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International Council, for the Exploration of the Sea


# report of the atlanto-scandian herring and capelin working group 

Copenhagen, 16-20 October 1989

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## 1 INTRODUCTION AND PARTICIPATION

### 1.1 Terms of Reference

The Atlanto-Scandian Herring and Capelin Working Group met at ICES Headquarters 16-20 October 1989.

The terms of reference are given in C.Res 1988/2:4:25: "The Atlanto-Scandian Herring and Capelin Working Group (Chairman: Dr V.N. Shleinik) will meet at ICES Headquarters from 16-20 October 1989 to assess the status of the Norwegian spring-spawning herring, Icelandic summer-spawning herring and capelin stocks in Sub-areas I, II, V and XIV and provide catch options within safe biological limits for the herring for 1990 and for the capelin for the winter $1989 / 1990$ and summer-autumn 1990 seasons".

### 1.2 Participants

| J. Carscadden | Canada |
| :--- | :--- |
| J.A. Jacobsen | Faroe Islands |
| A. Dommasnes | Norway |
| P. Kanneworff | Greenland |
| A. Krysov | USSR |
| V. Shleinik (Chairman) | USSR |
| G. Stefansson | Iceland |
| R. Toresen | Norway |

## 2 THE ICELANDIC SUMMER-SPAWNING HERRING

### 2.1 Working Paper presented

The following working paper was presented: "The Icelandic sum-mer-spawning herring" by Jakob Jakobsson.

### 2.2 The Fishery in 1988

The landings of the summer-spawning herring from 1969 to 1988 are given in Table 2.1. The 1988 landings amounted to about 93000 t . All the herring were caught in the purse-fishery which started on 8 th october and finished by 20th December. About 83,000 $t$ were taken in the fjords at east Iceland while about $10,000 t$ were caught in near shore areas of southeast Iceland. The text table below gives the landings and the TACs recommended during the last few years for this fishery:

| Year | Landings | TACs | Recommended TACs |
| :--- | :---: | :---: | :---: |
| 1984 | 50.3 | 50.0 | 50.0 |
| 1985 | 49.3 | 50.0 | 50.0 |
| 1986 | 65.5 | 65.0 | 65.0 |
| 1987 | 75.4 | 72.9 | 70.0 |
| 1988 | 92.8 | 90.0 | $100.0^{1}$ |
| Recommended by ACFM. Weights in '000 t. |  |  |  |

### 2.3 Catch in Number and Weight at Age

The catches in numbers at age for the Icelandic summer spawners for the period 1970-1988 are given in Table 2.1. In the first years after the fishery was re-opened in 1975 the 1971 year class was most abundant. During the period 1979-1982 the 1974 and 1975 year classes predominated in the catches. During the period 19831986 the fishery was dominated by the very strong 1979 year class. In 1987 and 1988 the fishery was on the other hand based on a number of year classes ranging from three to eleven ring herring. The weights at age for each year are given in Table 2.2 .

### 2.4 Acoustic Surveys

The Icelandic summer-spawning herring stock has been monitored by acoustic surveys annually since 1973. Such a survey was carried out in November-December 1988.

During the period 6-19 November, the distribution and abundance of immature small herring was investigated in the fjords and bays of west and north Iceland. The main concentration of this component of the stock was located in Eyjafjordur on the north coast. During the the period 20-26 November, the distribution and the abundance of the mature component of the stock was investigated in the east coast fjords as well as in the coastal areas off southeast Iceland. The concentrations in east coast fjords were lower in abundance in 1988 than in 1987. On the other hand, a large herring overwintering school was located off southwestern Iceland. At the end of November and beginning of December the area south and south-west of Iceland was surveyed. Good concentrations of one and two ringers were located south-west of Reykjanes. Due to bad weather for a long period this area could not be investigated properly. It should be noted that in 1987 considerable concentrations of the 1983 and 1984 year classes (three and two ringers respectively) were located in this area and prior to the 1988 survey fishermen reported that a component of these two year classes could be found in the south.

### 2.5 Stock Assessment

Results of the November-December acoustic survey together with the catch in numbers by age were used to calculate an exploitation pattern for the 1988 season. The results are given in Table 2.4. Usually it is considered that the Icelandic summerspawning herring is fully recruited as four ringers. In 1987 and 1988 it became clear however that the fishery was concentrated on the older component of the stock, that is 6 ring and older herring which were concentrated in the east coast fjords. Large quantities of younger age groups were located off the south-east coasts of Iceland in 1988 where fishing was only very limited.

Using this exploitation pattern a series of VPAs was run using a range of terminal Fs. The best one to one relation between the 12 acoustic estimates and virtual population analysis was obtained
with an input of $F=0.53$ on the older herring. According to this assessment the spawning stock has increased from $250,000 t$ in 1983 to about $300,000 \mathrm{t}$ in 1985. It is estimated that in 1989 the spawning stock was just less than $400,000 \mathrm{t}$ which is about $20 \%$ lower than was obtained according to the assessment made in 1988. The results of the VPA are given in Tables 2.5 and 2.6 , and Figures 2.1.A and 2.1.B.

## 2. 6 Catch and Stock Projections

Catches were calculated over a range of Fs for 1989 using the parameters given in Table 2.4. The stock in numbers data are derived from Table 2.6. Weight at age in the catch are obtained by using the relation:

$$
w_{i+1}-w_{i}=-0.186 w_{i}+80.415(g)
$$

where $W_{i}$ and $W_{i+1}$ are the mean weight of the same year class in year $i$ and $i+1$, $\frac{1}{r}+$ espectively, for the period 1978-1987. This relation was used to calculate the weight at age in the catch in 1988 for 1 to 8 -ringed herring. For older herring the mean weight at age from 1985-87 was used.

Projections of spawning stocks biomass and catches ('000 t) based on the input data shown in Table 2.7 for a range of values of Fs are given in the text table below:

| 1989 |  | 1990 |  |  | 1991 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Catch | $\mathrm{F}_{4+}$ | SSB at 1 July | $\mathrm{F}_{4+}$ | Catch | SSB | at 1 | July |
| 90 | 0.26 | 430 | 0.22 | 80 |  | 560 |  |
|  |  |  | 0.26 | 90 |  | 450 |  |
|  |  |  | 0.30 | 100 |  | 430 |  |

Weights in '000 t.
The details of the status quo prediction are given in Table 2.8 and Figure 2.1.D.

During the period 1982-1985 the fishing mortality varied from 0.192 to 0.319 (average, weighted by stock numbers, 4-14 rings) and was on average 0.217 or very close to the target level of fishing mortality for this stock which is $F_{0}=0.22$. During the period 1986 to 1988 the fishing mortality appears to have been somewhat higher.

### 2.7 Manaqement Considerations

Based on this assessment it is estimated that the spawning stock in 1989 was $385,000 t$ which is over $20 \%$ lower than what was expected according to the 1988 assessment. Similarly it is shown in the present projection of spawning stock and catches that fishing at $\mathrm{F}_{\mathrm{O}}, 1$ would lead to a catch of $76,000 \mathrm{t}$ in 1989 and a spawning stock of $450,000 \mathrm{t}$ in 1990. This is $20,000 \mathrm{t}$ less catch than had been predicted in the 1988 assessment. The catch of $90,000 t$
during 1989 season would result in fishing mortality of 0.26 which is somewhat above $F_{0}$. Despite this the spawning stock would increase from 385 ,0do t to 430,000 t in 1990. Taking into account that the herring stock has probably been underestimated during the 1988 acoustic survey and that the spawning stock is increasing, a TAC for the 1989 season has been set at 90,000 t. Fishing at the present fishing mortality ( 0.26 ) would result in a catch of $90,000 \mathrm{t}$ in 1990. Assuming a catch of $90,000 \mathrm{t}$ in 1989, fishing at $F_{0.1}$ in 1990 would yield a catch of $80,000 t$.
Advice on the TAC for 1990 should be deferred until after the acoustic survey in November-December 1989.

## 3 NORWEGIAN SPRING-SPAWNING HERRING

### 3.1 Working Papers Presented

The following working papers were presented: "Soviet investigations and fishery of Atlanto-Scandian herring in the Norwegian Sea in 1989" by A.I Kryssov and E.I. Seliverstova, "Norwegian spring spawning herring" by R. Toresen, and "Reappearance of Norwegian spring spawning herring on spawning grounds south of $60^{\circ} \mathrm{N}^{\prime \prime}$ by I. R $\phi$ ttingen.

### 3.2 Catch Statistics

The total annual catches of Norwegian spring-spawning herring during the period 1972-1989 in terms of weight and numbers are presented in Tables 3.1, 3.2 and 3.3. The estimated unreported catches have been converted to catch in numbers using Norwegian data on catch at age in the adult fisheries. Norwegian data have been applied to convert the USSR catch of 20,225 in the winter of 1988 to catch in numbers.

### 3.3 Recruitment

The nursery areas of herring recruits are the fjords, the area off the Norwegian west coast, and, in some years, the southern part of the Barents Sea. The recruitment has, therefore, been assessed in two components, one coastal and one from the Barents Sea.

### 3.3.1 Acoustic 0-qroup estimates in Norwegian coastal areas

An acoustic survey of 0 -group herring distributed in the coastal areas of Norway has been conducted in November-December each year since 1975. The results are presented in Table 3.4.

### 3.3.2 The 0-group index in the Barents Sea

Indices of 0 -group Norwegian spring-spawning herring have been estimated for the period 1965-1989 based on data from the international o-group surveys in the Barents sea (Toresen, 1985; Anon., 1989a) (Table 3.5).

### 3.3.3 Acoustic 0-group estimates in the Barents Sea

The acoustic estimates of 0 -group herring in the Barents sea for the last six years are shown in the text table below:

| Year <br> class | Estimated number <br> (billions) | Time of <br> survey |
| :--- | :---: | :--- |
| 1983 | 35.7 | Nov 1983 |
| 1984 | 6.2 | Nov 1984 |
| 1985 | 41.5 | Sep 1985 |
| 1986 | - | Sep 1986 |
| 1987 | - | Sep 1987 |
| 1988 | 4.9 | Nov 1988 |

The Barents Sea components of the 1984 and 1985 year classes are completely depleted, most probably due to predation by cod (Mehl, 1987). In 1986 and 1987, no 0-group herring were detected in the Barents Sea. In November 1988, 0-group herring were found in the area between 34 and $41^{1} \mathrm{E}$ and to the south of $71^{\circ} 30^{\prime} \mathrm{N}$ and an acoustic estimate was obtained. In 1989, no special survey will be conducted on O-group herring in the Barents Sea.

### 3.4 The Adult Stock

As in 1988, the adult stock is assessed as one unit.

### 3.4.1 Acoustic estimates

In February-March 1989, an acoustic survey was carried out along the Norwegian coast to cover the spawning grounds. The conditions for measuring the biomass were favourable during the survey as the herring were not mixed with other species and were distributed in a medium-density layer at $20-100 \mathrm{~m}$ depth when measured at night.

The distribution area of spawning herring delineated during this survey was somewhat larger than in 1988 and is, therefore, the largest since investigations started on the spawning grounds in 1982.

Another acoustic survey was carried out in August 1989. During this period, the herring were distributed in the Lofoten area, in northern Norway. The conditions for measuring the biomass were not as favourable as in February-March because the herring were concentrated in dense schools, and often close to the bottom. The estimate of the total abundance from this survey therefore must be regarded as being too low.

In the text table below, the results from both these surveys are presented, together with the prognosis for the stock (millions) at 1 January 1989 as estimated by the Atlanto-Scandian Herring and Capelin Working Group in 1988, but adjusted at this meeting by the total catch in 1988:

| Year class | 1985 | 1984 | 1983 | $1982+$ | Total |
| :--- | ---: | ---: | ---: | ---: | ---: |
| Prognosis Jan (adjusted) | 214 | 122 | 5,634 | 184 | 6,154 |
| Acoustic estimate (Mar) | 373 | 103 | 5,402 | 182 | 6,060 |
| Acoustic estimate (Aug) | 221 | 133 | 3,923 | 83 | 4,360 |

There is quite a good agreement between the prognosis and the acoustic estimate from February-March.

The year classes $1982+$ are scarce, representing only about $10 \%$ by number of the spawning stock during the spring survey. This observation supports the indications from the survey made last year that these old year classes are less abundant than earlier prognoses stated. The working Group in 1988 (Anon., 1989d) explained this feature as the effect of unreported additional mortality in the fishery through the years 1985-1987.

