year of release | m | r | K | ln K | $m_{82}$ |
|---|---|---|---|---|---|
| 1975 | 5000 | 2 | 25.0 | 3.22 | 999 |
| 76 | 3200 | 2 | 16.0 | 2.77 | 805 |
| 77 | 16044 | 12 | 13.4 | 2.59 | 5080 |
| 78 | 11998 | 8 | 15.0 | 2.71 | 4781 |
| 79 | 5995 | 9 | 6.7 | 1.90 | 3007 |
| 80 | 19994 | 23 | 8.69 | 2.16 | 12621 |
| 1981 | 15542 | 29 | 5.36 | 1.68 | 12349 |
| Sum | | 85 | | | 39642 |

$m$ = number released

$r$ = number of recoveries in winter 1982

$K$ = $m/r \cdot 10^{-2}$

$m_{82}$ = calculated number of surviving tagged fish in 1982, disregarding the initial mortality due to tagging.

The catch is estimated to contain $1\ 406 \times 10^{3}$ herring effectively screened. The releases, recoveries and catches refer to the year classes older than the 1978 year class (5+).

The plots of ln K against time (in liberty) of releases are shown in the text figure below:
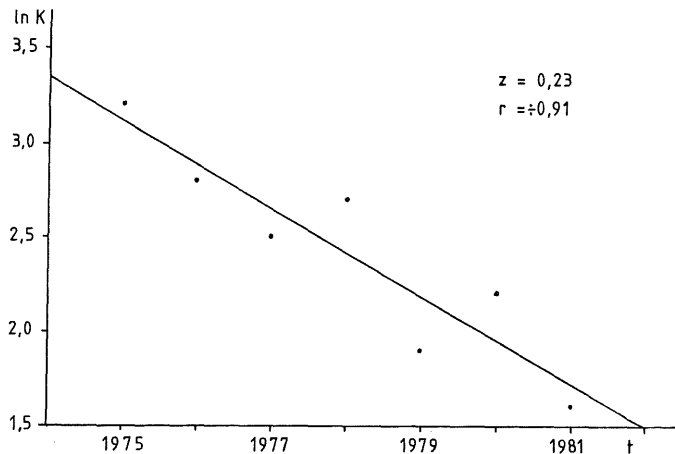
The plots yield an average Z for the years 1975-81 of 0.23, which
is the same Z-value as calculated last year

## 2.9 Abundance Estimates of the Spawning Stock

### 2.9.1 Southern component

Applying $Z = 0.23$ as annual mortality rate of the tagged population,
the state of the tagged population in 1982 is estimated and shown
in the column to the right of the text table on p.3 ($m_{82}$). Assuming
30% tagging mortality, as in the previous report, the stock in number
(N) for year classes older than 1978 (5+) in early 1982 is as follows:

$$N = \frac{39\ 642 \times 0.70 \times 1.406 \times 10^3}{85} = 460 \times 10^6$$

The percentage age distribution of the southern spawning component
is derived from 7 samples drawn from the experimental catches, each
sample containing 100 fish.

| Year class | 1979 | 1978 | 1977 | 1976 | 1975 | 1974 | 1973 | 1972 | 1969 |
|---|---|---|---|---|---|---|---|---|---|
| % | 19.0 | 15.2 | 16.8 | 25.1 | 6.4 | 10.8 | 6.0 | 0.2 | 0.5 |

Distributed on year classes according to the age distribution given
above, the stock in number and weight in early 1982 is calculated
as follows (in million individuals):

### Year classes

| Year | 1979 | -78 | -77 | -76 | -75 | -74 | -73 | -72 | -69 | 1978+ | Tonnes x $10^3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1981 | | 10 | 131 | 209 | 37 | 78 | 57 | 0 | 0 | 512 | 170 |
| 1982 | 133 | 107 | 117 | 175 | 45 | 77 | 42 | 1 | 3 | 567 | 190 |

The corresponding stock estimate in 1981 is included for comparison.
The estimates show that both the year classes 1977 and 1978 are weak,
compared to the 1976 year class, whereas the 1979 year class is more
promising. A slight increase in stock size (10%) is, however, observed
also this year.

### 2.9.2 Northern component

The assessment of the state of the northern stock component in 1982
is based on the stock estimated in 1981 and the age composition of the
spawning stock component in 1982. The percentage age distribution is
derived from two samples (200 fish) drawn from catches taken of
pre-spawners in the Lofoten area in February 1982 and given in the
text table below:

| Year class | 1978 | 1977 | 1976 | 1975 | 1974 | 1973 | 1972 | 1969 |
|---|---|---|---|---|---|---|---|---|
| % | 16 | 3 | 14 | 2 | 19 | 40 | 1 | 5 |

In the text table below are given the stock estimate in number (in million individuals) by year classes obtained in 1981 (Anon., 1981) and the calculated stock number in 1982, assuming that all age groups older than the 1976 year class were fully recruited in 1981. In this calculation, a Z-value of 0.2 was used:

Year classes

| Year | 1978 | -77 | -76 | -75 | -74 | -73 | -72 | -71 | -69 | 1978+ | Tonnes x $10^{-3}$ |
|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------------------|
| 1981 | | 7 | 86 | 21 | 157 | 343 | 7 | 7 | 86 | 714 | 270 |
| 1982 | 121 | 23 | 106 | 15 | 144 | 303 | 8 | 0 | 38 | 758 | 290 |

The estimate indicates a slight increase in the spawning stock size due to the somewhat better recruitment from the 1978 year class than from the year classes 1975-77.

2.10    Virtual Population Analysis

A VPA has been run, using the following input data:

Catch in number per year class:    Table 2.2

Weight at age:    Table 2.5

Natural mortality:    0.18

Maturation coefficients:    3 years old  0.1
4 years old  0.8
5 years old  0.9
6 years old  1.0

Terminal F (1981) for each year class:

$$\frac{N_{Dec\ 1981}}{C_{1981}} = \frac{e^{-Z}}{(1-e^{-Z})\frac{F}{Z}}$$

$N_{Dec\ 1981} = N_{spring\ 1982}$ found in the tagging experiment.

Table 2.6 gives the fishing mortalities and Table 2.7 the stock size from the VPA run. The latter shows that the spawning stock increased from 84 000 tonnes in 1973 to about 400 000 tonnes in 1978. During the last three years (1979-81) the spawning stock has been at the level of about 460 000 tonnes.

For the spawning stock, the estimates from the VPA show the same general trend in 1977-80 as the results from the tagging experiment, i.e., an increase of approximately 150 000 tonnes. The estimate for each year is, however, somewhat higher in the VPA. This is especially true for the 1973 year class.

2.11    Conclusion

The spawning stock of the Norwegian spring spawners consists of two components. The assessment of the southern stock component in 1982 is based on the results of the internal tagging project. From 85 recoveries of tagged herring, a total average mortality of 0.23 for the years 1975-81 was estimated for the tagged part of the population. Combined with catch data from the experimental fishery,

the abundance of the total southern stock component in
1982 was estimated to be 190 000 tonnes.

The assessment of the northern stock component is based on the
stock estimate from 1981 and the age composition in 1982. This
gave an estimate of 290 000 tonnes for the northern stock component
in 1982.

Thus, according to the present assessments, the overall abundance
of the spawning stock of Norwegian spring spawning herring is
estimated to be in the order of 450 000 - 500 000 tonnes. The
catch in 1981 is estimated to be 15 000 tonnes, in which an
assumed unreported catch of 5 000 tonnes has been included. This
catch generated a fishing mortality of about 0.03 in 1981.
Despite this low fishing mortality, there has only been a slight
increase in the spawning stock abundance in recent years. This
is due to the small recruitment to the spawning stock of two weak
year classes, i.e., 1977 and 1978. A certain increase is
expected in 1983, when the 1979 year class will begin to recruit
to the spawning stock. However, according to the 0-group
estimates, the 1980 and 1981 year classes are poor. The overall
abundance as well as recruitment are 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 maximized, if no fishing
is allowed. However, if a fishery is conducted, care should be
taken that such a fishery only generates a very low fishing
mortality. 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 contrast to the three previous years, in 1981 no by-catch of
spring-spawning herring was reported from the trawl fishery on the
Faroe Plateau. Furthermore, in the Faroese 0-group survey in
1981 no 0-group herring were caught.

The traditional spawning grounds were surveyed in March 1982 by
the Faroese research vessel "Magnus Heinason", using sonar and
echo-sounder in addition to extensive bottom trawling. The
result was totally negative. From this the Working Group notes
that the small component of spring-spawning herring present
on the Faroe Plateau in the years 1978-80 now seems to have
vanished.

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 1981 was entirely based (99.9%)
on Icelandic summer spawners.

The landings of summer-spawning herring from 1971 to 1981 are
given in Table 4.1. The 1981 landings were about 39 100 tonnes.
The catches with purse seine and drift nets are shown in the
text table below. It should be noted that the purse-seine
figures include 650 tonnes, which were taken in January 1981,

while the remainder of the catches were taken during the main
season September to December 1981. The drift-net landings
include 1 622 tonnes taken by set nets.