The 1983 year class estimate from March, representing approximately $90 \%$ of the spawning stock by number, is close to the 1988 prognosis estimate. However, when adjusted for the catch of $20,000 \mathrm{t}$ in January and February in 1989 and by an annual natural mortality of 0.13 for two months, some 14,300 t are still "missing" from the 1983 year class in the acoustic estimate from March. The August estimate gave a much lower number indicating an underestimate for this year class in the Lofoten area.

The 1984 year class was measured as weaker in February-March than the prognosis predicted. This may be explained by the fact that the young, recruiting year classes do not mix well with the older fish in the spawning stock. On the contrary, they tend to concentrate in certain areas, often close to the shore. This may lead to an underestimate if the survey does not cover the area adequately.

The 1985 year class was measured as weaker in February-March than the prognosis states. This year class was concentrated in a certain area, and the sampling in this area was rather poor. This might have led to an overestimation of this year class by letting a few samples represent a large echo amount. However, the samples were judged as being representative for the age composition in the area and this estimate must be regarded as the best available. The calculated amount in August is lower, but more in agreement with the prognosis. However, due to the overall undexestimation during this survey, the spring estimate of the 1985 year class is regarded as the best one.

The discrepancy between the prognosis and the acoustic estimates of the young recruits might be explained by the uncertainty in establishing the abundance of year classes not yet fully recruited to the spawning stock. It is not clear in what proportion the different year classes mature to spawn for the first time as this is very much dependent on the growth conditions of the young herring. However, at six years, even the slowest growing herring in this stock should reach the maturing size (approx. 30 cm ), and at that time the relative strength of each year class in the spawning stock is set. In addition, the first spawners do not mix well with the spawning stock, leading to difficulties in estab-
lishing the relative amount of these year classes while surveying the spawning grounds. Therefore, the variation in the acoustic estimates of the youngest year classes in the spawning stock is high.

### 3.4.2 The state of the stock and VPA

The Working Group accepted the estimates of the different year classes from the February-March survey, except for the 1984 year class. For this year class, the Working Group accepted the August estimate which is somewhat higher than the spring estimate, indicating a better coverage in the last survey. Furthermore, the Working Group pointed to the higher probability of underestimating the youngest age groups in the spawning stock due to concentration in certain areas, often close to shore.

The Working Group adjusted the catches for the "missing" 14,300 t of the 1983 year class, adding a number of 61,111 thousand individuals. This is included in Table 3.3.

Other input data in the VPA were: Catch in number per year class (Table 3.3); Weight at age in the stock (Table 3.6); Proportions of maturity (Table 3.8); Natural mortality M (age 3 and older) 0.13 .

The Working Group also decided to reduce the number of age groups in the VPA run from 14 to 10 so that the age group 12 includes this and older age groups. This was done to avoid presenting the uncertain figures of the different year classes older than 12 years. The fishing mortalities of the oldest true age group (11 years) were obtained by initially running a VPA calculating the average Fs for the age groups 11-16 years.

The fishing mortalities for the different age groups in 1988 were tuned so that the number in age groups 4 to 6 in January 1989 corresponded to the back-calculated number from the acoustic surveys in 1989 as accepted by the Working Group. The Fs of the age groups 6+ in 1988 (year classes $1982+$ ) were set to the constant value which gave a sum corresponding to the 1989 acoustic estimate ( 186 million).

The results of the VPA are given in Tables 3.9 and 3.10 and Figures 3.1A and 3.B.

The estimated average Fs for the age groups 4-9 weighted and unweighted illustrate the uneven fishing pressure on the different age groups in this stock. The 1983 year class is dominating the spawning stock, but is not exploited at the same level as the other year classes in the spawning stock. This may be explained by the prices set on the different size groups of herring in Norway leading the fishermen to avoid the younger year classes (including the 1983 year class) and to target the older and bigger herring. The weighted mean $F$ values, however, reflect the current fishing pressure on the adult stock quite well, which is also illustrated below in the results from the prognosis.

### 3.5 Catch and Stock Prognosis

The input data (Table 3.11) refer to the stock size on 1 January 1989. The estimate of the 1988 year class as 1 -year olds was taken from the o-group acoustic estimate in Norwegian coastal waters and the acoustic estimate of the 0-group in the Barents Sea, both in November 1988. The total number ( 6.17 billion individuals) was reduced by an annual natural mortality of 0.9 for two months. The number of 2-and 3-year olds (1987 and 1986 year classes) were derived from the prognosis made last year. These numbers were applied because no new estimate of these year classes exists although it is known that they are very weak. For age groups 4 and older, the acoustic estimate in February-March 1989 was used (except for the 5 -year olds where the acoustic estimate in August was used). The stock size on 1 January 1989 was estimated by adjusting these estimates by the catch in the winter of 1989 and by natural mortality.

The fishing pattern level was obtained as follows. As separable VPA is not appropriate for this stock (Anon., 1989d), the current fishing mortality estimates for the year 1988 were applied, except for the age group 5 which was scaled to 0.19 by averaging the observed mortality for the 4 - and 6 -year-olds. Future fishing mortality is assumed to be constant on ages 6-12.

### 3.6 Results of Prognosis

The results of the prognosis two years ahead are given in Tables 3.12 and 3.13 and Figure 3.1D.

The 1983 year class was fully recruited to the spawning stock in 1989, resulting in a spawning stock biomass of about 1.5 million $t$ in both 1989 and 1990. There is very weak recruitment from the year classes following the 1983 year classes, and consequently the spawning stock will make up almost $85 \%$ of the total stock by 1990. The poor recruitment will lead to a decrease in spawning stock size after 1990, whether any fishing takes place or not, since losses due to natural mortality will outweigh growth. This poor recruitment will continue at least until the 1988/1989 year classes recruit in the mid~1990s. However, these year classes are strong as 0 - and 1 -year olds, but it is too early to predict their strength when recruiting to the spawning stock. Thus, $a$ strong year class is needed to increase the spawning stock or even keep it at the present level if exploitation of the stock continues.

A long-term prediction for the next 5 years is illustrated in Figure 3.2. It was run based on the same recruitment as assumed for the 1989 year class and with varying levels of TAC.

### 3.7 Yield per Recruit

For yield-per-recruit computations, the Working Group used average catch and stock weights for the years 1984-1988 and recruitment at age 3. Otherwise the same values as in the catch and stock prognosis were used. As the fishing pattern of the oldest fish is not well known, the reference $F$ in this year's work was
based on the unweighted average of the fishing mortalities of ages 4-9.

### 3.8 Management Considerations

The Norwegian spring-spawning herring is a depleted stock (Category 1) according to the criteria used by ACFM (Anon., 1989C).

The preferred level of the spawning stock, 2.5 million $t$, will not be reached in the near future, even without any fishing. The Working Group has no reason to assume that the problems concerning the additional mortality in the fisheries will be solved even if the control now is somewhat better than in previous years. The Working Group also noted the overfishing of the quota in the Norwegian fishery in 1988. The Working Group recommends that overfishing of the quota, unreported catches, and additional mortality be taken into account and consequently that the utmost caution be exercised in the recommendation for the coming year.

### 3.9 NEAFC Request

The Working Group considered the NEAFC request to "summarize all information on the present spatial and temporal distribution of the Atlanto-Scandian herring stock"

Information about the distribution of Norwegian spring spawning herring at different times of the year is scattered and derives mainly from Norwegian sources, but some information from Soviet sources is also available.

The herring presently spawns along the Norwegian coast from Sklinna in the north to Stadt in the south in February to March. In 1989 some spawning was also observed at Karm $\phi$ y.

The larvae drift northwards with the coastal current and into the fjords. In some years large parts of the larval population also drift into the Barents Sea.

When the herring are 2-3 years old, at least part of the year classes congregate in the Vesteralen and Møre coastal areas of the Norwegian coast. Recruitment to the spawning stock takes place at $3-6$ years of age.

The adult herring at present have their feeding areas west of the Lofoten-Vesteralen area, mainly within 200 nautical miles off the coast. They are present in this area in early June. (In July 1988, some herring were observed west of $0^{0}$ by a Soviet research vessel but this has not been observed previously). By the middle of August they have congregated close to the coast in the vester-dlen-Lofoten area, and gradually move into Vestfjorden and the connecting fjord systems. They stay in deep water in this area until the middle of January, when they start migrating south to the spawning areas.

The distribution pattern in the period $1986-1989$ has been summarized in Figure 3.3.

## 4 BARENTS SEA CAPELIN

### 4.1 Working Papers Presented

The following working papers were presented: "Barents Sea Capelin" by A. Dommasnes, and "Soviet Investigations of Capelin in Spring 1989" by N.G. Ushakov and E.A. Shamrai.

### 4.2 Requlation of the Barents Sea Capelin Fishery

Since 1979, the Barents Sea capelin fishery has been regulated by a bilateral fishery management agreement between the USSR and Norway. A TAC has been set separately for the winter fishery and for the autumn fishery. The fishery was closed from 1 May to 15 August until 1984. During the period 1984-1986, the fishery was closed from 1 May to 1 September. Since May 1986, there has been no fishing.

### 4.3 Catch Statistics

The international catch by country in the years 1965-1989 is given in Table 4.1.

### 4.4 Stock Size Estimates

### 4.4.1 Larval and 0-group surveys

Larval surveys based on Gulf III plankton samples have been conducted in June each year since 1981. The calculated numbers by year are shown in Table 4.2. From 1981 to 1985, the index was almost constant, in the range 8.2-9.9. In 1986, no larvae were caught in the Norwegian larval survey, although some spawning is known to have taken place in the Varangerfjord area. In 1987 and 1988 the index was only 0.3, but in 1989 it was 7.3 - almost at the same level as in the period 1981-1985.

During the international o-group survey in the Barents sea in August 1989 (Anon., 1989a), o-group capelin were obseryed over the whole of the Barents Sea north to approximately $76 \mathrm{~N}^{\mathrm{N}}$, and along the western side of Spitsbergen (Figure 4.1). Judging from the distribution area in August 1989, the strength of the 1989 year class is at about the same level as the year classes of 1983 and 1984. This confirms the impression gained from the larval index in June.

### 4.4.2 Acoustic stock estimates

The 1989 acoustic survey was carried out jointly by three Soviet and three Norwegian vessels during the period 12 september - 3 October (Anon., 1989b). The distribution of capelin is shown in Figure 4.2. Table 4.3 gives the estimate as numbers by age and length, and as biomass. The results are summarized in the table below. (The estimates of the same age groups in 1988 are shown in parentheses).

| Year | class | Number <br> (billions) | Mean weight (g) |  | $\begin{gathered} \text { Biomass } \\ \text { ('000 tonnes) } \end{gathered}$ |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1988 | (1987) | 177.8 (20.0) | 3.4 | (3.5) | 608.3 | (69.6) |
| 1987 | (1986) | 18.5 (28.8) | 12.4 | $(12.3)$ | 229.8 | (353.4) |
| 1986 | (1985) | 1.5 (0.2) | 22.8 | (17.1) | 33.8 | (4.3) |
| 1985 | (1984) | 0.01 (0.0) | 21.0 | ( - ) | 0.3 | (0.0) |

The estimate of the 1988 year class (1-group) is about 9 times higher than the 1 -group estimate in 1988. The 1 -group estimate is probably not as reliable as those from the older age groups, but it indicates that the 1988 year class is at the level of the 1983 year class and about one third the size of the 1981 and 1982 year classes. The mean weight is 3.4 g in 1989 as compared to 3.5 g in 1988, and consequently the biomass of the 1988 year class is almost 9 times larger than the 1986 year class.

The estimated number of fish in the 1987 year class (2-group) is about $64 \%$ of the size of of the 2 -group measured in 1988. The biomass estimate is $65 \%$ of the estimate in 1988, as the mean weights are nearly identical.

The table below shows the number of fish in various year classes, and their survival from age 1 to age 2:

| Year class: | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: |
| Age 1 (Numbers*10E7) | 51,511 | 14,544 | 3,512 | 749 | 3,733 | 2,000 |
| Age 2 (Numbers*10E7) | 18,386 | 4,725 | 341 | 149 | 2,876 | 1,850 |
| Total mortality \% | 64 | 68 | 90 | 80 | 33 | 8 |

As there has been practically no fishing on these age groups, the figures for total mortality constitute natural mortality only, and probably reflect the predation on capelin. As can be seen from the table, the mortality was high until 1986-1987, but then a substantial decrease occurred in 1987-1989, probably caused by diminished predation pressure from cod.