Landings and TACs in tonnes ($\times 10^{-3}$) of Icelandic
summer spawners 1978-81

| Year | Purse seine | | Drift nets | | Total | | |
|------|-------|------|-------|------|-------|------|----------|
|      | Catch | TACs | Catch | TACs | Catch | TACs | Rec.TACs |
| 1978 | 20.2  | 20.0 | 17.0  | 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     |
| 1981 | 21.3  | 22.5 | 17.8  | 18.0 | 39.1  | 42.5 | 40.0     |

It is noted that about 5% of the set TAC was not taken. This was
due to the fact that owing to the difficult market situation,
12 of the purse seiners did not use their allotted quota.

4.2     Stock Abundance and Mortality Rates

The assessment of the stock and the exploitation for 1981 is, as
in previous years, based on an acoustic stock abundance estimate
and catches by age using a VPA.

4.3     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 1969-81. As in 1979 and
1980, the catches in 1981 were predominated by the 1974 and 1975
year classes (Table 4.2). It should be noted that the strong
year class from 1971 has contributed about 9% to the catch during
the two last years. As stated in last year's report of the
Working Group, the echo-abundance estimates in December 1980
gave very high values of 1- and 2-ringers (1978 and 1977 year
classes). It was, therefore, expected that 3-ringers would in
1981 be in high proportions in the catch that year. This,
however, was not the case, as shown in Table 4.2, because
3-ringers made up about 12% of the catch instead of the expected
30%.

The weight at age in grammes 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:

|         | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981  |
|---------|------|------|------|------|------|------|------|-------|
| Weight in g | 262  | 241  | 243  | 217  | 196  | 182  | 202  | 186.5 |

After a declining trend in the mean weights of 3-ringers, there was an increase in 1980. Due to very low mean weights of 2-ringers in 1980, it was expected that the mean weights of 3-ringers in 1981 would be very low indeed. As shown in the text table on p.7, the mean weights of 3-ringers in 1981 were at the same level as in 1978 and 1979 but not as low as expected.

During the period of low abundance of the stock, 95% - 98% of the 3-ringed herring were mature and spawned at that age. In the period 1979-81 about 30% - 50% of the 3-ringed herring in the catches were mature. In 1981, about 60% of the 3-ringed herring in the catches were mature. This was a much higher portion than expected on the basis of last year's samples. During the period of high abundance of the stock in the 1960s, about 50% of the 3-ringers were mature.

4.4     The Acoustic Abundance Surveys in 1981 and January 1982

As in 1980, the main herring fishery took place in the east coast fjords in 1981, but when the acoustic abundance surveys started about mid-November 1981, the major part of the herring concentrations had emigrated from the fjords. Repeated surveying until mid-December revealed some herring very close to the shore at southeast and south Iceland, but acoustic estimates could not be obtained in that area.

By 20 December some herring had assembled at southwest Iceland near the mouths of the two main rivers: Ölfuså and Thjörså. an acoustic abundance estimate was obtained, and according to this about 50 000 tonnes of herring had assembled in that area. During the period 9-10 January, the acoustic abundance estimates in the southwesterly area were repeated under excellent weather conditions (Figure 3).

Based on TS values for the various length categories obtained in 1980 as well as a few new estimates obtained in November and December 1981, the following equation was used to convert the echo abundance into fish abundance:

$$C = 13.0 \times 1^{-2.17} \times 10^6$$

where C is the density coefficient and l is the length of the fish in cm. The value used corresponds to a TS of -34.6 dB/kg for 20 cm herring weighing 55 g, and a TS of -36.5 dB/kg for 30 cm herring weighing 205 g.

Using the equation as well as the length and age distribution in the samples taken on the wintering grounds at southwest Iceland, an estimate of the number of herring in each age group 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 about 200 000 tonnes of herring. It is clear from the age distribution in Table 4.4 that the immature 1- and 2-ringers were more or less absent on the new wintering grounds in January 1982. Despite echo surveying in several of the north and east coast fjords in November and December 1981, these immature herring were only located in very low numbers. There is thus an uncertainty about the recruitment to the Icelandic summer-spawning stock in the near future.

4.5     The Fishing Mortality in 1981

As in previous years, the fishing mortality for 1981 was calculated

from the survey results as given in the text table below and from the catch data from the previous fishing season, using the equation with M = 0.1:

$$\frac{N_{Jan.\ 1982}}{C_{1981}} = \frac{e^{-Z}}{(1-e^{-Z})\ \frac{F}{Z}}$$

| Rings 81/82 | Catch in no. in millions 1981 | Echostock in millions Jan. 1982 | $F_{1981}$ |
|---|---|---|---|
| 0/1 | | 5 | 0.0 |
| 1/2 | 2.2 | 23 | 0.09 |
| 2/3 | 4.6 | 99 | 0.04 |
| 3/4 | 16.7 | 206 | 0.08 |
| 4/5 | 12.1 | 54 | 0.20 |
| 5/6 | 36.8 | 157 | 0.21 |
| 6/7 | 41.9 | 205 | 0.18 |
| 7/8 | 7.3 | 30 | 0.21 |
| 8/9 | 4.8 | 10 | 0.38 |
| 9/10 | 13.4 | 57 | 0.20 |
| 10/11 | 2.8 | 12 | 0.21 |
| 4+ | 119 | 525 | |

N = 2 051   $\bar{W}$ = 237 g   Weighted mean $F_{4+}$ = 0.20

## 4.6 The Results of the VPA

A VPA was run, using the mean F for adult herring = 0.20 obtained from the catch in number data in 1981 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 higher stock estimates for the earlier years than that estimated in the VPA in the 1981 report. This is due to lower F values for adult herring in 1981, which in turn result from a somewhat higher acoustic estimate of the adult stock in January 1982 than in December 1980. It should be noted that the herring were confined to narrow fjords in 1980, where acoustic surveying and especially sampling were much more difficult than on the wintering areas in 1982. It is now evident that the younger herring were overestimated in the 1980 survey and the adult herring correspondingly underestimated. The present acoustic estimate is in line with the estimate given in the 1980 report.

The fishery on this stock was re-opened in 1975, and according to this new assessment, the fishing mortality for 4 years and older herring was about 0.15 for the first 2 years. During the 5 last years (1977-81), the fishing mortality has been about or just above 0.2. As shown in Table 4.6, the 1971 year class is now estimated to have been about $495 \times 10^{-6}$ as 1-ringers. The 1972 and 1973 year classes are both weak (124 and 186 millions), while the 1974 and 1975 year classes are estimated to have been 685 and 493 millions as 1-ringers, respectively.

The 1976 year class is poor, or only about 142 millions. The estimates of the 1975 and 1976 year classes are considerably higher according to this new VPA than in that of last year. At that time very high estimates of the 1977 and 1978 year classes were obtained from the

acoustic survey. These year classes have not turned up in the catch in the same degree as expected, nor have they been located in great abundance during the echo-abundance surveys. The input F for those year classes was, therefore, adjusted to generate year classes of about 400 million herring as 1-ringers.

4.7    The State of the Stock

Based on the echo-abundance estimates from January 1982 of 5-ringers and older, and assuming that 3- and 4-ringers will be of average strength, the adult stock (3-ringers and older) will be about 290 000 tonnes in 1982. Of this adult stock biomass, about 60 000 tonnes are 3-ringed herring. In recent years only about half of the 3-ringers have reached maturity and contributed to the spawning stock. The spawning stock will, therefore, probably be about 260 000 tonnes in 1982. This level of stock abundance is within the range of stock biomass during the 1954-63 period of high and steady recruitment.

During the last few years, the fishing mortality in the adult component of the stock has been about, or just above, 0.2. The Working Group recommends that the exploitation of this stock should be continued at this level. On this basis, the Working Group recommends that the TAC for the Icelandic summer spawners for 1982 should be 50 000 tonnes.

5.    THE ICELANDIC CAPELIN

5.1    The Fishery during the 1981-82 Season

The season opened in August, and before the end of the month Norway had taken her share of the preliminary catch quota of 700 000 tonnes she had bilaterally agreed upon with Iceland. From then on, the fishery was conducted by Iceland, the Faroes and vessels from EEC countries, mainly Danish.

Although Icelandic vessels started fishing for capelin already in August, they took their catch mainly in October and November. Iceland allowed only a very limited fishing in December 1981 as well as during the 1982 winter season. Faroese and EEC vessels mainly took their catch in August and September.

The monthly catch from the Icelandic capelin stock in weight and number during the summer/autumn 1981 and winter 1982 season is given in Table 5.1. The annual catch by nations and seasons from 1981-82 is given in Table 5.2.

5.2    Estimates of Spawning Stock Abundance

As described in a previous Working Group report, the size of the adult component of the Icelandic stock of capelin has since 1978 been estimated twice annually by acoustic methods. For each spawning stock (1979, 1980, 1981 and 1982) a first estimate has been obtained in October/November, and a second one in January/ February in the following year. Estimates yielding suspiciously low results, due to extensive drift ice, weather and the behaviour of the fish, were repeated as soon as possible afterwards. Furthermore, several estimates have been repeated 2-3 times both in autumn and winter in order to test the reliability of the acoustic method. Under normal working conditions, deviations

within such sets of observations have been small (Vilhjálmsson et al., 1982).

On 28-30 October 1981 the Atlanto-Scandian Herring and Capelin Working Group met in Copenhagen in order to assess the state of the Barents Sea and Icelandic capelin stocks. A joint Norwegian-Icelandic acoustic abundance survey of the Icelandic stock of capelin had then just been completed. The conditions during that survey had been far from ideal in that drift ice covered possible distribution areas, and clearly some of the stock had not as yet returned to its over-wintering grounds in Icelandic waters.

The resulting stock abundance estimate was very low or only 144 000 tonnes, counting all year classes. While it was realized that the October estimate most likely was unrealistic, it was accepted as a strong indication of low stock abundance.

In addition to the Atlanto-Scandian Herring and Capelin Working Group report from October 1981, the following survey results as well as catch in numbers and weight for the 1981-82 season were available to the present Working Group meeting for a new assessment of the state of the 1982 spawning stock of the Icelandic capelin:

1.  R/V "Bjarni Sæmundsson" NW- and N-Iceland, 3-11 November 1981. Stock abundance in number and weight is given in Table 5.3.

    During this survey there was much less drift ice than in October, the distribution area was smaller, and the weather was good.

2.  R/V "Bjarni Sæmundsson" N- and NE-Iceland, 26-29 November 1981. Stock abundance in number and weight is given in Table 5.4.

    During this latter survey, reasonably good weather prevailed, and since the distribution of the stock was known due to previous surveying and information from the fishing fleet, it could be completed in a very short time.

As regards the mature stock component, there is very little difference between the abundance estimates derived from the two November surveys when account has been taken of the catch during the intervening period. (Table 5.8.)

The November estimates of stock abundance correspond to about 450 000 tonnes of spawning stock that should have been obtained in October had conditions been normal.

3.  A third abundance estimate was obtained during 11-22 January 1982 by R/V "Bjarni Sæmundsson" and R/V "Arni Fridriksson" off E- and SE-Iceland. Stock abundance in number and weight is given in Table 5.5.

    Weather conditions presented certain difficulties, because much time had to be spent in waiting for a favourable oppor-tunity. This waiting was rewarded, but a further survey in February showed that spawners recorded off NE-Iceland at that time (Table 5.6) had not been included. This capelin must be added to the January acoustic estimate of the 1982 spawning stock, which then becomes as shown in Table 5.7.

When account has been taken of the November-December catches (Table 5.8) as well as of natural mortality, the January-February estimate agrees with both those of November 1981. It is, therefore, concluded that all three estimates represent reliable evaluations of stock abundance at the times when they were obtained.

The results of the acoustic autumn and winter estimates of the
abundance of the mature stock component for the period October 1978 -
January 1982 are shown in Figure 4. It has been calculated, that,
when account has been taken of the catch during the intervening
period as well as of natural mortality, the difference between the
two sets of stock abundance estimates does not exceed 5-10%. This
is illustrated in further detail in Figure 5. With the exception
of surveys, which have been wrongly timed with regard to the
behaviour pattern of the fish or ice conditions, the results are
remarkably consistent. They are, therefore, considered reliable
and show an alarming decline in stock abundance.

## 5.3 Abundance Estimates of 0-Group and Juvenile Capelin

### 5.3.1 0-group abundance

Comparative measurements of the abundance of 0-group capelin have
been obtained in August annually since 1972 (Figure 6). During the
period 1972-75 the 0-group index indicates a high level of recruit-
ment which is followed by a downward trend and a distinctly lower
level during the last 5 years. This development coincides with the
large increase in fishing effort and catch as well as the change in
fishing pattern brought about by the recent multinational summer and
autumn fishing (Figure 7).

### 5.3.2 Abundance estimates of 1-2 group juveniles

As yet it has proved difficult to assess the relative or absolute
abundance of the 1-2 group juvenile stock component, mainly because
of its frequent distribution in or near areas that are impassable
due to drift ice for long periods of time.

During the first half of November 1981 2.7 and 1.4 x $10^9$ fish
belonging to the 1980 and 1979 year classes, respectively, were recorded
(Table 5.3). At the end of the month a shoal of capelin belonging to
the 1980 year class was further located off NE-Iceland (Table 5.4),
bringing the total for that year class to 23.7 x $10^9$ fish.

In February 1982, an acoustic survey covering the area off NW-, N- and
NE-Iceland was carried out. This survey was fairly extensive and
specially aimed at immature capelin of the 1980 and 1979 year classes.
The abundance estimate thus obtained is given in Table 5.6. It
should be noted that part of the possible area of distribution could
not be reached due to drift ice and weather.

Based on the results of acoustic surveying, the best approximation of
the abundance of the 1980 year class is 23.7 x $10^9$ fish obtained during
the two November surveys, and for the 1979 year class the February
1982 figure of 4.3 x $10^9$ fish. In spite of doubts as to the
accuracy of the above figures, they should be interpreted as a
strong warning of low abundance.

## 5.4 Present State of the Stock and Management Advice

Because of the very high spawning mortality, the main management
objective is to prevent the spawning stock being reduced to a level
which would cause reduced recruitment.

In 1979, when fishing was stopped in the third week of March, about
600 000 tonnes were left to spawn according to acoustic estimates of
stock size, when account had been taken of fishing mortality and
natural mortality.

In 1980 it was decided that, while gaining further experience, it would be inadvisable to reduce the spawning stock to less than 400 000 tonnes. To keep the spawning stock at this level has been the main management objective in the last three years. As shown in Figure 5, the spawning stocks in 1980, 1981 and 1982 have in fact been reduced to about 300 000 tonnes, 160 000 tonnes, and 140 000 tonnes respectively, as calculated from the winter acoustic surveys. It is, therefore, clear, that the management objective has not been obtained in any of the years 1980, 1981 and 1982. The available series of data on stock/recruitment relationship is still too short to pinpoint the minimum amount that must be allowed to spawn in order not to reduce recruitment for that reason, but the data since 1980 indicate that it is inadvisable to have a spawning stock smaller than 400 000 tonnes.

During the last 2-3 years, the abundance of the Icelandic capelin stock has declined at an alarming rate, as indicated by the O-group indices and the acoustic estimates. This, as well as the catches, are shown in Figure 8. Insufficient amounts have been left to spawn and the stock has been overfished. At present, the main management objective must therefore be to rebuild the stock to its previous level of abundance. In order to achieve this objective, a much larger spawning stock must be preserved than during the last three seasons or not less than 400 000 tonnes.

Although O-group indices cannot at present be used as a basis for TACs, a tentative indication of the relative size of each year class appears from that series of data. As shown in Figures 6 and 8, the 1980 year class is at a low level of abundance as judged from the O-group results.

Reliable and comparable quantitative data on the 1- and 2-ringers, which make up most of the immature stock, have also proved difficult to obtain before they enter the fishery. Nonetheless, survey results in November 1981 yielded approximately 120 000 tonnes of immature capelin of the 1979 and 1980 year classes (Tables 5.3 and 5.4). If no fishing is conducted during the 1982/83 season, this indicates that the spawning stock in 1983 will be below 300 000 tonnes.

Although the above preliminary abundance estimate for the 1983 spawning stock cannot be considered accurate, it should not be ignored. Together with the 1980 O-group index it must be interpreted as a strong indication of a very low level of stock abundance, a continuation of the trend observed in the last four years (Figure 8).

For the 1982/83 season a complete fishing ban is, therefore, recommended, until a new and reliable estimate of stock abundance is available.

In October 1982, Iceland and Norway have planned an acoustic survey on the distribution and abundance of the 1983 spawning stock. Depending on the results of this survey, further management advice will be given.

6.    IMPROVEMENTS OF THE DATA BASE

In accordance with C.Res.1981/2:27:15, the Working Group discussed various deficiencies in the data base and how these could be improved.

6.1    Norwegian Spring-Spawning Herring

The Working Group noted that a considerable proportion of the estimated catch is not reported in the official statistics. If these catches were reported, this would greatly improve the assessment based on fishery data (VPA).

It was also noted that information on by-catches of 0-group herring in the sprat fishery came from sales organisations and not from scientific sampling. However, the sprat catches north of 62°N have been decreasing recently and, therefore, the herring by-catches in this fishery are at the moment of secondary importance, but this could change if sprat catches increased again. Therefore, a sampling programme is needed for this fishery.

The Working Group appreciates that in 1982 an acoustic abundance survey of the spawning component was conducted. It is recommended that further attempts should be made to obtain an acoustic estimate of the stock.

6.2    Icelandic Summer-Spawning Herring

The Working Group recommends that acoustic surveys should be carried out to cover not only the adult herring but also the younger, immature herring.