### 4.4.3 Management considerations

A management aim for Barents Sea capelin has been to preserve an adequate spawning stock. In the 1970 s and early 1980s, the TAC recommendations were aimed at maintaining a spawning stock of about $500,000 t$ (see for example Anon., 1982). A paper by Hamre and Tjelmeland (1982) gave an optimal spawning stock of about $400,000 \mathrm{t}$. It is uncertain whether the stock/recruitment relations from the 1970 s are valid after the recent changes in the Barents sea ecosystem, but the Working Group is of the opinion that until other data are available, one should still aim at a spawning stock of $400,000-500,000 \mathrm{t}$.

The total stock biomass of $870,000 t$ in September-October 1989 is twice as high as in 1988. This increase is due to a large increase in the number of 1 -year-old capelin (1988 year class), which is almost back to the level which occurred during in the first half of the 1980 s. However, very few of these will spawn in 1990. The spawning stock in 1990 will consist of what is left of the 1986 year class, and part of the 1987 year class. If a maturing length of 14.0 cm is assumed, the maturing part of the stock, according to the acoustic estimate in September-October, was 180,000 t. Natural mortality will reduce the spawning stock further before spawning takes place.

Based on the available data on total stock, spawning stock, and recruitment, the Working Group recommends that no fishing should take place in 1990.

## 5 CAPELIN IN THE ICELAND-EAST GREENLAND-JAN MAYEN AREA

### 5.1 Working Papers Presented

The following working papers and documents were presented:

- "Capelin in the Iceland-Greenland-Jan Mayen Area" by $S$. Sveinbjörnsson.
- "Report on an Icelandic Survey of 1-group capelin in the Iceland-Greenland-Jan Mayen Area in August-September 1989" by s. Sveinbjörnsson.
- "Icelandic capelin catch statistics" by A. Dommasnes.
- "Cruise report, G.O. Sars, July-August 1989".
- "Distribution of the capelin fishery of the Greenland licensed vessels in 1986-1989 based on logbook recordings" by $P$. Kanneworff.


### 5.2 Catch Requlation

As this is a very short lived species the fishery depends to a very large extent upon the recruiting year class.

The fishery on the Iceland-East Greenland-Jan Mayen stock of capelin has been regulated by preliminary catch quotas set prior to each fishing season (July-March) based on the results of the surveys of the abundance of immature 1 - and 2 -group capelin carried out in August in the preceding year and/or January in the current year.

Final catch quotas for each season have then been set in accordance with the results of acoustic surveys of abundance of the maturing fishable stock carried out in the autumn (OctoberNovember) and/or winter (January-February) of that fishing season.

### 5.3 The Catch in the $1988 / 1989$ Season

The total annual catch of capelin in the Iceland-East GreenlandJan Mayen area since 1964 is shown in Table 5.1.

On the basis of an acoustic abundance estimate obtained in January 1989, a TAC of 1,065,000 $t$ was set for the whole 1988/ 1989 season. The total catch amounted to $1,022,800$ t leaving a spawning stock of $440,000 \mathrm{t}$. (The target spawning stock was
$400,000 \mathrm{t}$.

### 5.4 The Preliminary TAC for the $1989 / 1990$ Fishery

In August 1988, an estimate of the abundance of 1 group capelin (the 1987 year class) was obtained. All other attempts to obtain reliable estimates of the abundance of immature capelin, of either the 1987 or 1986 year classes in the autumn of 1988 and winter of 1989, failed.

The abundance of 1 -group capelin has been estimated annually in August since 1982. The resulting estimates can be compared to estimates of the same year classes, obtained by backcalculating theix abundance as 3 - and 4 -group spawners to the same point in time (1 August as 1-group) taking account of the catch and the mortality rate (M). Five such pairs of estimates were available excluding the 1986 year class which, was not fully recruited to the adult stock and is underestimated due to trawl selection favouring the larger fish. The data are given in Table 5.2 and the relation between the two data sets in figure 5.1.

Using the relationship in Figure 5.1, the August 1988 survey results correspond to $109 \times 10^{9} \quad$ 2-group capelin on 1 August 1989 with the assumed mortality rate ( $M=0.035 /$ month ) . A TAC for the 1989/1990 season was then calculated making the folowing assumptions:

1) The fishery will depend on maturing capelin only.
2) About $70 \%$ of the capelin belonging to the 1987 year class and all the remainder of the 1986 year class will mature and spawn
in 1990 .
3) The 1989/1990 fishable stock and, therefore, the 1990 spawning stock, will consist of the 1987 and 1986 year classes in the ratio $80 / 20$, this being close to the average for the 1981-1989 period excluding the abnormal $1986 / 1987$ season (Table 5.3).
4) The mean weight in the fishable stock will be 17.4 g and 24.6 $g$ for the 1987 and 1986 year classes respectively (mean weights of 2 and 3 years olds in the autumn in the 1980-1988
period (Table 5.4 ).
5) The mean weights in the 1990 spawning stock will be 19.4 g and 26.3 g for the same year classes (Table 5.4).
6) The natural mortality rate will be $M=0.035 /$ month (Table
5.5 ).
7) There will be 400,000 t left to spawn in 1990.

Calculations based on these assumptions gave a TAC of $1,065,000 t$ spread evenly over the period (ACFM, May 1989). In view of the short time series and other obvious uncertainties, a precautionary TAC of $900,000 t$ was recommended for the August-November 1989 pexiod. The TAC for the remainder of the season (December 1989March 1990) could then be set after the completion of the autumn 1989 survey of stock abundance, which is to take place in November.

### 5.5 TAC for the December 1989 - March 1990 Period

A Norwegian acoustic survey was carried out in the Jan MayenIceland and E-Greenland area in July-August 1989. Very few capelin recordings were made. An Icelandic survey will not take place until November and a TAC for the period December 1989-March 1990 can, therefore, not be set until after the completion of that survey.

### 5.6 TAC for the Summer/Autumn 1990 Season

The fishable stock in the $1990 / 1991$ season will consist of the 1988 year class and that part of the 1987 year class which does not mature and spawn in 1990. The abundance estimate (in numbers) of the 1988 year class was $111 \times 10^{\circ}$ capelin. Most of the distribution area appeared to be covered but surveying conditions were bad for part of the time. Details of the August 1989 abundance estimate are given in the survey report.

Using the relationship in Figure 5.1 and a natural mortality rate of $M=0.035 /$ month, the August 1989 survey results correspond to $96 \times 10^{9}$ 2-group capelin on 1 August 1990. A TAC for the 1990/ 1991 season may then be calculated using the assumptions listed in Section 5.4. This procedure gives a TAC of 965,000 for the 1990/1991 season, spread evenly over the period.

It should be noted, however, that considerable addition to the data base could be made after the completion of an acoustic survey of the stock planned for January/February 1990. This survey will provide the addition of one more year to the data series of estimates of year class abundance as 1 -group compared to adults and may provide an estimate of the abundance of the immature part of the 1987 year class, in addition to mean weights, year class ratios and maturity rates.

Advice on a TAC for the 1990 summer and autumn seasons should, therefore, be delayed until spring 1990.

### 5.7 Reliability of Acoustic Estimates

The ACFM has noted that "the assessment is based solely on acoustic surveys and the reliability of these results is known to be uncertain. The Working Group, therefore, should in future try to include error estimates for the acoustic results" (Vaske, 1989).

The Working Group noted that the current method of analysis does not yield useful variance estimates. Other methods of analysis are available but have not been well tested with acoustic data. It is, therefore, not known whether a change to a new method in order to obtain variance estimates would be at the cost of obtaining less useful estimates of abundance.

An ICES study group has been established to consider methods of estimating abundance based on acoustic surveys. The Working Group recommends that the results of the study group be applied to the problem of determining an appropriate method of analysis.

## 6 REFERENCES

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Table 2.1 Catch in numbers, millions and total catch in weight, 'OOO tonnes. Icelandic summer spawners. Age in years is number of rings +1 .

| Rings | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 |
| :--- | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 1 | 2.003 | 8.774 | 0.147 | 0.001 | 0.001 | 1.518 | 0.614 |
| 2 | 22.344 | 13.071 | 0.322 | 0.159 | 3.760 | 2.049 | 9.848 |
| 3 | 33.965 | 5.439 | 0.131 | 0.678 | 0.832 | 31.975 | 3.908 |
| 4 | 4.500 | 13.688 | 0.163 | 0.104 | 0.993 | 6.493 | 34.144 |
| 5 | 2.734 | 3.040 | 0.264 | 0.017 | 0.092 | 7.905 | 7.009 |
| 6 | 4.419 | 1.563 | 0.041 | 0.013 | 0.046 | 0.863 | 5.481 |
| 7 | 1.145 | 3.276 | 0.028 | 0.006 | 0.002 | 0.442 | 1.045 |
| 8 | 0.531 | 0.748 | 0.024 | 0.006 | 0.001 | 0.345 | 0.438 |
| 9 | 0.604 | 0.250 | 0.013 | 0.003 | 0.001 | 0.114 | 0.296 |
| 10 | 0.195 | 0.103 | 0.009 | 0.003 | 0.001 | 0.004 | 0.134 |
| 11 | 0.103 | 0.120 | 0.003 | 0.001 | 0.001 | 0.001 | 0.092 |
| 12 | 0.076 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| 13 | 0.061 | 0.001 | 0.003 | 0.001 | 0.001 | 0.001 | 0.001 |
| 14 | 0.051 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Tota1 | 15.779 | 10.975 | 0.310 | 0.255 | 1.274 | 13.280 | 17.168 |
| Rings | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
| 1 | 0.705 | 2.634 | 0.929 | 3.147 | 2.283 | 0.454 | 1.470 |
| 2 | 18.853 | 22.551 | 15.098 | 14.347 | 4.629 | 19.187 | 22.422 |
| 3 | 24.152 | 50.995 | 47.561 | 20.761 | 16.771 | 28.109 | 151.198 |
| 4 | 10.404 | 13.846 | 69.735 | 60.728 | 12.126 | 38.280 | 30.181 |
| 5 | 46.357 | 8.738 | 16.451 | 65.329 | 36.871 | 16.623 | 21.525 |
| 6 | 6.735 | 39.492 | 8.003 | 11.541 | 41.917 | 38.308 | 8.637 |
| 7 | 5.421 | 7.253 | 26.040 | 9.285 | 7.299 | 43.770 | 144.017 |
| 8 | 1.395 | 6.354 | 3.050 | 19.442 | 4.863 | 6.813 | 13.666 |
| 9 | 0.524 | 1.616 | 1.869 | 1.796 | 13.416 | 6.633 | 3.715 |
| 10 | 0.362 | 0.926 | 0.494 | 1.464 | 1.032 | 10.457 | 2.373 |
| 11 | 0.027 | 0.400 | 0.439 | 0.698 | 0.884 | 2.354 | 3.424 |
| 12 | 0.128 | 0.017 | 0.032 | 0.001 | 0.760 | 0.594 | 0.552 |
| 13 | 0.001 | 0.025 | 0.054 | 0.110 | 0.101 | 0.075 | 0.100 |
| 14 | 0.001 | 0.051 | 0.006 | 0.079 | 0.062 | 0.211 | 0.003 |
| Tota1 | 28.924 | 37.333 | 45.072 | 53.269 | 39.544 | 56.528 | 58.665 |
|  |  |  |  |  |  |  |  |


| Rings | 1984 | 1985 | 1986 | 1987 | 1988 |
| ---: | ---: | ---: | ---: | ---: | ---: |
| 1 | 0.421 | 0.111 | 0.100 | 0.029 | 0.869 |
| 2 | 18.011 | 12.800 | 8.161 | 3.144 | 4.702 |
| 3 | 32.237 | 24.521 | 33.893 | 44.590 | 40.855 |
| 4 | 141.324 | 21.535 | 23.421 | 60.285 | 98.222 |
| 5 | 17.039 | 84.733 | 20.654 | 20.622 | 68.533 |
| 6 | 7.111 | 11.836 | 77.526 | 19.751 | 22.691 |
| 7 | 3.915 | 5.708 | 18.228 | 46.240 | 19.899 |
| 8 | 4.112 | 2.323 | 10.971 | 15.232 | 31.830 |
| 9 | 4.516 | 4.339 | 8.583 | 13.963 | 12.207 |
| 10 | 1.828 | 4.030 | 9.662 | 10.179 | 10.132 |
| 11 | 0.202 | 2.758 | 7.174 | 13.216 | 7.293 |
| 12 | 0.255 | 0.970 | 3.677 | 6.224 | 7.200 |
| 13 | 0.260 | 0.477 | 2.914 | 4.723 | 4.752 |
| 14 | 0.003 | 0.578 | 1.786 | 2.280 | 1.935 |
| Total | 50.293 | 49.092 | 65.413 | 75.439 | 92.828 |

Table 2.2 HERRING.
Mean weight at age in grammes, Icelandic summer spawners. Age in years is number of rings +1 .


[^1]Table 2.3 Proportion of mature Icelandic summer spawners in each age group. Based on samples taken in September-December by purse seine.

| Rings | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 0.22 | 0.38 | 0.29 | 0.64 | 0.14 | 0.27 | 0.13 |
| 3 | 0.89 | 0.98 | 1.00 | 0.99 | 0.94 | 0.97 | 0.90 |
| 4 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 5 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 6 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 7 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 8 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 9 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 10 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 11 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 12 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 13 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 14 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Rings | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
| 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.00 |
| 2 | 0.02 | 0.04 | 0.07 | 0.05 | 0.03 | 0.05 | 0.00 |
| 3 | 0.87 | 0.78 | 0.65 | 0.92 | 0.65 | 0.85 | 0.64 |
| 4 | 1.00 | 1.00 | 0.98 | 1.00 | 0.99 | 1.00 | 1.00 |
| 5 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 6 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 7 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 8 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 9 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 10 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 11 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 12 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 13 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 14 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Rings | 1984 | 1985 | 1986 | 1987 | 1988 | $1989{ }^{1}$ |  |
| 1 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |  |
| 2 | 0.01 | 0.00 | 0.03 | 0.01 | 0.05 | 0.05 |  |
| 3 | 0.82 | 0.90 | 0.89 | 0.87 | 0.90 | 0.90 |  |
| 4 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |  |
| 5 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |  |
| 6 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |  |
| 7 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |  |
| 8 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |  |
| 9 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |  |
| 10 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |  |
| 11 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |  |
| 12 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |  |
| 13 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |  |
| 14 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |  |

[^2]Table 2. 4 Stock abundance and catches by age groups (millions) and fishing mortality rates for the Icelandic summer spawners. $F^{\prime}$ is the $F$ in 1988 calculated from the Nov/Dec survey. $F_{p}$ is the fishing pattern in 1988 calculated from the Nov/Dec survey. $F_{88}$ is the fishing mortality in 1988 according to the method introduced in the 1986 Report of the Herring Assessment Working Group for the Area South of

| Rings <br> 1988 | Acoustic survey estimate <br> Nov <br> Dec 1988 | Catch <br> 1988 | $F^{\prime}$ | $F_{p}$ | $F_{88}$ |
| :---: | :---: | :---: | :---: | :---: | ---: |
| 0 | 441.7 | - | - | - | - |
| 1 | 982.6 | .9 | - | - | - |
| 2 | 236.1 | 4.7 | .02 | .036 | 0.019 |
| 3 | 319.3 | 40.9 | .11 | .200 | .106 |
| 4 | 485.6 | 68.2 | .17 | .309 | .164 |
| 5 | 216.4 | 22.7 | .27 | .491 | .260 |
| 6 | 52.8 | 19.9 | .34 | .618 | .328 |
| 7 | 29.1 | 31.8 | .58 | 1 | .53 |
| 8 | 38.0 | 12.2 | .45 | 1 | .53 |
| 9 | 20.2 | 10.1 | .58 | 1 | .53 |
| 10 | 12.1 | 7.3 | .5 | 1 | .53 |
| 11 | 10.5 | 7.2 | .73 | 1 | .53 |
| 12 | 6.1 | 4.8 | .73 | 1 | .53 |
| 13 | 4.1 | 1.9 | .48 | 1 | .53 |
| 14 | 2.9 |  |  | .53 |  |

Table 2.5 VIRTUAL POPULATION ANALYSIS.

SUMinER SPAWNING HERRING AT ICELANO (FISHING AREA VA)

| FISHING M | ALITY | OEFFIC |  | UNIT: |  | NATURAL | MORTAL | COEF | CIENT | . 10 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 |
| 1 | . 064 | .1 .40 | . 002 | . 000 | . 000 | . 008 | . 001 | . 002 | . 013 | . 004 | . 012 | . 003 |
| 2 | . 907 | .645 | . 007 | . 002 | . 010 | . 016 | . 058 | . 039 | . 059 | . 087 | . 064 | .020 |
| 3 | 1.010 | . 508 | .012 | . 016 | . 012 | .102 | . 034 | .176 | . 126 | . 151 | . 148 | . 089 |
| 4 | . 636 | 1.491 | . 027 | . 010 | . 023 | . 117 | . 136 | . 107 | . 130 | . 227 | . 262 | . 108 |
| 5 | . 778 | 1.084 | . 093 | . 003 | . 009 | . 238 | . 160 | . 246 | . 111 | . 201 | . 306 | . 224 |
| 6 | . 725 | 1.346 | . 041 | . 005 | . 008 | . 097 | . 230 | . 204 | . 304 | . 126 | . 190 | . 292 |
| 7 | . 852 | 1.999 | . 069 | . 005 | . 001 | . 087 | . 147 | . 332 | . 313 | . 299 | .189 | . 158 |
| 8 | 1.008 | 3.116 | . 065 | . 015 | . 001 | . 156 | .105 | . 265 | .710 | . 187 | . 340 | .128 |
| 9 | 1.709 | 2.280 | . 730 | . 008 | . 003 | . 123 | . 174 | . 159 | . 491 | . 411 | . 144 | . 368 |
| 10 | . 655 | 1.908 | . 566 | . 253 | . 003 | . 012 | .186 | . 297 | . 408 | .242 | . 579 | . 103 |
| 11 | . 545 | . 989 | . 287 | . 080 | .112 | . 003 | . 367 | . 047 | . 547 | . 307 | . 554 | . 739 |
| 12 | 1.204 | . 008 | . 016 | . 097 | . 097 | .141 | . 004 | 1.130 | . 034 | . 067 | . 001 | 2.119 |
| 13 | 3.564 | . 035 | . 035 | . 018 | . 119 | . 119 | . 183 | . 004 | . 605 | . 128 | . 304 | .107 |
| 14 | 1.000 | 1.000 | . 040 | . 010 | . 020 | .150 | . 150 | . 250 | . 250 | . 250 | . 250 | . 250 |
| $15+$ | 1.000 | 1.000 | . 040 | . 010 | . 020 | .150 | . 150 | . 250 | . 250 | . 250 | .250 | .250 |
| $(4-14) U$ | 1.153 | 1.387 | .179 | . 046 | . 036 | .113 | .167 | $.276$ | $.355$ | $.222$ | $.284$ | $.418$ |
| $(4-14) w$ | . 754 | 1.522 | . 051 | . 007 | . 018 | .153 | .146 | . 208 | . 230 | $.224$ | $.272$ | .220 |
|  | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 882-85 |  |  |  |  |
| 1. | .002 | . 006 | . 001 | . 000 | . 000 | . 000 | . 001 | . 002 |  |  |  |  |
| 2 | . 024 | .107 | . 084 | $.025$ | $.010$ | $.007$ | $.019$ | $.060$ |  |  |  |  |
| 3 | .148 | . 239 | . 198 | . 142 | $.076$ | $.060$ | $.106$ | $.182$ |  |  |  |  |
| 4 | . 268 | . 210 | . 327 | .176 | .176 | .168 | $.164$ | $.245$ |  |  |  |  |
| 5 | . 190 | . 212 | . 157 | . 296 | . 228 | .207 | $.260$ | $.214$ |  |  |  |  |
| 6 | .340 | . 128 | . 090 | . 140 | . 427 | . 315 | $.328$ | $.175$ |  |  |  |  |
| 7 | .496 | . 179 | . 071 | . 088 | . 296 | .433 | $.530$ | . 209 |  |  |  |  |
| 8 | . 194 | .251 | . 066 | . 050 | . 216 | . 382 | . 530 | .140 |  |  |  |  |
| 9 | . 231 | . 138 | . 110 | . 083 | . 232 | . 414 | $.530$ | .141 |  |  |  |  |
| 10 | .484 | . 109 | . 084 | . 122 | . 238 | . 419 | $.530$ | . 200 |  |  |  |  |
| 11 | . 321 | .255 | . 011 | . 158 | . 294 | . 521. | $.530$ | . 186 |  |  |  |  |
| 12 | 1.651 | . 104 | . 024 | . 060 | . 290 | . 397 | . 530 | $.460$ |  |  |  |  |
| 13 | 1.620 | 1.534 | . 058 | . 052 | . 228 | . 648 | . 530 | . 816 |  |  |  |  |
| 14 | .300 | . 200 | .130 | .160 | . 250 | . 250 | . 530 | . 197 |  |  |  |  |
| $15+$ | .300 | .200 | . 1.30 | . 160 | .250 | . 250 | .530 | .197 |  |  |  |  |
| ( 4-14)U | . 554 | . 302 | .103 | . 126 | .261 | .378 | . 454 |  |  |  |  |  |
| ( 4-14) w | . 319 | . 193 | .223 | .193 | . 287 | .278 | .264 |  |  |  |  |  |

Table 2.6 Icelandic summer spawners.
VPA stock size in numbers (millions) and spawning stock biomass in '000 tonnes at 1 July.

| Rings | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 33.806 | 70.348 | 84.793 | 426.779 | 152.767 | 204.953 | 574.676 |
| 2 | 39.056 | 28.685 | 55.320 | 76.584 | 386.164 | 138.228 | 184.006 |
| 3 | 55.602 | 14.252 | 13.593 | 49.750 | 69.145 | 345.841 | 123.126 |
| 4 | 9.981 | 18.281 | 7.746 | 12.175 | 44.371 | 61.774 | 282.553 |
| 5 | 5.275 | 4.775 | 3.682 | 6.854 | 10.918 | 39.204 | 49.728 |
| 6 | 8.942 | 2.190 | 1.456 | 3.081 | 6.185 | 9.791 | 27.972 |
| 7 | 2.079 | 3.914 | 0.512 | 1.273 | 2.775 | 5.553 | 8.040 |
| 8 | 0.869 | 0.800 | 0.475 | 0.436 | 1.146 | 2.509 | 4.605 |
| 9 | 0.763 | 0.285 | 0.029 | 0.407 | 0.389 | 1.036 | 1.943 |
| 10 | 0.424 | 0.124 | 0.025 | 0.014 | 0.366 | 0.351 | 0.829 |
| 11 | 0.255 | 0.199 | 0.016 | 0.014 | 0.010 | 0.330 | 0.314 |
| 12 | 0.113 | 0.134 | 0.067 | 0.011 | 0.011 | 0.008 | 0.298 |
| 13 | 0.064 | 0.031 | 0.120 | 0.060 | 0.009 | 0.009 | 0.006 |
| 14 | 0.084 | 0.002 | 0.027 | 0.106 | 0.053 | 0.008 | 0.008 |
| Spawning <br> Stock | 20.015 | 13.576 | 11.044 | 28.713 | 45.653 | 118.885 | 134.272 |
| Rings | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 |
| 1 | 460.871 | 214.127 | 269.326 | 270.647 | 935.851 | 256.960 | 259.663 |
| 2 | 519.405 | 416.343 | 191.246 | 242.813 | 241.899 | 844.622 | 232.075 |
| 3 | 157.136 | 452.057 | 355.291 | 158.701 | 206.072 | 214.479 | 746.006 |
| 4 | 107.694 | 119.252 | 360.601 | 276.315 | 123.883 | 170.527 | 167.374 |
| 5 | 223.236 | 87.562 | 94.752 | 260.104 | 192.403 | 100.574 | 117.983 |
| 6 | 38.340 | 158.004 | 70.929 | 70.119 | 173.392 | 139.101 | 75.223 |
| 7 | 20.109 | 28.298 | 105.513 | 56.578 | 52.490 | 117.132 | 89.542 |
| 8 | 6.282 | 13.055 | 18.727 | 70.774 | 42.379 | 40.564 | 64.539 |
| 9 | 3.750 | 4.361 | 5.806 | 14.049 | 45.605 | 33.727 | 30.237 |
| 10 | 1.477 | 2.896 | 2.416 | 3.483 | 11.007 | 28.547 | 24.223 |
| 11 | 0.623 | 0.993 | 1.743 | 1.717 | 1.766 | 8.979 | 15.928 |
| 12 | 0.197 0.268 | 0.538 0.058 | 0.520 | 1.161 | 0.893 | 0.762 | 5.892 0.132 |
| 13 14 | 0.268 0.005 | 0.058 0.242 | 0.471 0.028 | 0.440 | 1.049 | 0.097 | 0.132 |
| Spawning <br> stock | 138.941 | 184.361 | 210.060 | 229.056 | 204.648 | 215.112 | 246.739 |
| Rings | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |  |
| 1 | 612.132 | 987.592 | 524.666 | 286.061 | 948.083 | 607.000 |  |
| 2 | 233.555 | 553.480 | 893.505 | 474.643 | 258.811 | 857.035 |  |
| 3 | 188.690 | 194.216 | 488.641 | 800.718 | 426.485 | 229.712 |  |
| 4 | 531.536 | 140.132 | 152.446 | 409.934 | 682.143 | 347.088 |  |
| 5 | 122.800 | 346.942 | 106.350 | 115.702 | 313.683 | 523.963 |  |
| 6 | 86.325 | 94.934 | 233.557 | 76.629 | 85.117 | 218.908 |  |
| 7 | 59.861 | 71.353 | 74.659 | 137.877 | 50.606 | 55.501 |  |
| 8 | 67.713 | 50.444 | 59.140 | 50.265 | 80.948 | 26.952 |  |
| 9 | 45.430 | 57.362 | 43.436 | 43.099 | 31.044 | 43.112 |  |
| 10 | 23.831 | 36.817 | 47.780 | 31.157 | 25.767 | 16.534 |  |
| 11 | 19.663 | 19.826 | 29.485 | 34.065 | 18.547 | 13.723 |  |
| 12 | 11.163 | 17.600 | 15.320 | 19.875 | 18.311 | 9.878 |  |
| 13 | 4.807 | 9.858 | 15.003 | 10.375 | 12.085 | 9.752 |  |
| 14 | 0.026 | 4.102 | 8.467 | 10.810 | 4.921 | 6.436 |  |
| Spawning stock | 263.794 | 292.036 | 318.180 | 393.535 | 422.478 | 385.528 |  |