6.3    The Icelandic Capelin

The Working Group strongly recommends that acoustic surveys on the 1- and 2-group capelin should be carried out in order to get an estimate on the recruiting year classes early enough in the year to make it possible for the Working Group to carry out an assessment prior to the start of each fishing season.

It is also suggested that both the data handling as well as the 0-group survey design should be reconsidered, thus attempting to obtain a better estimate of the year class strength already at the 0-group stage.

The Working Group noted that catch statistics with catch in numbers by age groups were supplied by two countries (Norway and Iceland). It is, however, clear that such basic data must be supplied by all countries participating in the fishery.

<div align="center">REFERENCES</div>

Anon., 1980. Report of the Atlanto-Scandian Herring Working Group, Bergen, 12-14 May 1980. ICES, C.M.1980/H:8.

Anon., 1981a. Atlanto-Scandian Herring and Capelin Working Group report. Part 1. Copenhagen, 12-14 May 1981. ICES, C.M.1981/H:11.

Anon., 1981b. Preliminary report of the International 0-Group Fish Survey in the Barents Sea and Adjacent Waters in August-September 1981. ICES, C.M.1981/G:78.

Anon., 1982. Atlanto-Scandian Herring and Capelin Working Group Report, Part 2. Copenhagen, 28-30 October 1981. C.M.1982/Assess:2.

Vilhjálmsson, H, Reynisson, P., Hamre, J, and I Røttingen, 1982. Acoustic abundance estimation of the Icelandic stock of capelin 1978-82. Symp. on Fisheries Acoustics, Bergen 1982, Doc. No.21.

Table 2.1    Catches north of $62^{O}N$ of Norwegian Spring
             Spawning herring (tonnes) since 1972.

| Year | Catches of adult herring in winter[1] | Mixed herring fishery in autumn[2] | Bycatches of O-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 |
| 81 | 844 | 7814 | 78 |
| 1982 | 983 | | |

1)  Mostly experimental fishing
2)  Includes also bycatches of adult herring in other fisheries
3)  In 1972 there was also a directed herring O-group fishery

Table 2.2     Catch in numbers, millions, Norwegian Spring Spawners.
              Unreported catches are included for 3 years and older
              herring.

| Age | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 |
|-----|------|------|------|------|------|------|
| 0 | 347.100 | 29.300 | 65.900 | 30.600 | 20.100 | 43.000 |
| 1 | 41.000 | 3.500 | 7.800 | 3.600 | 2.400 | 6.200 |
| 2 | 20.400 | 1.700 | 3.900 | 1.800 | 1.200 | 3.100 |
| 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 | 1981 |
|-----|------|------|------|------|
| 0 | 20.100 | 32.600 | 6.900 | 8.300 |
| 1 | 2.400 | 3.800 | 0.800 | 1.100 |
| 2 | 1.200 | 1.900 | 0.400 | 11.900 |
| 3 | 3.019 | 6.352 | 6.407 | 4.166 |
| 4 | 12.164 | 1.866 | 15.814 | 4.591 |
| 5 | 20.315 | 6.865 | 2.278 | 8.596 |
| 6 | 0.870 | 11.216 | 8.165 | 2.200 |
| 7 | 0.000 | 0.326 | 15.838 | 4.512 |
| 8 | 0.620 | 0.000 | 0.441 | 8.280 |
| 9 | 5.027 | 0.000 | 0.008 | 0.345 |
| 10 | 0.000 | 2.534 | 0.000 | 0.103 |
| 11 | 0.000 | 0.000 | 2.688 | 0.114 |
| 12 | 0.000 | 0.000 | 0.000 | 0.964 |

Table 2.3 Catches of sprat and small herring since 1978 in the area north of $62°N$

| Year | Catch (tonnes) | | O-group acoustic estimate (tonnes) |
|------|------|------|------|
| | Sprat | By-catch of herring 1) | |
| 1978 | 2445 | 189 | 6424 |
| 79 | 1350 | 307 | 20058 |
| 80 | 1050 | 65 | 1870 |
| 1981 | 420 | 78 | 2092 |

1) Most of the by-catch is O-group. Approximately 95% of the by-catch of herring is utilized by the canning industry. Because of the size, I and II-group herring cannot be utilized for this purpose.

Table 2.4    Norwegian Spring Spawners.  Abundance of O-group
herring in 1975 - 1980 (N x $10^{-6}$)

| Year | Area | | | Total |
|------|------|------|------|-------|
| | $62^O$N - $65^O$N | $65^O$N - $68^O$N | North of $68°$30' | |
| 1975 | 328 | 692 | 55 | 1075 |
| 76 | 415 | 2610 | 750 | 3775 |
| 77 | 70 | 305 | 37 | 412 |
| 78 | 302 | 511 | 392 | 1205 |
| 79 | 909 | 2260 | 288 | 3457 |
| 80 | 12 | 4 | 218 | 234 |
| 1981 | 262 | 2 | 1 | 265 |

Table 2.5    Average weight at age in grammes, Norwegian Spring
             Spawners, 1973-1981.

|     | Yearclass | | | | | | | | |
| Age | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|-----|------|------|------|------|------|------|------|------|------|
| 3   | 170  | 181  | 181  | 181  | 180  | 178  | 175  | 170  | 170  |
| 4   | 259  | 259  | 259  | 259  | 294  | 232  | 283  | 224  | 204  |
| 5   | 342  | 342  | 342  | 342  | 326  | 359  | 347  | 336  | 303  |
| 6   | 384  | 384  | 384  | 384  | 371  | 385  | 402  | 378  | 355  |
| 7   | 409  | 409  | 409  | 409  | 409  | 420  | 421  | 387  | 383  |
| 8   | 444  | 444  | 444  | 444  | 461  | 444  | 465  | 408  | 395  |
| 9   | 461  | 461  | 461  | 461  | 476  | 505  | 465  | 397  | 413  |
| 10  | 520  | 520  | 520  | 520  | 520  | 520  | 520  | 520  | 453  |
| 11  | 543  | 543  | 543  | 543  | 543  | 551  | 534  | 543  | 468  |
| 12  | 412  | 412  | 412  | 412  | 500  | 500  | 500  | 512  | 512  |

Table 2.6    Calculated fishing mortality, Norwegian Spring
             Spawners, 1973-1981, M = 0.18.

|     | Yearclass | | | | | | | | |
| Age | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 3   | 0.124 | 0.008 | 0.079 | 0.022 | 0.041 | 0.024 | 0.014 | 0.034 | 0.017 |
| 4   | 0.071 | 0.013 | 0.010 | 0.176 | 0.027 | 0.028 | 0.019 | 0.041 | 0.030 |
| 5   | 1.026 | 0.090 | 0.075 | 0.000 | 0.013 | 0.029 | 0.019 | 0.028 | 0.028 |
| 6   | 1.896 | 2.329 | 0.152 | 0.000 | 0.000 | 0.048 | 0.020 | 0.028 | 0.033 |
| 7   | 2.500 | 2.289 | 0.476 | 0.088 | 0.051 | 0.000 | 0.020 | 0.034 | 0.019 |
| 8   | 2.138 | 0.047 | 0.116 | 0.076 | 0.095 | 0.098 | 0.000 | 0.032 | 0.022 |
| 9   | 0.038 | 0.047 | 0.060 | 0.076 | 0.100 | 0.057 | 0.000 | 0.002 | 0.030 |
| 10  | 0.038 | 0.047 | 0.060 | 0.076 | 0.100 | 0.134 | 0.036 | 0.000 | 0.030 |
| 11  | 0.038 | 0.047 | 0.060 | 0.076 | 0.100 | 0.134 | 0.188 | 0.048 | 0.030 |
| 12  | 0.047 | 0.047 | 0.060 | 0.076 | 0.100 | 0.134 | 0.188 | 0.285 | 0.022 |
| Average F(4-12) | 0.086 | 0.090 | 0.142 | 0.094 | 0.035 | 0.031 | 0.020 | 0.035 | 0.025 |

Table 2.7    VPA.  Norwegian spring spawners.  Stock, 3 years and older, and
spawning stock, in millions.  M = 0.18.

| Age | 1973 | 1974 | 1975 | 1976 | Age 1977 | 1978 | 1979 | 1980 | 1981 | 1982 |
|-----|------|------|------|------|------|------|------|------|------|------|
| 3 | 22 | 13 | 47 | 1169 | 603 | 136 | 515 | 211 | 272 | |
| 4 | 400 | 17 | 11 | 36 | 955 | 483 | 111 | 424 | 170 | 223 |
| 5 | 1 | 311 | 13 | 9 | 26 | 776 | 392 | 91 | 340 | 138 |
| 6 | 2 | | 238 | 11 | 8 | 21 | 630 | 321 | 74 | 276 |
| 7 | | | | 170 | 9 | 6 | 17 | 516 | 261 | 59 |
| 8 | | | | | 130 | 7 | 5 | 14 | 416 | 214 |
| 9 | | | | | | 99 | 5 | 4 | 11 | 340 |
| 10 | | | | | | | 78 | 4 | 4 | 9 |
| 11 | | | | | | | | 63 | 4 | 3 |
| 12 | | | | | | | | | 50 | 3 |
| 13 | | | | | | | | | | 41 |
| Total | 425 | 341 | 309 | 1395 | 1731 | 1528 | 1753 | 1648 | 1602 | |
| Spawning stock | 325 | 295 | 263 | 335 | 995 | 1232 | 1229 | 1366 | 1289 | |
| Spawning stock[1] | 84 | 99 | 99 | 105 | 310 | 406 | 462 | 472 | 450 | |