## Table 2.7

List of input variables for the ICES prediction program.

ICELANDIC SUMMER SPAWNERS
The reference $F$ is the mean $F$ for the age group range from 4 to 14
The number of recruits per year is as follows:

| Year | Recruitment |
| :---: | ---: |
| 1989 | 600.0 |
| 1990 | 400.0 |
| 1991 | 400.0 |
| 1992 | 400.0 |

Proportion of $F$ (fishing mortality) effective before spawning: . 0000 Proportion of $M$ (natural mortality) effective before spawning: . 5000

Data are printed in the following units:

| Number of fish: | millions |
| :--- | :--- |
| Weight by age group in the catch: gram |  |
| Weight by age group in the stock: gram |  |
| Stock biomass: | tonnes |
| Catch weight: | tomnes |



```
* Year 1989. F-factor . 260 and reference F . 2600
```

|  |  |  |  |  | , | at 1 January! |  | at spa | ng time: |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| : age! | absolute F! | catch in! numbers: | catch in: weight! | $\begin{array}{r} \text { stock: } \\ \text { size } \end{array}$ | stock! <br> biomass: | sp.stock! <br> size: | sp.stock biomass | $\begin{array}{r} \text { sp.stock } \\ \text { size } \end{array}$ | sp.stock biomass |
| 11 | .0000 | . 000 | . 01 | 600.001 | 36000 ! | ! |  |  |  |
| $1 \quad 21$ | .0390 | 31.204 | 4234.4 | 857.00 | 116294 | 42.85 | 5814 | 40.76 | 5531 |
| $3!$ | . 13001 | 26.676 | 5252.5 | 229.70 | 45227 | 206.73 | 40705 ! | 196.65 | 38719 |
| 4 | . 2600 | 75.788 | 18226.9 | 347.101 | 83477 | 347.10 | 83477 | 330.17 | 79406 |
| 5 | . 26001 | 114.413 | 31372.0 | 524.00 | 143680 | 524.00 | 143680 | 498.44 | 136673! |
| 61 | . 26001 | 47.774 | 14528.0 | 218.80 | 66537 | 218.80 | 66537 | 208.13! | 632921 |
| 71 | . 26001 | 12.118 | 3971.1 | 55.50 | 18187 | 55.50 | 18187 | 52.79 | 17300 |
| 81 91 | . 26001 | 5.895 9.411 | 2054.5 | 27.00 43.10 | 9409 | 27.00 | 9409 | 25.68 | 8950 |
| 10 | . 2600 | 3.603 | 1384.9 | 43.10 16.50 | 16046 | 43.101 16.501 | 16046 | 41.001 | 15263: |
| 11 | . 2600 | 2.991 | 1241.7 | 13.70 | 5686 | 13.70 | 5342 | 15.70 | 6033 |
| $12!$ | . 2600 | 2.162 | 925.0 | 9.90 | 4236 | 13.701 9.901 | 4236 | 13.03 | 5409 |
| 131 | . 26001 | 2.140 | 899.8 | 9.80 | 4120 | 9.801 | 4120 | 9.321 | 3919 |
| 14, | . 26001 | 1.397 | 614.3 | 6.40 | 2813; | 6.401 | 2813 | 6.09 | 2676 |
| - Total | , | 335.571 | 88208.6! | 2958.501 | 558061 | 1521.38 | 407058 | 1447.18: | 387205! |

* Year 1990. F-factor . 260 and reference F . 2600 *

|  |  |  |  |  |  | at 1 January: |  | at spawning time! |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| age | absolute! | catch in! numbers: | catch in! weight | $\begin{aligned} & \text { stock } \\ & \text { size } \end{aligned}$ | $\begin{aligned} & \text { stock } \\ & \text { iomass } \end{aligned}$ | sp.stock <br> size! | sp.stock <br> biomass | sp.stock! size! | sp.stock! biomass: |
| $1!$ | . 0000' | .0001 |  |  |  |  |  |  |  |
| 21 | . 03901 | 19.768 | 2682.5 | 400.001 542.90 | 240001 | 27.00! | 01 | . 25.00 | 01 |
| $3!$ | . 1300 | 86.610 | 17053.6 | 745.791 | 146845! | 27.15 671.21 | 3683! | 25.82 638.47 | 3503 |
| $4!$ | . 2600 | 39.849 | 9583.7 | $182.50!$ | 146845 43892 | 671.21 182.50 | 132160 | 638.47 173.60 | 125715 |
| 51 | . 2600 | 52.875 | 14498.4 | 242.161 | 66401 | 242.16 ! | 66401 | 173.60 230.35 | 41751 |
| 6 7 | . 26001 | 79.8231 | 24274.2 | 365.58 ! | 111173 | 365.58 i | 111173! | 347.75 | 105751 |
| 8 | . 2600 | 33.331 8.455 | 10922.5 2946.4 | 152.65 38.72 | 50023 ! | 152.65 | 50023 | 145.21 | 47584 |
| 91 | . 2600 | 4.113 | 1531.31 | 18.84 | 13494 | 38.721 | 13494 | 36.83 | 12836 |
| 101 | . 2600 | 6.566 | 2523.8 | 30.07 | 11558 | 18.84 30.07 | 7013 ' | 17.921 | 6671 |
| 11 | . 2600 | 2.514 | 1043.4! | 11.51 | 4778 | 11.51 | .11558 | 28.60 | 10995 |
| 12! | . 2600 | 2.087 | 893.0 | 11.51 | 4778 | 11.51 | 4778 | 10.95 | 4545 ! |
| 13! | . 2600 | 1.508 | 634.2 | 6.91 | 2904 | 9.561 6.91 | 2904 | 9.09 | 38901 |
| 14! | .2600 | 1.4931 | 656.31 | 6.84 | $3005!$ | 6.84 | 3005 | 6.51 | 2762 |
| Total | , | 338.990 | 89243.0 | 2754.03! | 562852i | 1763.70 | 454180 | 1677.68! | 4320291 |

Table 2.8 (cont'd)

```
* Year 1991. F-factor . 260 and reference F . 2600*
***********************************************************
```

|  |  |  |  |  |  | at | January! | at spaw | ing time |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| age! | absolute | catch in | catch in: weight! | stock! <br> size! | stock! biomass | sp.stock! size! | sp.stock biomass | sp.stock <br> size | sp.stock biomass |
| 11 | .0000 | .000 | . 01 | 400.001 | 240001 | .001 | 0 ! | . 001 | 0 |
| $2!$ | . 0390 | 13.178 | 1788.3! | 361.931 | 49114 | 18.10 | 2455 | 17.21 | 2335 |
| 31 | . 1300 | 54.867 | 10803.3! | 472.45 | 93025 | 425.20 ! | 83722: | 404.471 | 79639 |
| 4 ! | . 2600 | 129.381 | 31116.0 | 592.55 | 142508 | 592.55 | 142508: | 563.651 | 135558 |
| 5 | . 26001 | 27.802 | 7623.21 | 127.33 ! | 34913: | 127.33 | 34913: | 121.12 ! | 33210 |
| 61 | . 2600 | 36.890 | 11218.2 | 168.95 | 51378 | 168.95 | 51378 | 160.71 | 488721 |
| 71 | . 2600 | 55.691 | 18249.81 | 255.06 | 83582 | 255.06 | 83582 | 242.621 | 795061 |
| 8 | . 2600 | 23.254 | 8104.0 | 106.50: | 37115 | 106.50 | 37115 | 101.31 | 35305 |
| 91 | . 2600 | 5.899 | 2196.01 | 27.01 ! | 10057 | 27.01: | 10057 | 25.70 | 9567 |
| 10 | . 2600 | 2.870 | 1103.1 | 13.14 | 5051 | 13.14 | 5051 | 12.50 | 4805 |
| 11 | . 2600 | 4.581 | 1901.4 | 20.98 | 8708 | 20.98 | 8708 | 19.96 | 8283 |
| 12 | . 2600 | 1.754 | 750.4 | 8.03 | 3436 | 8.031 | 3436 | 7.64 | 3269 |
| 13! | . 2600 | 1.456 | 612.31 | 6.671 | 2804 | 6.671 | 2804 | 6.341 | 26671 |
| 14 | . 2600 | 1.052 | 462.5 | 4.821 | 2118 | 4.821 | 2118 | 4.58 | 2015 |
| Total |  | 358.6731 | 95928.6! | 2565.431 | 547815 | 1774.35 | 467854 | 1687.811 | 445036! |

```
* Year 1992. F-factor . 260 and reference F . 2600*
```

*************************************************************)

|  |  |  |  |  |  | at 1 January: |  | at spawn | ing time! |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \|a | absolute Fi | catch in: numbers: | catch in: weight | stock! <br> size: | stock! <br> biomass | sp.stock! size! | sp.stock! biomass | sp.stock! size! | sp.stock bionass! |
| 11 | . 00001 | .000! | . 01 | 400.00: | 24000! | .001 | 01 | .001 | 1 |
| 21 | .0390! | 13.178 | 1788.31 | 361.93: | 49114 | 18.10 | 2455 | 17.211 | 23351 |
| 31 | . 1300 | 36.578 | 7202.2! | 314.97: | 62016 | 283.471 | 55815 | 269.641 | 530921 |
| 41 | . 26001 | 81.962 | 19711.81 | 375.38 | 90278 | 375.38 | 90278 | 357.071 | 85875 |
| 51 | . 2600 | 90.266 | 24750.9 | 413.41 | 113356 | 413.41 | 113356 | 393.25 | 107828 1 |
| 61 | . 2600 | 19.397 | 5898.5 | 88.831 | 27014 | 88.83i | 27014 | 84.501 | 256971 |
| 71 | . 26001 | 25.737 | 8434.0 | 117.87 | 38627 | 117.87 | 38627! | 112.12! | 367431 |
| 81 | . 26001 | 38.854 | 13540.6 | 177.95 | 62014 | 177.95 | 62014 | 169.27 ! | 58990 |
| 91 | .2600 | 16.224 | 6040.1 | 74.301 | 27663: | 74.301 | 27663 | 70.681 | $26314!$ |
| 101 | .2600 | 4.115 | 1581.9: | 18.85 | 7244 | 18.85 | 7244 | 17.931 | 6891! |
| 11! | . 26001 | 2.002 | 831.01 | 9.17! | 3805 | 9.171 | 3806 | 8.72 i | 3620 |
| 12 | . 2600 | 3.196 | 1367.5 | 14.64 | 6262! | 14.64 | 6262 | 13.92 ! | 59571 |
| 13 | . 2600 | 1.223 ! | 514.5: | 5.60 | 2356 | 5.60 | 2356 | 5.33 ! | 2241 |
| 14 | . 26001 | 1.016 | 446.6 | 4.65 | 2045 | 4.65 | 2045 | 4.431 | 1945; |
| - Total | ' | 333.748 | 92107.91 | 2377.56 | 5158011 | 1602.22i | 438941 | 1524.08 | 417533 |