[1]    Stock in weight in 1000 tonnes

Table 4.1    Landings of Icelandic summer spawning
             herring 1972 - 1981 in tonnes x $10^{-3}$

| 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|------|------|------|------|------|------|------|------|------|------|
| 0.3  | 0.2  | 1.2  | 12.8 | 17.8 | 28.7 | 37.3 | 45.1 | 53.3 | 39.1 |

Table 4.2    Catch in numbers, millions, Icelandic Summer Spawners
             1969 - 1981.

| 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 | 1981 |
|-------|------|------|------|------|------|------|
| 1 | 0.632 | 0.683 | 2.607 | 0.919 | 3.239 | 2.279 |
| 2 | 10.136 | 18.266 | 22.318 | 14.932 | 14.768 | 4.622 |
| 3 | 4.022 | 23.400 | 50.469 | 47.038 | 21.370 | 16.745 |
| 4 | 35.142 | 10.080 | 13.703 | 68.968 | 62.509 | 12.107 |
| 5 | 7.214 | 44.913 | 8.648 | 16.270 | 67.245 | 36.813 |
| 6 | 5.641 | 6.525 | 39.085 | 7.915 | 11.879 | 41.851 |
| 7 | 1.076 | 5.252 | 7.178 | 25.753 | 9.557 | 7.288 |
| 8 | 0.451 | 1.352 | 6.288 | 3.016 | 20.012 | 4.855 |
| 9 | 0.305 | 0.508 | 1.599 | 1.848 | 1.849 | 13.395 |
| 10 | 0.138 | 0.351 | 0.916 | 0.489 | 1.507 | 1.030 |
| 11 | 0.095 | 0.026 | 0.396 | 0.434 | 0.718 | 0.883 |
| 12 | 0.001 | 0.124 | 0.017 | 0.032 | 0.001 | 0.759 |
| 13 | 0.001 | 0.001 | 0.025 | 0.053 | 0.113 | 0.101 |
| 14 | 0.001 | 0.001 | 0.050 | 0.006 | 0.081 | 0.062 |
| SUM 1- 2 | 10.768 | 18.949 | 24.925 | 15.851 | 18.007 | 6.901 |
| SUM 3-14 | 54.087 | 92.533 | 128.374 | 171.822 | 196.841 | 135.889 |
| TOTAL | 64.855 | 111.482 | 153.299 | 187.673 | 214.848 | 142.790 |

Table 4.3   Weight at age, in grammes   Icelandic summer spawners
            1969 - 1981.

| 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 | 1981 |
|-------|------|------|------|------|------|------|
| 1 | 103.0 | 84.0 | 73.0 | 75.3 | 68.9 | 60.8 |
| 2 | 189.0 | 157.0 | 128.0 | 145.3 | 115.3 | 140.9 |
| 3 | 243.0 | 217.0 | 196.0 | 182.4 | 202.0 | 190.5 |
| 4 | 281.0 | 261.0 | 247.0 | 230.9 | 232.5 | 245.5 |
| 5 | 305.0 | 285.0 | 295.0 | 284.7 | 268.9 | 268.6 |
| 6 | 335.0 | 313.0 | 314.0 | 315.7 | 316.7 | 297.6 |
| 7 | 351.0 | 326.0 | 339.0 | 333.7 | 351.6 | 329.8 |
| 8 | 355.0 | 347.0 | 359.0 | 350.4 | 360.4 | 355.7 |
| 9 | 395.0 | 364.0 | 360.0 | 366.7 | 379.9 | 368.3 |
| 10 | 363.0 | 362.0 | 376.0 | 368.3 | 382.9 | 405.4 |
| 11 | 396.0 | 358.0 | 380.0 | 370.6 | 392.7 | 381.5 |
| 12 | 396.0 | 355.0 | 425.0 | 350.0 | 390.0 | 400.0 |
| 13 | 396.0 | 400.0 | 425.0 | 350.0 | 390.0 | 400.0 |
| 14 | 396.0 | 420.0 | 425.0 | 450.0 | 390.0 | 400.0 |

Table 4.4 Echo abundance estimate (millions of herring) Jan.1982

        age distribution, mean length and weight at age

| Winter rings | Echo abundance $\times \ 10^{-6}$ | Age distribution % | $\bar{1}$ | $\bar{W}$ |
|:---:|:---:|:---:|:---:|:---:|
| 1 | 5 | 1 | 14.2 | 20 |
| 2 | 23 | 3 | 21.9 | 86 |
| 3 | 99 | 12 | 26.2 | 143 |
| 4 | 206 | 24 | 28.8 | 181 |
| 5 | 54 | 6 | 31.4 | 236 |
| 6 | 157 | 18 | 32.0 | 256 |
| 7 | 205 | 24 | 33.3 | 291 |
| 8 | 30 | 3 | 34.5 | 324 |
| 9 | 10 | 1 | 34.5 | 324 |
| 10 | 57 | 7 | 35.8 | 352 |
| 10+ | 12 | 1 | 36.8 | 390 |

Weight in
tonnes $\times \ 10^{-3}$      204

Table 4.5  Calculated fishing mortality, Icelandic Summer Spawners
1969 - 1981.  M = 0.10, Initial F (4+) = 0.20

| Rings | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|
| 1 | 0.108 | 0.049 | 0.124 | 0.003 | 0.000 | 0.000 | 0.008 |
| 2 | 0.844 | 0.966 | 0.443 | 0.006 | 0.003 | 0.009 | 0.019 |
| 3 | 0.568 | 1.005 | 0.578 | 0.007 | 0.014 | 0.015 | 0.084 |
| 4 | 0.655 | 0.614 | 1.463 | 0.032 | 0.006 | 0.020 | 0.135 |
| 5 | 0.715 | 0.775 | 0.999 | 0.090 | 0.003 | 0.005 | 0.196 |
| 6 | 0.827 | 0.713 | 1.331 | 0.036 | 0.005 | 0.009 | 0.056 |
| 7 | 0.920 | 0.850 | 1.858 | 0.068 | 0.004 | 0.001 | 0.101 |
| 8 | 0.901 | 1.015 | 3.066 | 0.055 | 0.014 | 0.001 | 0.144 |
| 9 | 0.857 | 1.727 | 2.373 | 0.677 | 0.007 | 0.003 | 0.102 |
| 10 | 1.149 | 0.655 | 2.038 | 0.652 | 0.225 | 0.002 | 0.012 |
| 11 | 1.219 | 0.867 | 0.989 | 0.343 | 0.097 | 0.097 | 0.003 |
| 12 | 1.110 | 1.204 | 0.015 | 0.016 | 0.120 | 0.120 | 0.120 |
| 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

| | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|
| AVE 3-13 | 0.693 | 0.915 | 1.212 | 0.025 | 0.011 | 0.015 | 0.098 |
| AVE 4-14 | 0.750 | 0.744 | 1.474 | 0.054 | 0.006 | 0.015 | 0.145 |

| Rings | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|
| 1 | 0.001 | 0.001 | 0.019 | 0.002 | 0.009 | 0.006 |
| 2 | 0.066 | 0.031 | 0.054 | 0.133 | 0.043 | 0.014 |
| 3 | 0.043 | 0.191 | 0.102 | 0.138 | 0.254 | 0.056 |
| 4 | 0.117 | 0.131 | 0.147 | 0.177 | 0.246 | 0.200 |
| 5 | 0.202 | 0.192 | 0.142 | 0.232 | 0.234 | 0.200 |
| 6 | 0.195 | 0.254 | 0.228 | 0.168 | 0.237 | 0.200 |
| 7 | 0.085 | 0.250 | 0.432 | 0.206 | 0.280 | 0.200 |
| 8 | 0.133 | 0.132 | 0.470 | 0.289 | 0.219 | 0.200 |
| 9 | 0.170 | 0.194 | 0.204 | 0.217 | 0.258 | 0.200 |
| 10 | 0.161 | 0.269 | 0.555 | 0.080 | 0.247 | 0.200 |
| 11 | 0.371 | 0.037 | 0.484 | 0.492 | 0.144 | 0.200 |
| 12 | 0.003 | 1.034 | 0.028 | 0.057 | 0.002 | 0.200 |
| 13 | 0.152 | 0.003 | 0.520 | 0.102 | 0.261 | 0.200 |
| 14 | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 |

AVERAGE WEIGHTED BY STOCK IN NUMBERS

| | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|
| AVE 3-13 | 0.114 | 0.188 | 0.152 | 0.173 | 0.240 | 0.154 |
| AVE 4-14 | 0.131 | 0.186 | 0.216 | 0.190 | 0.238 | 0.200 |

Table 4.6  Stock in numbers, millions, Icelandic Summer Spawners
          1969 - 1981.  M = 0.10, Initial F (4+) = 0.20

| Rings | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|
| 1 | 46.312 | 44.331 | 79.056 | 71.917 | 494.879 | 123.829 | 185.555 |
| 2 | 143.544 | 37.611 | 38.209 | 63.199 | 64.906 | 448.402 | 112.031 |
| 3 | 19.980 | 55.845 | 12.954 | 22.190 | 56.819 | 58.566 | 402.230 |
| 4 | 11.264 | 10.249 | 18.499 | 6.574 | 19.929 | 50.714 | 52.219 |
| 5 | 20.474 | 5.295 | 5.016 | 3.876 | 5.763 | 17.925 | 44.964 |
| 6 | 5.271 | 9.059 | 2.208 | 1.672 | 3.207 | 5.198 | 16.134 |
| 7 | 2.408 | 2.086 | 4.020 | 0.528 | 1.460 | 2.888 | 4.660 |
| 8 | 2.071 | 0.868 | 0.806 | 0.567 | 0.446 | 1.315 | 2.611 |
| 9 | 1.104 | 0.761 | 0.285 | 0.034 | 0.486 | 0.398 | 1.189 |
| 10 | 0.646 | 0.424 | 0.123 | 0.024 | 0.016 | 0.437 | 0.359 |
| 11 | 0.422 | 0.185 | 0.199 | 0.014 | 0.011 | 0.011 | 0.394 |
| 12 | 0.216 | 0.113 | 0.071 | 0.067 | 0.009 | 0.009 | 0.009 |
| 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 |
| Adult stock weight 3-14 | 16.9 | 21.1 | 12.3 | 10.9 | 24.3 | 40.2 | 135.4 |

| Rings | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
|---|---|---|---|---|---|---|
| 1 | 688.828 | 493.252 | 142.014 | 412.559 | 389.460 | 428.830 |
| 2 | 166.505 | 622.678 | 445.665 | 126.021 | 372.425 | 349.319 |
| 3 | 99.490 | 141.027 | 546.058 | 382.043 | 99.847 | 322.947 |
| 4 | 334.635 | 86.199 | 105.393 | 446.147 | 301.012 | 70.069 |
| 5 | 41.298 | 269.408 | 68.422 | 82.350 | 338.210 | 213.053 |
| 6 | 33.444 | 30.520 | 201.134 | 53.698 | 59.073 | 242.210 |
| 7 | 13.807 | 24.906 | 21.425 | 144.901 | 41.073 | 42.179 |
| 8 | 3.811 | 11.471 | 17.553 | 12.585 | 106.667 | 28.098 |
| 9 | 2.047 | 3.020 | 9.095 | 9.927 | 8.527 | 77.523 |
| 10 | 0.971 | 1.562 | 2.250 | 6.712 | 7.228 | 5.961 |
| 11 | 0.321 | 0.748 | 1.081 | 1.169 | 5.608 | 5.110 |
| 12 | 0.356 | 0.201 | 0.652 | 0.603 | 0.647 | 4.393 |
| 13 | 0.007 | 0.321 | 0.065 | 0.574 | 0.515 | 0.585 |
| 14 | 0.006 | 0.006 | 0.289 | 0.035 | 0.469 | 0.359 |
| Adult stock weight 3-14 | 149.6 | 153.7 | 234.9 | 272.8 | 261.5 | 267.0 |

Table 5.1   The monthly catch, from the Icelandic capelin stock in weight and numbers by nations, August 1981 - March 1982

| Month | Catch in tons x $10^{-3}$ | | | | | Catch in numbers x $10^{-9}$ | | | | |
|-------|---------|--------|--------|------|-------|------|------|------|------|-------|
|       | Iceland | Norway | Faroes | EEC  | Total | 1980 | 1979 | 1978 | 1977 | Total |
| August    | 31.4  | 91.4 | 9.7 | 12.4 | 144.9 | +   | 6.4  | 0.8 | +   | 7.2  |
| September | 66.4  | -    | 6.5 | 8.4  | 81.3  | 0.1 | 4.2  | 0.3 | +   | 4.6  |
| October   | 151.3 | -    | -   | -    | 151.3 | +   | 7.7  | 0.2 | +   | 7.9  |
| November  | 187.4 | -    | -   | -    | 187.4 | 0.2 | 8.4  | 0.5 | -   | 9.1  |
| December  | 48.1  | -    | -   | -    | 48.1  | 0.1 | 2.5  | 0.1 | +   | 2.7  |
| Jan/March | 13.0  | -    | -   | -    | 13.0  | +   | 0.6  | +   | -   | 0.6  |
| Total     | 497.6 | 91.4 | 16.2 | 20.8 | 626.0 | 0.4 | 29.8 | 1.9 | +   | 32.1 |

Table 5.2

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 5.3

Stock abundance in number and weight by yearclasses and maturity, November 3-13, 1981.

Yearclasses

| 1980 imm. | | 1979 imm. | | 1979 mat. | | 1978 mat. | | Tot mat. | |
|---|---|---|---|---|---|---|---|---|---|
| $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ |
| 2.7 | 13.8 | 1.4 | 17.8 | 16.6 | 316.9 | 0.3 | 7.5 | 16.9 | 324.4 |

Table 5.4

Stock abundance in number and weight by yearclasses and maturity, November 26-29 1981.

Yearclasses

| 1980 imm. | | 1979 imm. | | 1979 mat. | | 1978 mat. | | Tot. mat. | |
|---|---|---|---|---|---|---|---|---|---|
| $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ |
| 21.0 | 76.0 | 1.1 | 13.5 | 11.9 | 230.4 | 0.6 | 13.5 | 12.5 | 243.9 |

Table 5.5

Stock abundance in number and weight by yearclasses and maturity, January 11-22, 1982.

Yearclasses

| 1980 imm. | | 1979 imm. | | 1979 mat. | | 1978 mat. | | Total mat. | |
|---|---|---|---|---|---|---|---|---|---|
| $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ |
| 1.8 | 12.6 | 1.6 | 18.7 | 6.9 | 135.5 | 0.5 | 12.7 | 7.4 | 158.2 |

Table 5.6

Stock abundance in number and weight by yearclasses and maturity, February 1982.

Yearclasses

| Area | 1980 imm. | | 1979 imm. | | 1979 mat. | | 1978 mat. | | Total mat. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ |
| NE-Icel. | | | 0.2 | 3.2 | 0.9 | 16.3 | + | 0.8 | 0.9 | 17.1 |
| E-Icel. | 2.3 | 16.0 | 4.1 | 50.4 | 1.2 | 20.9 | 0.2 | 2.7 | 1.4 | 23.6 |

Table 5.7

Spawning stock abundance in number and weight, Jan.-Febr. 1982.

Yearclasses

| 1979 | | 1978 | | Total | |
|------|------|------|------|------|------|
| $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ | $Nx10^{-9}$ | $Tx10^{-3}$ |
| 8.4 | 160.9 | 0.6 | 14.8 | 9.0 | 175.7 |

Table 5.8

The total catch from the Icelandic capelin stock in weight and numbers during periods between successive acoustic abundance estimates in 1981-1982.