Table 3.1 Catches of Norwegian spring-spawning herring (tonnes) since 1972.

| Year | A | $\mathbf{B}^{1}$ | C | D | Total | Total includ. unreported catches |
| :--- | ---: | ---: | ---: | ---: | ---: | :---: |
| 1972 | - | 9,895 | $3,266^{2}$ | - | 13,161 | 13,161 |
| 1973 | 139 | 6,602 | 276 | - | 7,017 | 7,017 |
| 1974 | 906 | 6,093 | 620 | - | 7,619 | 7,619 |
| 1975 | 53 | 3,372 | 288 | - | 3,713 | 13,713 |
| 1976 | - | 247 | 189 | - | 436 | 10,436 |
| 1977 | 374 | 11,834 | 498 | - | 12,706 | 22,706 |
| 1978 | 484 | 9,151 | 189 | - | 9,824 | 19,824 |
| 1979 | 691 | 1,866 | 307 | - | 2,864 | 12,864 |
| 1980 | 878 | 7,634 | 65 | - | 8,577 | 18,577 |
| 1981 | 844 | 7,814 | 78 | - | 8,736 | 13,736 |
| 1982 | 983 | 10,447 | 225 | - | 11,655 | 16,655 |
| 1983 | 3,857 | 13,290 | 907 | - | 18,054 | 23,054 |
| 1984 | 18,730 | 29,463 | 339 | - | 48,532 | 53,532 |
| 1985 | 29,363 | 37,187 | 197 | 4,300 | 71,047 | 169,872 |
| 1986 | 71,122 | 55,507 | 156 | - | 126,785 | 225,2563 |
| 1987 | 62,910 | 49,798 | 181 | - | 112,899 | 127,3063 |
| 1988 | 73,440 | 66,624 | 127 | - | 140,191 | $164,491^{3}$ |
| $1989^{4}$ | 53,346 | - | - | - | - | 53,346 |

$A=$ catches of adult herring in winter.
$B=$ mixed herring fishery in autumn.
$C=b y-c a t c h e s ~ o f ~ 0-$ and 1 -group herring in the sprat fishery.
$D=U S S R-N o r w a y$ by-catch in the capelin fishery (2-group).
${ }_{2}^{1}$ Includes also by-catches of adult herring in other fisheries.
${ }_{3}^{2}$ In 1972, there was also a directed herring 0-group fishery.
Includes mortality in addition to reported catches caused by fishing operations.
${ }^{4}$ Preliminary up to 1 october 1989.

Table 3.2 Total catch of Norwegian spring-spawning herring (tonnes) since 1972.

| Year | Norway | USSR | Total |
| :--- | ---: | ---: | ---: |
| 1972 | 13,161 | - | 13,161 |
| 1973 | 7,017 | - | 7,017 |
| 1974 | 7,619 | - | 7,619 |
| 1975 | 13,713 | - | 13,713 |
| 1976 | 10,436 | - | 10,436 |
| 1977 | 22,706 | - | 22,706 |
| 1978 | 19,824 | - | 19,824 |
| 1979 | 12,864 | - | 12,864 |
| 1980 | 18,577 | - | 18,577 |
| 1981 | 13,736 | - | 13,736 |
| 1982 | 16,655 | - | 16,655 |
| 1983 | 23,054 | 23,054 |  |
| 1984 | 53,532 | 53,532 |  |
| 1985 | 167,272 | - | 169,872 |
| 1986 | 225,256 | 225,256 |  |
| 1987 | 108,417 | 14,889 | 127,306 |
| 1988 | 144,266 | 15,123 | 164,491 |
| 1989 | 38,223 | 53,3461 |  |

${ }^{1}$ Preliminary up to 1 october.

Table 3.3 Catch in numbers ('000) of Norwegian spring spawners. Unreported catches are included for age 3 and older herring. The catches in 1985, 1986 and 1987 are adjusted for by the effects of discards and the breaking of gear, as reported by the Working Group in 1988.

| Age | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 0 | 347,100 | 29,300 | 65,900 | 30,600 | 20,100 | 43,000 | 20,100 | 32,600 | 6,900 |
| 1 | 41,000 | 3,500 | 7,800 | 3,600 | 2,400 | 6,200 | 2,400 | 3,800 | 8 |
| 2 | 20,400 | 1,700 | 3,900 | 1,800 | 1,200 | 3,100 | 1,200 | 1,900 | 400 |
| 3 | 35,376 | 2,389 | 100 | 3,268 | 23,248 | 22,103 | 3,019 | 6,352 | 6,407 |
| 4 | 3,476 | 25,220 | 241 | 132 | 5,436 | 23,595 | 12,164 | 1,866 | 5,814 |
| 5 | 3,583 | 651 | 24,505 | 910 | - | 336 | 20,315 | 6,865 | 2,278 |
| 6 | 2,481 | 1,506 | 257 | 30,667 | 13,086 | - | 870 | 11,216 | 2,278 8,165 |
| 7 | 694 | 278 | 196 | 5 | 13,086 | 419 | 8 | 326 | 15,838 |
| 8 | 1,486 | 178 | - | 2 | 13,086 | 10,766 | 620 | 32 | 151 |
| 9 | 198 | - | - | - | - | , | 5,027 | - | 8 |
| 10 | - | - | - | - | - | - | 5, | 2,534 | 8 |
| 11 | 494 | - | - | - | - | - | - | 2,534 | 2,688 |
| 12 | 593 | - | - | - | - | - | - | - | 2,688 |
| 13 | 593 | - | - | - | - | - | - |  |  |
| 14 | - | 178 | - | - | - | - | - | - |  |
| 15 | - | - | - | - | - | - | - | - |  |
| 16 | - | - | - | - | - | - | - | - | - |
| Age | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |  |
| 0 | 8,300 | 22,600 | 127,000 | 33,857 | 28,571 | 13,805 | 13,846 | 15,488 |  |
| 1 | 1,100 | 1,100 | 4,679 | 1,700 | 13,149 | 1,381 | 6,327 | 2,787 |  |
| 2 | 11,900 | 200 13817 | 1,675 | 2,489 | 207,224 ${ }^{1}$ | 3,091 | 35,770 | 10,930 |  |
| 3 | 4,166 | 13,817 | 3,183 | 4,483 | 21,500 | 539,785 | 19,776 | 61,678 |  |
| 4 5 | 4,591 | 7,892 | 21,191 | 5,388 | 15,500 | 17,594 | 501,393 | 23,904 |  |
| 6 | 8,596 2,200 | 4,507 6,258 | 9,521 6,181 | 61,543 18,202 | 16,500 | 14,500 | 18,672 | 588,457 |  |
| 7 | 4,512 | 1,960 | 6,823 | 12,638 | 130,000 59,000 | 15,500 105,500 | 3,502 7,058 | 8,600 4,686 |  |
| 8 | 8,280 | 5,075 | 1,293 | 15,608 | 55,000 | 75,000 | 18,058 28,000 | 4,686 5,664 |  |
| 9 | 345 | 6,047 | 4,598 | 7,215 | 63,000 | 42,000 | 12,000 | 14,107 |  |
| 10 | 103 | 121 | 7,329 | 16,338 | 10,000 | 77,000 | 9,500 | 3,550 |  |
| 11 | 114 | 37 | 143 | 6,478 | 31,000 | 19,469 | 4,500 | 3,100 |  |
| 12 13 | 964 | 37 | 40 | , | 50,000 | 66,000 | 7,834 | 3,645 |  |
| 13 | - | 37 | 143 | - | - | 80,000 | 6,500 | 2,512 |  |
| 14 15 | - | - | 862 | - | - | , | 7,000 | 1,538 |  |
| 15 16 | - | - | - | 1,652 | - | - | 453 | 611 |  |
| 16 | - | - | - | 1,652 | 2,638 | 2,469 | 4 | - |  |

${ }_{2}^{1} 197,244$ are from the oceanic component.
${ }^{2}$ 481,481 are from the oceanic component.

Table 3.4 Norwegian spring-spawners. Acoustic abundance of 0 group herring in Norwegian coastal waters in 19751988 (number in millions).

|  | Area |  |  | Total |
| :--- | :---: | :---: | ---: | ---: |
| Year | $62^{0} \mathrm{~N}-65^{\circ} \mathrm{N}$ | $65^{0} \mathrm{~N}-68^{0} \mathrm{~N}$ | North of $68^{0} 30^{\circ}$ |  |
| 1975 | 328 | 692 | 55 | 1,075 |
| 1976 | 415 | 2,610 | 750 | 3,775 |
| 1977 | 70 | 305 | 37 | 412 |
| 1978 | 302 | 511 | 392 | 1,205 |
| 1979 | 909 | 2,260 | 288 | 3,457 |
| 1980 | 12 | 4 | 218 | 234 |
| 1981 | 263 | 2 | 1 | 265 |
| 1982 | 64 | 571 | 2,301 | 2,936 |
| 1983 | 323 | 543 | 8,864 | 13,730 |
| 1984 | 4 | 467 | 930 | 1,401 |
| 1985 | 441 | 354 | 208 | 1,003 |
| 1986 | 10 | 144 | 254 | 408 |
| 1987 | 179 | 26 | 57 | 262 |
| 1988 | 14 | 552 | 708 | 1,274 |

Table 3.5 Abundance indices for o-group herring in the Barents Sea, 1973-1989 (Anon., 1989a).

| Year | Log index | Year | Log index |
| :---: | :---: | :---: | :---: |
| 1973 | 0.05 | 1982 | 0.00 |
| 1974 | 0.01 | 1983 | 1.77 |
| 1975 | 0.00 | 1984 | 0.34 |
| 1976 | 0.00 | 1985 | 0.23 |
| 1977 | 0.01 | 1986 | 0.00 |
| 1978 | 0.02 | 1987 | 0.00 |
| 1979 | 0.09 | 1988 | 0.30 |
| 1980 | 0.00 | 1989 | 0.58 |
| 1981 | 0.00 |  |  |

Table 3,6 Average weight ( $g$ ) in stock (1 January), Norwegian spring spawners, 19761989

| Age | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
| 3 | 181 | 181 | 180 | 178 | 175 | 170 | 170 | 155 | 140 | 148 | 146 | 90 | 88 | 154 |
| 4 | 259 | 259 | 294 | 232 | 283 | 224 | 204 | 249 | 204 | 234 | 206 | 143 | 135 | 175 |
| 5 | 342 | 342 | 326 | 359 | 347 | 336 | 303 | 304 | 295 | 265 | 265 | 241 | 297 | 209 |
| 6 | 384 | 384 | 371 | 385 | 402 | 378 | 355 | 368 | 338 | 312 | 289 | 279 | 277 | 252 |
| 7 | 409 | 409 | 409 | 420 | 421 | 387 | 383 | 404 | 376 | 346 | 339 | 299 | 315 | 305 |
| 8 | 444 | 444 | 461 | 444 | 465 | 408 | 395 | 424 | 395 | 370 | 368 | 316 | 339 | 367 |
| 9 | 461 | 461 | 476 | 505 | 465 | 397 | 413 | 437 | 407 | 395 | 391 | 342 | 343 | 377 |
| 10 | 520 | 520 | 520 | 520 | 520 | 520 | 453 | 436 | 413 | 397 | 382 | 343 | 359 | 359 |
| 11 | 543 | 543 | 543 | 551 | 534 | 543 | 468 | 493 | 422 | 425 | 388 | 362 | 365 | 395 |
| 12 | 412 | 412 | 500 | 500 | 500 | 512 | 512 | 480 | 459 | 434 | 383 | 370 | 370 | 375 |
| 13 | 412 | 412 | 500 | 500 | 500 | 512 | 500 | 470 | 449 | 443 | 403 | 378 | 375 | 406 |
| 14 | 412 | 412 | 500 | 500 | 500 | 512 | 500 | 500 | 427 | 452 | 403 | 381 | 385 | 436 |
| 15 | 412 | 412 | 500 | 500 | 500 | 512 | 500 | 500 | 437 | 463 | 450 | 388 | 390 | 417 |
| 16 | 412 | 412 | 500 | 500 | 500 | 512 | 500 | 500 | 437 | 480 | 470 | 390 | 400 | 417 |