| Period | Catch in numbers and weight | | Catch in numbers by yearclasses | | | |
|--------|------|------|------|------|------|------|
| | $Tx10^{-3}$ | $Nx10^{-9}$ | 1980 | 1979 | 1978 | 1977 |
| August-Oct. 23 | 358.0 | 17.7 | 0.1 | 17.3 | 1.3 | + |
| Oct. 24-Nov. 12 | 124.2 | 6.1 | 0.1 | 5.7 | 0.3 | - |
| Nov. 12-Nov. 29 | 76.6 | 3.7 | 0.1 | 3.4 | 0.2 | - |
| Nov. 30-Jan 22 | 54.2 | 3.0 | 0.1 | 2.8 | 0.1 | - |
| Total | 613.0 | 31.5 | 0.4 | 29.2 | 1.9 | + |
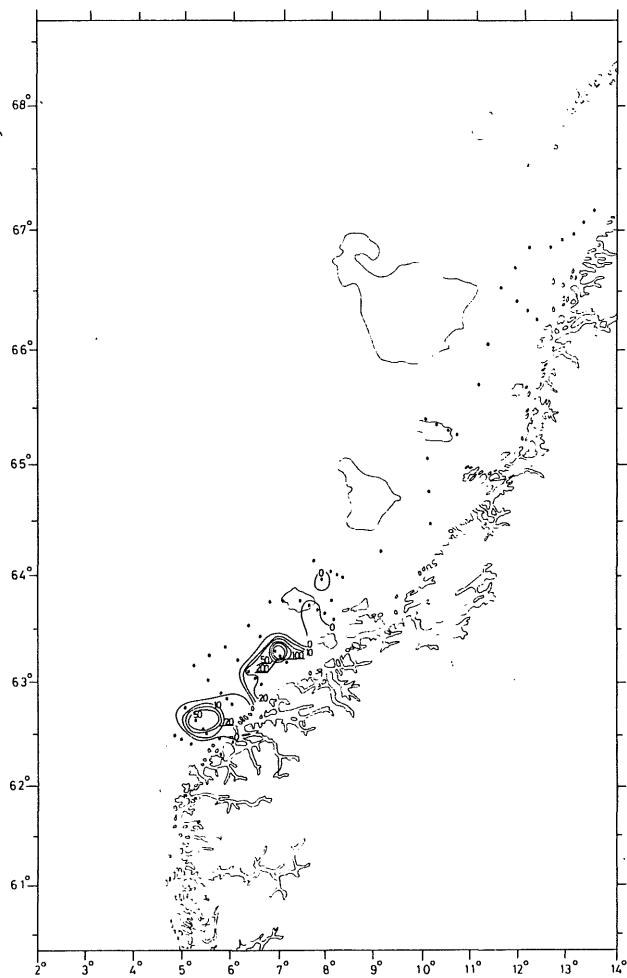
Figure 1. Distribution of herring larvae 4.4.-6.4 1982.
Density in no per. $m^2$ surface.
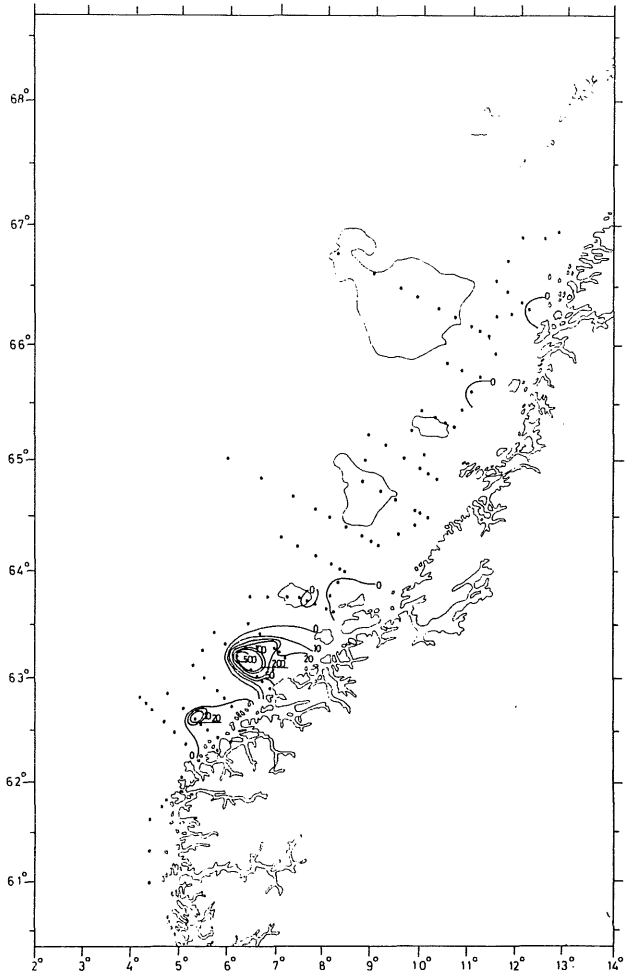
Figure 2. Distribution of herring larvae 17.4.-
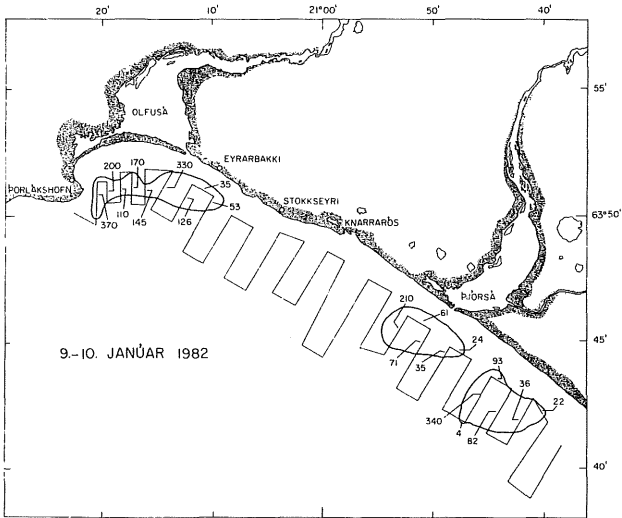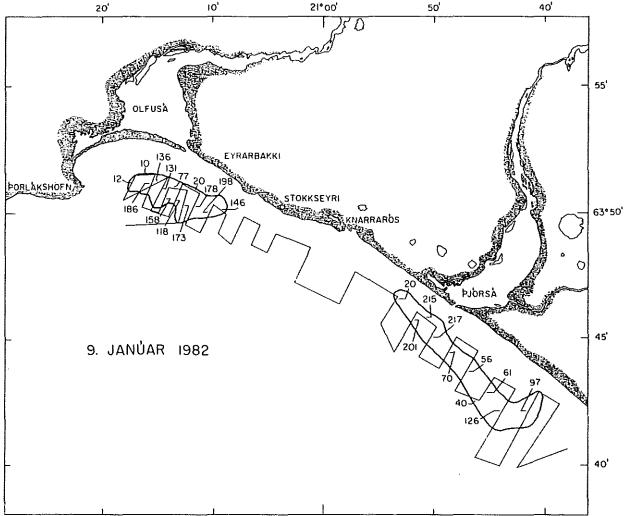24.4. 1982. Density in no per. m$^2$
surface.