Table 3.7 Average weight ( $g$ ) in catch, Norwegian spring spawners, 1975-1988.

| Age | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 3 | 259 | 259 | 294 | 232 | 283 | 224 | 204 | 249 | 204 | 233 | 226 | 160 | 121 | 149 |
| 4 | 342 | 342 | 326 | 359 | 347 | 336 | 303 | 304 | 250 | 281 | 292 | 244 | 169 | 186 |
| 5 | 384 | 384 | 371 | 385 | 402 | 378 | 355 | 368 | 317 | 348 | 311 | 288 | 248 | 234 |
| 6 | 409 | 409 | 409 | 420 | 421 | 387 | 383 | 404 | 356 | 371 | 357 | 306 | 287 | 291 |
| 7 | 444 | 444 | 461 | 444 | 465 | 408 | 395 | 424 | 386 | 408 | 380 | 345 | 306 | 320 |
| 8 | 461 | 461 | 476 | 505 | 465 | 397 | 413 | 437 | 401 | 428 | 402 | 367 | 321 | 367 |
| 9 | 520 | 520 | 520 | 520 | 520 | 520 | 453 | 436 | 410 | 442 | 419 | 390 | 342 | 368 |
| 10 | 543 | 543 | 543 | 551 | 534 | 543 | 468 | 493 | 418 | 434 | 432 | 394 | 346 | 382 |
| 11 | 412 | 412 | 500 | 500 | 500 | 512 | 512 | 480 | 441 | 456 | 440 | 393 | 362 | 372 |
| 12 | 412 | 412 | 500 | 500 | 500 | 512 | 500 | 470 | 455 | 469 | 458 | 392 | 371 | 383 |
| 13 | 412 | 412 | 500 | 500 | 500 | 512 | 500 | 500 | 438 | 460 | 460 | 409 | 379 | 398 |
| 14 | 412 | 412 | 500 | 500 | 500 | 512 | 500 | 500 | 432 | 460 | 465 | 434 | 380 | 440 |
| 15 | 412 | 412 | 500 | 500 | 500 | 512 | 500 | 500 | 432 | 445 | 470 | 450 | 390 | 440 |
| 16 | 412 | 412 | 500 | 500 | 500 | 512 | 500 | 500 | 432 | 445 | 470 | 454 | 400 | 440 |

Table 3.8 VIRTUAL POPULATION ANALYSIS.

NORWEGIAN SPRING SPAWNING HERRING
PROPORTIONS OF MATURITY
UNIT:

|  |  |  |  |  |  |  |  |  |  |  |  |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
| 3 | .130 | .100 | .250 | .300 | .100 | .100 | .100 | .100 | .100 | .100 | .100 |
| 4 | .900 | .620 | .500 | .500 | .480 | .500 | .500 | .500 | .200 | .300 | .300 |
| 5 | 1.000 | .950 | .970 | .900 | .700 | .690 | .900 | .900 | .900 | .900 | .900 |
| 6 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | .710 | .950 | 1.000 | 1.000 | 1.000 | 1.000 |
| 7 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 8 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 9 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 10 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 11 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| $12+$ | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

Table 3.9 VIRTUAL POPULATION ANALYSIS.

NORWEGIAN SPRING SPAWNING HERRING
FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT $=.13$

|  | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | :--- |
| 3 | .023 | .014 | .021 | .010 | .020 | .028 | .055 | .187 | .058 | .093 | .141 |
| 4 | .028 | .016 | .040 | .017 | .022 | .037 | .055 | .252 | .212 | .065 | .144 |
| 5 | .038 | .019 | .023 | .025 | .020 | .031 | .133 | .221 | .364 | .336 | .095 |
| 6 | .042 | .025 | .026 | .026 | .022 | .032 | .070 | .412 | .307 | .129 | .235 |
| 7 | .000 | .019 | .041 | .017 | .027 | .027 | .078 | .312 | .630 | .206 | .235 |
| 8 | .046 | .000 | .029 | .026 | .022 | .021 | .075 | .514 | .751 | .311 | .235 |
| 9 | .037 | .000 | .000 | .027 | .022 | .023 | .145 | .442 | .872 | .230 | .235 |
| 10 | .023 | .022 | .000 | .002 | .011 | .031 | .098 | .198 | 1.455 | .446 | .235 |
| 11 | .030 | .027 | .027 | .013 | .001 | .015 | .032 | .252 | 1.080 | .250 | .235 |
| $12+$ | .030 | .027 | .027 | .013 | .001 | .015 | .032 | .252 | 1.080 | .250 | .235 |
| $(4-9) \cup$ | .032 | .013 | .027 | .023 | .022 | .028 | .093 | .359 | .523 | .213 | .196 |
| $(4-9) W$ | .033 | .020 | .034 | .022 | .022 | .031 | .098 | .384 | .574 | .073 | .099 |

## Table 3.10 VIRTUAL POPULATION ANALYSIS.

NORWEGIAN SPRING SPAWNING HERRING
STOCK SIZE IN NUMBERS UNIT: thousands
BIOMASS TOTALS UNIT: tonnes
all values are given for 1 January

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: |
|  | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 |
| 3 | 142160 | 499805 | 329147 | 449022 | 730435 | 124760 | 89068 | 13444510200248 | 237194 | 499379 | 0 |  |
| 4 | 463847 | 122004 | 432929 | 283024 | 390384 | 628457 | 106571 | 74014 | 97963 | 8451650 | 189779 | 380834 |
| 5 | 574364 | 395915 | 105384 | 365351 | 244224 | 335406 | 532009 | 88537 | 50517 | 69584 | 6952178 | 144295 |
| 6 | 22311 | 485332 | 341224 | 90404 | 312766 | 210233 | 285606 | 409103 | 62330 | 30834 | 43680 | 5554204 |
| 7 | 66576 | 18777 | 415667 | 291984 | 77324 | 268780 | 178818 | 233757 | 238036 | 40266 | 23800 | 30322 |
| 8 | 14564 | 58459 | 16182 | 350171 | 252165 | 66063 | 229627 | 145195 | 150198 | 111357 | 28763 | 16522 |
| 9 | 147953 | 12208 | 51332 | 13797 | 299733 | 216674 | 56799 | 187031 | 76277 | 62220 | 71650 | 19967 |
| 10 | 47 | 125211 | 10719 | 45067 | 11792 | 257533 | 185956 | 43130 | 105518 | 28013 | 43426 | 49739 |
| 11 | 36 | 40 | 107575 | 9411 | 39476 | 10241 | 219278 | 148004 | 31081 | 21636 | 15745 | 30146 |
| $12+$ | 180 | 200 | 200 | 79912 | 82154 | 74983 | 56055 | 251326 | 237022 | 104757 | 42192 | 40220 |

JOTAL NO 143203717179501810360197814524404542193128193978717145431124918891575127910592 SPS NO 12619741201969134387314857821506795160167317388601547681198554430209226633088 $\begin{array}{lllllllllllll}\text { SPS BIOM } & 426083 & 451495 & 623369 & 627467 & 707734 & 739762 & 663807 & 580973 & 1849755 & 1380015 & 1535009\end{array}$ $\begin{array}{llllllllllllllllll}\text { SPS BIOM } & 426083 & 453564 & 517812 & 530059 & 532365 & 590070 & 621194 & 552059 & 491959 & 513114 & 1336072\end{array}$

## Table 3.11

## List of input variables for the ICES prediction program.

NORWEGIAN SPRING-SPAWNING HERRING
The reference $F$ is the mean $F$ for the age group range from 4 to 9
The number of recruits per year is as follows:

| Year | Recruitment |
| ---: | ---: |
| 1989 | 5314000.0 |
| 1990 | 7000000.0 |
| 1991 | 7000000.0 |

Data are printed in the following units:
Number of fish: thousands
Weight by age group in the catch: kilogram Weight by age group in the stock: kilogram Stock biomass: tonnes Catch weight: tonnes

| age ${ }^{\text {' }}$ | stock size! | fishing pattern: | natural mortality! | maturity ogive: | weight in! <br> the catch! | weight in! the stock! |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | 5314000.01 | . 051 | . 901 | . 00 | .009! | .006 |
| 21 | 90000.01 | . 081 | . 901 | . 001 | .111 | . 100 |
| 31 | 60000.01 | . 14 | .131 | . 10 | .154 | . 154 |
| $4!$ | 380834.01 | .14! | .131 | . 301 | . 195 | . 175 |
| 5 | 144295.01 | . 19 | . 131 | . 901 | . 234i | . 2091 |
| 61 | 5554204.01 | .24! | . 131 | 1.00 | . $262!$ | . 2521 |
| 71 | 30322.0 ! | . 24 | .131 | 1.001 | . 291 | . 305 |
| 8 | 16522.0 | .24i | .131 | 1.001 | . 2931 | . 325 |
| 91 | 19967.01 | . 24 | .13! | 1.00 | . 341 ! | . 3401 |
| 10 | 49739.0 | . 24 | .131 | 1.00 | . 351 | . 3591 |
| 11 | 30146.0 | . 24 | .131 | 1.00 | . 394 | . 395 |
| 12+ | 40220.01 | . 24 | .131 | 1.001 | . 361 | . 375 |

Table 3.12

Effects of different levels of fishing mortality on catch, stock biomass and spawning stock biomass.

NORWEGIAN SPRING-SPAWNING HERRING


The data unit of the biomass and the catch is 1000 tonnes.
The spawning stock biomass is given for 1 January.
The reference $F$ is the mean $F$ for the age group range from 4 to 9

Table 3.13 Norwegian Spring-spawning HERRING.

| * Year | 1989. F-fa | actor | 292 and ref | ference $F$ | . 0519 |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| * Run depending on a TAC value |  |  |  |  |  |  |  |
|  |  |  |  |  | ' | at | 1 January |
| ' age! | absolute: Fi | catch in! numbers: | catch in! weight | stock! <br> size! | stock <br> biomass: | $\begin{array}{r} \text { sp.stock } \\ \text { size } \end{array}$ | sp.stock biomass |
| 11 | .0146 | 50785; | 457 | 5314000 | 31884 ! | 01 | 01 |
| 21 | . 0230 | 1354 | 150 | 90000 | 90001 | 01 | 0 |
| 31 | . 04111 | 2268! | 349 | 60000 | 9240 | 60001 | 924 |
| 4 | . 04201 | 14695 | 2865 | 380834 | 66645 | 114250 | 19993! |
| 5 | .0554 | 72991 | 1708 | 144295 | 301571 | 129865 | 27141' |
| 6 | . 0685 | 345306 | 90470 | 5554204 | 1399659 | 5554204 | 1399659 |
| 7 | . 0685 | 1885; | 548 | 30322 ! | 9248 | 30322 | 9248: |
| 81 | . 0585 | 1027! | 3001 | 16522 ! | 53691 | 16522! | 53691 |
| 91 | . 0685 | 12411 | 423 | 19967 | 6788 | 19967! | 6788! |
| 101 | . 0685 | 3092 ! | 1085 | 49739 | 17856 | 49739 | 17856 |
| 111 | . 0685 | 1874 | 738 | 30146 | 11907 | 30146: | 11907 |
| , 12+ | . 0685 | 2500! | 902 | 40220 | 15082! | 40220 | 15082 |
| ( Total | I | 4333301 | 100000 | 11730250! | 1612840 | 5991236 | 1513972! |

```
* Year 1990, F-factor . 300 and reference F . 0637*
```

************************************************************)


## Table 3.13 (cont'd)

* Year 1991. F-factor .300 and refererice $F$


|  |  |  |  |  |  | at | January! |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | absolute Fi | catch in: numbers: | catch in: weight | stock! <br> size! | stock biomass: | $\begin{array}{r} \text { sp.stock! } \\ \text { size } \end{array}$ | sp.stock <br> biomass: |
| 11 | . 0150 | 68793! | 619.1! | 70000001 | 420001 | ! | 01 |
| 21 | . 02371 | 43372 | 4814.4 | 2803616 | 280361 | 01 | 01 |
| 31 | .04231 | 328491 | 5058.8 | 845405 | 130192 ; | 84540 | 13019 |
| 41 | . 0432 | 1193! | 232.81 | 30098 | 5267! | 9029 | 1580: |
| 51 | . 0570 | 2210 | 517.31 | 42521 | 8887 | 38269 | 7998 |
| 61 | . 0705 | 16990 | 4451.5 | 265964 | 67022! | 265964 | 67022: |
| $7!$ | . 0705 | 6266 | 1823.6 | 98095 | 29919 | 98095 | 299191 |
| 81 | . 0705 | 238065 | 69753.2 ? | 3726646 | 1211160 | 3726646 | 1211160 |
| 91 | . 0705 | 1299 | 443.2 | 20344 | 6917 | 20344 | 6917! |
| 10 | . 0705 | 708 | 248.61 | 11085 | 3979 | 11085: | 39791 |
| - 11! | . 0705 | 8551 | 337.21 | 13397! | 52911 | 13397 | 5291 |
| $12+$ | .0705 | 5147 | 1858.4 | 80585 | 30219! | 80585 | 30219 |
| 1 Total | ' | 417754 | 90158.01 | 14937762 | 1821218 | 4347959 | 1377108 |

Table 4.1 International catch of Barents Sea Capelin ('000 tonnes) in the years 1965-1989.

| Year | Norway | USSR | Other | Total |
| :--- | ---: | ---: | ---: | ---: |
| 1965 | 217 | 7 | - | 224 |
| 1966 | 380 | 9 | - | 389 |
| 1967 | 403 | 6 | - | 409 |
| 1968 | 522 | 15 | - | 537 |
| 1969 | 679 | 1 | - | 680 |
| 1970 | 1,301 | 13 | - | 1,314 |
| 1971 | 1,371 | 21 | - | 1,392 |
| 1972 | 1,556 | 37 | - | 1,593 |
| 1973 | 1,291 | 45 | - | 1,336 |
| 1974 | 987 | 162 | - | 1,149 |
| 1975 | 943 | 431 | 43 | 1,417 |
| 1976 | 1,949 | 596 | - | 2,545 |
| 1977 | 2,116 | 822 | 2 | 2,940 |
| 1978 | 1,122 | 747 | 25 | 1,894 |
| 1979 | 1,109 | 669 | 5 | 1,783 |
| 1980 | 999 | 641 | 9 | 1,649 |
| 1981 | 1,238 | 721 | 28 | 1,987 |
| 1982 | 1,158 | 596 | 5 | 1,759 |
| 1983 | 1,493 | 846 | 36 | 2,375 |
| 1984 | 811 | 628 | 42 | 1,481 |
| 1985 | 453 | 398 | 17 | 868 |
| 1986 | 72 | 51 | - | 123 |
| 1987 | - | - | - | - |
| 1988 | - | - | - | - |
| 1989 | - | - | - | - |

## Table 4.2 Larval index for Barents Sea Capelin.

| Year | Index |
| :---: | :---: |
| 1981 | 9.7 |
| 1982 | 9.9 |
| 1983 | 9.9 |
| 1984 | 8.2 |
| 1985 | 8.6 |
| 1986 | - |
| 1987 | 0.3 |
| 1988 | 0.3 |
| 1989 | 7.3 |

Table 4.3 Acoustic estimate, autumn 1989, for Barents Sea Capelin.

| Total length | Age |  |  |  | Total <br> number (10E-7) | Biomass tonnes (10E-3) | Biomass <br> (cum.) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | 1 | 2 | 3 | $4+$ |  |  |  |
| 8.0-8.4 | 1704 |  |  |  | 1704 | 36.7 |  |
| 8.5-8.9 | 2739 |  |  |  | 2739 | 68.4 |  |
| 9.0-9.4 | 3982 |  |  |  | 3982 | 111.5 |  |
| 9.5-9.9 | 3350 |  |  |  | 3350 | 107.7 |  |
| 10.0-10.4 | 2501 | 29 |  |  | 2529 | 96.8 |  |
| 10.5-10.9 | 1627 | 19 |  |  | 1646 | 70.1 |  |
| 11.0-11.4 | 747 | 145 |  |  | 892 | 46.5 |  |
| 11.5-11.9 | 512 | 18 |  |  | 530 | 32.5 |  |
| 12.0-12.4 | 322 | 91 |  |  | 413 | 28.4 |  |
| 12.5-12.9 | 172 | 102 |  |  | 274 | 23.1 |  |
| 13.0-13.4 | 94 | 255 |  |  | 349 | 33.5 |  |
| 13.5-13.9 | 14 | 303 |  |  | 317 | 35.8 |  |
| 14.0-14.4 | 10 | 302 |  |  | 311 | 39.3 | 181.3 |
| 14.5-14.9 | 5 | 205 | 7 |  | 216 | 30.8 | 142.0 |
| 15.0-15.4 | 2 | 166 | 15 |  | 184 | 30.2 | 111.2 |
| 15.5-15.9 |  | 87 | 14 |  | 101 | 18.4 | 81.0 |
| 16.0-16.4 |  | 40 | 28 |  | 69 | 15.1 | 62.6 |
| $16.5-16.9$ $17.0-17.4$ |  | 39 | 45 | 1 | 84 | 19.2 | 47.5 |
| $17.0-17.4$ $17.5-17.9$ |  | 32 |  |  | 41 | 11.6 | 28.3 |
| $17.5-17.9$ $18.0-18.4$ |  | 12 | 18 |  | 29 | 9.0 | 16.7 |
| $18.0-18.4$ $18.5-18.9$ |  | 5 3 | 9 |  | 14 | 4.8 | 7.7 |
| 18.5-18.9 |  | 3 | 4 |  | 8 | 2.9 | 2.9 |
| Number (10E-7) | 17779 | 1851 | 148 | 1 | 19780 |  |  |
| Biomass (t.*10E-3) | 608.3 | 229.8 | 33.8 | 0.3 | 872.2 |  |  |
| Mean length (cm) | 9.7 | 13.9 | 16.6 | 16.8 | 10.2 |  |  |
| Mean volume (ml) | 3.4 | 12.4 | 22.8 | 21.0 | 4.4 |  |  |

Table 5.1 The total annual and seasonal catch of CAPELIN in the Iceland-East Greenland-Jan Mayen area since 1964 (in 'OOO t).

| Year | Winter season |  | Summer and autumn seasons |  |  |  | Total |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Iceland | Far/Nor | Iceland | Norway | Faroes | EEC |  |
| 1964 | $8 . .6$ | - | - | - | - | - | 8.6 |
| 1965 | 49.7 | - | - | - | - | - | 49.7 |
| 1966 | 124.5 | - | - | - | - | - | 124.5 |
| 1967 | 97.2 | - | - | - | - | - | 97.2 |
| 1968 | 78.1 | - | - | - | - | - | 78.1 |
| 1969 | 170.6 | - | - | - | - | - | 170.6 |
| 1970 | 190.8 | - | - | - | - | - | 190.8 |
| 1971 | 182.9 | - | - | - | - | - | 182.9 |
| 1972 | 276.5 | - | - | - | - | - | 276.5 |
| 1973 | 440.9 | - | - | - | - | - | 440.9 |
| 1974 | 461.9 | - | - | - | - | - | 461.9 |
| 1975 | 457.1 | - | 3.1 | - | - | - | 460.2 |
| 1976 | 338.7 | - | 1.14 .4 | - | - | - | 453.1 |
| 1977 | 549.2 | 24.3 | 259.7 | - | - | - | 833.2 |
| 1978 | 468.4 | 36.2 | 497.5 | 154.1 | 3.4 | - | 1,159.6 |
| 1979 | 521.7 | 18.2 | 442.0 | 124.0 | 22.0 | 17. | 1,127.9 |
| 1980 | 392.0 | - | 367.4 | 11.8 .7 | 24.2 | 17.3 | 916.6 |
| 1981 | 156.0 | - | 484.6 | 91.4 | 16.2 | 20.8 | 769.0 |
| 1982 | 13.2 | - | - | - | - | - | 13.2 |
| 1983 | - | - | 133.4 | - | - | - | 133.4 |
| 1984 | 439.6 | - | 425.2 | 104.6 | 10.2 | 8.5 | 988.1 |
| 1985 | 348.5 | - | 644.8 | 193.0 | 65.9 | 16.0 | 1,268.3 |
| 1986 | 342.0 | 50.0 | 552.5 | 149.7 | 65.4 | 5.3 | 1,164.7 |
| 1987 | 500.6 | 59.9 | 311.3 | 82.1 | 65.2 | - | 1,019.1 |
| 1988 | 600.6 | 53.2 | 311.4 | 15.5 | 48.8 | - | 1,029.5 |
| 1989 | 609.1 | 52.0 | - | - | - | - | - |

${ }^{1}$ Preliminary.

Table 5.2 Abundance by number ( $x 10^{-9}$ ) of capelin year classes as indicated by two different methods of estimation.

| Year <br> class | Estimates in August <br> as <br> 1 -group | Calculated from estimates <br> of 3 - and |
| :--- | :---: | :---: |
| 1981 | 119 | 145 |
| 1982 | 155 | 147 |
| 1983 | 286 | 252 |
| 1984 | 31 | 100 |
| 1985 | 71 | 142 |
| 1986 | 101 | $111^{1}$ |
| 1987 | 147 | - |
| 1988 | 111 | - |
| The 1986 year class is not fully recruited to the surveys |  |  |
| of the adult stock and consequently somewhat underestimated. |  |  |

Table 5.3 The percentage of 4-group Capelin in the spawning stock in the years 1981-1987. (The high contribution in 1987 is due to the very rich 1983 year class and was omitted when calculating the mean.)

| Year | Percentage |
| :--- | :---: |
|  |  |
| 1981 | 22 |
| 1982 | 7 |
| 1983 | 12 |
| 1984 | 16 |
| 1985 | 34 |
| 1986 | 25 |
| 1987 | 63 |
| 1988 | 21 |
| 1989 | 32 |
|  |  |
| Mean | 21 |

Table 5.4 Mean weight (g) of mature 2-3- and 3-4-years-old capelin in autumn and winter in the seasons 1980/1981-1988/1989.

| Age | Season | Year <br> class | Mean weight <br> autumn | Mean weight <br> winter | Year <br> class | Mean weight <br> autumn | Mean weight <br> winter |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| 1 | $1980 / 1981$ | 1977 | 26.6 | 27.7 | 1978 | 19.3 | 20.7 |
| 2 | $1981 / 1982$ | 1978 | 23.8 | 25.7 | 1979 | 19.2 | 19.9 |
| 3 | $1982 / 1983$ | 1979 | 24.1 | 25.1 | 1980 | 16.5 | 18.7 |
| 4 | $1983 / 1984$ | 1980 | 23.0 | 25.8 | 1981 | 15.9 | 19.3 |
| 5 | $1984 / 1985$ | 1981 | 25.7 | 27.1 | 1982 | 15.8 | 19.1 |
| 6 | $1985 / 1986$ | 1982 | 24.9 | 27.6 | 1983 | 18.1 | 20.3 |
| 7 | $1986 / 1987$ | 1983 | 24.1 | 25.4 | 1984 | 18.1 | 19.6 |
| 8 | $1987 / 1988$ | 1984 | 25.4 | 28.1 | 1985 | 17.9 | 19.5 |
| 9 | $1988 / 1989$ | 1985 | 23.4 | 23.9 | 1986 | 15.6 | 17.8 |
| Mean |  |  | 24.6 | 26.3 |  |  |  |

Table 5.5 Natural mortality rates of the Icelandic capelin as calculated from successive acoustic estimates of spawning stock abundance and catch.


FISH STOCK SUMMARY
STOCK: Herring - Va (Summer)

$$
24-10-1989
$$

Trends in yield and fishing mortality (F)



FISH STOCK SUMMARY

$$
24-10-1989
$$

## Long-term yield and spawning stock biomass



C

Short-term yield and spawning stock biomass


D

Figure 3.1
FISH STOCK SUMMARY STOCK: Norwegian Spring Spawning Herring

$$
24-10-1989
$$



FISH STOCK SUMMARY

$$
24-10-1989
$$

Long-term yield and spawning stock biomass


C

Short-term yield and spawning stock biomass


D

Figure 3.2
Norwegian spring-spawning herring. Catch in 1989: 100.000 t .




Figure 4.1 0-group distribution Barents Sea Capelin, August 1989.


Figure 4.2 Estimated total density distribution of Barents Sea Capelin, September 1989 (tonnes per square nautical mile).


Figure 5.1 The relation between two different estimates of the abundance of the 1981-1985 year classes of capelin. $R^{2}=0.92, \mathrm{a}=83.89, \mathrm{~b}=0.55$. Numbers are in $10^{9}$.


[^0]:    *General Secretary
    ICES
    Palægade 2-4
    DK-1261 Copenhagen K
    DENMARK

[^1]:    ${ }^{1}$ Estimated.

[^2]:    ${ }^{1}$ Estimated.