Figure 3. The wintering concentrations in January 1982. Echo intensities and distribution are shown on two successive nights.
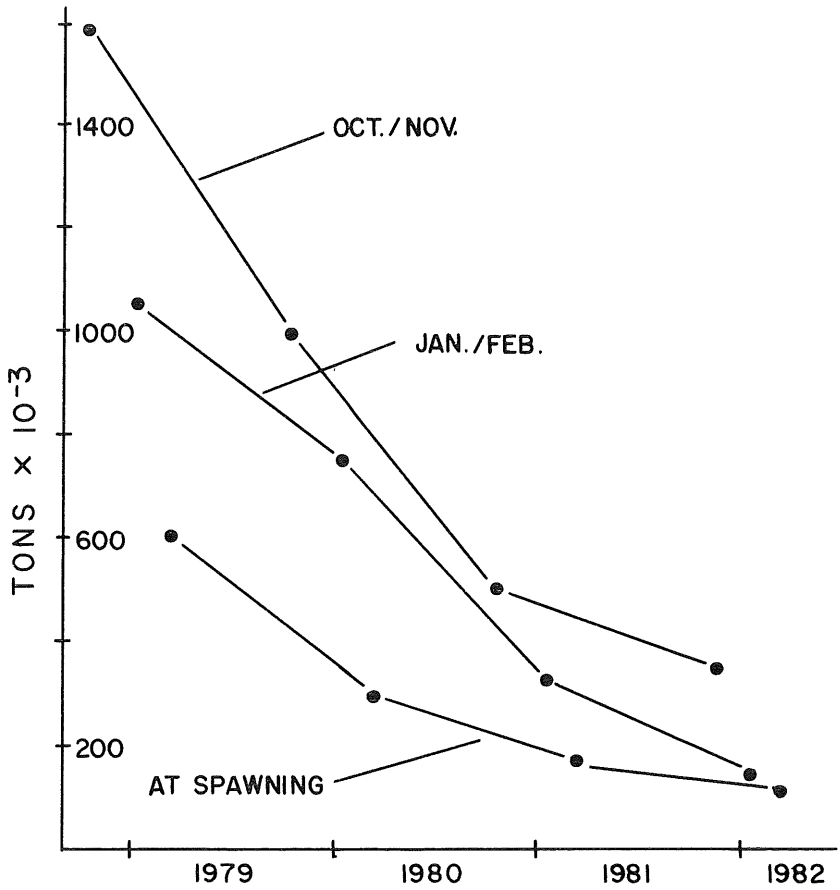
Figure 4. Acoustic abundance estimates of the 1979-1982 spawning stock of the Icelandic capelin, autumn 1978 - winter 1982.
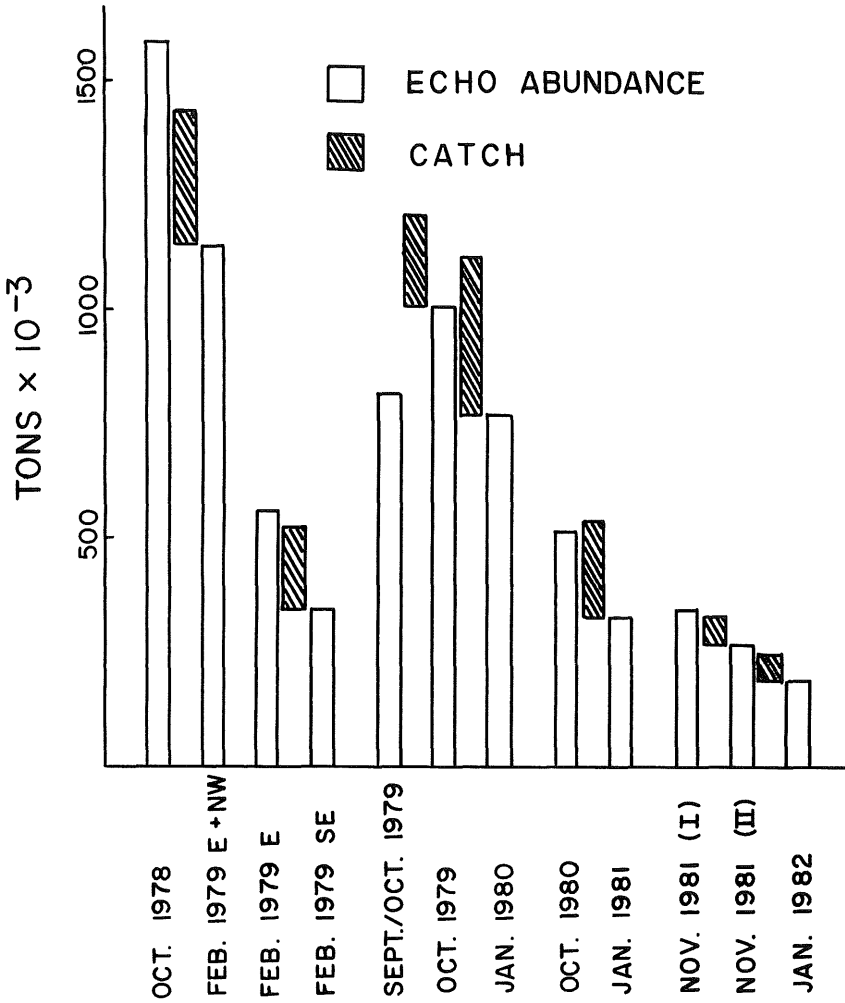
Figure 5. Successive acoustic abundance estimates of the Icelandic capelin stock and the catch during intervening periods, October 1978 - January 1982.
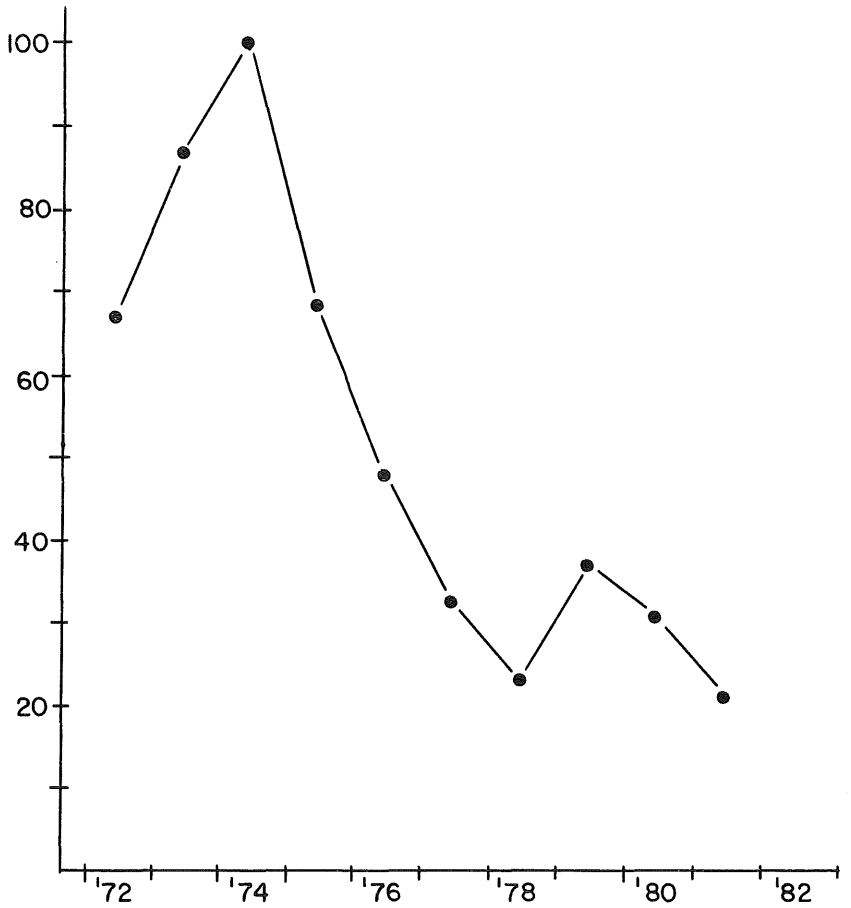
Figure 6.   Relative abundance of 0-group capelin 1972-1981.

THE SEASONAL CATCH OF CAPELIN
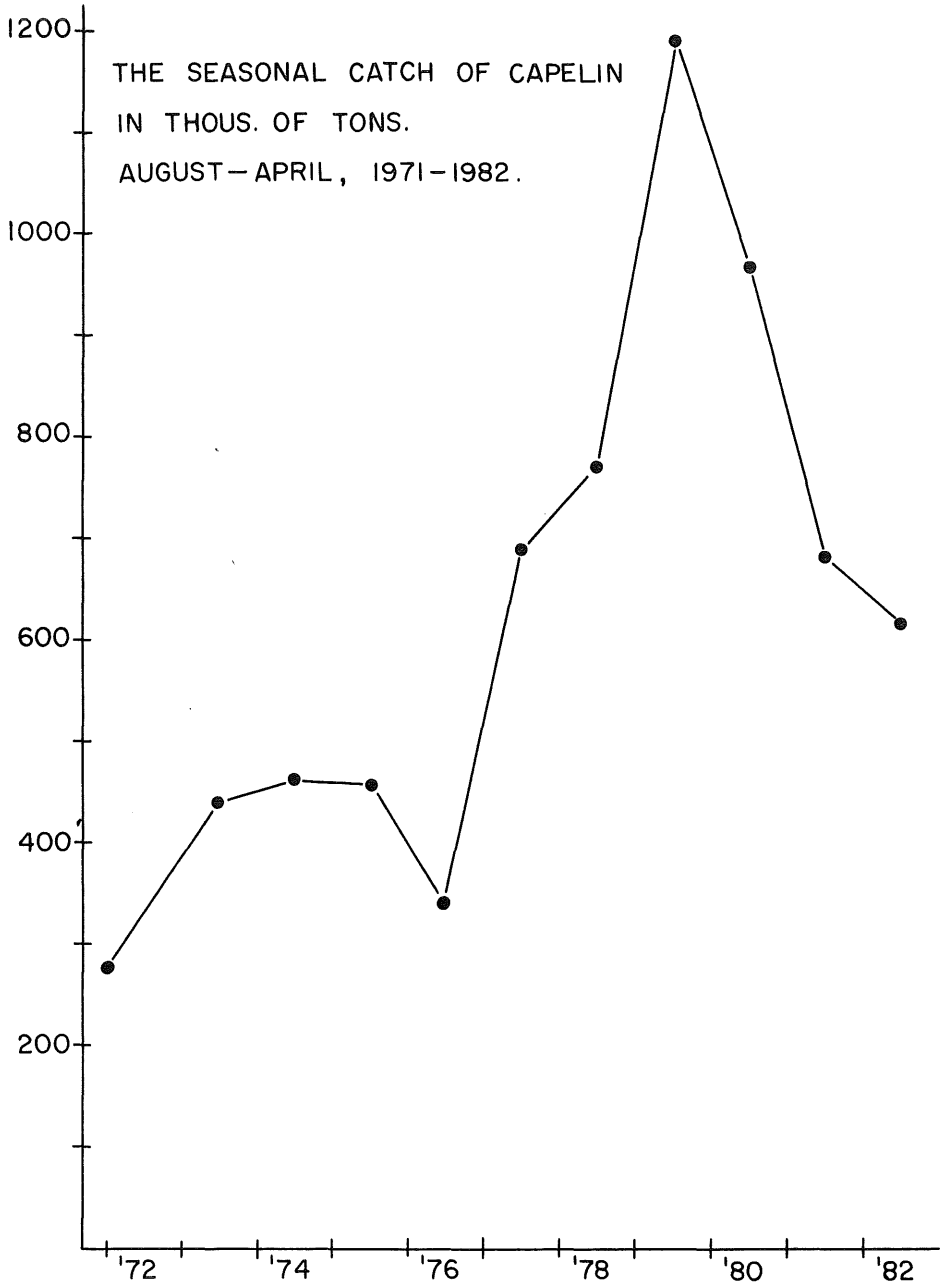IN THOUS. OF TONS.
AUGUST−APRIL, 1971−1982.

Figure 7. Seasonal catch of Capelin (in '000 tonnes)
August-April, 1971-82.

Figure 8. Seasonal catch of Capelin, spawning stock based on acoustic estimates, and 0-group indices for the Icelandic capelin 1972-82.

———————— Seasonal catch August-April ('000 tonnes)

·············· Spawning stock based on acoustic estimates ('000 tonnes)

— — — — 0-group index